ENERGY FUELS

Energy Fuels Resources (USA) Inc.
225 Union Blvd. Suite 600
Lakewood, CO, US, 80228
303 974 2140
www.energyfuels.com

February 8, 2018

Sent VIA OVERNIGHT DELIVERY

Mr. Scott Anderson
Director
Division of Waste Management and Radiation Control
Utah Department of Environmental Quality
195 North 1950 West
P.O. Box 144880
Salt Lake City, UT 84114-4820

Re: Transmittal White Mesa Uranium Mill Reclamation Plan, Revision 5.1B

Dear Mr. Anderson:

Attached please find two hard copies and the associated electronic copies of the Energy Fuels Resources (USA) Inc. ("EFRI") White Mesa Mill (the "Mill") Reclamation Plan, Revision 5.1B. Hard copies of the redline and clean versions of the modified sections are included for your convenience. Electronic copies of the redline versions of the modified sections and the clean version of the entire Reclamation Plan are provided.

EFRI prepared this Revision 5.1B to address select public comments on the Mill's Groundwater Discharge Permit and Radioactive Materials License. EFRI responses to public comments were documented in the EFRI letter dated October 23, 2017 and an updated Section 6 of the Main Text to Revision 5.1 of the Plan was provided as an attachment to the October 23, 2017 letter. Reclamation Plan 5.1B, Attachment A (Technical Specifications) and the remaining Main Text sections have also been updated with minor revisions to address public comments and for consistency. The remaining attachments and appendices do not require revisions and therefore the designation of Revision 5.1 or reference to Revision 5.1 remain to indicate changes have not been made to these components of the Plan.

If you should have any questions regarding this transmittal please contact me at 303-389-4134.

Yours very truly,

ENERGY FUELS RESOURCES (USA) INC.
Kathy Weinel
Quality Assurance Manager

CC: David C. Frydenlund
David Turk
Logan Shumway
Scott Bakken
Paul Goranson

Energy Fuels Resources (USA) Inc.
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February 8, 2018

Sent VIA OVERNIGHT DELIVERY

Mr. Scott Anderson
Director
Division of Waste Management and Radiation Control
Utah Department of Environmental Quality
195 North 1950 West
P.O. Box 144880
Salt Lake City, UT 84114-4820

Re: Transmittal White Mesa Uranium Mill Reclamation Plan, Revision 5.1B

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Attached please find two hard copies and the associated electronic copies of the Energy Fuels Resources (USA) Inc. ("EFRI") White Mesa Mill (the "Mill") Reclamation Plan, Revision 5.1B. Hard copies of the redline and clean versions of the modified sections are included for your convenience. Electronic copies of the redline versions of the modified sections and the clean version of the entire Reclamation Plan are provided.

EFRI prepared this Revision 5.1B to address select public comments on the Mill's Groundwater Discharge Permit and Radioactive Materials License. EFRI responses to public comments were documented in the EFRI letter dated October 23, 2017 and an updated Section 6 of the Main Text to Revision 5.1 of the Plan was provided as an attachment to the October 23, 2017 letter. Reclamation Plan 5.1B, Attachment A (Technical Specifications) and the remaining Main Text sections have also been updated with minor revisions to address public comments and for consistency. The remaining attachments and appendices do not require revisions and therefore the designation of Revision 5.1 or reference to Revision 5.1 remain to indicate changes have not been made to these components of the Plan.

If you should have any questions regarding this transmittal please contact me at 303-389-4134.

Yours very truly,

ENERGY FUELS RESOURCES (USA) INC.
Kathy Weinel
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CC: David C. Frydenlund
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Energy Fuels Resources (USA) Inc.
225 Union Blvd. Suite 600
Lakewood, CO, US, 80228
303 974 2140
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December 5, 2016

SENT VIA E-MAIL AND EXPRESS DELIVERY

Mr. Scott Anderson
Director of Waste Management and Radiation Control
Utah Department of Environmental Quality
195 North 1950 West
P.O. Box 144880
Salt Lake City, UT 84114-4880

Re: Transmittal White Mesa Uranium Mill Reclamation Plan, Revision 5.1

Dear Mr. Anderson:

Pursuant to discussions with the Division for Waste Management and Radiation Control ("DWMRC") regarding the draft Stipulation and Consent Agreement ("SCA", dated July 1, 2016) for the Cell 2 cover placement activities, Energy Fuels Resources (USA) Inc. ("EFRI") provided the DWMRC with the White Mesa Uranium Mill Reclamation Plan, Revision 5.1 ("Reclamation Plan") on August 10, 2016. DWMRC provided written review comments to EFRI on both documents, including draft redlines on the SCA on September 28, 2016. EFRI revised the SCA and select sections of the Reclamation Plan to address DWMRC's review comments and also incorporate comments resulting from discussions with the DWMRC during a meeting on October 5, 2016 and during follow up conference calls. Select sections of the Reclamation Plan and SCA were submitted on November 11, 2016 to incorporate the above referenced comments. DWMRC provided verbal comments to the November 11, 2016 revisions in a conference call on November 16, 2016. The attached redlines address the verbal comments provided by DWMRC in the November 16, 2016 conference call. This letter transmits the revised documents and includes:

- Two CDs each containing:
  - An electronic file of the revised draft SCA (with redlines since last draft provided to DWMRC)
  - a word searchable electronic copy of the White Mesa Uranium Mill Reclamation Plan, Revision 5.1 dated December 2016 (includes revised sections of the Reclamation Plan since the August 2016 version)
  - electronic file copies of redlined report sections changed since the November 11, 2016 submittal of the Reclamation Plan
- Two sets of hard copies of the revised draft SCA
- Two sets of hard copies of replacement sections to the August 2016 version of the Reclamation Plan. Hard copies include:
  - Binder covers

- o Reclamation Plan main text
- o Drawings
- o Updated Cover Design Report main text (Appendix A to Reclamation Plan)
- o Appendix G to Updated Cover Design Report (main text only)
- o Appendix L to Updated Cover Design Report (main text only)

If you should have any questions regarding this transmittal please contact me at 303-389-4160 or Kathy Weinel at 303-389-4134.

ENERGY FUELS RESOURCES (USA) INC.
Harold R. Roberts
Executive Vice President Conventional Operations

cc: David C. Frydenlund
Kathy Weinel
Logan Shumway
Scott Bakken

Energy Fuels Resources (USA) Inc.
225 Union Blvd. Suite 600
Lakewood, CO, US, 80228
303 974 2140
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August 10, 2016

Sent VIA OVERNIGHT DELIVERY

Mr. Scott Anderson
Director
Division of Waste Management and Radiation Control
Utah Department of Environmental Quality
195 North 1950 West
P.O. Box 144880
Salt Lake City, UT 84114-4820

Re: Transmittal White Mesa Uranium Mill Reclamation Plan, Revision 5.1

Dear Mr. Anderson:

Pursuant to discussions with the Division of Waste Management and Radiation Control ("DWMRC") regarding the Stipulated Consent Agreement for the Cell 2 cover activities, enclosed are two copies of the White Mesa Uranium Mill Reclamation Plan, Revision 5.1. Also enclosed are two CDs each containing a word searchable electronic copy of the document.

If you should have any questions regarding this transmittal please contact me at 303-389-4160 or Kathy Weinel at 303-389-4134.

Yours very truly,

ENERGY FUELS RESOURCES (USA) INC.
Harold R. Roberts
Executive Vice President Conventional Operations

CC: David C. Frydenlund
Kathy Weinel
David Turk
Logan Shumway
Scott Bakken

Reclamation Plan

White Mesa Mill

Blanding, Utah

Radioactive Materials License No. UT1900479

Revision 5.1B

February 2018

Prepared by:
Energy Fuels Resources (USA) Inc.
225 Union Blvd., Suite 600
Lakewood, CO 80228

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INTRODUCTION

This Reclamation Plan (the "Plan") has been prepared by Energy Fuels Resources (USA) Inc. ("EFRI")[1] for EFRI's White Mesa Uranium Mill (the "Mill"), located approximately six miles south of Blanding, Utah. This Plan presents EFRI's plans and estimated costs for the reclamation of cells for the tailings management system, and for decommissioning of the Mill and Mill site.[2] This Plan is an update to the White Mesa Mill Reclamation Plan Revision 3.2b (Denison, 2011b) approved by the Utah Department of Environmental Quality (UDEQ) Division of Radiation Control (DRC) on January 26, 2011.

Summary of Plan

The uranium and vanadium processing areas of the Mill, including equipment, structures and support facilities, will be decommissioned and disposed of in tailings or buried at the Mill site as appropriate. Equipment (including tankage and piping, agitation, process control instrumentation and switchgears, and contaminated structures) will be cut up, removed, and buried in tailings prior to final cover placement. Concrete structures and foundations will be demolished and removed for disposal in tailings or covered in place with soil as appropriate.

The sequence of demolition will proceed so as to allow the maximum use of support areas of the facility, such as the office and shop areas. Uncontaminated or decontaminated equipment to be considered for salvage will be released in accordance with United States Nuclear Regulatory Commission ("NRC") guidance and in compliance with the conditions of the EFRI's State of Utah Radioactive Materials License No. UT1900479 (the "License"). As with the equipment for disposal, contaminated soils from the Mill and surrounding areas and ore or feed materials on the Mill site will be disposed of in the tailings cells in accordance with Attachment A, Technical Specifications. An evapotranspiration cover system is proposed for reclamation of the tailings management system cells.

The estimated reclamation costs for surety are set out in Attachment C. Attachment C will be reviewed and updated in accordance with License requirements. The reclamation costs are based on the approved Reclamation Plan (Denison, 2011b) and incorporate reclamation work completed to date. The reclamation costs will be updated when this Plan is approved and the Cell 2 cover performance test sections (see Sections 3.0, 5.0, and 6.0) are verified based on requirements outlined in a Stipulation and Consent Agreement (SCA) being developed between EFRI and UDEQ Division of Waste Management and Radiation Control (DWMRC) (see Sections 5.0 and 6.0).

Plan Organization

General site characteristics pertinent to this Plan are contained in Section 1.0. Descriptions of the facility construction, operations and monitoring are given in Section 2.0. The reclamation plan itself, including descriptions of facilities to be reclaimed and design criteria, is presented in Section 3.0. Section 4.0 provides an overview of the preliminary mill decommissioning plan. Section 5.0 presents how reclamation would proceed if the "Proposed Cover Design" in Appendix A is not approved. Milestones and schedule commitments for reclamation are outlined in Section 6.0. Design drawings ("Drawings") are attached to this plan following the main text. Attachments A through D comprise the Technical Specifications,

[1] Prior July 25, 2012 EFRI was "Denison Mines (USA) Corp." and prior to December 16, 2006, Denison was named "International Uranium (USA) Corporation."
[2] Cell 1 was previously referred to as Cell 1-I. It is now referred to as Cell 1.

Construction Quality Assurance/Quality Control (QA/QC) Plan, Reclamation Cost Estimate, and Radiation Protection Manual for Reclamation Activities. Attachment E provides documents on the approved "Existing Cover Design" including the Titan Environmental 1996 Tailings Cover Design Report (Attachment E.1) and Technical Specifications (Attachment E.2). Both documents were included in the approved Reclamation Plan Revision 3.2b (Denison, 2011b).

Supporting documents include:

- *Updated Tailings Cover Design Report,* December 2016. MWH, Inc. (Appendix A)
- *Preliminary Mill Decommissioning Plan,* August 2016. MWH, Inc. (Appendix B)

As required by Part I.H.11 of previous revisions of the Mill's State of Utah Ground Water Discharge Permit No. UGW370004 (the "GWDP"), and Part I.H.2 of the current revision of the GWDP, EFRI completed an infiltration and contaminant transport model of the final tailings cover system to demonstrate the long-term ability of the cover to protect nearby groundwater quality (MWH, 2010). The model was updated to address DWMRC comments on the ICTM Report (DRC, 2012; 2013) and to incorporate additional geotechnical and hydrologic data collected as part of field investigations conducted in 2010 and 2012 for cover borrow material and in 2013 for in situ tailings. The updated infiltration modeling results were presented in EFRI (2012b) and EFRI (2015c). The updated cover design is included in the Updated Tailings Cover Design Report, included as Appendix A to this Reclamation Plan, and includes a monolithic evapotranspiration (ET) cover for the tailings cells. The revised cover design and basis was used for this version of the Plan.

The Reclamation Plan is written assuming Cells 2, 3, 4A, and 4B of the tailings management system will receive tailings to the maximum permitted tailings elevations. Cell 2 is full and partially reclaimed. Cell 3 was used for tailings storage, but currently only receives mill waste and byproduct material in accordance with License provisions. Cell 3 is partially full, and partially reclaimed. Cell 4A is the only cell currently receiving tailings and is partially full. Cell 4B is used for evaporation of process solutions and has not been used for tailings disposal. The Plan has been written assuming Cell 4B will be used in the future for permanent tailings disposal. If Cell 4B is not used in the future for tailings disposal, Cell 4B can be reclaimed for clean closure. This design is not presented in this report.

A Cell 1 Disposal Area is included in the reclamation design to provide additional storage for permanent disposal of contaminated materials and debris from the Mill site decommissioning and windblown cleanup. The current design is approved per the existing License, however this additional storage area is not currently needed for reclamation. If the Cell 1 Disposal Area is required for storage at the time of final Mill decommissioning, the liner system design will be updated to be the same basic design as the liner system for Cell 4B, including the same basic leak detection system. The revised design would be submitted to the Director prior to construction. After approval of the design by the Director, the Plan and surety would be updated to reflect the approved design.

Revisions to this Reclamation Plan include information related to the updated tailings cover design, as well as results of data collection and monitoring since Revision 5.0 of this Plan (Denison, 2011c). Revisions to the attachments and appendices of the Reclamation Plan are listed in a tabular format in Table I-1.

Table I-1
Revisions to Attachments and Appendices in Reclamation Plan

Attachments/ Appendices	Reclamation Plan Revision 5.0 (2011)	Reclamation Plan Revision 5.1B (2018)*
Drawings	Included in Attachment A	**Updated and provided as a standalone attachment**
Attachment A	Plans and Technical Specifications for Reclamation of White Mesa Mill Facility, Blanding, Utah	**Updated -** Technical Specifications for Reclamation of White Mesa Mill Facility, Blanding, Utah
Attachment B	Construction Quality Assurance/Quality Control Plan for Reclamation of White Mesa Mill Facility, Blanding, Utah	**Updated** - Construction Quality Assurance/Quality Control Plan for Reclamation of White Mesa Mill Facility, Blanding, Utah
Attachment C	Cost Estimates for Reclamation of White Mesa Facility in Blanding, Utah	**Updated** - Cost Estimates for Reclamation of White Mesa Facility in Blanding, Utah
Attachment D	Radiation Protection Manual for Reclamation	**Updated -** Radiation Protection Manual for Reclamation Activities
Attachment E	Not included	**Added** – Existing Cover Design Documents
Appendix A	*Semi-Annual Effluent Report* (January through June, 2011), for the Mill	**Deleted to reduce redundancy** (latest report was submitted to DWMRC)
Appendix B	*Hydrogeology of the Perched Groundwater Zone and Associated Seeps and Springs Near the White Mesa Uranium Mill Site, Blanding, Utah*, November 12, 2010, prepared by Hydro Geo Chem, Inc. (the "2010 HGC Report")	**Deleted to reduce redundancy** (latest report was submitted to DWMRC)
Appendix C	The Mill's *Stormwater Best Management Practices Plan*, Revision 1.3, June 12, 2008, *Emergency Response Plan*, Revision 2.1, August 18, 2009, and Spill Prevention, Control, and Countermeasures Plan, 2011.	**Deleted to reduce redundancy** (latest report was submitted to DWMRC)
Appendix D	*Updated Tailings Cover Design Report*, White Mesa Mill, September 2011. MWH Americas, Inc.	**Updated and now Appendix A -** *Updated Tailings Cover Design Report*, White Mesa Mill, December 2016. MWH, Inc.
Appendix E	*National Emission Standards for Hazardous Air Pollutants Radon Flux Measurement Program, White Mesa Mill Site*, 2010, Tellco Environmental	**Deleted to reduce redundancy** (latest report was submitted to DWMRC)
Appendix F	*Semi-Annual Monitoring Report January 1 - June 30, 2010, White Mesa Mill Meteorological Station*, August 19, 2011, McVehil-Monnett Associates, Inc.	**Deleted to reduce redundancy** (latest report was submitted to DWMRC).
Appendix G	*Preliminary Mill Decommissioning Plan*, White Mesa Mill, September 2011, MWH Americas, Inc.	**Updated and now Appendix B** - *Preliminary Mill Decommissioning Plan*, White Mesa Mill, August 2016, MWH, Inc.

*Main Text and Attachment A were updated from Revision 5.1 to 5.1B (see Section 1).

1 SITE CHARACTERISTICS

EFRI operates the Mill, which is located approximately six miles south of Blanding, Utah (see Figures 1-1 and 1-2). The Mill was initially licensed by the NRC in May 1980 under NRC Source Material License No. SUA-1358. Upon the State of Utah becoming an Agreement State for uranium mills in August 2004, the Mill's NRC license was replaced with the Mill's current State of Utah License and the Mill's GWDP.

The License was up for timely renewal on March 31, 2007 in accordance with Utah Administrative Code ("UAC") R313-22-36.[3] In accordance with R313-22-36, EFRI submitted an application to the Director ("Director") of Utah Department of Environmental Quality, Division of Waste Management and Radiation Control ("DWMRC")[4] on February 27, 2007 for renewal of the License under R313-22-37 (the "2007 License Renewal Application"). Similarly, the GWDP was up for timely renewal on March 8, 2010, in accordance with UAC R317-6-6.7. In 2009, 2012, and 2014, EFRI filed an application to the DWMRC for renewal of the GWDP for under R313-6-6.7.

The Mill is also subject to State of Utah Air Quality Approval Order DAQE-AN1205005-06 (the "Air Approval Order") which was re-issued on March 2, 2011 and is not up for renewal at this time.

Revision 3.0 of this Plan was submitted to and approved by NRC in 2000. A copy of Revision 3.0 of this Plan was also submitted to the DWMRC as part of the 2007 License Renewal Application. The most recently approved version of the Reclamation Plan is Revision 3.2b (Denison, 2011a). This version of the Reclamation Plan was approved by DRC under the Mill License on January 26, 2011. A copy of the White Mesa Mill Reclamation Plan, Revision 4.0 was previously submitted to the Director in November 2009 and is on file at the DRC. This version and previous versions of the Reclamation Plan presented design criteria for a multi-layered cover system. Revision 5.0 of this Plan was submitted to the DWMRC in September 2011. EFRI prepared Revision 5.0 of the Plan to incorporate changes since 2009 and to address interrogatories from the DWMRC (DRC, 2010 and 2011). EFRI prepared Revision 5.1 of the Plan to incorporate changes since 2011 and include updates provided in EFRI response to interrogatories and review comments from DWMRC on Reclamation Plan, Revision 5.0 (Denison, 2012; EFRI, 2012a; EFRI, 2015). EFRI prepared this Revision 5.1B to address select public comments on the White Mesa Mill Groundwater Discharge Permit and Radioactive Materials License. EFRI responses to public comments were documented in EFRI (2017) and an updated Section 6 to Revision 5.1 of the Plan was provided as an attachment. Attachment A (Technical Specifications) has also been updated for Revision 5.1B with a minor revision to address public comments. The remaining attachments and appendices do not require revisions and therefore the designation of Revision 5.1 or reference to Revision 5.1 remain to indicate changes have not been made to these components of the Plan.

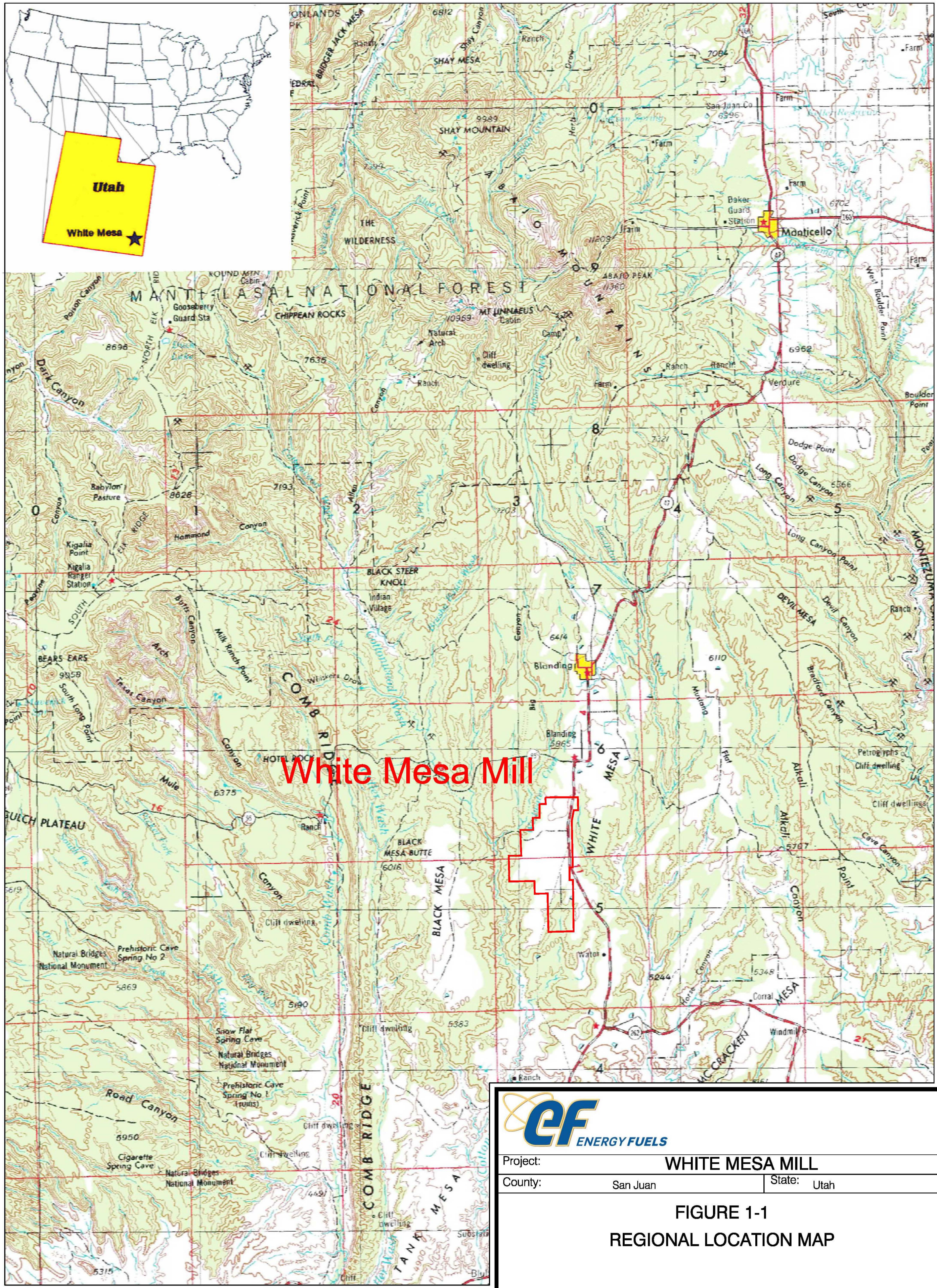
This Section 1.0 of the Plan incorporates by reference, updates or supplements, information previously submitted in previous environmental analyses performed at the Mill, as described below.

[3] The License was originally issued by the NRC as a source material license under 10 CFR Part 40 on March 31, 1980. It was renewed by NRC in 1987 and again in 1997. After the State of Utah became an Agreement State for uranium mills in August 2004, the License was re-issued by the DWMRC as a State of Utah Radioactive Materials License on February 16, 2005, but the remaining term of the License did not change.

[4] Prior to 2015, the DWMRC was two separate divisions of UDEQ, the Division of Radiation Control and the Division of Solid and Hazardous Waste.

A Final Environmental Statement Related to Operation of White Mesa Uranium Project, Energy Fuels Nuclear, Inc., May, 1979, Docket No. 40-8681 (the "FES") was prepared by NRC for the original License application in May 1979, which is incorporated by reference into, updated or supplemented by this Section 1.0. The basis for the FES was the *Environmental Report, White Mesa Uranium Project San Juan County, Utah*, dated January 1978, prepared by Dames & Moore (the "1978 ER"). In addition, the following environmental evaluations and other reports have been performed for the Mill and are incorporated by reference into, updated or supplemented by this Section 1.0:

- the Environmental Assessment ("EA") prepared for this Plan in February 2000 by NRC (the "2000 EA");
- the EA prepared in August 2002 by NRC (the "2002 EA") in connection with a License amendment issued by NRC authorizing receipt and processing at the Mill of certain alternate feed materials from the Maywood Formerly Utilized Sites Remedial Action Program site in Maywood, New Jersey;
- the *Statements of Basis* prepared in December 2004 by the State of Utah Department of Environmental Quality ("UDEQ") DWMRC in connection with the issuance of the GWDP revisions (the "GWDP Statement of Basis");
- the *Environmental Report in Support of the License Renewal Application, State of Utah Radioactive Materials License No. UT1900479*, prepared by Denison Mines (USA), Inc., February 28, 2007 (the "2007 ER");
- Background Groundwater Quality Reports, Source Assessment Reports (SARs), Pyrite Investigation Report and pH Report as discussed in Section 1.5.4.



Scale 1"=5 miles   A portion of USGS Map No NJ12-9 Cortez, CO-UT

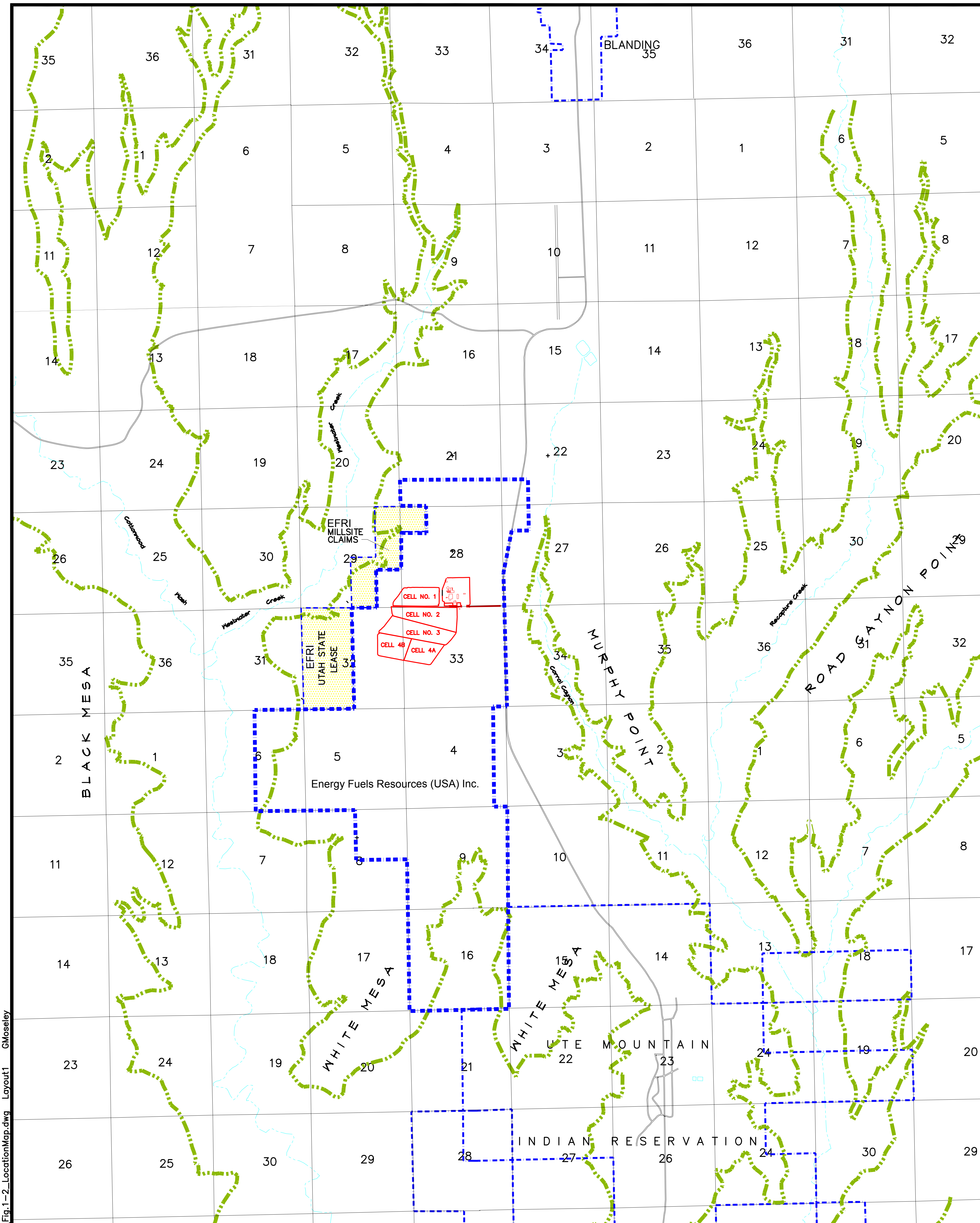
ENERGY FUELS

Project:	WHITE MESA MILL
County: San Juan	State: Utah

FIGURE 1-1
REGIONAL LOCATION MAP

Date: Nov 2009	Design:	Drafted By: D.Sledd

Y:\USA\Utah\Mill\dwgs\Reclamation Plan 4.0\Figure 1-1.dwg Figure 1 03/11/2009 dsledd



N

2,500' 0 2,500' 5,000'

SCALE: 1" = 5,000'

UT83-SF

ENERGY FUELS

REVISIONS		Project: White Mesa Mill	
Date	By	County: San Juan	State: UT
07-11	GM	Location:	
		LOCATION MAP FIGURE 1-2	
		Author:	Date: May 1999 / Drafted By: RAH

W:\USA\Utah\Mill\dwgs\Reclamation Plans\Rev_07-2011\Work01_Harold\Fig.1-2_LocationMap.dwg Layout1 GMoseley

1.1 Climate and Meteorology

1.1.1 Regional

The climate of southeastern Utah is classified as dry to arid continental. Although varying somewhat with elevation and terrain, the climate in the vicinity of the Mill is semi-arid with normal annual precipitation of about 13.32 inches (see Table 1.1-1). Most precipitation is in the form of rain with snowfall accounting for about 29 percent of the annual total precipitation. There are two separate rainfall seasons in the region, the first in late summer and early autumn (August to October) and the second during the winter months (December to March). The mean annual relative humidity is about 44 percent and is normally highest in January and lowest in July. The average annual Class A pan evaporation rate is 68 inches (NOAA, 1977), with the largest evaporation rate typically occurring in July. This evaporation rate is not appropriate for determining water balance requirements for the tailings management system and must be reduced by the Class A pan coefficient to determine the latter evaporation rate. Values of pan coefficients range from 60 to 81 percent. EFRI assumes for water balance calculations an average value of 70 percent to obtain an annual lake evaporation rate for the Mill area of 47.6 inches. Given the annual average precipitation rate of 13.32 inches, the net evaporation rate is 34.28 inches per year.

The weather in the Blanding area is typified by warm summers and cold winters. The National Weather Service Station in Blanding, Utah is located about 6.25 miles north of the Mill. Data from the station is considered representative of the local weather conditions (1978 ER, Section 2.7.2). The mean annual temperature in Blanding was 50.3°F, based on the Period of Record Summary (1904 - 2006). January is usually the coldest month and July is usually the warmest month (see Table 1.1-2).

Table 1.1-1
Period of Record General Climate Summary – Precipitation

Station:(420738) BLANDING														
From Year=1904 To Year=2006														
	Precipitation											Total Snowfall		
	Mean	High	Year	Low	Year	1 Day Max.		>= 0.01 in.	>= 0.10 in.	>= 0.50 in.	>= 1.00 in.	Mean	High	Year
	in.	in.	-	in.	-	in.	dd/yyyy or yyyymmdd	# Days	# Days	# Days	# Days	in.	in.	-
January	1.39	5.31	1993	0.00	1972	1.49	15/1978	6	4	1	0	10.8	46.9	1979
February	1.21	3.87	1913	0.00	1906	1.50	03/1908	6	3	1	0	7.3	39.7	1913
March	1.05	3.72	1906	0.00	1932	1.13	01/1970	6	3	1	0	4.4	17.9	1970
April	0.87	4.35	1926	0.00	1908	1.33	04/1987	5	2	0	0	1.9	15.2	1957
May	0.71	2.62	1926	0.00	1910	1.26	25/1994	4	2	0	0	0.2	4.0	1978
June	0.45	2.84	1948	0.00	1906	1.40	28/1938	3	1	0	0	0.0	0.0	1905
July	1.15	3.55	1914	0.00	1920	1.74	21/1985	6	3	1	0	0.0	2.5	1906
August	1.38	4.95	1968	0.03	1985	4.48	01/1968	7	4	1	0	0.0	0.0	1905
September	1.28	4.80	1927	0.00	1912	1.85	29/1905	5	3	1	0	0.0	3.5	1905
October	1.45	7.01	1916	0.00	1915	2.00	19/1908	5	3	1	0	0.3	6.0	1984
November	1.05	4.17	1905	0.00	1929	2.79	27/1919	4	3	1	0	3.3	19.0	1931
December	1.33	6.84	1909	0.00	1917	3.50	23/1909	5	3	1	0	9.8	55.0	1909
Annual	13.32	24.42	1909	4.93	1956	4.48	19680801	62	36	7	1	38.2	121.0	1909
Winter	3.93	11.95	1909	0.29	1964	3.50	19091223	17	10	2	0	27.9	100.2	1979
Spring	2.63	7.77	1926	0.10	1972	1.33	19870404	15	8	1	0	6.5	28.7	1970
Summer	2.98	6.90	1987	0.12	1960	4.48	19680801	16	8	2	0	0.0	2.5	1906
Fall	3.78	8.70	1972	0.50	1917	2.79	19191127	14	9	2	1	3.7	19.5	1908

Table updated on Jul 28, 2006
For monthly and annual means, thresholds, and sums:
Months with 5 or more missing days are not considered
Years with 1 or more missing months are not considered
Seasons are climatological not calendar seasons

Winter = Dec., Jan., and Feb. Spring = Mar., Apr., and May
Summer = Jun., Jul., and Aug. Fall = Sep., Oct., and Nov.

Table 1.1-2
Period of Record General Climate Summary - Temperature

Station:(420738) BLANDING																
From Year=1904 To Year=2006																
	Monthly Averages			Daily Extremes				Monthly Extremes				Max. Temp.		Min. Temp.		
	Max.	Min.	Mean	High	Date	Low	Date	Highest Mean	Year	Lowest Mean	Year	>= 90 F	<= 32 F	<= 32 F	<= 0 F	
	F	F	F	F	dd/yyyy or yyyymmdd	F	dd/yyyy or yyyymmdd	F	-	F	-	# Days	# Days	# Days	# Days	
January	39.1	17.2	28.2	63	31/2003	-20	12/1963	40.2	2003	12.6	1937	0.0	6.2	30.3	1.8	
February	44.9	22.3	33.6	71	28/1906	-23	08/1933	44.2	1995	18.8	1933	0.0	2.0	26.1	0.7	
March	52.7	27.8	40.3	86	31/1906	-3	28/1975	51.0	2004	33.0	1948	0.0	0.3	23.4	0.0	
April	62.2	34.3	48.2	88	19/1905	10	24/1913	56.9	1992	39.4	1928	0.0	0.0	12.4	0.0	
May	72.3	42.1	57.2	98	31/2002	15	16/1910	65.0	2000	50.1	1917	0.4	0.0	2.7	0.0	
June	83.3	50.7	67.0	110	22/1905	28	03/1908	75.3	2002	61.2	1907	6.3	0.0	0.2	0.0	
July	88.7	57.9	73.3	109	19/1905	36	15/1934	81.1	2003	66.3	1916	15.1	0.0	0.0	0.0	
August	86.2	56.2	71.2	106	18/1905	38	23/1968	77.2	1926	65.6	1968	9.0	0.0	0.0	0.0	
September	78.2	48.3	63.3	100	01/1905	20	26/1908	70.2	2001	56.6	1922	1.3	0.0	0.3	0.0	
October	66.0	38.0	52.0	99	08/1905	10	30/1971	59.6	2003	44.6	1969	0.1	0.0	6.6	0.0	
November	51.4	26.7	39.1	74	04/1905	-7	25/1931	47.3	1999	32.4	1952	0.0	0.4	23.6	0.1	
December	41.2	19.2	30.2	65	03/1929	-13	23/1990	39.4	1980	19.4	1931	0.0	4.5	30.0	0.9	
Annual	63.8	36.7	50.3	110	19050622	-23	19330208	55.1	2003	47.2	1932	32.2	13.5	155.6	3.4	
Winter	41.7	19.5	30.7	71	19060228	-23	19330208	37.5	1907	19.3	1933	0.0	12.7	86.4	3.3	
Spring	62.4	34.7	48.6	98	20020531	-3	19750328	54.8	2004	43.6	1909	0.4	0.3	38.5	0.0	
Summer	86.0	54.9	70.5	110	19050622	28	19080603	76.4	2002	67.4	1941	30.4	0.0	0.2	0.0	
Fall	65.2	37.7	51.4	100	19050901	-7	19311125	58.3	1926	47.8	1912	1.4	0.4	30.5	0.1	

Table updated on Jul 28, 2006
For monthly and annual means, thresholds, and sums:
Months with 5 or more missing days are not considered
Years with 1 or more missing months are not considered
Seasons are climatological not calendar seasons

Winter = Dec., Jan., and Feb. Spring = Mar., Apr., and May
Summer = Jun., Jul., and Aug. Fall = Sep., Oct., and Nov.

Winds are usually light to moderate in the area, although occasional stronger winds may occur in the late winter and spring. The predominant winds are from the north through north-east (approximately 30 percent of the time) and from the south through south-west (about 25 percent of the time). Winds are generally less than 15 mph, with wind speeds greater than 25 mph occurring less than one percent of the time (1978 ER, Section 2.7.2). As an element of the pre-construction baseline study and ongoing monitoring programs, the Mill operates an onsite meteorological station, described below. Further details about weather and climate conditions are provided in the 1978 ER (Section 2.7) and in the FES (Section 2.1).

1.1.2 Storms (FES Section 2.1.4, updated)

Thunderstorms are frequent during the summer and early fall when moist air moves into the area from the Gulf of Mexico. Related precipitation is usually light, but a heavy local storm can produce over an inch of rain in one day. The maximum 24-hour precipitation reported to have fallen during period 1904-2006 at Blanding was 4.48 inches (11.36 cm). Hailstorms are uncommon in this area. Although winter storms may occasionally deposit comparable amounts of moisture, maximum short-term precipitation is usually associated with summer thunderstorms.

Tornadoes have been observed in the general region, but they occur infrequently. Strong winds can occur in the area along with thunderstorm activity in the spring and summer. The Mill area is susceptible to occasional dust storms, which vary greatly in intensity, duration, and time of occurrence. The basic conditions for blowing dust in the region are created by wide areas of exposed dry topsoil and strong, turbulent winds. Dust storms usually occur following frontal passages during the warmer months and are occasionally associated with thunderstorm activities.

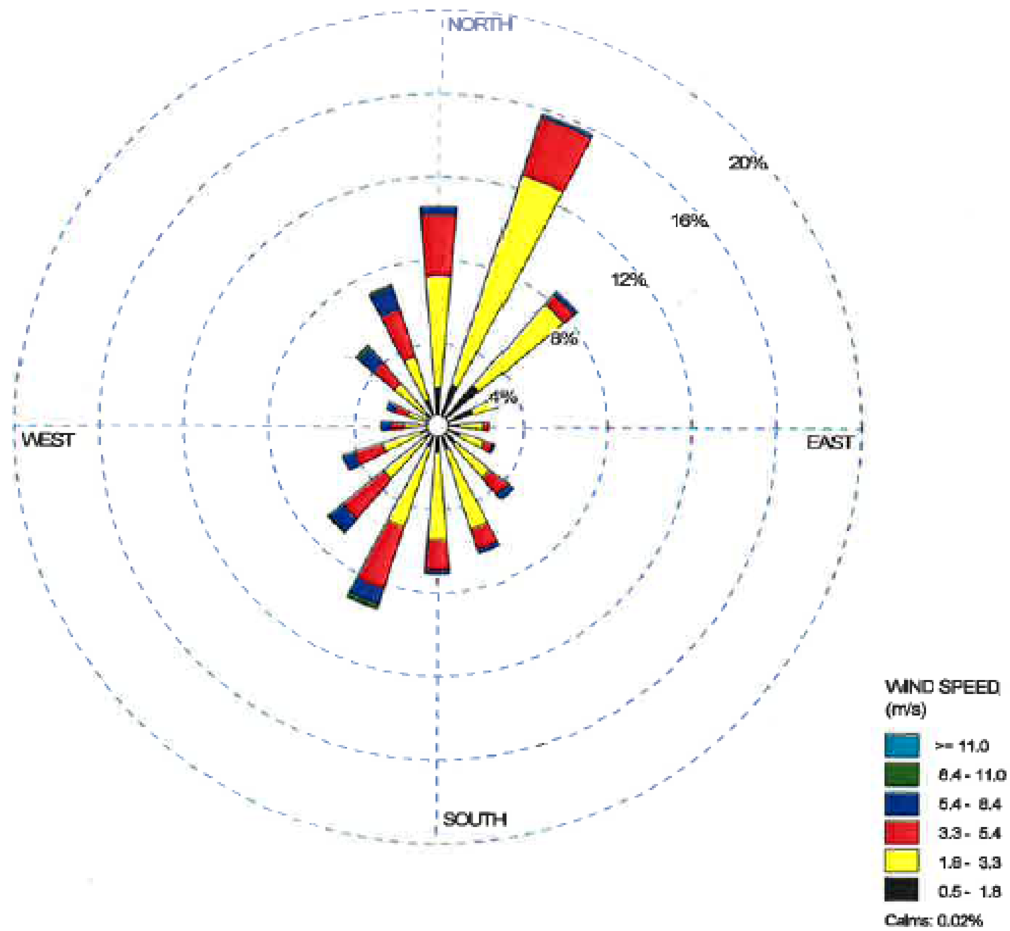
1.1.3 On Site

On-site meteorological monitoring at the Mill was initiated in early 1977 and continues today. The original purpose of the meteorological monitoring program was to document the regional atmospheric baseline and to provide data to assist in assessing potential air quality and radiological impacts arising from operation of the Mill.

After the Mill construction was completed, the monitoring programs were modified to facilitate the assessment of Mill operations. The current meteorological monitoring program includes data collection for wind speed, wind direction, atmospheric stability according to the standard Pasquill scheme (via measurements of deviations in wind direction, referred to as sigma-theta), and precipitation as either rain or snow. The recorded on-site meteorological conditions are reported to EFRI on a semi-annual basis and are described in semi-annual reports maintained at the Mill. Figure 1.1-1 shows the windrose for the Mill site for January – December 2015, the most recent full year of compiled meteorological data.

White Mesa Mill
Meteorological Data

Wind Speed
Direction (blowing from)



DATA PERIOD: 2015 Jul 1 - Dec 31 00:00 - 23:00	COMPANY NAME: Energy Fuels Resources (USA) Inc.		
	MODELER: McVehil-Monnett Associates		
CALM WINDS: 0.02%	TOTAL COUNT: 4412 hrs.		
AVG. WIND SPEED: 2.99 m/s	DATE: 1/22/2016	PROJECT NUMBER: 2397-10	

WRPLOT View - Lakes Environmental Software

ENERGY FUELS

REVISIONS		
Date	By	

Project: White Mesa Mill
County: San Juan State: UT
Location:

WIND ROSE - 2015
(McVehil-Monnett Associates)
FIGURE 1.1-1

Author: Date: 1/22/2016 Drafted By:

1.2 Topography

The following text is reproduced from Section 2.3 of the FES.

The site is located on a "peninsula" platform tilted slightly to the south-southeast and surrounded on almost all sides by deep canyons, washes, or river valleys. Only a narrow neck of land connects this platform with high country to the north, forming the foothills of the Abajo Mountains. Even along this neck, relatively deep stream courses intercept overland flow from the higher country. Consequently, this platform (White Mesa) is well protected from runoff flooding, except for that caused by incidental rainfall directly on the mesa itself. The land on the mesa immediately surrounding the Mill site is relatively flat.

1.3 Archeological Resources

The following discussion of archeological sites is adapted from Section 2.5.2.3 of the FES.

1.3.1 Archeological Sites

Archeological surveys of portions of the entire Mill site were conducted between the fall of 1977 and the spring of 1979. The total area surveyed contained parts of Section 21, 22, 27, 28, 32, and 33 of T37S, R22E, and encompassed 2,000 acres (809 ha), of which 200 acres (81 ha) are administered by the U. S. Bureau of Land Management (“BLM”) and 320 acres (130 ha) are owned by the State of Utah. The remaining acreage is privately owned. During the surveys, 121 archeological sites were recorded and all were determined to have an affiliation with the San Juan Anasazi who occupied this area of Utah from 0 A.D. to 1300 A.D. All but 22 of the sites were within the Mill site boundaries.

Table 1.3-1, adapted from FES Table 2.18, summarizes the recorded sites according to their probable temporal positions. The dates of occupation are the best estimates available, based on professional experience and expertise in the interpretation of archeological evidence. Available evidence suggests that settlement on White Mesa reached a peak in perhaps 800 A.D. Occupation remained at approximately that level until sometime near the end of Pueblo II or in the Pueblo II/Pueblo III transition period. After this period, the population density declined sharply, and it may be assumed that the White Mesa area was, for the most part, abandoned by about 1250 A.D.

Archeological test excavations were conducted by the Antiquities Section, Division of State History, in the spring of 1978, on 20 sites located in the area later to be occupied by Cells 2, 3 and 4 (now comprised of Cell 4A and Cell 4B). Of these sites, 12 were deemed by the State Archeologist to have significant National Register potential and four to have possible significance. The primary determinant of significance in this study was the presence of structures, though storage features and pottery artifacts were also common.

In the fall of 1978, a surface survey was conducted on much of the previously unsurveyed portions of the proposed Mill site. Approximately 45 archeological sites were located during this survey, some of which are believed to be of equal or greater significance than any sites from the earlier study. Determination of the actual significance of all untested sites would require additional field investigation.

Table 1.3-1
Distribution of Recorded Sites According to Temporal Position

Temporal position	Approximate dates (A.D.)*a*	Number of sites
Basket Maker III	575-750	2
Basket Maker III/Pueblo I	575-850	27
Pueblo I	750-850	12
Pueblo I/Pueblo II	850-950	13
Pueblo II	950-1100	14
Pueblo II/Pueblo III	1100-1150	12
Pueblo III	1150-1250	8
Pueblo II+	*B*	
Multicomponent	*C*	3
Unidentified	*D*	14

a Includes transitional periods.
b Although collections at these locations were lacking in diagnostic material, available evidence indicates that the site would have been used or occupied no earlier than 900 A.D. and possibly later.
c Ceramic collections from each of these sites indicate an occupation extending from Pueblo I through Pueblo II and into Pueblo III.
d These sites did not produce evidence strong enough to justify any identification.

Source: Adapted from Dames & Moore (1978b) (1978 ER), Table 2.3-2, FES, Page 2-20, Table 2.18, and from supplementary reports on project archeology.

Pursuant to 10 CFR Part 63.3, the NRC submitted on March 28, 1979, a request to the Keeper of the National Register for a determination of eligibility for the area which had been surveyed and tested. The area contained 112 archeological sites and six historical sites. The determination by the Keeper of the National Register on April 6, 1979, was that the White Mesa Archeological District is eligible for inclusion in the National Register.

1.3.2 Current Status of Excavation

Archeological investigations for the entire Mill site and for Cells 1 through Cell 4 (now comprised of Cell 4A and Cell 4B) were completed with the issuance of four separate reports covering 30 sites, excluding re-investigations. (Lindsay 1978, Nielson 1979, Casjens et al 1980, and Agenbroad et al 1981).

The sites reported as excavated are as follows:

6380	6394	6437
6381	6395	6684
6384	6396	6685
6385	6397	6686
6386	6403	6697
6387	6404	6698
6388	6420	6699
6391	6429	6754
6392	6435	6757
6393	6436	7754

Sites for which excavation has not been required are:

6379	6441	7658	7690
6382	6443	7659	7691
6405	6444	7660	7693

The sites remaining to be excavated or investigated for significance are:

6408	6445	7657	7687
6421	6739	7661	7689
6427	6740	7665	7696
6430	7653	7668	7700
6432	7655	7675	7752
6439	7656	7684	7876

The following site was excavated in 2009 in connection with the construction of the new decontamination pad at the Mill:

42Sa27732

The following sites were excavated in the summer of 2010 in connection with the construction of Cell 4B and a final report was prepared:

42Sa6391	42Sa6431	42Sa28129	42Sa28133
42Sa6392	42Sa6757	42Sa28130	42Sa28134
42Sa6393	42Sa8014	42Sa28131	
42Sa6397	42Sa28128	42Sa28132	

1.4 Surface Water

The following description of undisturbed surface water conditions is adapted from Section 2.6.1 of the FES and Section 3.7.1 of the 2007 ER and is updated to include current data.

The Mill was designed and constructed to prevent run-on or runoff of stormwater by a) diverting runoff from precipitation on the Mill site to the tailings management cells; and b) diverting runoff from surrounding areas away from the Mill site. In addition to these designed control features, the facility has developed a *Stormwater Best Management Practices Plan*, Revision 1.5: May 2, 2016 (EFRI, 2016) which describes site drainage features and the best management practices employed to assure appropriate control and routing of stormwater.

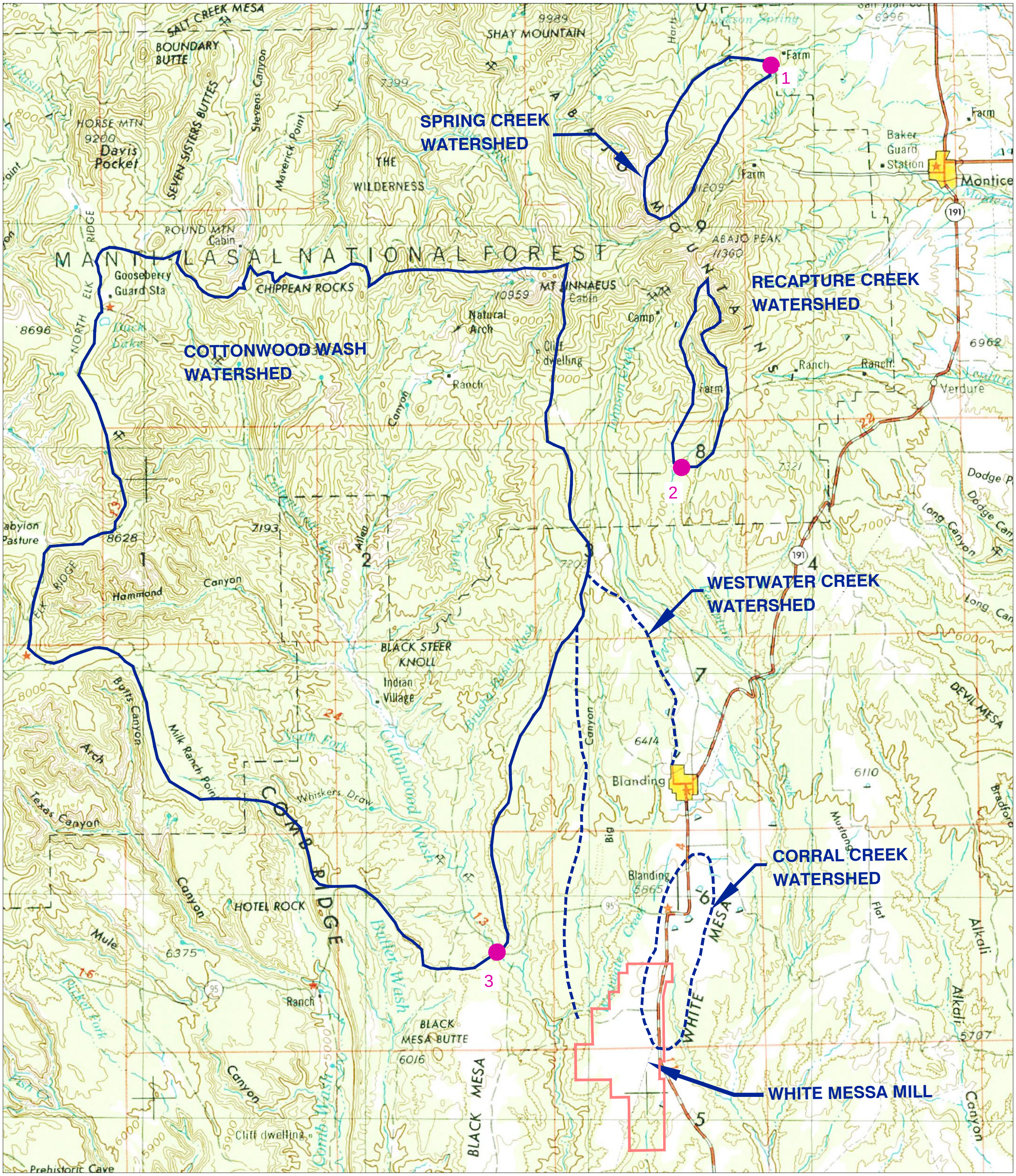
1.4.1 Surface Water Description (FES Section 2.6.1.1)

The Mill site is located on White Mesa, a gently sloping (1 percent SSW) plateau that is physically defined by the adjacent drainages which have cut deeply into regional sandstone formations. There is a small drainage area of approximately 62 acres (25 ha) above the site that could yield surface runoff to the site. Runoff from the Mill area is conducted by the general surface topography to either Westwater Creek, Corral

Creek, or to the south into an unnamed branch of Cottonwood Wash. Local porous soil conditions, topography and low acreage annual rainfall of 13.32 inches cause these streams to be intermittently active, responding to spring snowmelt and local rainstorms (particularly thunderstorms). Surface runoff from approximately 384 acres (155 ha) of the Mill site drains westward and is collected by Westwater Creek, and runoff from another 384 acres (155 ha) drains east into Corral Creek. The remaining southern and southwestern portions of the site drain indirectly into Cottonwood Wash (Dames & Moore, 1978b, p. 2-143). The site and vicinity drainages carry water only on an intermittent basis. The major drainages in the project vicinity are depicted on Figure 1.4-1 and their drainages tabulated in Table 1.4-1. Total runoff from the site area (total yield per watershed area) is estimated to be less than 0.5 inch (1.3 cm) annually (Dames & Moore, 1978b, p. 2-143).

There are no perennial surface waters on or in the vicinity of the Mill site. This is due to the gentle slope of the mesa on which the site is located, the low average annual rainfall of 13.32 inches (33.8 cm) per year at Blanding, local soil characteristics and the porous nature of local stream channels. Prior to construction, three small ephemeral catch basins were present on the site to the northwest and northeast of the Mill site.

Corral Creek is an intermittent tributary to Recapture Creek. The drainage area of that portion of Corral Creek above and including drainage from the eastern portion of the site is about 5 square miles (13 km^2). Westwater Creek is also an intermittent tributary of Cottonwood Wash. The Westwater Creek drainage basin covers nearly 27 square miles (70 km^2) at its confluence with Cottonwood Wash 1.5 miles (2.5 km) west of the Mill site. Both Recapture Creek and Cottonwood Wash are similarly intermittently active, although they carry water more often and for longer periods due to their larger watershed areas. They both drain to the south and are tributaries of the San Juan River. The confluences of Recapture Creek and Cottonwood Wash with the San Juan River are approximately 18 miles (29 km) south of the Mill site. The San Juan River, a major tributary for the upper Colorado River, has a drainage of 23,000 square miles (60,000 km^2) measured at the USGS gauge to the west of Bluff, Utah (Dames & Moore, 1978b, p. 2-130).



1 USGS GAUGE NO. 09376900

2 USGS GAUGE NO. 09378630

3 USGS GAUGE NO. 09378700

Energy Fuels

REVISIONS		WHITE MESA MILL	
Date	By	County: San Juan	State: Utah
5–14	DLS	Location:	

Drainage Map of the Vicinity of the White Mesa Mill

Figure 1.4-1

Scale: 1:250,000 | Date: Aug, 2009 | Drafted By: D.Sledd

Table 1.4-1
Drainage Areas of Project Vicinity and Region

Basin description	Drainage area	
	km^2	sq. miles
Corral Creek at confluence with Recapture Creek	15.0	5.8
Westwater Creek at confluence with Cottonwood Wash	68.8	26.6
Cottonwood Wash at USGS gage west of project site	<531	<205
Cottonwood Wash at confluence with San Juan River	<860	<332
Recapture Creek at USGS gage	9.8	3.8
Recapture Creek at confluence with San Juan River	<518	<200
San Juan River at USGS gage downstream at Bluff, Utah	<60,000	<23,000

Source: Adapted from Dames & Moore (1978b), Table 2.6-3

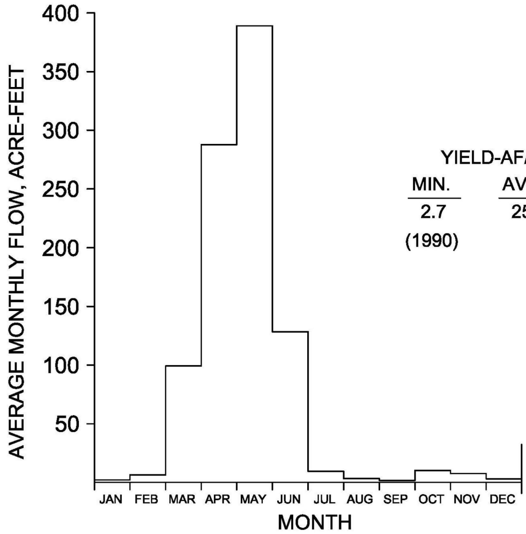
Storm runoff in these streams is characterized by a rapid rise in the flow rates, followed by rapid recession primarily due to the small storage capacity of the surface soils in the area. For example, on August 1, 1968, a flow of 20,500 cfs (581 m^3/sec) was recorded in Cottonwood Wash near Blanding. The average flow for that day, however, was only 4,340 cfs (123 m^3/sec). By August 4, the flow had returned to 16 cfs (0.5 m^3/sec) (Dames & Moore, 1978b, p. 2-135). Monthly streamflow summaries updated from Figure 2.4 of the FES are presented in Figure 1.4-2 for Cottonwood Wash, Recapture Creek and Spring Creek. Flow data are not available for the two smaller water courses closest to the Mill site, Corral Creek and Westwater Creek, because these streams carry water infrequently and only in response to local heavy rainfall and snowmelt, which occurs primarily in April, August, and October. Flow typically ceases in Corral and Westwater Creeks within 6 to 48 hours after precipitation or snowmelt ends.

1.4.2 Surface Water Quality as of the Date of the FES (FES Section 2.6.1.2)

Sampling of surface water quality in the Mill vicinity began in July 1977 and continued through March 1978. Baseline data describe and evaluate existing conditions at the Mill site and vicinity. Sampling of the temporary on-site surface waters (two catch basins) was attempted, but without success because of the lack of naturally occurring water in these basins. Sampling of ephemeral surface waters in the vicinity was possible only during major precipitation events, as these streams are normally dry. See FES Section 2.6.1.2.

Surface water sample sites used prior to Mill operations are presented on Figure 1.4-3. The water quality values obtained for these sample sites are given in Dames & Moore (1978b) Table 2.6-7, and FES Table 2.22. Water quality samples were collected during the spring at several intermittently active streams that drain the Mill area. These streams include Westwater Creek (S1R, S9) Corral Creek below the small irrigation pond (S3R), the junction of Corral Creek and Recapture Creek (S4R), and Cottonwood Creek (S8R). Samples were also taken from a surface pond southeast of the Mill (S5R). No samples were taken at S2R on Corral Creek or at the small wash (S6R) located south of the site.

AVERAGE ANNUAL FLOW=950 AF - (1966-2001)
DRAINAGE AREA=3.77 SQ. MI.
AVERAGE ANNUAL YIELD=252.1 AF/SQ. MI.

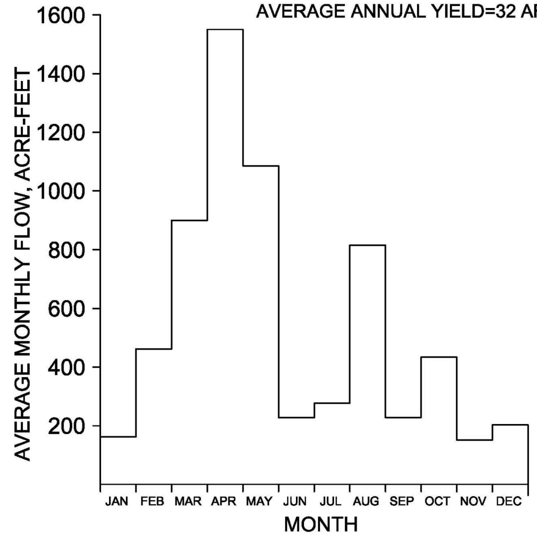


RECAPTURE CREEK NEAR BLANDING
USGS GAUGE 09378630

YIELD-AF/SQ. MI

MIN.	AVG.	MAX.
2.7	252	881
(1990)		(1983)

AVERAGE ANNUAL FLOW=6547 AF - (1965-1986)
DRAINAGE AREA=205 SQ. MI.
AVERAGE ANNUAL YIELD=32 AF/SQ. MI.

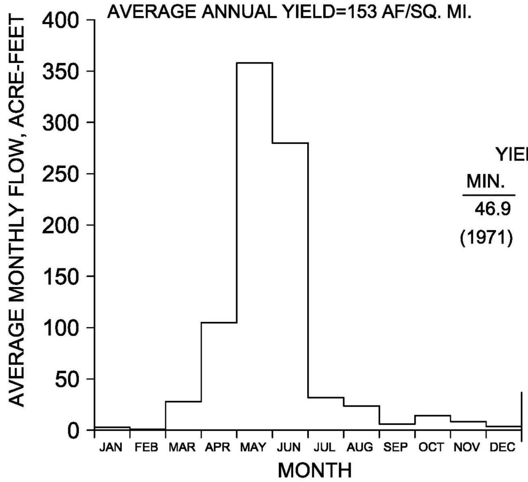


COTTONWOOD WASH NEAR BLANDING
USGS GAUGE 09378700

YIELD-AF/SQ. MI

MIN.	AVG.	MAX.
4.9	32	88
(1976)		(1983)

AVERAGE ANNUAL FLOW=7757 AF - (1966-1971)
DRAINAGE AREA=4.95 SQ. MI.
AVERAGE ANNUAL YIELD=153 AF/SQ. MI.



SPRING CREEK ABOVE DIVERSIONS,
USGS GAUGE 09376900

YIELD-AF/SQ. MI

MIN.	AVG.	MAX.
46.9	153	262
(1971)		(1966)

NOTES

1. FOR THE LOCATION OF WATER COURSES SUMMARIZED, SEE FIGURE 3.7-1
2. SOURCE OF DATA. WATER RESOURCES DATA RECORDS. COMPILED AND PUBLISHED BY USGS.

ENERGY FUELS

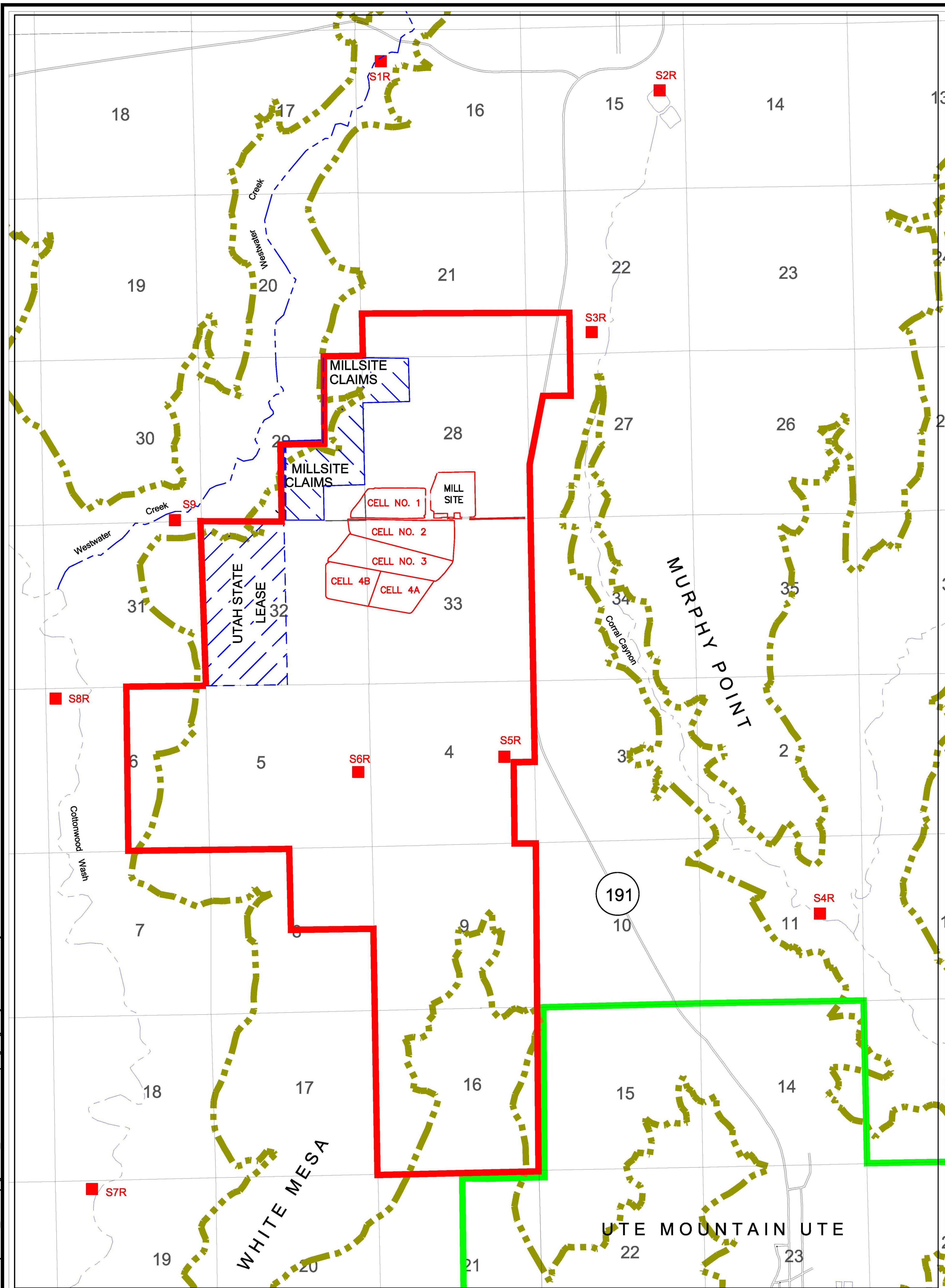
Project: WHITE MESA MILL
County: San Juan State: Utah

FIGURE 1.4-2

Streamflow Summary
Blanding, UT Vicinity

Date: Nov, 2009 Design: Drafted By: DLS

W:\USA\Utah\Mill\dwgs\Reclamation Plans\RecPlan4.0\Figure 1.4-2 Streamflow.dwg Fig 1.4-2 23/11/2009 dsledd



PROPERTY BOUNDARY

RESERVATION BOUNDARY

CANYON RIM

S SURFACE WATER SAMPLING LOCATION

N

1,500' 0 1,500' 3,000'

SCALE: 1" = 3,000'

UT83-SF

ENERGY FUELS

REVISIONS		Project: White Mesa Mill
Date	By	County: San Juan State: UT
07-11	GM	Location:
		SURFACE WATER QUALITY SAMPLING STATIONS IN THE WHITE MESA VICINITY FIGURE 1.4-3
		Author: Date: Nov 2009 Drafted By: DLS

W:\USA\Utah\Mill\dwgs\Reclamation Plans\Rev_07-2011\Work01_Harold\Fig.1.4-3_SurfaceWaterSampling.dwg Layout1 GMoseley

Natural surface water quality in the vicinity of the Mill is generally poor. Waters in Westwater Creek (S1R and S9) were characterized by high total dissolved solids (TDS; mean of 674 mg/liter) and sulfate levels (mean 117 mg of SO_4 per liter). The waters were typically hard (total hardness measured as $CaCO_3$; mean 223 mg/liter) and had an average pH of 8.25. Estimated water velocities for Westwater Creek averaged 0.3 fps (0.08 m/sec) at the time of sampling.

Samples from Cottonwood Creek (S8R) at the time of the FES were generally similar in quality to Westwater Creek water samples, although the TDS and sulfate levels were lower (TDS averaged 264 mg/liter; SO_4 averaged 40 mg/liter) during heavy spring flow conditions (80 fps [24 m/sec] water velocity).

The concentrations of TDS increased downstream in Corral Creek, averaging 3,180 mg/liter at S3R and 6,660 mg/liter (one sample) at S4R. Total hardness averaged in excess of 2,000 mg/liter, and pH values were slightly alkaline. Estimated water velocities in Corral Creek were typically less than 0.1 fps (0.03 m/sec) during sampling.

The spring sample collected at the surface pond south of the Mill site (S5R) indicated a TDS concentration of less than 300 mg/liter. The water was slightly alkaline with moderate dissolved sulfate levels averaging 42 mg/liter.

During heavy runoff, the concentration of total suspended solids in these streams increased sharply to values in excess of 1,500 mg/liter (FES, Table 2.22). High concentrations of certain trace elements were measured in some sampling areas. Levels of mercury (total) were reported as high as 0.002 mg/liter (S3R, 7/25/77; S8R, 7/25/77). Total iron measured in the pond (S5R, 11/10/77) was 9.4 mg/liter. The FES concluded (Section 2.6.1.2 of the FES) that these values appear to reflect groundwater quality in the vicinity and are probably due to evaporative concentration and not due to human perturbation of the environment. Corral Creek was also sampled at the time of the FES, but it has not been included in subsequent operational monitoring at the Mill. See Table 2.22 of the FES for sampling results for Corral Creek.

1.4.3 Surface Water Background Quality

Surface water samples are collected for Cottonwood Wash and Westwater Creek as part of the Mill's operational monitoring program. Samples were also taken prior to Mill construction and summarized in the FES as well as at various times and for various parameters since then. A comparison of the FES results and subsequent sampling results during Mill operation is shown in Table 1.4-2. Surface water values over time for both Cottonwood Wash and Westwater Creek are included in the Semi-Annual Effluent Reports.

Table 1.4-2
Summary of FES and Subsequent Sampling Results For Cottonwood Wash and Westwater Creek

Parameter	FES Cottonwood Wash (7/25/77-3/28/78)*	Cottonwood Wash (9/16/81-6/20/09)	Cottonwood Wash 2010	Cottonwood Wash 2011	Cottonwood Wash 2012	Cottonwood Wash 2013	Cottonwood Wash 2014	Cottonwood Wash 2015	FES Westwater Creek (11/10/77-3/23/78)*	Westwater Creek (2/22/82-6/20/09)	Westwater Creek 2010	Westwater Creek 2011	Westwater Creek 2012	Westwater Creek 2013	Westwater Creek 2014	Westwater Creek 2015
Field Specific Conductivity (µmhos/cm)	240-550	-	1612[3] 1625[3] 1600[3] 513[4] 622[4] 259[4] 785[4]	1402[5] 1631[5] 230[6]	1568[7] 674[8] 201[8]	1634[10] 653.8[11] 703[11] 140[11]	1677[12] 683[13] 785[13] 304[13]	1658[14] 740[15] 792[15] 472[15] 180[15]	320-620	-	1707[3] 1782[3] 1650[3] 1645[4]	1234[5] 806[6]	-	283[11]	412[13]	1372[14] 257[15]
Field pH	6.6 to 8.1	-	6.42[3] 6.67[3] 8.16[4] 8.20[4] 7.94[4] 7.21[4]	7.04[5] 6.84[5] 7.79[6]	7.06[7] 7.84[8] 7.95[8]	7.25[10] 7.98[11] 7.72[11] 8.74[11]	7.18[12] 7.81[13] 8.17[13] 8.77[13]	7.30[14] 6.86[15] 7.43[15] 8.30[15] 7.26[15]	7.6-8.3	-	7.03[3] 6.98[3] 8.16[4]	6.67[5] 7.60[6]	-	7.45[11]	8.64[13]	7.24[14] 7.55[15]
Dissolved Oxygen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temperature (ºC)	6.0 to 35	-	16.17[3] 15.85[3] 15.05[3] 3.19[4] 9.70[4] 21.37[4] 4.50[4]	16.50[5] 15.91[5] 12.60[6]	16.28[7] 9.80[8] 18.07[8]	16.28[10] 8.11[11] 5.48[11] 16.90[11]	16.90[12] 13.61[13] 18.92[13] 17.65[13]	16.40[14] 6.75[15] 16.19[15] 22.39[15] 12.59[15]	3-14	-	17.99[3] 17.21[3] 10.1[3] -0.03[4]	15.13[5] 10.68[6]	-	21.16[11]	17.00[13]	17.52[14] 17.69[15]
Estimated Flow m/hr	0.4 to 80	-	-	-	-	-	-	-	0.28 to 39.9	-	-	-	-	-	-	-
pH	7.5 to 8.21	-	7.47[3]	7.55[5] 8.04[5]	-	-	-	-	8.2 to 8.35	-	7.38[3]	7.20[5]	-	-	-	-
Redox Potential	210 to 260	-	501[3] 492[3]	441[5]	421[7]	259[10]	238[12]	189[14]	186 to 220	-	401[3] 342[3]	-	-	-	-	201[14]
Alkalinity (as $CaCO_3$)	134 to 195	76 to 257*	-	-	-	-	-	-	147 to 229	230*	-	-	-	-	-	-
Hardness, total (as $CaCO_3$)	148 to 195	-	-	-	-	-	-	-	117 to 289	-	-	-	-	-	-	-
Carbonate (as CO_3)	0.0	ND	ND[3]	6[5] mg/L	ND[7]	ND[10]	ND[12]	ND[14]	0.0 to 2.3	ND	ND[3]	ND[5]	-	-	-	ND[14]
Bicarbonate (as HCO3)	-	316 mg/L	340[3] mg/L	316[5] mg/L	326[7] mg/L	280[10] mg/L	251[12] mg/L	271[14] mg/L	-	465 mg/L	450 mg/L	330[5] mg/L	-	-	-	359[14] mg/L
Aluminum, dissolved	0.16 to 3.0	-	-	-	-	-	-	-	0.1 to 4.0	-	-	-	-	-	-	-
Ammonia (as N)	<0.1 to 0.16	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	0.512[14] mg/L	<0.1 to 0.75	ND	0.50[3] mg/L	0.06[5] mg/L	-	-	-	0.123[14] mg/L
Arsenic, total	0.02 to 0.041	-	-	-	-	-	-	-	0.007 to 0.037	-	-	-	-	-	-	-
Arsenic, Dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	12.3[5] ug/L	-	-	-	ND[14]
Barium, total	0.2 to 1.2	-	-	-	-	-	-	-	<0.2 to 0.81	-	-	-	-	-	-	-
Beryllium, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	0.91[5] ug/L	-	-	-	ND[14]
Boron, total	<0.1 to 0.2	-	-	-	-	-	-	-	<0.1 to 0.1	-	-	-	-	-	-	-
Cadmium, total	<0.002 to 0.01	-	-	-	-	-	-	-	<0.002 to 0.006	-	-	-	-	-	-	-
Cadmium, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	0.9[5] ug/L	-	-	-	ND[14]
Calcium, dissolved	54 to 178	90.3 mg/L	92.2[3] mg/L	94.2 – 95.4[5] mg/L	101[7] mg/L	87.9[10] mg/L	99.7[12] mg/L	111[14] mg/L	76 to 172	191 mg/L	179[3] mg/L	247[5] mg/L	-	-	-	150[14] mg/L
Calcium	-	37 to 71*	-	-	-	-	-	-	-	94.5*	-	-	-	-	-	-
Chlorine	-	-	-	-	-	-	-	-	-	41*	-	-	-	-	-	-
Chloride	6 to 24	5 to 33.3*	112[3] mg/L	113 - 134[5] mg/L	149[7] mg/L	118[10] mg/L	128[12] mg/L	133[14] mg/L	17 to 125	76*	40[3] mg/L	21[5] mg/L	-	-	-	32.6[14] mg/L

Table 1.4-2
Summary of FES and Subsequent Sampling Results For Cottonwood Wash and Westwater Creek

Parameter	FES Cottonwood Wash (7/25/77-3/28/78)*	Cottonwood Wash (9/16/81-6/20/09)	Cottonwood Wash 2010	Cottonwood Wash 2011	Cottonwood Wash 2012	Cottonwood Wash 2013	Cottonwood Wash 2014	Cottonwood Wash 2015	FES Westwater Creek (11/10/77-3/23/78)*	Westwater Creek (2/22/82-6/20/09)	Westwater Creek 2010	Westwater Creek 2011	Westwater Creek 2012	Westwater Creek 2013	Westwater Creek 2014	Westwater Creek 2015
Sodium	-	18 to 104*	-	-	-	-	-	-	-	160.5*	-	-	-	-	-	-
Sodium, dissolved	21 to 66	205 mg/L	214[3] mg/L	227 - 229[5] mg/L	247[7] mg/L	217[10] mg/L	227[12] mg/L	251[14] mg/L	31 to 60	196 mg/L	160[3] mg/L	112[5] mg/L	-	-	-	139[14] mg/L
Silver, dissolved	0.002 to <0.005	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	<0.005 to 0.006	ND	ND[3]	ND[5]	-	-	-	ND[14]
Sulfate, dissolved (as SO_4)	39.7 to 564	57 to 245*	389[3] mg/L	389 - 394[5] mg/L	356[7] mg/L	403[10] mg/L	417[12] mg/L	442[14] mg/L	85 to 163	408*	607[3] mg/L	354[5] mg/L	-	-	-	392[14] mg/L
Vanadium, dissolved	<0.005 to <0.018	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	<0.001 to 0.008	ND	ND[3]	34 ug/L[5]	-	-	-	ND[14]
Manganese, dissolved	0.02 to 0.84	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	0.03 to 0.60	37 ug/L	87[3] ug/L	268[5] ug/L	-	-	-	0.171[14] mg/L
Chromium, total	<0.01 to 0.14	-	-	-	-	-	-	-	<0.01 to 0.60	-	-	-	-	-	-	-
Chromium, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Copper, total	0.005 to 0.09	-	-	-	-	-	-	-	<0.005 to 0.05	-	-	-	-	-	-	-
Copper, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	16[5] ug/L	-	-	-	ND[14]
Cobalt, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Fluoride, dissolved	0.2 to 0.36	0.4 mg/L	0.38[3] mg/L	0.34 - 0.38[5] mg/L	0.38[7] mg/L	0.417[10] mg/L	ND[12]	0.318[14] mg/L	0.2 to 0.4	0.7 mg/L	0.60[3] mg/L	0.54[5] mg/L	-	-	-	0.424[14] mg/L
Iron, total	5.9 to 150	-	-		-	-	-	-					-	-	-	-
Iron, dissolved	0.11 to 1.9	ND	ND[3]	ND - 53[5]	ND[7]	ND[10]	ND[12]	ND[14]	0.17 to 2.5	89 ug/L	56[3] ug/L	4540[5] ug/L	-	-	-	ND[14]
Lead, total	0.05 to 0.14	-	-	-	-	-	-		<0.05 to 0.1	-	-	-	-	-	-	-
Lead, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	41.4[5] ug/L	-	-	-	ND[14]
Magnesium	-	10.5 to 38.1*	-	-	-	-	-	-	-	23.5*	-	-	-	-	-	-
Magnesium, dissolved	17 to 28	25 mg/L	24.8[3] mg/L	25.2[5] mg/L	27.7[7] mg/L	23.6[10] mg/L	29.0[12] mg/L	27.4[14] mg/L	13 to 26	-	44.7[3] mg/L	34.7[5] mg/L	-	-	-	34.0[14] mg/L
Mercury, total	0.00006 to 0.002	-	-	-	-	-	-	-	<0.00003 to <0.0005	-	-	-	-	-	-	-
Mercury, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Molybdenum, dissolved	0.002 to 0.10	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	0.002 to 0.006	ND	29[3] ug/L	ND[5]	-	-	-	ND[14]
Nitrate (as N)	0.12 to 1.77	0.1 mg/L	ND[3]	0.1 mg/L[5]	ND[7]	ND[10]	ND[12]	ND[14]	<0.05 to 0.05	0.8 mg/L	ND[3]	ND[5]	-	-	-	ND[14]
Nickel, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	-	ND[3]	29 ug/L[5]	-	-	-	ND[14]
Phosphorus, total (as P)	0.05 to 3.2	-	-	-	-	-	-	-	0.05 to 0.88	-	-	-	-	-	-	-
Potassium, dissolved	1.2 to 6.9	1.77 to 4 mg/L	5.77[3] mg/L	5.9 – 6.0[5] mg/L	6.27[7] mg/L	5.53[10] mg/L	6.18[12] mg/L	5.91[14] mg/L	2.0 to 3.2	4.05*	6.57[3] mg/L	3.9[5] mg/L	-	-	-	1.98[14] mg/L
Selenium, dissolved	<0.005 to 0.08	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	<0.005 to 0.003	ND	ND[3]	ND[5]	-	-	-	ND[14]
Silica, dissolved (as SiO_2)	8 to 18	-	-	-	-	-	-	-	7 to 11	-	-	-	-	-	-	-
Strontium, total	0.34 to 0.64	-	-	-	-	-	-	-	0.44 to 0.76	-	-	-	-	-	-	-
Thallium, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Tin, dissolved	-	-	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Uranium, total	0.004 to 0.27	-	-	-	-	-	-	-	0.006 to 0.004	-	-	-	-	-	-	-
Uranium, dissolved	0.004 to 0.015	8.42 ug/L	8.24[3] ug/L	7.87 - 8.68[5] ug/L	8.17[7] ug/L	8.95[10] ug/L	9.62[12] ug/L	9.12[14] mg/L	0.002 to 0.015	15.1 ug/L	46.6[3] ug/L	6.64[5] ug/L	-	-	-	2.10[14] mg/L
Zinc, dissolved	0.008 to 0.06	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	0.04 to 0.12	ND	22[3] ug/L	28[5] ug/L	-	-	-	ND[14]
Total Organic Carbon	7 to 12	-	-	-	-	-	-	-	6 to 16	-	-	-	-	-	-	-
Chemical Oxygen Demand	61 to 163	-	-	-	-	-	-	-	23 to 66	-	-	-	-	-	-	-
Oil and Grease	2	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-

Table 1.4-2
Summary of FES and Subsequent Sampling Results For Cottonwood Wash and Westwater Creek

Parameter	FES Cottonwood Wash (7/25/77-3/28/78)*	Cottonwood Wash (9/16/81-6/20/09)	Cottonwood Wash 2010	Cottonwood Wash 2011	Cottonwood Wash 2012	Cottonwood Wash 2013	Cottonwood Wash 2014	Cottonwood Wash 2015	FES Westwater Creek (11/10/77-3/23/78)*	Westwater Creek (2/22/82-6/20/09)	Westwater Creek 2010	Westwater Creek 2011	Westwater Creek 2012	Westwater Creek 2013	Westwater Creek 2014	Westwater Creek 2015
Total Suspended Solids	146 to 2,025	0 to 24,300*	19 - 5880[4] mg/L	ND - 8860[6] mg/L	15 – 1260[8] mg/L	6 – 21800[10,11] mg/L	12 – 7500[12] mg/L	28 – 2600[15] mg/L	12 to 1940	<4 to 1,190*	13[4] mg/L	ND[6]	-	-	-	4390[15] mg/L
Total Dissolved Solids	253 to 944	10 to 1,130*	202 – 900[3,4] mg/L	425 – 1030[5,6] mg/L	224 – 1040[7,8] mg/L	287 – 996[10,11] mg/L	271 – 968[12] mg/L	218 – 1020[14,15] mg/L	496 to 969	93-1370*	1140 – 1270[3,4] mg/L	853[5]	-	-	-	337 – 896[14,15] mg/L
Gross Alpha	-	<1.0E-9 to 9.0E-7*	-	-	-	-	-	-	1E-10 to 4.5E-9	<1.0E-9*	-	-	-	-	-	-
Gross Alpha minus Rn & U	-	-	ND – 2.0[3,4] pCi/L	ND[5,6]	ND – 3.1[7,8] pCi/L	ND – 10.8[10,11] pCi/L	ND – 13.0[12,13] pCi/L	ND – 14.8[14,15] pCi/L	-	-	ND[3,4] pCi/L	ND - 0.5[5] pCi/L	-	20.4[11] pCi/L	7.5[13] pCi/L	ND – 2.2[14,15] pCi/L
Gross Beta	-	-	-	-	-		-	-	0 to 8E-9	-	-	-	-	-	-	-
Uranium, dissolved	1.02E-9 to 2.79E-9	2.23E-9 to 6.02E-6*	0.0060 – 0.0116[3,4] mg/L	0.00787 – 0.0102[5,6] mg/L	0.0017 - 0.00817[7,8] mg/L	0.0084 - 0.0090[10,11] mg/L	ND - 0.009620[12,13] mg/L	0.0022 – 0.00912[14,15] mg/L	1.03E-9 to 1.35E-9	8.8E-7*	0.0057 – 0.0466[3,4] mg/L	ND – 0.00664[5,6] mg/L	-	0.0108[11] mg/L	0.0046[13] mg/L	0.0013 – 0.0021[14,15] mg/L
Uranium, total[2]	21.83E-7	-	-	-	-	-	-	-	6.09E-7	-	-	-	0.08[8,9] mg/kg	-	-	-
Uranium, suspended	-	<2.0E-10 to 2.0E-7*	ND - 0.0014[4] mg/L	ND[6]	0.0035[8] mg/L	ND – 0.0005[11] mg/L	ND[13]	0.0004 – 0.0069[14,15] mg/L	0 to 1E-9	6.09E-7*	0.0005[4] mg/L	0.0014[6] mg/L		0.0176[11] mg/L	0.0017[13] mg/L	0.0026[15] mg/L
Th-230, dissolved	-	<2.0E-10 to 4.14E-6*	ND - 0.05[4] pCi/L	ND[6]	7.2[8] pCi/L	ND[11]	ND[13]	ND[15]	-	<2.0E-10*	ND[4] pCi/L	ND[6]	-	0.02[11] pCi/L	ND[13]	ND[15]
Th-230, suspended	-	<2.0E-10 to <9.0E-7*	ND - 0.7[4] pCi/L	ND[6]	3.1[8] pCi/L	ND – 0.2[11] pCi/L	0.1[13] pCi/L	ND – 2.0[15] pCi/L	2E-10	3.0E-10*	0.2[4] pCi/L	0.7 pCi/L[6]	-	8.7[11] pCi/L	1.1[13] pCi/L	1.2[15] pCi/L
Ra-226, dissolved	-	<2.0E-10 to 2.0E-9*	0.26 – 1.8[4] pCi/L	ND[6]	0.53[8] pCi/L	0.16 – 1.8[11] pCi/L	0.39[13] pCi/L	0.05 – 7.8[15] pCi/L	-	2.0E-10*	0.18[4] pCi/L	ND[6]	-	0.68[11] pCi/L	0.24[13] pCi/L	0.49[15] pCi/L
Ra-226, suspended	-	<2.0E-10 to <2.0E-7*	ND - 1.3[4] pCi/L	ND[6]	4.4[8] pCi/L	ND – 0.68[11] pCi/L	ND[13]	0.39 – 6.7[15] pCi/L	7E-10 to 1.1E-9	<2.0E-10*	4.3[4] pCi/L	0.3 pCi/L[6]	-	28[11] pCi/L	6.5[13] pCi/L	3.4[15] pCi/L
Ra-226, total	-	-	-	-	-	-	-	-	-	-	-	-	0.05[8,9] pCi/g	-	-	-
Pb-210	-	-	-	-	-	-	-	-	0 to 1E-10	-	-	-	-	-	-	-
Acetone	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Benzene	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Carbon Tetrachloride	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Chloroform	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Chloromethane	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Methyl ethyl ketone	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Methylene chloride	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Napthalene	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Toluene	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Xylenes, total	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]

Source: FES Table 2.22 and Mill Sample Data
*Data are from historical sampling events. All other data were collected during the 2009 annual Seeps and Springs and Semi-Annual Effluent Report (SAER) sampling events.
[2] Calculated by EFRI for activity comparison using the Specific Activity for U-nat (6.77E-7 Ci U-nat/g U-nat)
[3] Data are from the 2010 Seeps and Springs sampling event.
[4] Data are from 2010 SAER sampling events.
[5] Data are from 2011 Seeps and Springs sampling event.
[6] Data are from 2011 SAER quarterly sampling events.
[7] Data are from 2012 Seeps and Springs sampling event.
[8] Data are from 2012 SAER quarterly sampling events.
[9] Sediment samples are collected in the 4th quarter in lieu of surface water when Westwater Creek is dry throughout the year.
[10] Data are from 2013 Seeps and Springs sampling event.
[11] Data are from 2013 SAER quarterly sampling events.
[12] Data are from 2014 Seeps and Springs sampling event.
[13] Data are from 2014 SAER quarterly sampling events.
[14] Data are from 2015 Seeps and Springs sampling event.
[15] Data are from 2015 SAER quarterly sampling events.

1.5 Groundwater

Groundwater investigation and monitoring at the Mill focus on the perched groundwater zone, which is the shallowest groundwater encountered beneath the site. Although this section focuses primarily on the perched water zone, deeper groundwater is discussed as needed, and the site geology is addressed to the extent necessary for interpretive context. A more extensive discussion of site geology is provided in Section 1.6.

Sections 1.5.1 and 1.5.2 are based primarily on the following reports prepared by Hydro Geo Chem, Inc. ("HGC"): *Hydrogeology of the Perched Groundwater Zone and Associated Seeps and Springs Near the White Mesa Uranium Mill Site* (HGC, 2010b), and *Hydrogeology of the White Mesa Uranium Mill, Blanding, Utah* (HGC, 2014). Information abstracted from these reports presented here is updated with information collected subsequent to June 6, 2014.

HGC (2010b) and HGC (2014) supplement the "HGC 2009" report summarized in Revision 4.0 of the Reclamation Plan. They provide additional information in response to requirements set out in previous revisions of the GWDP and Part 1F.10 of the current GWDP dated August 24, 2012. Specifically, the additional information contained in HGC (2010b) and HGC (2014) include data on seeps and springs in the vicinity of the Mill, the relationship of the seeps and springs with the perched water system, and estimated travel times for shallow groundwater to travel from the tailings cells to the nearest discharge points. This information addresses requirements set out in previous revisions of the GWDP and Part 1F.10 of the current GWDP dated August 24, 2012. HGC (2014) contains refined estimates of shallow groundwater travel times downgradient of the tailings cells based on data collected from DR-series piezometers installed south, southwest, and west of the tailings cells in 2011, as described in *Second Revision, Hydrogeology of the Perched Groundwater Zone in the Area Southwest of the Tailings Cells, White Mesa Uranium Mill Site, Blanding Utah* (HGC 2012b; the "southwest area investigation" report).

Sections 1.5.3, 1.5.5, and 1.5.6 are based primarily on groundwater sampling programs at the Mill and Section 1.5.4 is based primarily on the analysis of groundwater analytical data by INTERA, Inc. (INTERA). INTERA performed extensive analysis of background perched water quality data and established site-specific groundwater compliance limits ("GWCLs"). Reports detailing work by INTERA include *Revised Background Groundwater Quality Report: Existing Wells For Denison Mines (USA) Corp.'s White Mesa Mill Site, San Juan County, Utah* (INTERA 2007a), and subsequent reports, as discussed in Section 1.5.4.

1.5.1 Groundwater Characteristics

Groundwater investigations at the Mill have been ongoing for more than 38 years, beginning with the initial investigation by Dames and Moore in 1977 and 1978 (Dames and Moore 1978a and 1978b). The initial investigation by Dames and Moore pre-dated Mill construction and operation.

Although more than 35 years of perched groundwater monitoring at the Mill indicates that tailings cell operation has not impacted perched groundwater (as will be discussed in Section 1.5.4), perched groundwater was impacted by disposal of laboratory wastes to two (now abandoned) sanitary leach fields (prior to about 1980) before the Mill and tailings cells were operational. Disposal of laboratory wastes is considered the source of a chloroform plume (defined by concentrations greater than 70 micrograms per liter [µg/L]) located upgradient to cross-gradient (northeast to east) of the tailings cells. A nitrate plume (defined by concentrations greater than 10 milligrams per liter [mg/L]) that contains elevated chloride (exceeding 100 mg/L) extends from upgradient (northeast) of the tailings cells to a portion of the area beneath the tailings cells. The precise source(s) of the nitrate plume are not well defined; however, because the majority of the plume exists upgradient (northeast) of the tailings cells, the sources must be located upgradient (northeast) of the tailings cells. Based on the investigation and source evaluations, there are no known current unidentified or unaddressed sources. There appear to have been a number of known and potential historical sources; however, it has not been possible to confirm or quantify the contribution of each source.

The northwest portion of the chloroform plume commingles with the nitrate plume. Both chloroform and nitrate plumes are under corrective action by pumping.

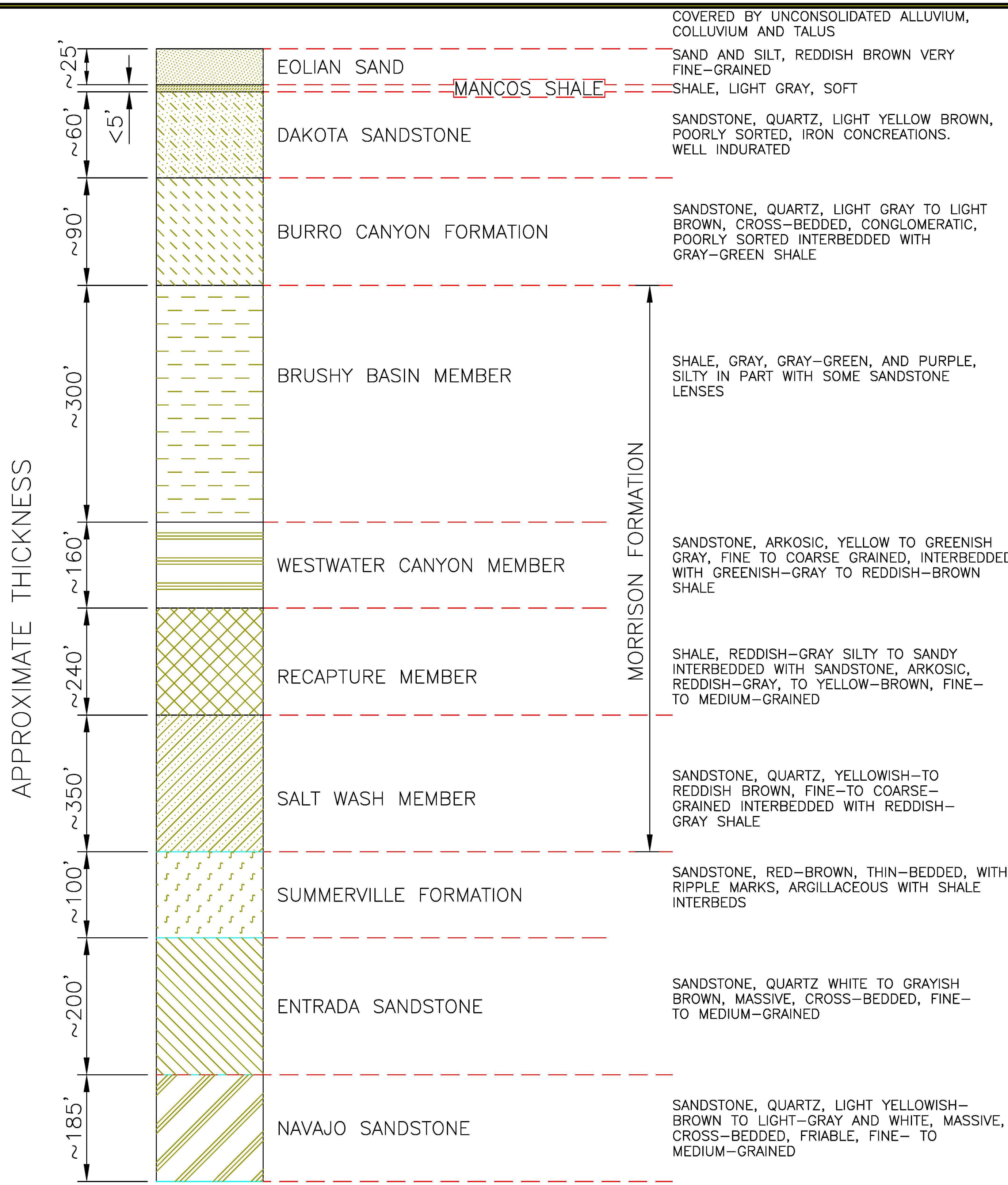
1.5.1.1 Geologic Setting

The Mill is located within the Blanding Basin of the Colorado Plateau physiographic province. Typical of large portions of the Colorado Plateau province, the rocks underlying the site are relatively undeformed. The average site elevation is approximately 5,600 ft (1,707 m) above mean sea level (amsl).

The site is underlain by unconsolidated alluvium and indurated sedimentary rocks consisting primarily of sandstone and shale. The indurated rocks are relatively flat lying with dips generally less than 3 degrees. The alluvial materials consist mostly of aeolian silts and fine-grained aeolian sands with a thickness varying from a few feet to as much as 25 to 30 ft (7.6 to 9.1 m) across the site. The alluvium is underlain by the Dakota Sandstone and Burro Canyon Formation, which are sandstones with a total thickness ranging from approximately 55 to 140 ft (17 to 43 m). Beneath the Burro Canyon Formation lies the Morrison Formation, consisting (in descending order) of the Brushy Basin Member, the Westwater Canyon Member, the Recapture Member, and the Salt Wash Member. Kirby (2008) indicates that the contact between the Morrison Formation and the Burro Canyon Formation (between the Brushy Basin Member of the Morrison and the Burro Canyon Formation) near Blanding, Utah is disconformable with “local erosional relief of several feet”. Data collected from perched borings at the site that penetrate the Brushy Basin Member are consistent with a disconformable, erosional contact in agreement with Kirby (2008).

The Brushy Basin and Recapture Members of the Morrison Formation, classified as shales, are fine-grained and have a low permeability. The Westwater Canyon and Salt Wash Members also have a low average vertical permeability due to the presence of interbedded shales. See Figure 1.5-1 for a generalized stratigraphic column for the region.

Beneath the Morrison Formation lies the Summerville Formation, an argillaceous sandstone with interbedded shales, and the Entrada Sandstone. Beneath the Entrada Sandstone lies the Navajo Sandstone. The Navajo and Entrada Sandstones constitute the primary aquifer in the area of the site. The Entrada and Navajo Sandstones are separated from the Burro Canyon Formation by approximately 1,000 to 1,100 ft (305 to 335 m) of materials with a low average vertical permeability. Groundwater within this system is under artesian pressure in the vicinity of the site, and is used only as a secondary source of water at the site. Water in WW-series supply wells completed across these sandstone units at the site rises approximately 800 feet above the base of the overlying Summerville Formation (Titan, 1994a).



Taken from Stratigraphic Section near Water Well #3

W:\USA\Utah\Mill\dwgs\Reclamation Plans\RecPlan4.0\Figure 1.5-1 Stratigraphic Column.dwg Figure 3 23/11/2009 dsledd

ENERGY FUELS

Project: WHITE MESA MILL

REVISIONS		County:	State: UT
Date	By	Location:	

Figure 1.5-1

Generalized Stratigraphy of White Mesa Mill

Scale: N/A	Date: Aug 2009
Author: HRR	Drafted By: D.Sledd

1.5.1.2 Hydrogeologic Setting

The site is located within a dry to arid continental climate region with an average annual precipitation of less than 13.3 in. and an annual lake evaporation rate of approximately 47.6 inches. Recharge to aquifers (such as the Entrada/Navajo) occurs primarily along the mountain fronts (for example, the Henry, Abajo, and La Sal Mountains), and along the flanks of folds such as Comb Ridge Monocline.

The Entrada/Navajo aquifer can yield significant quantities of water to wells (hundreds of gallons per minute [gpm]). Although the water quality and productivity of the Entrada/Navajo aquifer are generally good, the depth of the aquifer (approximately 1,200 ft below land surface [bls]) makes access difficult.

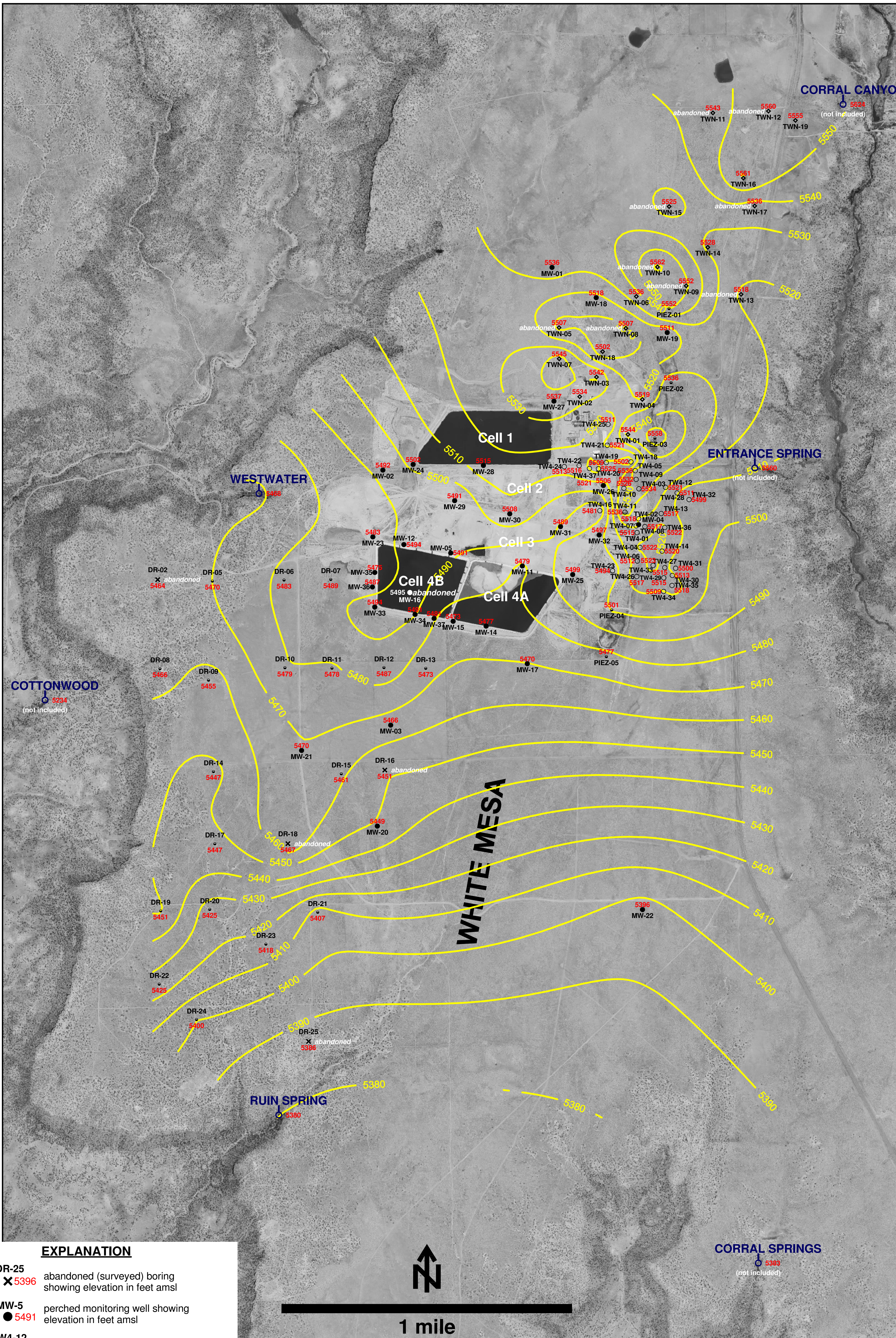
1.5.1.3 Perched Zone Hydrogeology

Perched groundwater beneath the site occurs primarily within the Burro Canyon Formation, although in areas having greater saturated thicknesses, perched groundwater extends into the overlying Dakota Sandstone. Perched groundwater originates mainly from precipitation and local recharge sources such as unlined reservoirs (Kirby, 2008). Perched groundwater at the site has a generally low quality due to high total dissolved solids (TDS) and is used primarily for stock watering and irrigation in the areas upgradient (north) of the site. As of the first quarter of 2016, TDS concentrations measured in water sampled from on-site perched monitoring wells range between approximately 1,000 and 8,300 mg/1. The saturated thickness of the perched water zone generally increases to the north of the site, increasing the yield of the perched zone to wells installed north of the site. Perched water is supported within the Burro Canyon Formation by the underlying, fine-grained Brushy Basin Member.

The Brushy Basin Member is primarily composed of bentonitic mudstones, siltstones, and claystones and is considered an aquiclude. Figure 1.5-2 is a contour map showing the approximate elevation of the contact of the Burro Canyon Formation with the Brushy Basin Member, which essentially forms the base of the perched water zone at the site. The elevations of Ruin Spring and Westwater Seep, which occur at the contact between the Brushy Basin Member and the Burro Canyon Formation, are included in the contouring. Abandoned borings/wells, monitoring wells, and piezometers shown on Figure 1.5-2 consist of surveyed perched zone monitoring wells and piezometers that include temporary perched zone borings and monitoring wells associated with the chloroform and nitrate plumes located east and northeast (cross gradient to upgradient) of the tailings cells. TW-4-series wells, MW-4, MW-26, and MW-32 are chloroform program wells and TWN-series wells are nitrate program wells. Contact elevations are based on monitoring well drilling and geophysical logs and surveyed land surface elevations.

As indicated on Figure 1.5-2, the contact generally dips to the south/southwest beneath the site. A structural high that is evident in the Brushy Basin Member/Burro Canyon Formation contact extends from beneath Cell 4B southwest to the vicinity of abandoned boring DR-18. A paleovalley in the Brushy Basin Member surface is present along the western mesa rim to the west of the structural high.

The permeability of the Dakota Sandstone and Burro Canyon Formation at the site is generally low. No significant joints or fractures within the Dakota Sandstone or Burro Canyon Formation have been documented in any wells or borings installed across the site (Knight Piésold, 1998). Any fractures observed in cores collected from site borings are typically cemented, showing no open space.



EXPLANATION

DR-25 ✕ 5396	abandoned (surveyed) boring showing elevation in feet amsl
MW-5 ● 5491	perched monitoring well showing elevation in feet amsl
TW4-12 ○ 5521	temporary perched monitoring well showing elevation in feet amsl
TWN-7 ◆ 5545	temporary perched nitrate monitoring well showing elevation in feet amsl
PIEZ-1 5552	perched piezometer showing elevation in feet amsl
RUIN SPRING 5380	seep or spring showing elevation in feet amsl

HYDRO GEO CHEM, INC.

KRIGED TOP OF BRUSHY BASIN MEMBER WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
		H:/718000/RelamationPlan/Ubb0316_Rec.srf	1.5-2

Based on samples collected during installation of wells MW-16 (immediately downgradient of tailings cell 3 and abandoned prior to construction of cell 4B) and MW-17 (cross-gradient of the tailings cells complex (Figure 1.5-2)), porosities of the Dakota Sandstone range from 13.4 percent to 26 percent, averaging 20 percent. Water saturations range from 3.7 percent to 27.2 percent, averaging 13.5 percent. The average volumetric water content is approximately 3 percent. The hydraulic conductivity of the Dakota Sandstone, based on packer tests in borings installed at the site, ranges from 2.71E-06 centimeters per second (cm/s) to 9.12E-04 cm/s, with a geometric average of 3.89E-05 cm/s (Titan, 1994a).

The average porosity of the Burro Canyon Formation is similar to that of the Dakota Sandstone. Based on samples collected from the Burro Canyon Formation at MW-16 (abandoned), porosity ranges from 2 percent to 29.1 percent, averaging 18.3 percent. Water saturations of unsaturated materials range from 0.6 percent to 77.2 percent, averaging 23.4 percent. Titan (1994a) reported that the hydraulic conductivity of the Burro Canyon Formation ranges from 1.9E-07 to 1.6E-03 cm/s, with a geometric mean of 1.1E-05 cm/s, based on the results of 12 pump/recovery tests performed in monitoring wells and 30 packer tests performed in borings prior to 1994.

Subsequent hydraulic testing of perched zone wells yielded a site-wide hydraulic conductivity range of 2 x 10^{-8} to 0.01 cm/s (HGC, 2014). In general, the highest permeabilities and well yields are immediately northeast and east (upgradient to cross gradient) of the tailings cells. A relatively continuous, higher permeability zone (associated with poorly indurated coarser-grained materials in the general area of the chloroform plume) has been inferred to exist in this portion of the site. Analysis of drawdown data collected from this zone during long-term pumping of MW-4, MW-26 (formerly TW4-15), and TW4-19 yielded estimates of hydraulic conductivity ranging from 4E-05 to 1E-03 cm/s. The decrease in perched zone permeability south, southwest, and southeast of TW4-4, based on hydraulic tests at TW4-6, TW4-23, TW4-26, TW4-27, TW4-29 through TW4-31, and TW4-33 through TW4-35 indicate that this higher permeability zone “pinches out”.

Hydraulic tests performed at groups of wells and piezometers located northeast (upgradient) of, in the immediate vicinity of, and southwest (downgradient) of the tailings cells indicate generally lower permeabilities compared with the area of the chloroform plume. The following results from HGC (2014) are based on analysis of automatically logged slug test data using the KGS solution available in AQTESOLVE (HydroSOLVE, 2000).

Testing of 19 TWN-series wells installed in the northeast portion of the site as part of nitrate investigation activities yielded a hydraulic conductivity range of approximately 3.6 x 10^{-7} to 0.01 cm/s with a geometric average of approximately 6 x 10^{-5} cm/s. The value of 0.01 cm/s estimated for TWN-16 is the highest measured at the site, and the value of 3.6 x 10^{-7} cm/s estimated for TWN-7 is one of the lowest measured at the site. Testing of MW-series wells MW-23 through MW-32 installed between and at the margins of the tailings cells in 2005 (and using the higher estimate for MW-23) yielded a hydraulic conductivity range of approximately 2 x 10^{-7} to 1 x 10^{-4} cm/s with a geometric average of approximately 2 x 10^{-5} cm/s. Hydraulic tests conducted at DR-series piezometers installed as part of the southwest area investigation downgradient of the tailings cells yielded hydraulic conductivities ranging from approximately 2 x 10^{-8} to 4 x 10^{-4} cm/s with a geometric average of 9.6 x 10^{-6} cm/s. The low permeabilities and shallow hydraulic gradients downgradient of the tailings cells result in average perched groundwater pore velocity estimates that are among the lowest on site (approximately 0.26 feet per year (ft/yr) to 0.91 ft/yr).

The extensive hydraulic testing of perched zone wells at the site indicates that perched zone permeabilities are generally low with the exception of the apparently isolated zone of higher permeability associated with the chloroform plume east to northeast (cross-gradient to upgradient) of the tailings cells. The geometric average hydraulic conductivity (less than 1 x 10^{-5} cm/s) of the DR-series piezometers which cover an area nearly half the size of the total monitored area at White Mesa (excluding MW-22), is nearly identical to the geometric average hydraulic conductivity of 1.01 x 10^{-5} cm/s reported by Titan (1994a), and is within the range of 5 to 10 feet per year (ft/yr) [approximately 5 x 10^{-6} cm/s to 1 x 10^{-5} cm/s] reported by Dames and Moore (1978b) for the (saturated) perched zone during the initial site investigation.

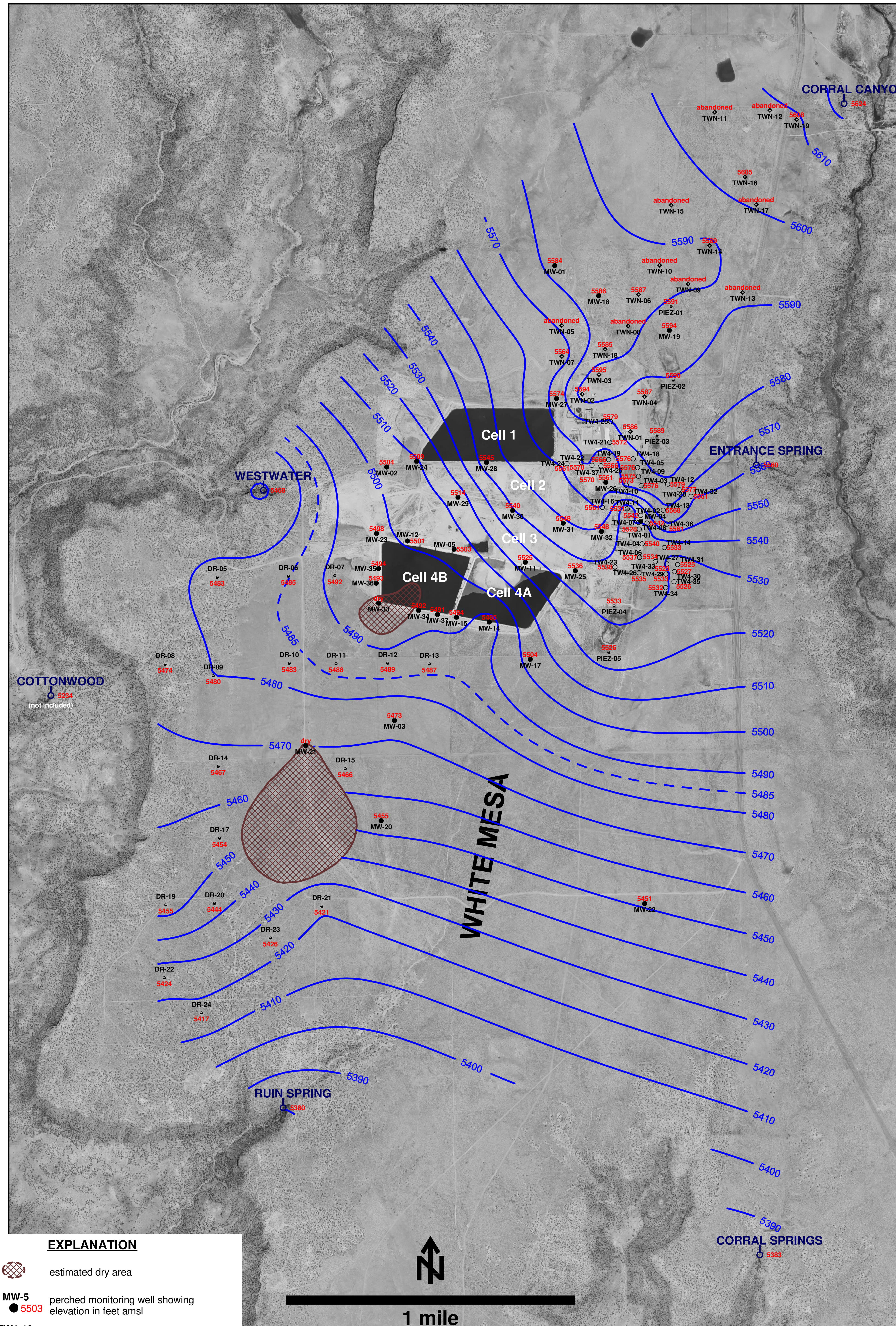
Because of the generally low permeability of the perched zone beneath the site, well yields are typically low (generally less than 0.5 gpm). Many of the perched monitoring wells purge dry and take several hours to more than a day to recover sufficiently for groundwater samples to be collected. Sufficient productivity can generally be obtained only in areas where the saturated thickness is greater, which is the primary reason that the perched zone has been used on a limited basis as a water supply to the north (upgradient) of the site, but has not been used downgradient of the site. Within areas on the east side of the site that have greater saturated thicknesses due to proximity to the two northern wildlife ponds, and that intercept the higher permeability materials associated with the chloroform plume, well yields of as much as 4 gpm were achievable. However, since water delivery to the two northern wildlife ponds ceased in 2012, saturated thicknesses and well productivities in this area have diminished. As of the fourth quarter of 2015, sustainable, average pumping rates at chloroform and nitrate pumping wells ranged from less than 0.1 to approximately 1 gpm

1.5.1.4 Perched Groundwater Flow

Perched groundwater flow at the site is generally from northeast to southwest. Figure 1.5-3 displays the local perched groundwater elevation contours at the Mill, as measured in the first quarter of 2016. Depression of the perched water table occurs near chloroform pumping wells MW-4, MW-26, TW4-1, TW4-2, TW4-4, TW4-11, TW4-19, TW4-20, TW4-21, TW4-22 and TW4-37, and near nitrate pumping wells TW4-22, TW4-24, TW4-25, and TWN-2. These wells are pumped to reduce chloroform and nitrate mass in the perched zone east and northeast of the tailings cells. As shown on Figure 1.5-3, beneath and south of the tailings management cells, in the west central portion of the site, perched water flow is south-southwest to southwest. Flow on the western margin of the mesa is generally south, approximately parallel to the rim (where the Burro Canyon Formation [and perched water zone] is terminated by erosion). On the eastern side of the site perched water flow is also generally to the south. Because of mounding near wildlife ponds, flow direction ranges locally from westerly (west of the ponds) to easterly (east of the ponds).

Dry areas in the perched zone southwest of the tailings management cells occur along the structural high in the Brushy Basin Member/Burro Canyon Formation contact that extends from beneath tailings cell 4B southwest to the vicinity of abandoned boring DR-18. In places along this structural high the contact rises above the perched water elevation creating the dry areas shown on Figure 1.5-3.

An apparent groundwater divide occurs west of Cell 4B near DR-2. Water north of the apparent divide flows primarily north-northeast to Westwater Seep and water south of the apparent divide flows south toward Ruin Spring.



EXPLANATION

estimated dry area

MW-5 5503 — perched monitoring well showing elevation in feet amsl

TW4-12 5579 — temporary perched monitoring well showing elevation in feet amsl

TWN-7 5564 — temporary perched nitrate monitoring well showing elevation in feet amsl

PIEZ-1 5591 — perched piezometer showing elevation in feet amsl

RUIN SPRING 5380 — seep or spring showing elevation in feet amsl

NOTES: MW-4, MW-26, TW4-1, TW4-2, TW4-4, TW4-11,TW4-19, TW4-20, TW4-21 and TW4-37 are chloroform pumping wells; TW4-22, TW4-24, TW4-25, and TWN-2 are nitrate pumping wells
TW4-11 water level is below the base of the Burro Canyon Formation

HYDRO GEO CHEM, INC.

KRIGED 1st QUARTER, 2016 WATER LEVELS WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
		H:/718000/ReclamationPlan/Uwl0316_Rec.srf	1.5-3

Perched zone hydraulic gradients currently range from a maximum of approximately 0.096 ft/ft east of tailings cell 2 (north of pumping well TW4-11) to approximately 0.0042 ft/ft west-southwest of Cell 4B (between DR-7 and DR-5). The overall average site hydraulic gradient of approximately 0.011 ft/ft (between TWN-19 and Ruin Spring) is similar to the average hydraulic gradient downgradient of the tailings management cells of approximately 0.012 ft/ft (between MW-37 and Ruin Spring).

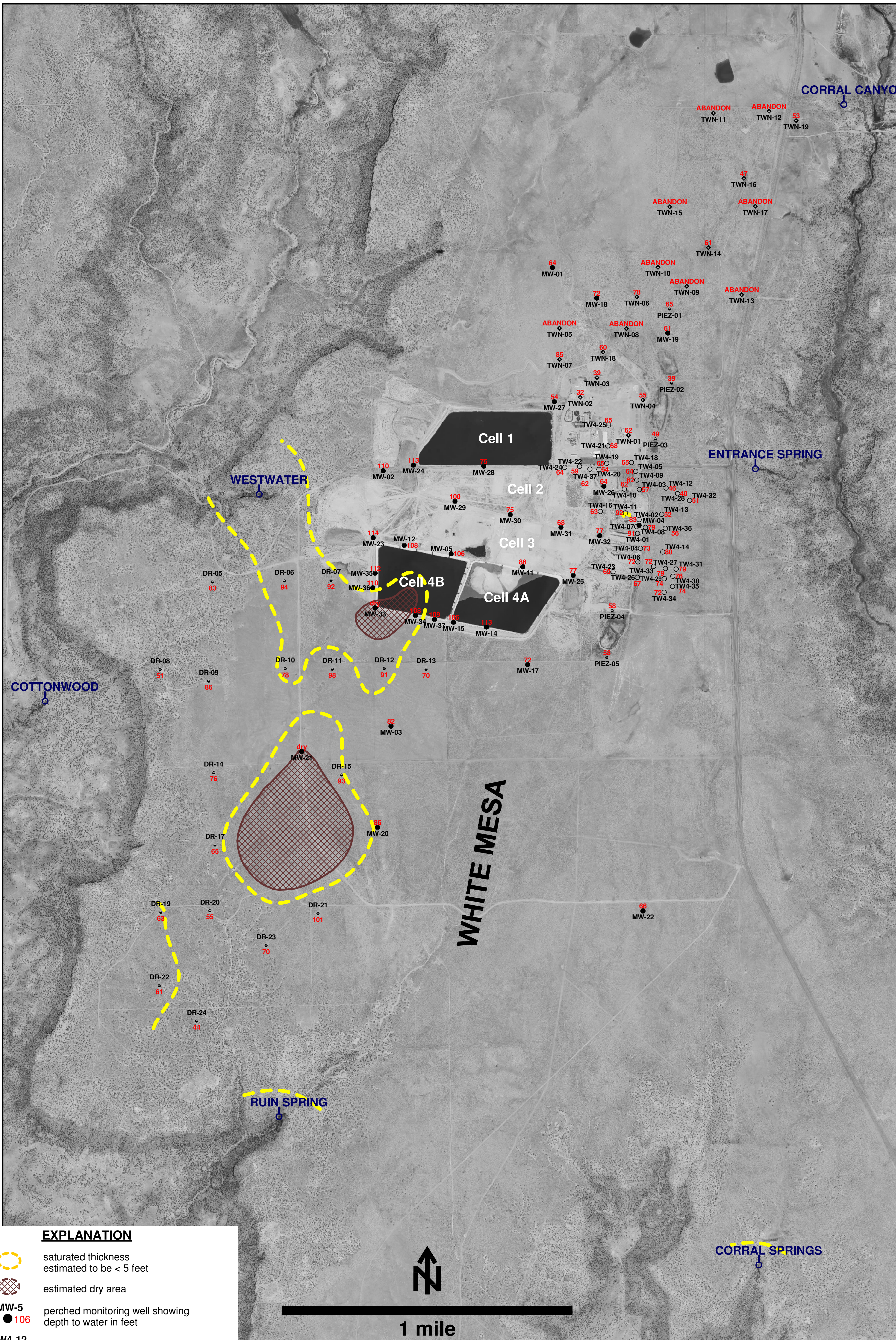
1.5.1.5 Perched Zone Hydrogeology Beneath and Downgradient of The Tailings Management Cells

Based on measurements at non-pumping wells, 1st Quarter, 2016 perched water depths ranged from approximately 32 feet in the northeastern portion of the site (adjacent to the wildlife ponds) to approximately 114 feet at the southwest margin of Cell 3 (Figure 1.5-4). Based on measurements at non-pumping wells, 1st Quarter, 2016 perched zone saturated thicknesses ranged from approximately 83 ft in the northeast portion of the site to less than 1 ft in the southwest portion of the site (Figure 1.5-5). The relatively large saturated thicknesses in the northeastern portion of the site are related to past seepage from the northern wildlife ponds located northeast of the tailings management cells.

Water levels in DR-22 and chloroform pumping well TW4-11 are below the top of the Brushy Basin Member, yielding saturated thicknesses of zero. Casings in DR-22 and TW4-11 extend approximately 2.5 feet and 11.5 feet, respectively, below the Brushy Basin Member contact. Although water is present in the bottom of the DR-22 casing, the level is below the Brushy Basin contact. The water level in TW4-11 is maintained at or below the Brushy Basin contact by pumping.

Areas of small saturated thickness (less than 5 feet) occur west and southwest of the tailings management cells. As shown in Figures 1.5-4 and 1.5-5, an area of small saturated thickness extends between Westwater Seep and the southwest portion of Cell 4B, encompassing DR-6 and DR-10. As discussed in HGC (2014), perched water flows westward from the area of the tailings cells through the area of low saturated thickness between DR-6 and DR-10, into an area having saturated thicknesses several times larger than at DR-6 and DR-10. The transmissivity (the product of hydraulic conductivity and saturated thickness) of the area of low saturated thickness is two to three orders of magnitude lower than for the area of larger saturated thickness to the west (near DR-2 [abandoned], DR-5, and DR-9). Water flows out of the area of larger saturated thickness (near DR-2 [abandoned] and DR-5) to the northeast toward known discharge point Westwater Seep and to the south through a paleovalley in the Brushy Basin Member surface towards known discharge point Ruin Spring. The relationship between perched water and seeps and springs is discussed in more detail in Section 1.5.2.

Darcy's Law calculations presented in HGC (2014) indicate that an additional water source is needed to maintain the relatively large saturated thicknesses west of the area of low saturated thickness encompassing DR-6 and DR-10; otherwise Westwater Seep and the paleovalley to the south would drain the area of larger saturated thickness more quickly than water was supplied. The most likely source of additional water to the area of larger saturated thickness is infiltration of precipitation.



EXPLANATION

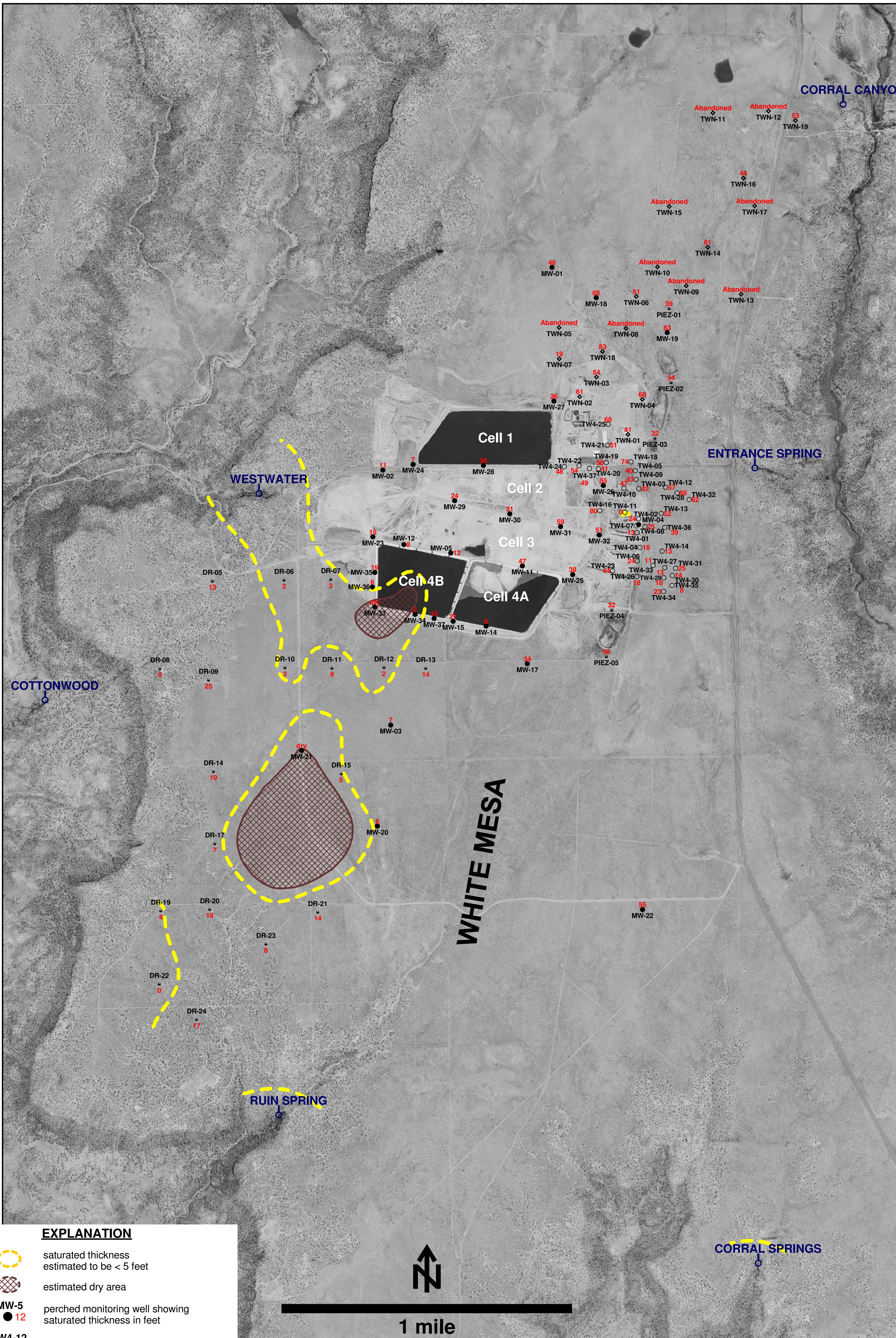
- saturated thickness estimated to be < 5 feet
- estimated dry area
- MW-5 ● 106 — perched monitoring well showing depth to water in feet
- TW4-12 ○ 46 — temporary perched monitoring well showing depth to water in feet
- TWN-7 ◆ 85 — temporary perched nitrate monitoring well showing depth to water in feet
- PIEZ-1 ◒ 65 — perched piezometer showing depth to water in feet
- RUIN SPRING — seep or spring

NOTES: MW-4, MW-26, TW4-1, TW4-2, TW4-4, TW4-11,TW4-19, TW4-20, TW4-21 and TW4-37 are chloroform pumping wells; TW4-22, TW4-24, TW4-25, and TWN-2 are nitrate pumping wells
TW4-11 water level is below the base of the Burro Canyon Formation

HYDRO GEO CHEM, INC.

1st QUARTER, 2016 DEPTHS TO PERCHED WATER (FROM MEASURING POINT) WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
		H:/718000/ReclamationPlan/Udtw0316_Rec.srf	1.5-4



EXPLANATION

saturated thickness estimated to be < 5 feet

estimated dry area

MW-5 ● 12 perched monitoring well showing saturated thickness in feet

TW4-12 ○ 57 temporary perched monitoring well showing saturated thickness in feet

TWN-7 ◆ 19 temporary perched nitrate monitoring well showing saturated thickness in feet

PIEZ-1 ◓ 39 perched piezometer showing saturated thickness in feet

RUIN SPRING seep or spring

NOTES: MW-4, MW-26, TW4-1, TW4-2, TW4-4, TW4-11,TW4-19, TW4-20, TW4-21 and TW4-37 are chloroform pumping wells; TW4-22, TW4-24, TW4-25, and TWN-2 are nitrate pumping wells
TW4-11 water level is below the base of the Burro Canyon Formation

HYDRO GEO CHEM, INC.

1st QUARTER, 2016 PERCHED ZONE SATURATED THICKNESSES WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
		H:/718000/ReclamationPlan/Usat0316_Rec.srf	1.5-5

As discussed above, perched zone hydraulic gradients currently range from a maximum of approximately 0.096 feet per foot (ft/ft) east of Cell 2 to approximately 0.0042 ft/ft west-southwest of the tailings management cells, between DR-7 and DR-5. The average hydraulic gradient between the downgradient edge of tailings Cell 4B and Ruin Spring is approximately 0.012 ft/ft, similar to the overall site hydraulic gradient (between TWN-19 and Ruin Spring) of approximately 0.011 ft/ft. The combination of relatively low hydraulic conductivities (geometric average of approximately 1 x 10^{-5} cm/s) and relatively flat hydraulic gradients downgradient of the tailings management cells imply small groundwater velocities and large travel times.

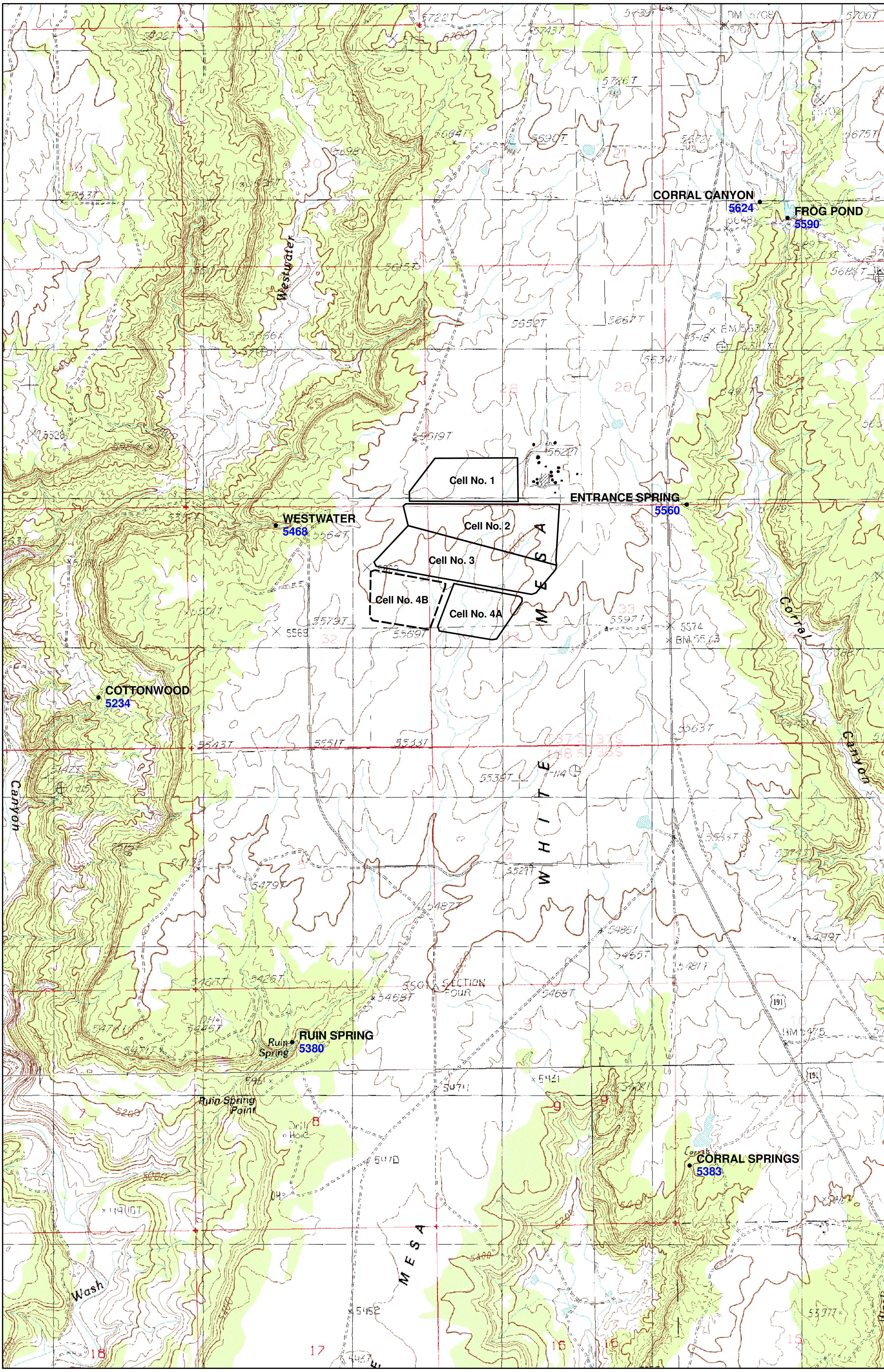
1.5.2 Seep and Spring Occurrence and Hydrogeology

Perched groundwater discharges in seeps and springs located to the west, south, east, and southeast of the site along the margins of White Mesa.

All seeps and springs examined have associated cottonwood trees that suggest a relatively consistent source of water. Seeps and springs occurring at the margins of White Mesa are typically associated with sandstones of the Burro Canyon Formation, except Cottonwood Seep, which is associated with the lower portion of the Brushy Basin Member of the Morrison Formation. Figure 1.5-6 shows the December 2009 surveyed locations of seeps and springs and the Frog Pond. As shown on Figure 1.5-6, all springs and seeps are located within drainages, and except for Cottonwood Seep, are located at the mesa margins. Table 1.5-1 provides surveyed locations and elevations of the seeps and springs and the Frog Pond. The December 2009 seep and spring survey data shown in Table 1.5-1 were used in subsequent reporting where seep and spring locations and elevations were relevant.

Table 1.5-1
Surveyed Locations and Elevations of Seeps and Springs and the Frog Pond
(December 2009)

Location	Latitude (N)	Longitude (W)	Elevation
FROG POND	37°33'03.5358"	109°29'04.9552"	5589.56
CORRAL CANYON	37°33'07.1392"	109°29'12.3907"	5623.97
ENTRANCE	37°32'01.6487"	109°29'33.7005"	5559.71
CORRAL SPRINGS	37°29'37.9192"	109°29'35.8201"	5383.35
RUIN SPRING	37°30'06.0448"	109°31'23.4300"	5380.03
COTTONWOOD	37°31'21.7002"	109°32'14.7923"	5234.33
WEST WATER	37°31'58.5020"	109°31'25.7345"	5468.23
Re-Surveyed July 2010			
RUIN SPRING	37°30'06.0456"	109°31'23.4181"	5380.01
COTTONWOOD	37°31'21.6987"	109°32'14.7927"	5234.27
WEST WATER	37°31'58.5013"	109°31'25.7357"	5468.32



0.5 0.25 0 0.5 1 Mile

● WESTWATER 5468 Seep or Spring Elevation (feet) above mean sea level

NORTH

HYDRO GEO CHEM, INC.

SEEPS AND SPRINGS
ON USGS TOPOGRAPHIC BASE
WHITE MESA

Approved	Date	Author	Date	File Name	Figure
SJS	09/17/10	DRS	07/16/10	7180002G	1.5-6

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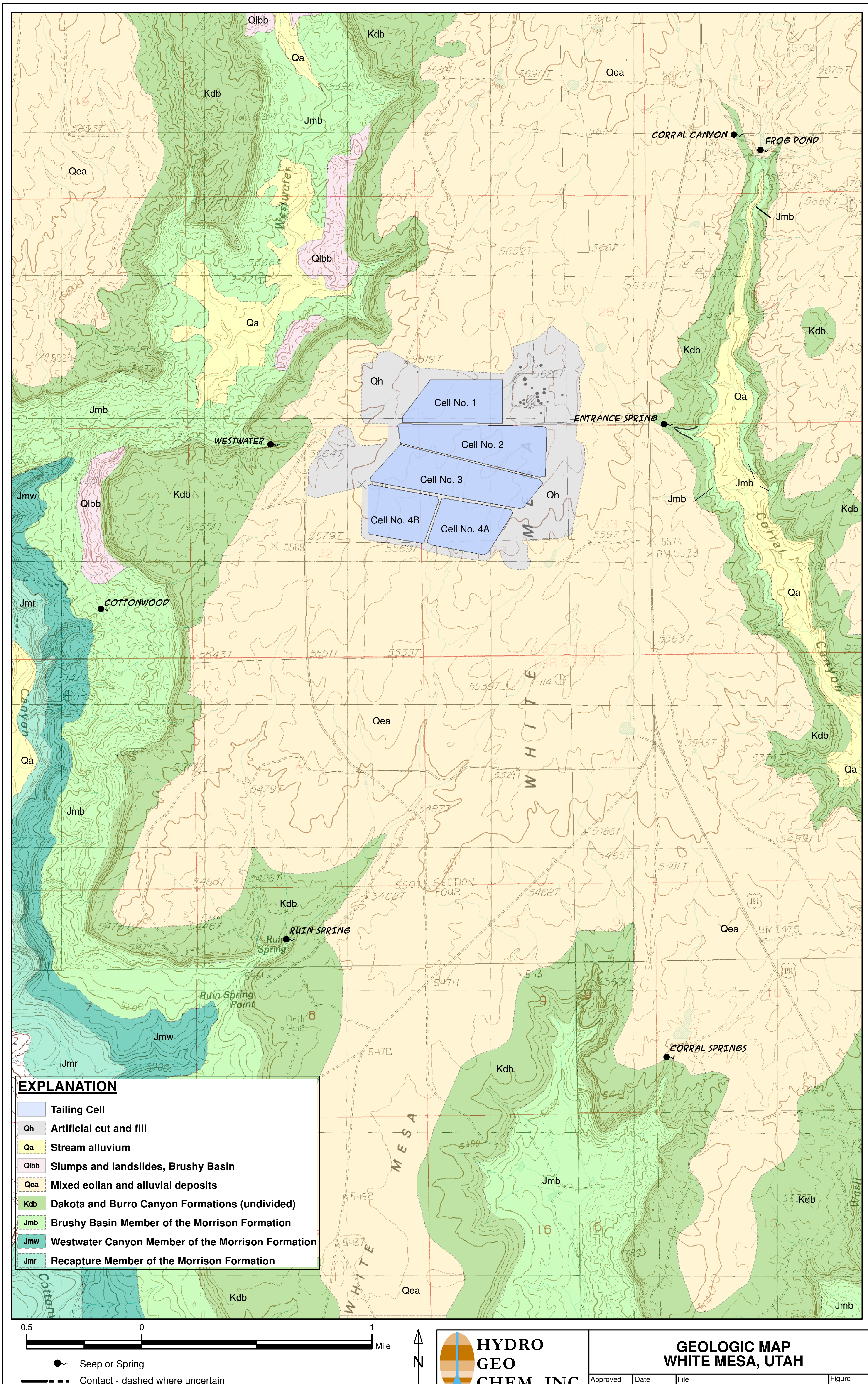
As discussed in Section 1.1.5.4, Figure 1.5-3 shows first quarter 2016 perched water level contours and the locations and elevations of seeps and springs. Perched water level contours are based on water levels measured in the perched groundwater monitoring wells shown on Figure 1.5-3, and include elevations of all seeps and springs except Cottonwood Seep. Based on Figure 1.5-3, Corral Canyon Seep is located upgradient of the tailings management cells, and Entrance Spring and Corral Springs are located cross gradient of the tailings management cells. Both Entrance Spring and Corral Springs are separated from the tailings management cells by a groundwater divide. Westwater Seep is the closest discharge point west of the tailings management cells and Ruin Spring is the closest discharge point south-southwest of the tailings management system. Ruin Spring is located downgradient of approximately the southeastern 2/3 of the tailings management system, and Westwater Seep appears to be downgradient of approximately the northwestern 1/3 of the tailings management system. Cottonwood Seep is neither cross gradient nor downgradient of the tailings management cells because it is interpreted to receive water from a source other than the perched groundwater system hosted by the Burro Canyon Formation.

The relationship between seeps and springs and the geology of White Mesa are shown on Figure 1.5-7. The geology on Figure 1.5-7 is based on Kirby (2008) and Hintze, et al. (2000), and has been modified locally by field reconnaissance. The Burro Canyon Formation and the Dakota Sandstone are undifferentiated on the geologic map. As shown on Figure 1.5-7, all seeps and springs except Cottonwood Seep are associated with outcrops of the Burro Canyon Formation (and/or Dakota Sandstone). Some are also associated with mixed eolian and alluvial deposits stratigraphically above the Burro Canyon Formation and/or Dakota Sandstone. Ruin Spring and Westwater Seep are located at the contact between the Burro Canyon Formation and underlying Brushy Basin Member. Westwater Seep (where typically sampled) occurs within alluvium at the Burro Canyon Formation/Brushy Basin Member contact whereas Ruin Spring occurs at the contact but above the alluvium in the associated drainage. Corral Canyon Seep, Entrance Spring, and Corral Springs occur within alluvium near the contact of the alluvium with the Burro Canyon Formation, but at an elevation above the contact between the Burro Canyon Formation and Brushy Basin Member. In contrast, Cottonwood Seep is mapped within the Brushy Basin Member, approximately 1,500 feet west of the termination of the Burro Canyon Formation at the western mesa rim, and stratigraphically more than 200 feet below the contact between the Burro Canyon Formation and Brushy Basin Member.

The Burro Canyon Formation (and perched water zone) does not exist at Cottonwood Seep because it has been eroded. Cottonwood Seep is interpreted to receive water primarily from a source stratigraphically below the Burro Canyon Formation and from a hydrogeologic system other than the perched water system at the site. The primary source of Cottonwood Seep (and “2nd Seep” immediately to the north of Cottonwood Seep) is interpreted to be coarser-grained materials within the lower portion of the Brushy Basin Member or upper portion of the Westwater Canyon Member.



Geological Map of the Blanding Area, San Juan County, Utah (modified from Haynes et al., 1962; Dames & Moore, 1978 and Kirby, 2008)
Base Map Prepared from Portions of the Blanding South, Black Mesa Butte, Big Bench and No Mans Land U.S.G.S. 7.5' Quadrangles.

Springs occurring within alluvium deposited within drainages cutting the Burro Canyon Formation may or may not receive a contribution from perched water. Except for Ruin Spring (and "2nd Seep" immediately to the north of Cottonwood Seep), each spring and seep occurs in alluvial materials within a drainage that will supply surface water during wet periods and help to recharge any alluvial materials within the drainage as well as bedrock near the drainage. Westwater Seep, Corral Canyon Seep, Entrance Spring, and Corral Springs may therefore receive water from both alluvial and bedrock (perched water) sources. Corral Springs, located immediately downgradient of a stock pond, may receive water primarily from alluvium recharged from the stock pond. Any alluvial materials within the drainage or marginal bedrock that are recharged during precipitation events will likely, at least temporarily, yield water to the seeps.

HGC (2014) discusses the potential for enhanced recharge from precipitation along the mesa margins where Dakota Sandstone and/or Burro Canyon Formation are exposed by erosion. Such recharge is expected to temporarily enhance flow at nearby seeps and springs draining the Burro Canyon Formation and/or Dakota Sandstone. The area of increased saturated thickness west of DR-6 and DR-10 is likely the result of recharge enhanced by the direct exposure of weathered Dakota Sandstone and Burro Canyon Formation, and the thinness or absence of any overlying low permeability materials such as the Mancos Shale (Figure 1.5-7).

Although seep and spring elevations (except Cottonwood Seep) have been included in perched water level contour maps (such as Figure 1.5-3) since the HGC (2010b) investigation, the assumption that the seep or spring elevation is representative of the perched water elevation is likely to be correct only in cases where the feature receives most or all of its flow from the perched water, and where the supply is relatively continuous (for example, Ruin Spring). The uncertainty that results from including seeps and springs in the contouring of perched water levels must be considered when interpreting perched water level data.

Using amethod similar to that presented in HGC (2009a), perched water pore velocities and travel times between the tailings management cells and Ruin Spring and between the tailings management cells and Westwater Seep were calculated in HGC (2014) using first Quarter 2014 water levels. As discussed in more detail in HGC (2014), the calculated travel times between the downgradient margin of cell 4B and Ruin Spring range from approximately 10,650 to 19,650 years. The calculated travel time between the southwest corner of Cell 3 to Westwater Seep is approximately 3,230 years.

1.5.3 Groundwater Quality

1.5.3.1 Entrada/Navajo Aquifer

The Entrada and Navajo Sandstones are relatively prolific aquifers beneath and in the vicinity of the site. Water wells at the site are screened in both of these units, and for the purposes of this discussion they will be treated as a single aquifer. Water in the Entrada/Navajo Aquifer is under artesian pressure, rising 800 to 900 ft above the top of the Entrada's contact with the overlying Summervillle Formation; static water levels are 390 to 500 ft below ground surface.

Within the region, this aquifer is capable of yielding domestic quality water at rates of 150 to 225 gpm. For that reason, it serves as a secondary source of water for the Mill. Additionally, two domestic water supply wells drawing from the Entrada/Navajo Aquifer are located 4.5 miles southeast of the Mill site on the Ute Mountain Ute Reservation. Although the water quality and productivity of the Navajo/Entrada aquifer are generally good, the depth of the aquifer (greater than1,000 ft bls) makes access difficult.

Table 1.5-2 is a tabulation of groundwater quality of the Navajo Sandstone aquifer as reported in the FES and subsequent sampling. TDS ranges from 216 to 1,110 mg/l in three samples taken over a period from January 27, 1977, to May 4, 1977. High iron concentrations are found in the Navajo Sandstone. Because the Navajo Sandstone aquifer is isolated from the perched groundwater zone by approximately 1,000 to 1,100 ft of materials having a low average vertical permeability, sampling of the Navajo Sandstone is not required under the Mill's previous NRC Point of Compliance monitoring program or under the GWDP. However, samples were taken at two other deep aquifer wells (#2 and #5) on site (see Figure 1.5-8 for the locations of these wells), on June 1, 1999 and June 8, 1999, respectively, and the results are included in Table 1.5-2.

Table 1.5-2
Water Quality of the Navajo Sandstone Aquifer in the Mill Vicinity

Parameter	FES, Test Well (G2R) (1/27/77 - 3/23/78[1])	Well #2 6/01/99[1]	Well #5 6/08/99[1]
Field Specific Conductivity (umhos/cm)	310 to 400		
Field pH	6.9 to 7.6		
Temperature (ºC)	11 to 22		
Estimated Flow m/hr (gpm)	109(20)		
pH	7.9 to 8.16		
Determination, mg/liter			
TDS (@180ºC)	216 to 1110		
Redox Potential	211 to 220		
Alkalinity (as $CaCOS_3$)	180 to 224		
Hardness, total (as $CaCO_3$)	177 to 208		
Bicarbonate		226	214
Carbonate (as CO_3)	0.0	<1.0	<1.0
Aluminum		0.003	0.058
Aluminum, dissolved	<0.1		
Ammonia (as N)	0.0 to 0.16	<0.05	<0.05
Antimony		<0.001	<0.001
Arsenic, total	.007 to 0.014	0.018	<0.001
Barium, total	0.0 to 0.15	0.119	0.005
Beryllium		<0.001	<0.001
Boron, total	<0.1 to 0.11		
Cadmium, total	<0.005 to 0.0	<0.001	0.018
Calcium		50.6	39.8
Calcium, dissolved	51 to 112		
Chloride	0.0 to 50	<1.0	2.3
Sodium		7.3	9.8
Sodium, dissolved	5.3 to 23		
Silver		<0.001	<0.001
Silver, dissolved	<0.002 to 0.0		
Sulfate		28.8	23.6
Sulfate, dissolved (as SO_4)	17 to 83		
Vanadium		0.003	0.003
Vanadium, dissolved	<.002 to 0.16		
Manganese		0.011	0.032
Manganese, dissolved	0.03 to 0.020		
Chromium, total	0.02 to 0.0	0.005	0.005
Copper, total	0.005 to 0.0	0.002	0.086
Fluoride		0.18	0.18
Fluoride, dissolved	0.1 to 0.22		

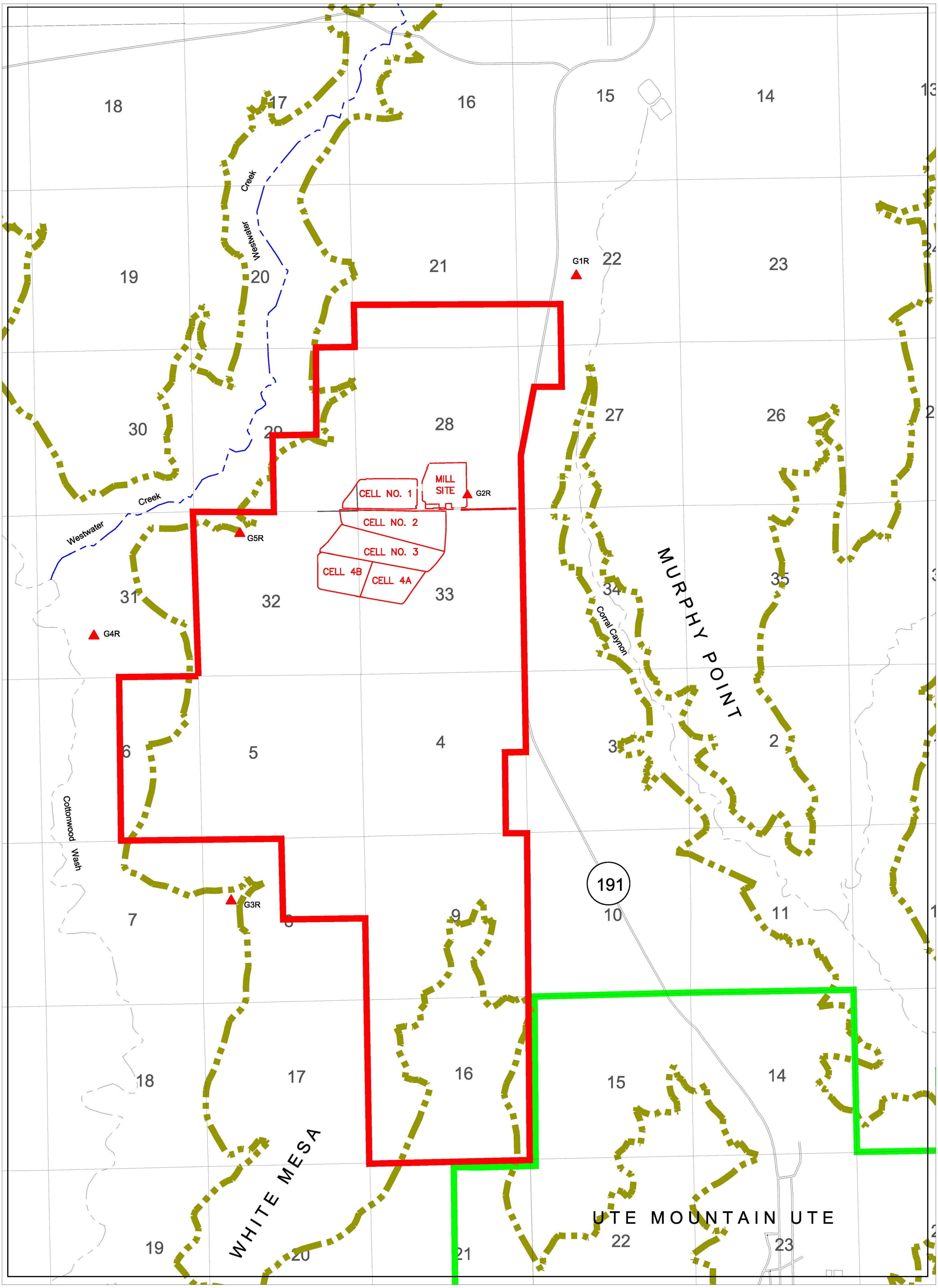
[1] Zero values (0.0) are below detection limits.

Table 1.5-2
Water Quality of the Navajo Sandstone Aquifer in the Mill Vicinity (continued)

Parameter	FES, Test Well (G2R) (1/27/77 - 3/23/78[1])	Well #2 6/01/99[1]	Well #5 6/08/99[1]
Iron, total	0.35 to 2.1	0.43	0.20
Iron, dissolved	0.30 to 2.3		
Lead, total	0.02 - 0.0	<0.001	0.018
Magnesium		20.4	21.3
Magnesium, dissolved	15 to 21		
Mercury, total	<.00002 to 0.0	<0.001	<0.001
Molybdenum		0.001	<0.001
Molybdenum, dissolved	0.004 to 0.010		
Nickel		<0.001	0.004
Nitrate + Nitrate as N		<0.10	<0.10
Nitrate (as N)	<.05 to 0.12		
Phosphorus, total (as P)	<0.01 to 0.03		
Potassium		3.1	3.3
Potassium, dissolved	2.4 to 3.2		
Selenium		<0.001	<0.001
Selenium, dissolved	<.005 to 0.0		
Silica, dissolved (as SiO_2)	5.8 to 12		
Strontium, total (as U)	0.5 to 0.67		
Thallium		<0.001	<0.001
Uranium, total (as U)	<.002 to 0.16	0.0007	0.0042
Uranium, dissolved (as U)	<.002 to 0.031		
Zinc		0.010	0.126
Zinc, dissolved	0.007 to 0.39		
Total Organic Carbon	1.1 to 16		
Chemical Oxygen Demand	<1 to 66		
Oil and Grease	1		
Total Suspended Solids	6 to 1940	<1.0	10.4
Turbidity		5.56	19.1
Determination (pCi/liter)			
Gross Alpha			<1.0
Gross Alpha ± precision	1.6±1.3 to 10.2±2.6		
Gross Beta			<2.0
Gross Beta ± precision	8±8 to 73±19		
Radium 226 ± precision			0.3±0.2
Radium 228			<1.0
Ra–226 ± precision	0.1±.3 to 0.6±0.4		
Th–230 ± precision	0.1±0.4 to 0.7±2.7		
Pb–210 ± precision	0.0±4.0 to 1.0±2.0		
Po–210 ± precision	0.0±0.3 to 0.0±0.8		

Source: Adapted from FES Table 2.25 with additional Mill sampling data

[1] Zero values (0.0) are below detection limits.



PROPERTY BOUNDARY

RESERVATION BOUNDARY

CANYON RIM

G4R GROUNDWATER (WELL OR SPRING) SAMPLING LOCATION

5 WATER SUPPLY WELL

N

1,500' 0 1,500' 3,000'

SCALE: 1" = 3,000'

UT83-SF

ENERGY FUELS

REVISIONS		Project: White Mesa Mill	
Date	By	County: San Juan	State: UT
09-11	GM	Location:	

GROUNDWATER (WELL OR SPRING) SAMPLING STATIONS IN THE WHITE MESA VICINITY
FIGURE 1.5-8

Author: bm | Date: Aug 2009 | Drafted By: D.Sledd

W:\Legacy\USA\UTAH\Mill\DWGs\Reclamation Plans\Rev_07-2011\Work01\Fig.1.5-8_GroundWaterSampling.dwg Layout1 GMoseley

1.5.3.2 Perched Groundwater Zone

Perched groundwater in the Dakota/Burro Canyon Formation is used on a limited basis to the north (upgradient) of the site because the saturated thickness generally increases to the north of the site and it is more easily accessible than the Entrada/Navajo aquifer. The quality of the perched water at the site is generally poor and extremely variable. As of the first quarter of 2016, the concentrations of TDS measured in water sampled from upgradient and downgradient wells range between approximately 1,000 and 8,300 mg/1. Sulfate concentrations measured in far upgradient wells MW-1, MW-18 and MW-19 ranged from 580 and 2,000 mg/l, and across the site sulfate varied from 430 mg/L to 6,570 mg/L. The perched groundwater therefore is used primarily for stock watering and irrigation. Section 1.5.3 below provides a more detailed discussion of background groundwater quality in the perched aquifer.

1.5.4 Background Groundwater Quality in the Perched Aquifer

A significant amount of historical groundwater quality data has been collected by EFRI and previous operators of the Mill for many wells at the facility.

At the time of original issuance of the GWDP, the Director had not yet completed an evaluation of the historical data, particularly with regard to data quality, and quality assurance issues. The Director also noted several groundwater quality issues that needed to be resolved prior to a determination of background groundwater quality at the site, such as a number of constituents that exceeded their respective Groundwater Quality Standard ("GWQS") and long-term trends in uranium in downgradient wells MW-14, MW-15 and cross-gradient well MW-17, and a spatial high of uranium in those three wells.

As a result of the foregoing, the Director required that an Existing Well Background Report (INTERA, 2007a) be prepared to address and resolve these issues. Prior to the approval of the Existing Well Background Report, GWCLs were set in Table 2 of the GWDP as 0.25 and 0.5 times the GWQS for Class II and III groundwater respectively.

The Director reviewed the Existing Well Background Report and GWCLs that reflect background groundwater quality were set for all monitoring wells except newly installed MW-35, MW-36, and MW-37. Background data collected for the establishment of GWCLs that reflect background groundwater quality at MW-35, MW-36 and MW-37 were being collected at that time and were subsequently provided in INTERA (2014c).

As required by the GWDP, the Existing Well Background Report addressed all available historical data, which included pre-operational and operational data, for the compliance monitoring wells under the GWDP that existed at the date of issuance of the GWDP. The Regional Background Report (INTERA, 2007b) focused on pre-operational site data and available regional data to develop the best available set of background data that could not conceivably have been influenced by Mill operations. The New Well Background Report (INTERA 2008), which was required by Part I.H.4 of a previous revision of the GWDP, analyzed the data collected from wells MW-3A, MW-23, MW-24, MW-25, MW-27, MW-28, MW-29, MW-30 and MW-31 (the "new" wells), which were installed in 2005, to determine background concentrations for constituents listed in the GWDP for each new well.

The purpose of the Existing Well Background Report and the New Well Background Report was to satisfy several objectives. First, in the case of the Existing Well Background Report, to perform a quality assurance evaluation and data validation of the existing and historical on-site groundwater quality data in accordance with the requirements of Part I.H.3 of a previous revision of the GWDP, and to develop a database consisting of historical groundwater monitoring data for "existing" wells and constituents.

Second, in the case of the New Well Background Report, to compile a database consisting of monitoring results for new wells, which were collected subsequent to issuance of the GWDP, in accordance with the Mill's Groundwater Quality Assurance Plan ("QAP") data quality objectives.

Third, to perform a statistical, temporal and spatial evaluation of the existing well and new well data bases to determine if there have been any impacts to groundwater from Mill activities. Since the Mill is an existing facility that has been in operation since 1980, such an analysis of historical groundwater monitoring data was required in order to ensure that the monitoring results to be used to determine background groundwater quality at the site establish GWCLs that have not been impacted by Mill activities.

Finally, in the event the analysis demonstrates that groundwater has not been impacted by Mill activities, to develop a GWCL for each constituent in each well.

The Regional Background Report was prepared as a supplement to the Existing Well Background Report to provide further support to the conclusion that Mill activities have not impacted groundwater.

In evaluating the historical data for the existing wells, INTERA used the following approach:

- If historical data for a constituent in a well do not demonstrate a statistically significant upward trend (or downward trend in pH), then the proposed GWCL for that constituent is accepted as representative of background, regardless of whether or not the proposed GWCL exceeds the GWQS for that constituent. This is because the monitoring results for the constituent can be considered to have been consistently representative since commencement of Mill activities or installation of the well; and
- If historical data for a constituent in a monitoring well represent a statistically significant upward trend (or downward trend in the case of pH), then the data is further evaluated to determine whether the trend is the result of natural causes or Mill activities. If it is concluded that the trend results from natural causes, then the GWCL proposed in the Existing Well Background Report will be appropriate.

After applying the foregoing approach, INTERA concluded that, other than some detected chloroform and related organic contamination at the Mill site, which is the subject of a separate investigation and corrective action, and that is the result of pre-Mill activities, there have been no impacts to groundwater from Mill activities.

In reaching this conclusion, INTERA noted that, even though there are a number of increasing trends in various constituents at the site, none of the trends are caused by Mill activities for the following reasons:

- Chloride is unquestionably the best indicator parameter, and there are no significant trends in chloride which are attributable to Mill activities in any of the wells
- There are no noteworthy correlations between chloride and uranium in wells with increasing trends in uranium, other than in far upgradient wells MW-19 and MW-18, which INTERA concluded are not related to potential tailings seepage. MW-18 and MW-19 cannot have been impacted because they are located more than 2,200 feet northeast (upgradient) of the tailings management system and perched water elevations in these wells are approximately 15 to 25 feet higher than perched water elevations beneath the northeast (upgradient) corner of the tailings management cells. INTERA noted that it is inconceivable to have an increasing trend in any other parameter caused by seepage from the Mill tailings without a corresponding increase in chloride

- There are significant increasing trends far upgradient in MW-1, MW-18 or MW-19 in uranium, sulfate, TDS, iron, selenium, thallium, ammonia and fluoride and far downgradient in MW-3 in uranium and selenium, sulfate, TDS and pH (decreasing trend). INTERA concluded that these data provide very strong evidence that natural site phenomena are the cause of increasing trends in these constituents (decreasing with respect to pH) in other site wells and that these data also support the conclusion that natural phenomena are the cause of increasing trends in other constituents
- On a review of the spatial distribution of constituents, it is quite apparent that the constituents of concern are dispersed across the site and not located in any systematic manner that would suggest tailings leakage.

INTERA concluded that, after extensive analysis of the data, and given the conclusion that there have been no impacts to groundwater from Mill activities, the proposed GWCLs set out in Table 16 of the Existing Well Background Report are appropriate, and are indicative of background perched groundwater quality. INTERA did advise, however, that proposed GWCLs for all the trending constituents should be re-evaluated upon GWDP renewal to determine if they are still appropriate at the time of renewal.

In the New Well Background Report, INTERA followed the same approach used in the Existing Well Background Report for evaluating the existing well data. In addition, INTERA compared the groundwater monitoring results for the new wells to the results for the existing wells analyzed in the Existing Well Background Report and to the pre-operational and regional results analyzed in the Regional Background Report. This was particularly important for analysis of the new wells because available historical analytical data for constituents in those wells post-date the commencement of Mill operations. Available data for the new wells may not be sufficient to identify long-term constituent trends. By comparing the means for the constituents in the new wells to those for existing well and regional background data, INTERA was able to determine if the concentrations of constituents in the new wells were consistent with site background.

After applying the foregoing approach, INTERA concluded that the new monitoring wells were not impacted by Mill activities. INTERA also concluded that the new well groundwater monitoring results were consistent with the existing well results provided in the Existing Well Background Report and consistent with the pre-operational and regional well, seep and spring results provided in the Regional Background Report. INTERA noted some detections of chloroform and related organic contamination and degradation products and nitrate and nitrite in the new wells, which are the subject of separate investigations and corrective actions, but that such contamination was the result of pre-Mill activities. Corrective actions for nitrate and chloroform, respectively, are described in: *Nitrate Corrective Action Plan* (CAP), [HGC, 2012a]; and *Groundwater Corrective Action Plan* (GCAP) found in Attachment 1, of the final Stipulation and Consent Order Docket No. UGW20-01, approved on September 14, 2015 by the Utah Department of Environmental Quality Division of Waste Management and Radiation Control (DWMRC) [Utah Department of Environmental Quality Division of Solid Waste and Radiation Control, 2015]).

Given its conclusion that there were no impacts to groundwater from Mill activities, INTERA concluded that the proposed GWCLs for new wells set out in Table 10 of the New Well Background Report were appropriate, and indicative of background perched groundwater quality. Again, INTERA noted that GWCLs for trending constituents should be re-evaluated upon GWDP renewal to determine if they are still appropriate at the time of renewal.

Subsequent investigation of nitrate delineated the nitrate plume and indicated that ammonium sulfate handling in the vicinity of the ammonium sulfate crystal tanks (southeast of well TWN-2) is potentially a source of nitrate to the nitrate plume. There are no known current unidentified or unaddressed sources of the nitrate plume. There appear to have been a number of known and potential historical sources; however, it has not been possible to confirm or quantify the contribution of each source. The conclusion that there were no impacts to perched groundwater from Mill activities has therefore been modified to include a potential contribution to the nitrate plume from Mill and non-mill sources. However, the conclusion that there have been no impacts to perched groundwater from the tailings management system operation is valid.

During the course of discussions with EFRI staff, and further DWMRC review, DWMRC supplemented the analysis provided in the Background Reports by commissioning the University of Utah to perform a geochemical and isotopic groundwater study at the Mill, described in *Summary of work completed, data results, interpretations and recommendations for the July 2007 Sampling Event at the Denison Mines, USA, White Mesa Uranium Mill Near Blanding Utah*, May 2008, prepared by T. Grant Hurst and D. Kip Solomon, Department of Geophysics, University of Utah (the "University of Utah Study" [University of Utah, 2008]). The purpose of the University of Utah Study was to evaluate whether the increasing and elevated trace metal concentrations (such as uranium) found in the monitoring wells at the Mill were due to potential leakage from the on-site tailings management cells. To investigate this potential problem, the study examined groundwater flow, chemical composition, noble gas and isotopic composition, and age of the on-site groundwater. Similar evaluations were also made on samples of the tailings wastewater and nearby surface water stored in the northern wildlife ponds at the facility. Fieldwork for the University of Utah Study was conducted July 17 - 26, 2007. The conclusions in the University of Utah Study supported EFRI's conclusions in the Background Reports that tailings management cells had not impacted groundwater.

Upon approval of the GWDP in 2010, constituents with two consecutive GWCL exceedances were subject to a Source Assessment Report (SAR) as defined in the GWDP. The initial SAR was submitted in October of 2012 (INTERA 2012a) and covered the constituents in wells with consecutive exceedances since the approval of the GWDP in 2010. The October 2012 SAR (INTERA 2012a) presented a geochemical analysis of parameters that exhibited exceedances as well as an analysis of the indicator parameters in each of those wells to determine if the exceedance could be related to potential tailings seepage or Mill-related activities. Since then, additional SARs that include INTERA 2013a, 2013b, 2014a, 2014b, and 2015 cover additional consecutive exceedances. In all cases the exceedances for which the SARs were performed were determined to result from naturally occurring conditions in the groundwater at the site or from other factors that are affecting groundwater but are unrelated to Mill operation. These other factors include the nitrate/chloride plume that is addressed by the nitrate CAP and the site-wide decline in pH that was identified at the time of the Background Report.

With regard to the decline in pH, background analysis and determination of GWCLs for pH were performed using laboratory pH measurements rather than using measurements that are collected in the field at the time of sampling by using a pH probe. Since the latter of these two methods of measuring pH is more reliable, an additional pH analysis was performed in 2012 using only field data. GWCLs for pH were recalculated at this time using the field measurements (INTERA, 2012b). EFRI compared the Mill's groundwater pH data from the second quarter of 2011 and noted that *all* of the June 2011 groundwater results, and many of the other results from the second quarter of 2011, were already outside the revised GWCLs that were to be proposed. Pursuant to teleconferences with DWMRC on December 5, and December 19, 2011, EFRI submitted a Work Plan and Schedule on January 20, 2012 and a revised plan based on DWMRC comments on April 13, 2012. Based on the approved Work Plan and Time Schedule, EFRI and DWMRC entered into a Stipulated Consent Agreement ("SCA") dated July 12, 2012. The SCA required the completion of the pH Report (INTERA, 2012b) and the Pyrite Investigation and associated report (HGC, 2012c). The pH Report and Pyrite Investigation Report were submitted to DWMRC on November 9, 2012 and December 7, 2012 respectively. By letter dated April 25, 2013, DWMRC accepted the conclusions that the out-of-compliance results for pH are due to background effects within the aquifer matrix and are not caused by Mill activities. DWMRC also approved the recalculation of the GWCLs.

HGC (2012c) determined that pH decreases resulted primarily from pyrite oxidation enhanced by oxygen delivery to the perched zone. Pyrite exists naturally in the Burro Canyon Formation and Dakota Sandstone, and is present both above and below the perched water table. Oxygen delivery mechanisms include diffusive and advective gas-phase transport to the Burro Canyon Formation and /or Dakota Sandstone in the vicinities of perched wells via perched well screens, and advective liquid-phase transport dissolved in wildlife pond seepage. HGC (2012c) and HGC (2014) also noted that pyrite may be degraded by nitrate present in the perched water. Pyrite oxidation by either mechanism may release acid and sulfate. The site-wide pH decreases were therefore determined to be unrelated to tailings management cell operation.

1.5.5 Quality of Groundwater at the Compliance Monitoring Point

Analytical results from groundwater sampling are reported quarterly in Groundwater Monitoring Reports, which are filed with the Director pursuant to Part I.F.1 of the GWDP.

1.5.6 Springs and Seeps

As discussed in Section 1.5.1.4, perched groundwater at the Mill site discharges in springs and seeps along Westwater Creek Canyon and Cottonwood Canyon to the west-southwest of the site, and along Corral Canyon to the east of the site, where the Burro Canyon Formation outcrops. Water samples have been collected and analyzed from springs and seeps in the Mill vicinity as part of the baseline field investigations reported in the 1978 ER (See Table 2.6-6 in Dames & Moore, 1978).

During the period 2003-2004, EFRI implemented a sampling program for seeps and springs in the vicinity of the Mill which had been sampled in 1978, prior to the Mill’s construction. Four locations were designated for sampling (shown on Figure 1.5-8). These are Ruin Spring (G3R), Cottonwood Seep (G4R), west of Westwater Creek (G5R) and Corral Canyon (G1R). During the 2-year study period only two of the four locations were able to be sampled, Ruin Spring and Cottonwood Canyon. The other two locations, Corral Creek and the location west of Westwater Creek were not flowing (seeping) and samples could not be collected. With regard to the Cottonwood seep, while water was present, the volume was not sufficient to complete all determinations, and only organic analyses were conducted. The results of the organic analysis did not detect any detectable organics.

Samples at Ruin Spring were analyzed for major ions, physical properties, metals, radionuclides, volatile and semi-volatile organic compounds, herbicides and pesticides, and synthetic organic compounds. With the exception of one chloromethane detection, organic determinations were at less than detectable concentrations and are not shown in Table 1.5-3. The detection of chloromethane is not uncommon in groundwater and can be due to natural sources. In fact, chloromethane has been observed by EFRI at detectable concentrations in field blank samples during routine groundwater sampling events.

The results of the 2003/2004 sampling for the other parameters tested are shown in Table 1.5-3. The results of the sampling did not indicate the presence of Mill-derived groundwater constituents and are representative of background conditions.

Table 1.5-3
Results of Quarterly Sampling Ruin Spring (2003-2004)

Parameter	Ruin Spring							
	Q1-03	Q2-03	Q3-03	Q4-3	Q1-04	Q2-04	Q3-04	Q4-04
Major Ions (mg/L)								
Alkalinity	-	-	196	198	193	191	195	183
Carbon Dioxide	-	-	ND	ND	ND	ND	12	ND
Carbonate	-	-	ND	ND	ND	ND	ND	ND
Bicarbonate	-	-	239	241	235	232	238	223
Hydroxide	-		ND	ND	ND	ND	ND	ND
Calcium	153	156	149	158	158	162	176	186
Chloride	28.1	21.5	27.4	28.0	29.3	28.5	26	25
Fluoride	-	-	ND	0.5	0.5	0.6	0.6	0.6
Magnesium	34.8	34.2	31.7	34.2	35.8	35.1	37.1	38.6
Nitrogen, Ammonia As N	ND	ND	ND	ND	ND	0.06	ND	0.06
Nitrogen, Nitrate+Nitrite as N	1.6	1.5	1.4	1.4	1.73	1.85	1.34	1.7
Phosphorous	0.10	ND	-	ND	ND	ND	ND	ND
Potassium	2.6	3.3	3.3	3.9	3.4	3.6	4.0	3.7
Sodium	110	105	103	113	104	110	113	116
Sulfate	503	501	495	506	539	468	544	613
Physical Properties								
Conductivity (umhos/cm)	-	-	1440	1410	1390	1440	1320	1570
pH	-	-	7.91	7.98	-	-		-
TDS (mg/L)	-	-	1040	1000	1050	1110	1050	1070
TSS (mg/L)	-	-	13.5	ND	ND	ND	ND	ND
Turbidity (NTU)	-	-	0.16	0.13	ND	0.12	-	-
Metals-Dissolved (mg/L)								
Aluminum	ND	ND	0.40	ND	ND	ND	ND	ND
Antimony	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	0.001	ND	ND	0.001	ND	ND	ND	ND
Barium	ND	ND	ND	ND	ND	ND	ND	ND
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND

Table 1.5-3
Results of Quarterly Sampling Ruin Spring (2003-2004) (continued)

Parameter	Ruin Spring							
	Q1-03	**Q2-03**	**Q3-03**	**Q4-3**	**Q1-04**	**Q2-04**	**Q3-04**	**Q4-04**
Major Ions (mg/L)								
Chromium	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ND	ND	0.082	ND	ND	ND	ND	ND
Iron	ND	ND	ND	ND	ND	ND	ND	ND
Lead	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	ND	ND	ND	ND	ND	ND	ND	ND
Mercury	ND	ND	ND	ND	ND	ND	ND	ND
Molybdenum	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	0.013	0.012	0.012	0.012	0.012	0.012	0.012	0.012
Silver	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND	ND
Uranium	0.009	0.011	0.010	0.010	0.011	0.011	0.009	0.010
Vanadium	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	0.014	ND	ND	ND	ND	ND	ND	ND
Radionuclides (pCi/L)								
Gross Alpha Minus Rn & U	-	-	-	-	ND	ND	1.4	ND
Lead 210	42	ND	ND	ND	ND	ND	ND	ND
Radium 226	0.3	ND	0.3	ND	ND	ND	1.3	ND
Thorium 230	0.3	0.2	0.5	ND	ND	ND	0.4	ND
Thorium 232	-	-	ND	ND	ND	ND	ND	-
Thorium 228	-	-	ND	ND	ND	ND	-	-

Source: Table 3.7-9 of 2007 ER.

During 2009, the Mill implemented an annual sampling program for seeps and springs. The seeps and springs sampling program is included in the Sampling Plan for Seeps and Springs in the Vicinity of the White Mesa Uranium Mill Revision: 0, March 17, 2009 (and as submitted to UDEQ for approval, Draft Sampling Plan for Seeps and Springs, Revision 1, June 10, 2011). The annual sampling program for seeps and springs requires sampling once per year at the four seeps and springs described above, plus a fifth seep, Corrals Seep, to the extent water flow is sufficient for sampling. Samples were collected in July 2009; August and November 2010; May and July 2011, June 2012, July 2013, June 2014; and June 2015. Under the Plan only springs and seeps that had sufficient water flow were selected for sampling. The results of the annual sampling are shown in Table 1.5-4.

Table 1.5-4
Seeps and Springs Sampling

Constituent	Ruin Spring							Ruin Spring Duplicate			Cottonwood Spring							Entrance Spring							Dup	Westwater Seep						
Major Ions (mg/L)	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**9**	**10**	**11**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**15**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Carbonate	ND	<1	1	<1	<1	<1	<1	ND	<1	2	ND	<1	6	<1	<1	<1	<1	ND	<1	7	<1	<1	<1	<1	<1	<1	<1	<1				<1
Bicarbonate	233	254	239	237	208	204	200	232	254	236	316	340	316	326	280	251	271	292	332	299	298	292	247	324	326	465	450	371				359
Calcium	151	136	148	147	149	150	162	149	137	147	90.3	92.2	94.2	101	87.9	99.7	111	90.8	96.5	96.6	105	121	103	131	132	191	179	247				150
Chloride	28	23	44	28	26.3	27.1	27.4	27	23	27	124	112	134	149	118	128	133	60	63	64	78	139	76.8	75.6	75.3	41	40	21				32.6
Fluoride	0.5	0.53	0.5	0.52	0.538	<1	0.445	0.5	0.51	0.49	0.4	0.38	0.38	0.38	0.417	<1	0.318	0.7	0.73	0.58	0.64	0.71	<1	0.606	0.6	0.7	0.6	0.54				0.424
Magnesium	32.3	29.7	31.1	31.9	32.1	35.4	31.8	31.6	30.4	30.9	25	24.8	25.2	27.7	23.6	29.0	27.5	26.6	28.9	28.4	32.7	43	34.9	33.3	33.7	45.9	44.7	34.7	Not Sampled - Dry	Not Sampled - Dry	Not Sampled - Dry	34
Nitrogen, Ammonia As N	0.09	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	ND	<0.05	<0.05	ND	<0.05	<0.05	<0.05	<0.05	<0.05	0.0512	0.28	<0.05	0.32	<0.05	<0.05	<0.05	0.202	0.139	<0.05	0.5	0.06				0.123
Nitrogen, Nitrate+Nitrite as N	1.4	1.7	1.6	1.6	1.56	1.54	1.31	1.4	1.7	1.7	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.4	1	0.5	2.8	2.06	3.65	<0.1	0.276	0.8	<0.1	<0.1				<0.1
Potassium	3.3	3.07	3.3	3.5	3.46	3.24	3.14	3.2	3.08	3.3	5.7	5.77	5.9	6.2	5.53	6.18	5.91	2.4	2.74	2.9	2	3.83	1.56	1.62	1.72	1.19	6.57	3.9				1.98
Sodium	104	93.4	111	115	118	119	126	103	97.4	108	205	214	227	247	217	227	251	61.4	62.7	68.6	77.4	127	78.9	93.1	93.8	196	160	112				139
Sulfate	528	447	484	464	553	553	528	520	444	483	383	389	389	256	403	417	442	178	179	171	171	394	219	210	214	646	607	354				392
Physical Properties																																
pH	7.85	7.51	8.14	7.53			7.27	7.7	7.55	8.1	7.73	7.47	8.04	7.53			7.30	7.85	7.56	8.17	7.5			6.57		8.01	7.38	7.2	Not Sampled - Dry			7.24
TDS (mg/L)	1010	903	905	1000	952	984	1000	996	950	911	1010	900	978	1040	996	968	1020	605	661	582	660	828	688	680	708	1370	1270	853				896
Metals-Dissolved (ug/L)																																
Arsenic	ND	<5	<5	<5	<5	<5	<5	ND	<5.0	<5.0	ND	<5	<5	<5	<5	<5	<5	ND	<5	<5	<5	<5	<5	5.02	5.02	<5	<5	12.3				<5.0
Beryllium	ND	< 0.5	< 0.5	<0.5	<0.5	<0.5	<0.5	ND	<0.05	<0.05	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.91				<0.5
Cadmium	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	<0.05	<0.05	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.9				<0.5
Chromium	ND	<25	<25	<25	<25	<25	<25	ND	<25	<25	ND	<25	<25	<25	<25	<25	<25	ND	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25				<25
Cobalt	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10				<10
Copper	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	<10	<10	<10	<10	<10	<10	<10	16	Not Sampled - Dry	Not Sampled - Dry	Not Sampled - Dry	<10
Iron	ND	<30	<30	<30	<30	<30	<30	ND	36	36	ND	<30	<30	<30	<30	<30	<30	ND	<30	55	34	162	37.2	295	298	89	56	4540				<30
Lead	ND	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	ND	<1.0	<1.0	ND	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	ND	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	41.4				<1.0
Manganese	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	ND	<10	<10	<10	<10	<10	<10	54	11	84	<10	259	16.1	367	371	37	87	268				171
Mercury	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	<0.05	<0.05	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5				<0.5
Molybdenum	17	17	17	16	16.1	16.0	18.3	17	17	17	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	<10	<10	<10	<10	<10	29	29	<10				<10
Nickel	ND	<20	<20	<20	<20	<20	<20	ND	<20	<20	ND	<20	<20	<20	<20	<20	<20	ND	<20	<20	<20	<20	<20	<20	<20	<20	<20	29				<20

Table 1.5-4
Seeps and Springs Sampling (continued)

Constituent	Ruin Spring							Ruin Spring Duplicate			Cottonwood Spring							Entrance Spring							Dup	Westwater Seep						
Metals-Dissolved (mg/L)	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**9**	**10**	**11**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**15**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Selenium	12.2	10	10.2	10.8	10.2	12.0	10	12.3	9.5	9.7	ND	<5.0	<5.0	<5.0	<5.0	<5.0	<5	12.1	9.2	5.5	13.2	11.2	15.9	<0.5	<5	<5.0	<5.0	<5.0				<5.0
Silver	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10				<10
Thallium	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	<0.5	<0.5	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<5	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5				<0.5
Tin	ND	<100	<100	<100	<100	<100	<100	ND	<100	<100	ND	<100	<100	<100	<100	<100	<100	ND	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100				<100
Uranium	9.11	8.47	8.63	8.68	9.12	9.61	9.03	9	8.52	8.28	8.42	8.24	8.68	8.17	8.95	9.62	9.12	15.2	17.8	15.3	21.1	38.8	23.2	36	36.1	15.1	46.6	6.64				2.1
Vanadium	ND	<15	<15	<15	<15	<15	<15	ND	<15	<15	ND	<15	<15	<15	<15	<15	<15	ND	<15	<15	<15	<15	<15	<15	<15	<15	<15	34				<15
Zinc	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	<10	<10	<10	<10	<10	<10	<10	28				<10
Radionuclides (pCi/L)																																
Gross Alpha Minus Rn & U	<0.2	<0.2	<-0.05	<-0.09	<1.0	<1	<1.0	-0.02	<0.3	<-0.1	0.3	<0.2	<-0.1	<-0.2	<1.0	<1.0	<1.0	0.9	<0.5	1.6	0.5	2.3	<1	3.05	3.11	< -0.1	<0.3	0.5	Not Sampled - Dry	Not Sampled - Dry	Not Sampled - Dry	<1.0
Volatile Organic Compounds (ug/L)																																
Acetone	ND	ND	ND	<20	<20	<20	<20	ND	ND	ND	ND	ND	ND	<20	<20	<20	<20	ND	ND	ND	<20	<20	<20	<20	ND	ND	ND	ND	Not Sampled - Dry	Not Sampled - Dry	Not Sampled - Dry	<20
Benzene	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND				<1.0
Carbon tetrachloride	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND				<1.0
Chloroform	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND				<1.0
Chloromethane	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND				<1.0
MEK	ND	ND	ND	<20	<20	<20	<20	ND	ND	ND	ND	ND	ND	<20	<20	<20	<20	ND	ND	ND	<20	<20	<20	<20	ND	ND	ND	ND				<20
Methylene Chloride	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND				<1.0
Naphthalene	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND				<1.0
Tetrahydrofuran	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND				<1.0
Toluene	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	1.32	<1.0	ND	ND	ND	ND				<1.0
Xylenes	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND				<1.0

1.5.7 Groundwater Appropriations Within a Five Mile Radius

Two hundred sixty one groundwater appropriation applications, within a five-mile radius of the Mill site, are on file with the Utah State Engineer's office. A summary of the applications is presented in Table 1.5-5 and shown on Figure 1.5-9. The majority of the applications are by private individuals and for wells drawing small, intermittent quantities of water, less than eight gpm, from the Burro Canyon formation. For the most part, these wells are located upgradient (north) of the Mill site. Domestic water, stock watering, and irrigation are listed as primary uses of the majority of the wells. It is important to note that no water supply wells completed in the perched groundwater of the Burro Canyon formation exist directly downgradient of the site within the five-mile radius. Two water supply wells, which available data indicate are completed in the Entrada/Navajo sandstone, exist approximately 4.5 miles southeast of the site on the Ute Mountain Ute Reservation. These wells supply domestic water for the Ute Mountain Ute White Mesa Community, situated on the mesa along Highway 191 (see Figure 1.5-9). Data supplied by the Tribal Environmental Programs Office indicate that both wells are completed in the Entrada/Navajo sandstone, which is approximately 1,200 feet below the ground surface. Insufficient data are available to define the groundwater flow direction in the Entrada/Navajo sandstone in the vicinity of the Mill.

The yield from wells completed in the Burro Canyon formation within the White Mesa site is generally lower than that obtained from wells in this formation upgradient of the site. For the most part, the documented sustainable pumping rates from on-site wells completed in the Burro Canyon formation are typically less than 1/2 gpm. Even at low pumping rates, on-site wells completed in the Burro Canyon formation are typically pumped dry within a couple of hours, and corrective action pumping wells have to be cycled on and off due to the low productivity.

This low productivity suggests that the Mill is located over a peripheral fringe of perched water, with saturated thickness in the perched zone discontinuous and generally decreasing beneath the site, and with conductivity of the formation being very low. These observations have been verified by studies performed for the U.S. Department of Energy's disposal site at Slick Rock, which noted that the Dakota Sandstone, Burro Canyon formation, and upper claystone of the Brushy Basin Member are not considered aquifers due to the low permeability, discontinuous nature, and limited thickness of these units (U.S. DOE, 1993).

1.6 Geology

The following text is copied, with minor revisions, from the 1978 ER (Dames and Moore, 1978b). The text has been included here for ease of reference and to provide background information concerning the site geology. 1978 ER subsections used in the following text are shown in parentheses immediately following the subsection titles.

The site is near the western margin of the Blanding Basin in southeastern Utah and within the Monticello uranium-mining district. Thousands of feet of multi-colored marine and non-marine sedimentary rocks have been uplifted and warped, and subsequent erosion has carved a spectacular landscape for which the region is famous. Another unique feature of the region is the wide-spread presence of unusually large accumulations of uranium-bearing minerals.

Table 1.5-5
Wells Located Within a 5-Mile Radius of the White Mesa Uranium Mill (Denison, 2009)

WR Number	Diversion Type/Location	Well Log	Status	Priority	Uses	CFS	ACFT	Owner Name
09-1006	Underground		U	19771110	IS	0.500	0.000	DOROTHY PERKINS
	S30 W20 E4 02 37S 22E SL							NORTH RESERVOIR ROAD (37-1)
09-1008	Underground		T	19771110	IS	0.500	0.000	ARDEN NIELSON
	S460 E117 W4 01 37S 22E SL							P.O. BOX #378
09-1009	Underground		U	19771110	I	0.500	0.000	BAR M. K. RANCHES INCORPORATED
	N1200 E990 W4 14 37S 22E SL							P.O. BOX 576
09-1009	Underground		U	19771110	I	0.500	0.000	BAR M. K. RANCHES INCORPORATED
	0 W990 N4 14 37S 22E SL							P.O. BOX 576
09-1009	Underground		U	19771110	I	0.500	0.000	BAR M. K. RANCHES INCORPORATED
	N990 W990 S4 11 37S 22E SL							P.O. BOX 576
09-101	Underground	well info	P	19450702	DIS	0.004	0.000	ILO M. BROWN
	N1275 E2708 SW 01 37S 22E SL							BLANDING UT 84535
09-1013	Underground		P	19771207	DI	0.015	0.000	LEWIS A. BLACK
	N2510 E75 S4 34 36S 22E SL							P.O. BOX #403
09-1016	Underground		T	19780103	DIS	0.500	0.000	KENNETH P. MCDONALD
	N559 0 S4 34 36S 22E SL							60 NORTH 100 WEST (16-5)
09-1017	Underground		P	19780105	DI	0.015	0.000	JOHN BRAKE
	N150 E137 S4 34 36S 22E SL							P.O. BOX #173
09-1018	Underground		T	19780104	DIS	0.015	0.000	MARGARET E. THOMPSON

	S2620 W840 NE 36 36S 22E SL							P.O. BOX #231
09-1023	Underground		T	19780126	DIS	1.000	0.000	CALVIN BLACK
	S10 W4000 NE 16 37S 22E SL							P.O. BOX #885
09-1023	Underground		T	19780126	DIS	1.000	0.000	CALVIN BLACK
	S600 W1320 NE 16 37S 22E SL							P.O. BOX #885
09-103	Underground	well info	P	19450710	S	0.003	0.000	WILLARD M. GUYMAN
	S1394 E2295 NW 02 37S 22E SL							BLANDING UT 84535
09-1031	Underground	well info	P	19830425	SX	0.136	0.000	COLLEGE OF EASTERN UTAH
	0 E1000 SW 23 38S 21E SL							451 EAST 400 NORTH
09-1032	Underground		T	19780309	DIS	0.015	0.000	BLANDING CITY
	S840 W875 NE 15 37S 22E SL							BLANDING UT 84511
09-1033	Underground	well info	P	19780309	DIS	0.015	0.000	BARRY LEE AND LOREE A. WOOLLEY
	N1050 W1195 SE 10 37S 22E SL							191 BUTTERNUT DRIVE NORTH
09-1042	Underground	well info	A	19780505	DI	0.015	1.450	AROE G. BROWN
	N1580 W1090 SE 01 37S 22E SL							BLANDING UT 84511
09-1043	Underground		T	19780505	DI	0.015	0.000	ARVID K. BLACK
	S1000 E300 NW 01 37S 22E SL							BOX 339
09-1044	Underground		P	19780429	DI	0.015	0.000	PETE M. BLACK
	S150 E1840 W4 36 36S 22E SL							BOX 386
09-1045	Underground	well info	P	19780504	DIS	0.015	0.000	KENNETH BROWN
	N1580 W1040 SE 01 37S 22E SL							P.O. BOX #637
09-1047	Underground	well info	P	19780511	DIS	0.015	1.586	IVAN Q. JONES
	N105 W1110 E4 02							881 EAST BROWNS

	37S 22E SL							CANYON ROAD
09-1048	Underground	well info	P	19780511	DIS	0.015	0.000	DORIS GUYMON
	N105 W1110 E4 02 37S 22E SL							P.O. BOX #117
09-1057	Underground	well info	P	19780623	DIS	0.015	0.000	EUGENE & DORTHEA GUYMON
	S100 W1400 NE 02 37S 22E SL							BOX 117
09-1058	Underground		U	19780623	I	0.100	0.000	EUGENE & DOROTHEA GUYMON
	N400 W400 E4 02 37S 22E SL							BOX 117
09-1059	Underground	well info	U	19780623	DIS	0.100	0.000	EUGENE & DOROTHEA GUYMON
	S100 W1400 NE 02 37S 22E SL							BOX 117
09-1063	Underground		P	19780802	DO	0.015	0.000	C & C CONSTRUCTION
	N900 W660 SE 34 36S 22E SL							P.O. BOX 415
09-1071	Underground		T	19780824		0.015	0.000	JAMES J. HARRIS
	S600 W1280 E4 36 36S 22E SL							BOX 392
09-1090	Underground	well info	P	19790521	DI	0.015	0.000	GUY DENTON AND PEGGY DENTON
	N1090 W20 S4 02 37S 22E SL							632 EAST BROWNS CANYON ROAD
09-110	Underground	well info	P	19460415	DIS	0.100	0.000	HENRY M. LYMAN
	N1305 W1023 E4 03 37S 22E SL							BLANDING UT 84511
09-1100	Underground		A	19790904	DI	0.015	0.000	LOYD ROPER
	N1430 E275 S4 34 36S 22E SL							P.O. BOX 469
09-1110	Underground	well info	P	19830304	DI	0.015	0.000	RICHARD W. & ARLEEN HURST
	N1170 W1000 SE 01							P.O. BOX 1090

	37S 22E SL							
09-1124	Underground		P	19860818	IS	0.015	0.000	JOHN BRAKE
	N310 E280 S4 34 36S 22E SL							1300 S. 300 W. (60-9)
09-1128	Underground		P	19800310	DIS	0.015	0.000	JAMES A. LAWS
	S1610 E560 N4 02 37S 22E SL							P.O. BOX 1210
09-1144	Underground		P	19800630	DIS	0.015	0.000	LEE R. & MARYLYNN SMITH
	N1272 E149 S4 34 36S 22E SL							P.O. BOX 1169
09-1145	Underground		P	19800630	DIS	0.015	0.000	LEE R. & MARYLYNN SMITH
	N1272 E149 S4 34 36S 22E SL							P.O. BOX 1169
09-1146	Underground		P	19800630	DIS	0.015	0.000	LEE R. & MARYLYNN SMITH
	N1272 E149 S4 34 36S 22E SL							P.O. BOX 1169
09-1147	Underground		P	19800630	DIS	0.015	0.000	LEE R. & MARYLYNN SMITH
	N1272 E149 S4 34 36S 22E SL							P.O. BOX 1169
09-1153	Underground		P	19800825	IS	0.015	0.000	PARLEY V. & REVA V. REDD
	N1350 E1150 SW 34 36S 22E SL							PARLEY AND REVA REDD FAMILY LIVING TRUST (1981)
09-1156	Underground	well info	P	19800909	DIS	0.015	0.000	AL B. CLARKE AND SHIRLEY W. CLARKE
	N2580 W921 S4 01 37S 22E SL							1555 BROWN`S CANYON ROAD
09-1157	Underground		T	19800912	O	0.700	511.540	IUC WHITE MESA LLC
	N1200 E280 SW 21 37S 22E SL							1050 17TH STREET, SUITE 950
09-1157	Underground		T	19800912	O	0.700	511.540	IUC WHITE MESA LLC

	N200 W200 SE 28 37S 22E SL							1050 17TH STREET, SUITE 950
09-1157	Underground		T	19800912	O	0.700	511.540	IUC WHITE MESA LLC
	N1200 W200 SE 33 37S 22E SL							1050 17TH STREET, SUITE 950
09-1157	Underground		T	19800912	O	0.700	511.540	IUC WHITE MESA LLC
	N1200 0 SE 21 37S 22E SL							1050 17TH STREET, SUITE 950
09-116	Underground		P	19460903	S	0.005	0.000	TODD MILTON HURST
	S150 W925 E4 35 36S 22E SL							747 NORTH 300 WEST (34-2)
09-1167	Underground		P	19801209	DIS	0.012	0.000	LYNDA HARRELSON
	S1430 W270 N4 02 37S 22E SL							133 SOUTH 100 WEST A
09-1173	Underground		T	19810202		0.000	1.000	CARBONIT EXPLORATION INCORPORATED
	S1550 W1300 NE 32 38S 22E SL							C/O K & A/HELTON
09-1176	Underground		P	19800912	O	0.600	0.000	IUC WHITE MESA LLC.
	N1400 W3000 SE 28 37S 22E SL							1050 17TH STREET, SUITE 950
09-1176	Underground	well info	P	19800912	O	0.600	0.000	IUC WHITE MESA LLC.
	N1300 W2400 SE 28 37S 22E SL							1050 17TH STREET, SUITE 950
09-1176	Underground	well info	P	19800912	O	0.600	0.000	IUC WHITE MESA LLC.
	N2100 W2200 SE 28 37S 22E SL							1050 17TH STREET, SUITE 950
09-1176	Underground		P	19800912	O	0.600	0.000	IUC WHITE MESA LLC.
	N1290 W170 SE 33 37S 22E SL							1050 17TH STREET, SUITE 950
09-1176	Underground		P	19800912	O	0.600	0.000	IUC WHITE MESA LLC.

	N1000 E650 SW 22 37S 22E SL							1050 17TH STREET, SUITE 950
09-1198	Underground		T	19810406	DIS	0.015	0.000	NED J. AND MARILYN PALMER
	S585 E1460 W4 01 37S 22E SL							12 EAST 5TH SOUTH 107-5
09-1199	Underground		T	19810403	I	0.052	0.000	IVAN R. WATKINS
	S2722 E310 NW 01 37S 22E SL							P.O. BOX 372
09-1201	Underground		P	19810416	DIS	0.015	0.000	KAREN C. KNIGHT
	N100 E1920 W4 36 36S 22E SL							2164 BLUFF ROAD
09-1221	Underground		U	19810721	DIS	1.000	0.000	DENNIS F. AND EDITH G. ANDERSON
	N760 E1532 W4 02 37S 22E SL							1307 SO MAIN
09-1225	Underground		T	19810708	DIS	0.100	0.000	DENNIS E. GUYMON
	N105 W1110 E4 02 37S 22E SL							BOX 657
09-1227	Underground	well info	P	19810810	S	0.015	0.000	DENNIS F. AND EDITH G. ANDERSON
	N760 E1532 W4 02 37S 22E SL							1307 SOUTH MAIN (79-9)
09-123	Underground	well info	P	19470822	S	0.015	0.000	GEORGE F. LYMAN
	N500 E200 SW 15 37S 22E SL							BLANDING UT 84511
09-1230	Underground		T	19810921	DIS	0.015	0.000	RICHARD ARTHUR
	N750 E2390 W4 02 37S 22E SL							427 SOUTH 100 WEST
09-1233	Underground		P	19811007	DIS	0.000	3.266	KIRK BLACK
	N306 E51 W4 01 37S 22E SL							1727 SOUTH AROUND THE WORLD 103-23
09-1236	Underground	well info	P	19811102	DIS	0.015	0.000	JAMES R. AND CHRISTINA J. BRANDT
	S910 E2020 W4 01							139 SOUTH 100

	37S 22E SL							WEST (68-2)
09-1238	Underground	well info	P	19811223	DI	0.015	0.000	ALYCE M. RENTZ
	N1300 E50 S4 01 37S 22E SL							BROWN CANYON ROAD 103-8
09-1248	Underground		P	19820209	D	0.015	0.000	REED HURST
	S1470 E125 N4 02 37S 22E SL							354 S. 300 W. #56
09-1262	Underground	well info	P	19820811	DI	0.015	0.000	GERALD B. HEINER
	N132 E2244 W4 02 37S 22E SL							P.O. BOX 1127
09-1287	Underground	well info	P	19830207	DIS	0.015	0.000	ALVIN H. KAER
	N476 E2256 W4 02 37S 22E SL							P.O. BOX 1133
09-1290	Underground		P	19830323	DI	0.015	0.000	CARLA L. AND MARK E. ENDRES
	S932 W363 N4 03 37S 22E SL							444 WEST 1600 SOUTH
09-1346	Underground		P	19840305	S	0.015	0.000	J. GLEN & EVA L. SHUMWAY
	S1321 W1980 E4 15 37S 22E SL							578 SOUTH 200 WEST 61-1
09-138	Underground		P	19500525	S	0.015	0.000	LORRAINE AND VERL J. ROSE
	S1326 W1205 E4 02 37S 22E SL							1166 SOUTH 100 EAST
09-1396	Underground		T	19841026	O	0.000	3.000	WINTERSHALL OIL & GAS CORPORATION
	S2722 E10 NW 01 37S 22E SL							1020 15TH STREET, SUITE 122E
09-1402	Underground		T	19841113	O	0.000	6.000	C/O PERMITCO WINTERSHALL OIL & GAS CORPORATION
	S2722 E10 NW 01 37S 22E SL							1020 15TH STREET, SUITE 22E
09-141	Underground	well info	P	19500918	S	0.015	0.000	WILLARD M. GUYMON

	N1287 W448 SE 10 37S 22E SL							BLANDING UT 84511
09-1457	Underground		T	19860103	O	0.000	3.000	WINTERSHALL OIL & GAS CORPORATION C/O PERMITCO
	S2722 E10 NW 12 37S 22E SL							1020 15TH STREET SUITE 22E
09-1468	Underground		A	19860414	DIS	0.015	0.000	RONALD D. & CATHERINE A. KIRK
	S570 E1458 W4 01 37S 22E SL							BROWN CANYON ROAD (103-9)
09-1477	Underground	well info	P	19931108	DI	0.015	0.000	JOANN WATKINS
	N750 W2180 SE 01 37S 22E SL							EAST BROWN CANYON ROAD 103-14
09-1535	Underground		T	19871013	O	0.000	3.000	QUINTANA PETROLEUM CORPORATION
	S2722 E10 SW 01 37S 22E SL							ATTN: LISA GREEN, AGENT FOR QUINTANA PETROLEUM
09-1548	Underground		T	19871202	O	0.000	8.000	YATES PETROLEUM CORPORATION
	N2558 E10 SW 01 37S 22E SL							C/O PERMITS WEST INC.
09-1664	Underground		P	19890913	DIS	0.015	0.000	F. GREG STRINGHAM
	N340 W305 SE 34 36S 22E SL							1244 SOUTH 100 EAST (80-1)
09-1673	Underground	well info	A	19940524	IS	0.015	0.000	HENRY CLYDE WATKINS
	S3000 E200 NW 01 37S 22E SL							1000 BROWNS CANYON 103-14
09-1686	Underground		T	19900402	O	0.000	8.000	GENERAL ATLANTIC RESOURCES INC.
	S2722 E10 NW 01 37S 22E SL							C/O PERMITS WEST INC. ATTN: BRIAN

								WOOD
09-1709	Underground		P	19900504	I	0.000	1.120	GORDON REDD MANAGEMENT INC.
	N2505 E1629 S4 34 36S 22E SL							82 SOUTH MAIN STREET
09-1734	Underground		T	19901010	O	0.000	2.000	CELSIUS ENERGY COMPANY
	S2722 E10 NW 01 37S 22E SL							C/O PERMITS WEST INC.
09-1785	Underground		A	19911031	DIS	0.100	0.000	BERTHA SNYDER
	S200 E800 W4 01 37S 22E SL							409 EAST 1000 NORTH
09-1794	Underground	well info	T	19920313	DI	0.100	0.000	JAMES D. REDD
	N1115 E2320 SW 02 37S 22E SL							SANTA FE HEIGHTS 104-9
09-1801	Underground		T	19920714	O	0.000	9.000	TEXAS INC. AMPOLEX
	S2722 E10 NW 01 37S 22E SL							C/O BILLY HASS
09-1822	Underground	well info	A	19930315	IS	0.000	4.730	DENNIS F. AND EDITH G. ANDERSON
	S250 W250 NE 03 37S 22E SL							1307 SOUTH MAIN
09-1843	Underground	well info	P	19940323	DIS	0.000	1.560	JEROLD PERKINS
	S201 E1530 NW 03 37S 22E SL							1092 EAST BROWNS CANYON ROAD (103-18)
09-1844	Underground	well info	T	19940331	IS	0.000	3.760	PRESTON KIRK REDD
	N2125 E846 SW 02 37S 22E SL							292 WEST CENTER STREET BOX 67-7
09-1845	Underground		T	19940331	IS	0.000	3.760	PRESTON KIRK REDD
	N1115 E1220 SW 02 37S 22E SL							292 WEST CENTER STREET BOX 67-7
09-1848	Underground	well info	P	19940411	S	0.000	0.750	M. DALE SLADE

	N35 E40 SW 04 37S 23E SL							332 WEST 400 SOUTH (64-5)
09-1862	Underground		T	19950118	O	0.500	0.000	KOKEPELLI BOTTLING
	N200 W2250 E4 36 36S 22E SL							36 EAST 500 SOUTH (77-15)
09-1875	Underground		T	19950417	DIS	0.000	4.730	STAN & SANDRA PERKINS
	N2105 W235 SE 34 36S 22E SL							686 NORTH DAYBREAK DRIVE
09-1878	Underground		P	19950505	S	0.000	1.680	BRUCE J. LYMAN
	S92 W2566 E4 33 36S 23E SL							SHIRTAIL JUNCTION (105-7)
09-1880	Underground	well info	P	19950620	DIS	0.000	4.730	MITCHELL H. & JANA L. BAILEY
	S945 E1095 NW 15 37S 22E SL							SHIRTAIL CORNER 105-14
09-1886	Underground	well info	A	19950807	DIS	0.000	1.730	PAUL A. OR SHARON BROWN
	N868 W1260 SE 01 37S 22E SL							BROWN`S CANYON ROAD (103-16)
09-1912	Underground	well info	T	19960521	DI	0.000	4.730	THOMAS A. MAY
	N500 W545 S4 02 37S 22E SL							2202 SOUTH CINCO CEDROS ROAD (104-8)
09-193	Underground		P	19560316	S	0.015	0.000	ALMA U. JONES
	S50 W1420 E4 33 37S 22E SL							BLANDING UT 84511
09-1934	Underground	well info	P	19960830	DIS	0.000	1.882	RONALD F. & MERLE MCDONALD
	N1816 W651 S4 01 37S 22E SL							1500 BROWN`S CANYON ROAD (103-2)
09-1947	Underground	well info	P	19961126	DIS	0.000	3.110	THOMAS A. MAY
	N174 W901 S4 02 37S 22E SL							2202 SOUTH CINCO CEDROS ROAD (104-8)
09-1953	Underground		T	19970430	DIS	0.000	4.730	JERRY HOLLIDAY

	S2393 W2494 NE 02 37S 22E SL							P.O. BOX 502
09-1955	Underground	well info	T	19970527	DI	0.000	4.730	JIM & MARY BOURNE
	N3055 W1059 SE 01 37S 22E SL							468 NORTH 500 WEST
09-1959	Underground		T	19970729	I	0.000	4.730	LLOYD D. & CLARABELLA ELLGEN
	N2339 E191 SW 35 36S 22E SL							859 SOUTH 100 EAST (82-9)
09-1964	Underground	well info	P	20030512	DIS	0.000	0.990	BEN J. BLACK
	N516 E625 W4 02 37S 22E SL							83 WEST 300 SOUTH 75-5
09-1968	Underground	well info	A	19970915	DIS	0.000	4.730	BRUCE & PEGGY ROYER
	N600 W880 SE 01 37S 22E SL							PO BOX 1145
09-197	Underground	well info	P	19560512	DS	2.000	0.000	UTE MOUNTAIN UTE TRIBE
	N1005 W207 S4 23 38S 22E SL							TOWAOC CO 81334
09-1972	Underground		T	19971023	DIS	0.000	4.730	DALE & MARTHA LYMAN
	N1095 W725 E4 21 37S 22E SL							P.O. BOX 729
09-1979	Underground	well info	P	19980217	DIS	0.000	3.774	PAUL REDD & LISA MACDONALD
	N110 W2339 W4 34 36S 22E SL							466 WEST 800 SOUTH 60-15
09-1982	Underground		T	19980320	DIS	0.000	4.730	JEANNINE B. ERICKSEN
	N1420 W1560 SE 01 37S 22E SL							771 SOUTH 700 EAST
09-1983	Underground	well info	P	19980413	DI	0.000	1.894	DON C. & REBECCA P. LARSON
	S251 E933 W4 35 36S 22E SL							301 E. EAGLE VIEW LN. 95-19
09-1990	Underground	well info	P	20040304	DI	0.000	4.450	DUSTIN AND BEVERLY

								FELSTEAD
	N1847 W893 SE 01 37S 22E SL							1863 NORTH CANYON VIEW DRIVE (103-22)
09-1991	Underground	well info	T	19980702	DIS	0.000	4.730	ARDEN C. & BILLIE SUE NIELSON
	N1480 W1905 SE 11 37S 22E SL							BOX 864
09-2001	Underground	well info	T	19981002	DIS	0.000	1.480	ANNA M. RAFFERTY
	S860 E315 NW 22 37S 22E SL							P.O. BOX 553
09-2006	Underground		T	19990112	DIS	0.000	4.730	MARTHA LYMAN
	S660 W700 NE 21 37S 22E SL							P.O. BOX 96
09-2010	Underground	well info	P	19990315	DI	0.000	3.130	STEVEN C. AND SHAUNA E. BLACK
	N2430 E2540 SW 36 36S 22E SL							1606 EAST HARRIS LANE (102-9)
09-2012	Underground		P	19990402	DIS	0.000	4.194	JULIE MAY KNITTEL AND CAROL ANN BLISS
	S76 W1085 E4 02 37S 22E SL							2250 NORTH 1200 EAST
09-2021	Underground	well info	P	19990810	DIS	0.000	3.518	SHELLY BLAKE
	S275 E561 W4 35 36S 22E SL							853 SOUTH 200 EAST (95-23)
09-2033	Underground		T	20000412	DIS	0.000	4.730	RANDALL & MARILYN PEMBERTON
	N1652 E30 SW 36 36S 22E SL							1727 SOUTH AROUND THE WORLD 103-23
09-2035	Underground	well info	A	20000504	DI	0.000	4.730	ALAN SHUMWAY
	N1151 E577 SW 35 36S 22E SL							1201 SOUTH 200 EAST (95-22)
09-2040	Underground	well info	T	20000725	DIS	0.000	4.730	DAVID RAY PALMER
	N112 W270 E4 35							755 SOUTH MAIN

	36S 22E SL							STREET
09-2065	Underground		T	20011221	DIS	0.000	4.730	JAMES G. AND STACY MONTELLA
	S100 W650 E4 02 37S 22E SL							978 EAST BROWN CANYON ROAD (103-19)
09-2068	Underground	well info	P	20070502	DIS	0.000	2.904	BRUCE E. STEVENS
	S80 W710 NE 02 37S 22E SL							1314 SOUTH 1100 EAST 102-16
09-2069	Underground	well info	A	20070912	DIS	0.000	1.506	JOE (JR) AND SHIRLEY A. GRISHAM
	S1110 W277 E4 02 37S 22E SL							2044 SOUTH PERKINS LANE 103-20
09-2070	Underground	well info	P	20020409	DI	0.000	1.450	RICHARD I. AND MARIEANN WATKINS
	S162 W4489 E4 01 37S 22E SL							1302 BROWN CANYON ROAD 103-24
09-2074	Underground		T	20020521	S	0.000	4.730	BRUCE J. LYMAN
	N1020 W1220 SE 15 37S 22E SL							SHIRTAIL JUNCTION 105-7
09-2075	Underground		T	20020603	OX	0.000	16.140	USA CORPORATION INTERNATIONAL URANIUM
	S769 W1812 NE 33 37S 22E SL							P.O. BOX 809
09-2075	Underground		T	20020603	OX	0.000	16.140	USA CORPORATION INTERNATIONAL URANIUM
	S1039 W1600 NE 33 37S 22E SL							P.O. BOX 809
09-2075	Underground		T	20020603	OX	0.000	16.140	USA CORPORATION INTERNATIONAL URANIUM
	S1156 W1591 NE 33 37S 22E SL							P.O. BOX 809
09-2075	Underground		T	20020603	OX	0.000	16.140	USA CORPORATION

								INTERNATIONAL URANIUM
	S1023 W1576 NE 33 37S 22E SL							P.O. BOX 809
09-2075	Underground		T	20020603	OX	0.000	16.140	USA CORPORATION INTERNATIONAL URANIUM
	S903 W1563 NE 33 37S 22E SL							P.O. BOX 809
09-2075	Underground		T	20020603	OX	0.000	16.140	USA CORPORATION INTERNATIONAL URANIUM
	S1434 W1537 NE 33 37S 22E SL							P.O. BOX 809
09-2087	Underground	well info	A	20020815	DIS	0.000	3.010	BEN J. BLACK
	N516 E631 W4 02 37S 22E SL							303 EAST BROWNS CANYON RD.
09-2094	Underground		P	20020924	DI	0.000	0.838	SUMNER H. PATTERSON
	N125 W907 E4 34 36S 22E SL							788 SOUTH MAIN STREET 78-11
09-2097	Underground		P	20021004	IS	0.000	4.730	NORMAN F. NIELSON
	S581 E53 W4 01 37S 22E SL							63 NORTH 100 WEST (17-2)
09-2100	Underground		T	20021118	OX	0.000	32.280	INTERNATIONAL URANIUM USA CORPORATION
	N36 W2249 SE 28 37S 22E SL							P.O. BOX 809
09-2100	Underground		T	20021118	OX	0.000	32.280	INTERNATIONAL URANIUM USA CORPORATION
	N139 W2146 SE 28 37S 22E SL							P.O. BOX 809
09-2100	Underground		T	20021118	OX	0.000	32.280	INTERNATIONAL URANIUM USA CORPORATION
	N138 W1890 SE 28 37S 22E SL							P.O. BOX 809

09-2100	Underground		T	20021118	OX	0.000	32.280	INTERNATIONAL URANIUM USA CORPORATION
	N148 W1696 SE 28 37S 22E SL							P.O. BOX 809
09-2100	Underground		T	20021118	OX	0.000	32.280	INTERNATIONAL URANIUM USA CORPORATION
	S6 W1614 NE 33 37S 22E SL							P.O. BOX 809
09-2100	Underground		T	20021118	OX	0.000	32.280	INTERNATIONAL URANIUM USA CORPORATION
	S178 W1598 NE 33 37S 22E SL							P.O. BOX 809
09-211	Underground	well info	P	19570129	S	0.015	0.000	USA BUREAU OF LAND MANAGEMENT
	N3279 E3641 SW 29 38S 23E SL							2370 SOUTH 2300 WEST
09-2125	Underground	well info	P	20030715	M	0.000	4.730	SAN JUAN COUNTY
	N1247 W433 SE 34 36S 22E SL							P.O. BOX 9
09-2139	Underground		T	20040126	DIS	0.000	4.730	MITCHELL H. BAILEY
	N95 E1830 SW 10 37S 22E SL							105-14 SHIRTAIL CORNER
09-2140	Underground	well info	T	20040217	DIS	0.000	4.730	TONY F. GUYMON
	N2565 E2680 SW 02 37S 22E SL							BROWN CANYON ROAD 104-7
09-2152	Underground		A	20041115	DIS	0.000	4.730	JAMES R. AND WENDY L. BUNTING
	S2520 E420 NW 36 36S 22E SL							905 EAST HARRIS LANE
09-2162	Underground		A	20050407	DIS	0.000	4.730	LEE R. & DENIECE A. MEYERS
	N1095 W725 E4 21 37S 22E SL							1051 WEST 4350 SOUTH 105-10
09-2170	Underground	well	P	20060103	DI	0.000	4.730	DANIEL AND

		info						MARILYN KARTCHNER
	S1285 E573 NW 06 37S 23E SL							1551 S. BOOTS & SPURS LANE
09-2182	Underground		A	20060814	DIS	0.000	4.730	GLENN & GLORIA PATTERSON
	N1390 E90 S4 02 37S 22E SL							P.O BOX 972
09-2185	Underground		T	20060908	DI	0.000	4.730	MARTHA A. LYMAN
	S100 W990 NE 21 37S 22E SL							90 WEST 100 SOUTH
09-2187	Underground	well info	A	20060920	DIS	0.000	4.730	RANDALL & MARILYN PEMBERTON
	N784 E278 W4 01 37S 22E SL							72 SOUTH 100 WEST 70-1
09-226	Underground	well info	P	19580110	D	0.015	0.000	WAUKESHA OF UTAH
	S1639 E1689 N4 03 37S 22E SL							BOX #714
09-2263	Underground		A	20070124	DIS	0.000	4.730	STAN & SANDRA PERKINS
	N2010 W235 SE 34 36S 22E SL							686 NORTH DAYBREAK
09-2267	Underground	well info	A	20070323	D	0.000	0.450	JEFF & SHERI MONTELLA
	S516 E2 E4 02 37S 22E SL							P.O. BOX 285
09-2270	Underground	well info	A	20070530	DIS	0.000	2.562	CRAIG B. AND JOANNE T BARLOW
	N2383 E1328 SW 35 36S 22E SL							P.O. BOX 625
09-2276	Underground	well info	A	20070829	DIS	0.000	2.478	GLENN T. AND GLORIA J. PATTERSON
	N348 W1021 E4 01 37S 22E SL							1981 KOKOPELLI LANE
09-2286	Underground		A	20071218	DIS	0.000	4.730	MITCHELL H. & JANA L. BAILEY
	N834 E1230 S4 16 37S 22E SL							210 N. SHIRTTAIL WAY

09-2290	Underground		A	20080221	DIS	0.000	4.730	LOIS SHUMWAY
	S284 W423 NE 03 37S 22E SL							PO BOX 447
09-2296	Underground		A	20080505	DIS	0.000	4.730	WENDELL & ELIZA FRY
	S1255 W814 E4 02 37S 22E SL							P.O. BOX 555
09-2297	Underground		A	20080516	DIS	0.000	4.728	NELLADEE AND JACK L. STREET
	S100 W650 E4 02 37S 22E SL							1004 EAST BROWNS CANYON ROAD
09-2306	Underground	well info	A	20081006	DS	0.000	0.534	ANDY & ALICIA BLACK
	S400 E738 W4 36 36S 22E SL							1312 HARRIS LANE
09-2309	Underground		A	20081103	DIS	0.000	4.470	KEVIN BLACK
	S955 E192 NW 01 37S 22E SL							41 EAST 300 SOUTH
09-2311	Underground		A	20081110	DIS	0.000	4.730	MARK & TERRI LYMAN
	S50 W990 NE 21 37S 22E SL							PO BOX 106
09-2312	Underground		A	20081230	DIS	0.000	4.730	JACK & NELLADEE STREET
	S72 W662 E4 02 37S 22E SL							1004 EAST BROWNS CANYON RD
09-2316	Underground		A	20090209	DIS	0.000	4.590	FRANKLIN P. HAWKINS
	S1095 W725 NE 21 37S 22E SL							4238 SOUTH 1000 WEST
09-255	Underground		P	19660304	S	0.015	0.000	USA BUREAU OF LAND MANAGEMENT
	S688 E128 W4 14 38S 21E SL							2370 SOUTH 2300 WEST
09-275	Underground		P	19600804	S	0.001	0.000	UTAH SCHOOL AND INSTITUTIONAL TRUST LANDS ADMIN.
	S943 W546 N4 32 38S 23E SL							675 EAST 500 SOUTH, 5TH FLOOR

09-348	Underground		P	19640513	S	0.011	0.000	KELLY G. & TERRI J. LAWS
	N2265 W900 S4 33 36S 23E SL							295 W. 400 N.
09-365	Underground		P	19641013	S	0.015	0.000	EUGENE GUYMON
	N747 W932 E4 02 37S 22E SL							P.O. BOX 117
09-385	Underground		T	19650715	I	0.500	0.000	HARRIS SHUMWAY
	S1320 E395 NW 33 37S 22E SL							BOX 172
09-423	Underground		P	19350522	DIS	0.022	5.580	FRED S. LYMAN
	N340 W750 S4 10 37S 22E SL							BLANDING UT 84511
09-466	Underground		P	19680308	S	0.007	0.000	LORENZO HAWKINS
	S152 W76 NE 32 37S 22E SL							P.O. BOX 182
09-473	Underground		P	19680927	D	0.015	0.000	USA UTAH LAUNCH COMPLEX WHITE SANDS MISSLE RANGE
	S608 W327 NE 27 37S 22E SL							C/O A. MURAY MAUGHN, SITE DIRECTOR
09-474	Underground		T	19690303		0.015	0.000	HARVEY J. KARTCHNER
	S3700 W2000 N4 35 36S 22E SL							BOX 232
09-496	Underground		T	19700325		0.100	0.000	MONTICELLO DISTRICT USA BUREAU OF LAND MANAGEMENT
	N1098 E1642 SW 11 38S 21E SL							P.O. BOX 1327
09-504	Underground		P	19700722	S	0.010	0.000	USA BUREAU OF LAND MANAGEMENT
	S3219 E3255 NW 08 37S 22E SL							2370 SOUTH 2300 WEST
09-510	Underground		T	19710318		2.000	0.000	WILLIAM B. REDD
	N200 E2750 SW 03 37S 21E SL							BOX 531

09-510	Underground		T	19710318		2.000	0.000	WILLIAM B. REDD
	N0 E3000 SW 03 37S 21E SL							BOX 531
09-528	Underground		P	19720315	DIS	0.015	0.000	J. PARLEY LAWS
	N3110 W1790 SE 02 37S 22E SL							P.O. BOX #315
09-541	Underground		T	19720731		0.100	0.000	BLANDING VACATIONS INCORPORATED
	S1550 E2500 NW 15 37S 22E SL							PO BOX 66
09-544	Underground		T	19720922		0.015	0.000	ROBERT E. HOSLER
	N1678 W953 SE 03 37S 22E SL							PO BOX 421
09-546	Underground		P	19721012	DI	0.030	0.000	WILLIAM W. AND ROSELINE M. SIMPSON
	S3273 E1687 N4 03 37S 22E SL							P.O. BOX #263
09-573	Underground		P	19730927	DIS	0.084	0.000	ERWIN OLIVER
	N1610 E1260 SW 35 36S 22E SL							P.O. BOX #285
09-581	Underground		P	19740502	I	0.300	0.000	DELORES HURST
	S70 W900 E4 35 36S 22E SL							516 WEST 100 SOUTH (50-5)
09-581	Underground		P	19740502	I	0.300	0.000	DELORES HURST
	S750 W430 E4 35 36S 22E SL							516 WEST 100 SOUTH (50-5)
09-581	Underground		P	19740502	I	0.300	0.000	DELORES HURST
	S20 W325 E4 35 36S 22E SL							516 WEST 100 SOUTH (50-5)
09-582	Underground		P	19740502	I	0.750	0.000	TODD MILTON HURST
	S75 W1185 E4 35 36S 22E SL							747 NORTH 300 WEST (34-2)
09-582	Underground		P	19740502	I	0.750	0.000	TRAVIS EVAN PEHRSON
	S60 W860 E4 35 36S 22E SL							747 NORTH 300 WEST (34-2)
09-584	Underground	well	P	19740503	O	0.015	0.000	LEONARD R. HOWE

		info						
	S619 W135 N4 03 37S 22E SL							P.O. BOX #1025
09-597	Underground		P	19740829	S	0.015	0.000	DOROTHY PERKINS
	S590 W810 E4 21 37S 22E SL							NORTH RESERVOIR ROAD (37-1)
09-606	Underground		T	19741127	DIS	0.100	0.000	JESS M. GROVER
	N2040 W350 S4 01 37S 22E SL							P.O. BOX #564
09-618	Underground	well info	P	19750421	DIS	0.010	0.000	MARK EUGENE SHUMWAY
	S1140 W220 N4 03 37S 22E SL							444 WEST 1600 SOUTH (79-2)
09-619	Underground		T	19750619	DIS	0.015	0.000	BOYD LAWS
	S2400 W210 N4 22 37S 22E SL							P.O. BOX #317
09-631	Underground		P	19751120	DIS	0.100	0.000	EUGENE GUYMON
	N747 W932 E4 02 37S 22E SL							P.O. BOX #117
09-631	Underground		P	19751120	DIS	0.100	0.000	EUGENE GUYMON
	N400 W350 E4 02 37S 22E SL							P.O. BOX #117
09-631	Underground		P	19751120	DIS	0.100	0.000	EUGENE GUYMON
	N275 W150 E4 02 37S 22E SL							P.O. BOX #117
09-634	Underground	well info	P	19751129	S	0.015	0.000	LORRAINE ROSE AND VERL J. ROSE
	S1326 W1205 E4 02 37S 22E SL							1166 SOUTH 100 EAST
09-637	Underground	well info	P	19760103	IS	0.200	0.000	HENRY CLYDE WATKINS
	S2722 E10 NW 01 37S 22E SL							EAST BROWN CANYON ROAD 103-14
09-663	Underground		T	19760623	DIS	0.015	0.000	GRANT L. BAYLES
	N1155 E870 SW 22 37S 22E SL							P.O. BOX #275
09-666	Underground		T	19761021	O	1.000	0.000	HEMI WEST PROPERTIES

	N3200 W2600 SE 23 37S 21E SL							1325 SOUTH 800 EAST
09-666	Underground		T	19761021	O	1.000	0.000	HEMI WEST PROPERTIES
	N3000 W1300 SE 23 37S 21E SL							1325 SOUTH 800 EAST
09-666	Underground		T	19761021	O	1.000	0.000	HEMI WEST PROPERTIES
	N2100 W200 SE 23 37S 21E SL							1325 SOUTH 800 EAST
09-666	Underground		T	19761021	O	1.000	0.000	HEMI WEST PROPERTIES
	N2100 E1200 SW 24 37S 21E SL							1325 SOUTH 800 EAST
09-672	Underground	well info	P	19761210	OS	0.015	0.000	ENERGY FUELS LIMITED
	N640 W1650 SE 28 37S 22E SL							1200 17TH STREET, ONE TABOR CENTER SUITE 2500
09-689	Underground	well info	P	19770307	MOS	1.110	803.600	IUC WHITE MESA LLC
	N1400 W3000 SE 28 37S 22E SL							1050 17TH STREET SUITE 950
09-689	Underground	well info	P	19770307	MOS	1.110	803.600	IUC WHITE MESA LLC
	N1300 W2400 SE 28 37S 22E SL							1050 17TH STREET SUITE 950
09-689	Underground	well info	P	19770307	MOS	1.110	803.600	ENERGY FUELS LTD.
	N2100 W2200 SE 28 37S 22E SL							1200 17TH STREET, ONE TABOR CENTER SUITE 2500
09-689	Underground		P	19770307	MOS	1.110	803.600	IUC WHITE MESA LLC
	N1000 E650 SW 22 37S 22E SL							1050 17TH STREET SUITE 950
09-713	Underground	well info	P	19770407	DIS	0.015	0.000	DEAN W. GUYMON
	S360 W350 NE 03 37S 22E SL							P.O. BOX #194
09-740	Underground	well	P	19770419	I	0.015	0.000	WINSTON AND

		info						KATHRYN J. HURST BAYLISS
	N320 W1240 E4 27 38S 22E SL							259 NORTH 100 WEST
09-743	Underground		T	19851016	DI	0.015	0.000	O. FROST BLACK
	N150 E50 SW 36 36S 22E SL							208 SOUTH 200 WEST (65-5)
09-771	Underground		P	19770427	I	0.015	0.000	ELIZABETH ANN HURST PHILLIPS
	N670 E950 S4 34 36S 22E SL							P.O. BOX #389
09-778	Underground		T	19770504	O	0.015	0.000	REX D. ANDERSON
	S310 E1240 W4 15 37S 22E SL							P.O. BOX 569
09-792	Underground	well info	P	19770509	DIS	0.015	0.000	HENRY CLYDE WATKINS
	S80 E220 W4 01 37S 22E SL							1000 EAST BROWNS CANYON ROAD 103-14
09-805	Underground		T	19770510	DIS	0.015	0.000	BAR M. K. RANCHES INCORPORATED
	N1540 E1340 W4 03 37S 22E SL							BOX 576
09-806	Underground		T	19770510	DIS	0.015	0.000	BAR M. K. RANCHES INCORPORATED
	N1200 E990 W4 14 37S 22E SL							BOX 576
09-808	Underground		T	19770510	DIS	0.015	0.000	BAR M. K. RANCHES INCORPORATED
	N990 W990 S4 11 37S 22E SL							BOX 576
09-826	Underground		U	19770523	DIS	0.500	0.000	CLISBEE LYMAN
	N665 W1015 S4 10 37S 22E SL							435 SOUTH 200 WEST 63-2
09-826	Underground		U	19770523	DIS	0.500	0.000	CLISBEE LYMAN
	N70 W790 S4 10 37S 22E SL							435 SOUTH 200 WEST 63-2
09-826	Underground		U	19770523	DIS	0.500	0.000	CLISBEE LYMAN
	N340 W750 S4 10 37S 22E SL							435 SOUTH 200 WEST 63-2

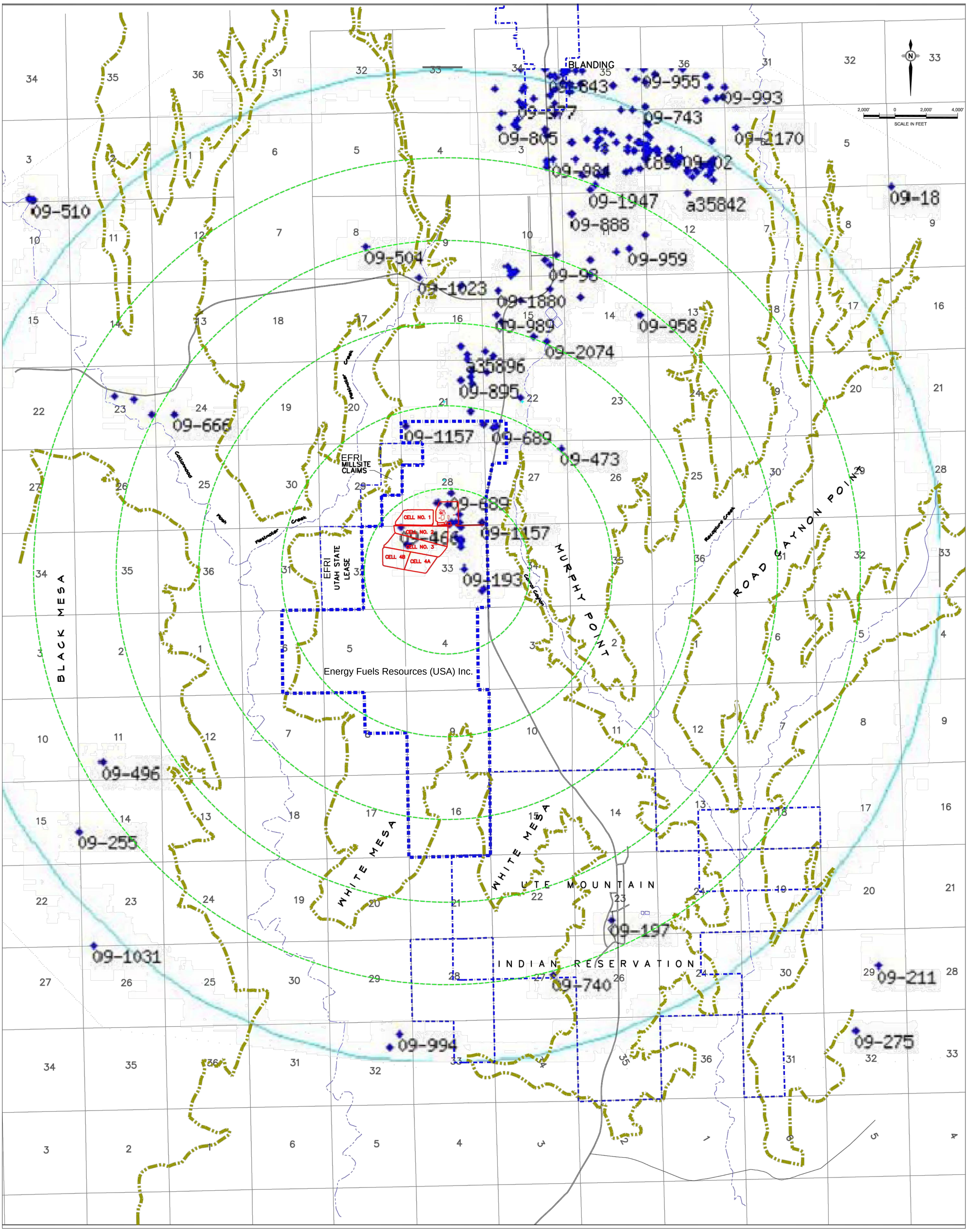
09-826	Underground		U	19770523	DIS	0.500	0.000	CLISBEE LYMAN
	N315 W450 S4 10 37S 22E SL							435 SOUTH 200 WEST 63-2
09-831	Underground		T	19800516	DIS	0.015	0.000	J. KEITH ROGERS
	N2306 E217 SW 35 36S 22E SL							3488 FOOTHILL DRIVE
09-832	Underground		T	19800516	DIS	0.015	0.000	J. KEITH ROGERS
	N1728 E215 SW 35 36S 22E SL							3488 FOOTHILL DRIVE
09-833	Underground		P	19800516	I	0.015	0.000	J. KEITH ROGERS
	N1265 W250 SE 34 36S 22E SL							3488 NORTH FOOTHILL DRIVE
09-834	Underground		T	19800516	DIS	0.015	0.000	J. KEITH ROGERS
	N2208 E2252 S4 34 36S 22E SL							3488 FOOTHILL DRIVE
09-843	Underground		P	19900308	DI	0.015	0.000	STAN AND SANDRA PERKINS
	N2220 E1930 S4 34 36S 22E SL							864 NORTH DAYBREAK DRIVE
09-860	Underground	well info	P	19770620	DI	0.015	0.000	STANLEY D. MARTINEAU
	S830 E1740 W4 01 37S 22E SL							P.O. BOX #822
09-871	Underground		P	19770606	S	0.015	0.000	JESS M. GROVER
	N270 E520 W4 36 36S 22E SL							BLANDING UT 84511
09-872	Underground	well info	P	19770606	S	0.015	0.000	JESS M. GROVER
	S420 E2080 W4 01 37S 22E SL							BLANDING UT 84511
09-875	Underground	well info	P	19770630	IS	0.015	2.512	AROE G. BROWN
	N1570 W1230 SE 01 37S 22E SL							BOX 213
09-876	Underground	well info	P	19770630	IS	0.015	1.400	PETER D. AND GEORGIA R. KARAMESINES
	N1150 W1900 SE 01 37S 22E SL							1527 LINCOLN STREET APT. #4
09-879	Underground		P	19770706	I	0.015	0.000	JAMES DEWEY AND

								SHIRLEY LOU B. BRADFORD
	N570 W700 SE 36 36S 22E SL							149 SOUTH 800 EAST
09-885	Underground		P	19770711	I	0.015	0.000	GEORGE H. BRADFORD
	N1280 W1050 SE 36 36S 22E SL							BOX 855
09-888	Underground	well info	P	19770711	IS	0.015	0.000	FRED E. HALLIDAY
	S1310 E585 NW 11 37S 22E SL							BOX 335
09-895	Underground		T	19800925	IS	0.015	0.000	NELDON E. HOLT
	S1340 E1300 N4 21 37S 22E SL							BOX 394
09-896	Underground	well info	P	19770713	S	0.007	0.000	NELDON E. HOLT
	N100 E680 SW 15 37S 22E SL							BOX 394
09-906	Underground		T	19770719	DIS	0.015	0.000	REED E. BAYLES
	N1520 E650 S4 35 36S 22E SL							P.O. BOX #203
09-914	Underground		P	19770726	IS	0.015	0.000	EUGENE GUYMON
	N275 W150 E4 02 37S 22E SL							P.O. BOX #117
09-915	Underground		U	19770726	IS	0.100	0.000	EUGENE GUYMON
	N300 W100 E4 02 37S 22E SL							P.O. BOX #117
09-925	Underground	well info	P	19770728	DIS	0.015	0.000	DOROTHY PERKINS
	S75 W25 E4 02 37S 22E SL							205 EAST 700 SOUTH
09-93	Underground		P	19440929	S	0.013	0.000	BARRY LEE AND LOREE A. WOOLLEY
	N644 W855 SE 10 37S 22E SL							191 BUTTERNUT DRIVE NORTH
09-949	Underground		T	19770816	DIS	0.015	0.000	BERTHA SNYDER
	S200 E800 W4 01 37S 22E SL							P.O. BOX 1318
09-954	Underground		P	19770907	DIS	0.015	0.000	PHYLLIS B. JONES

	N500 W1280 SE 36 36S 22E SL							P.O. BOX #472
09-955	Underground		P	19770907	I	0.015	0.000	O. FROST BLACK
	S175 E50 W4 36 36S 22E SL							P.O. BOX #71
09-958	Underground		T	19770915	IS	0.015	0.000	RICHARD & NORMAN NIELSON
	S2640 W400 NE 14 37S 22E SL							P.O. BOX #245
09-959	Underground		T	19840329	DIS	0.015	0.000	NORMAN AND RICHARD C. NIELSON
	N1700 W1100 SE 11 37S 22E SL							63 NORTH 100 WEST (17-2)
09-960	Underground		T	19880622	IS	0.015	0.000	NORMAN AND RICHARD NIELSON
	S585 E40 W4 01 37S 22E SL							63 NORTH 100 WEST (17-2)
09-977	Underground		T	19771005	DIS	0.015	0.000	KENNETH P. MCDONALD
	N559 0 S4 34 36S 22E SL							60 NORTH 100 WEST (16-5)
09-983	Underground		T	19771007	IS	0.500	0.000	PETER D. AND GEORGIA R. KARAMESINES
	N1270 W1980 SE 01 37S 22E SL							1527 LINCOLN STREET APT. #4
09-984	Underground	well info	P	19771013	DIO	0.015	0.000	FRANK A. MONTELLA
	S545 W505 E4 03 37S 22E SL							P.O. BOX #643, HIGHWAY 163 NORTH
09-988	Underground		A	19811117	DI	0.015	0.000	GARTH L. BRADFORD
	N700 W270 SE 36 36S 22E SL							P.O. BOX #1357
09-989	Underground		T	19771031	DO	0.015	0.000	REX D. ANDERSON
	N155 E1010 W4 15 37S 22E SL							P.O. BOX 569
09-990	Underground	well info	P	19771101	IS	0.015	1.280	EUGENE GUYMON

	N400 W350 E4 02 37S 22E SL							P.O. BOX #117
09-993	Underground		P	19771027	DI	0.015	0.000	BERNAL BRADFORD
	N1260 W200 SE 36 36S 22E SL							P.O. BOX #594
09-994	Underground		P	19771108	S	0.015	0.000	UTAH SCHOOL AND INSTITUTIONAL TRUST LANDS ADMIN.
	S660 W660 NE 32 38S 22E SL							675 EAST 500 SOUTH, 5TH FLOOR
a12177	Underground		A	19820223	DIS	0.015	0.000	NED J. AND MARILYN PALMER
	S551 E1540 W4 01 37S 22E SL							12 EAST 5TH SOUTH 107-5
a13054	Underground		T	19831205	IS	0.015	0.000	NORMAN AND RICHARD NIELSON
	S585 E40 W4 01 37S 22E SL							P.O. BOX #245
a20266	Underground		T	19770315	M	2.000	0.000	BLANDING CITY
	S2440 W1245 NE 35 36S 22E SL							50 WEST 100 SOUTH
a20266	Underground		T	19770315	M	2.000	0.000	BLANDING CITY
	S2440 W870 NE 35 36S 22E SL							50 WEST 100 SOUTH
a21545	Underground	well info	T	19970915	DI	0.000	4.730	JIM & MARY BOURNE
	N3055 W1059 SE 01 37S 22E SL							468 NORTH 500 WEST
a24139	Underground	well info	T	20000201	DIS	0.000	1.480	ANNA M. RAFFERTY
	S860 E315 NW 22 37S 22E SL							P.O. BOX 553
a35842	Underground		U	20090819	M	2.000	0.000	BLANDING CITY
	N938 E135 W4 01 37S 22E SL							50 WEST 100 SOUTH
a35842	Underground		U	20090819	M	2.000	0.000	BLANDING CITY
	S145 E133 N4 12 37S 22E SL							50 WEST 100 SOUTH
a35896	Underground		U	20090908	DIS	0.000	4.730	MITCHELL H. &

								JANA L. BAILEY
	N256 W943 SE 16 37S 22E SL							210 N. SHIRTTAIL WAY
t89-09-01	Underground		T	19890118	O	0.000	5.000	IVAN R. WATKINS
	S2722 E10 NW 01 37S 22E SL							BOX 938
t89-09-02	Underground		T	19890504	O	0.000	5.000	IVAN R. WATKINS
	S2722 E10 NW 01 37S 22E SL							BOX 938



ENERGY FUELS

REVISIONS		
Date	By	
09-11	GM	

Project: White Mesa Mill

County: San Juan   State: UT

Location:

GROUNDWATER APPROPRIATIONS WITHIN A 5-MILE RADIUS OF THE WHITE MESA MILL

FIGURE 1.5-9

Author: unknown   Date: May 2010   Drafted By: D.Sledd

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1.6.1 Regional Geology

The following descriptions of regional physiography; rock units; and structure and tectonics are reproduced from the 1978 ER for ease of reference and as a review of regional geology.

1.6.1.1 Physiography (1978 ER Section 2.4.1.1)

The Mill site lies within the Canyon Lands section of the Colorado Plateau physiographic province. To the north, this section is distinctly bounded by the Book Cliffs and Grand Mesa of the Uinta Basin; western margins are defined by the tectonically controlled High Plateaus section, and the southern boundary is arbitrarily defined along the San Juan River. The eastern boundary is less distinct where the elevated surface of the Canyon Lands section merges with the Southern Rocky Mountain province.

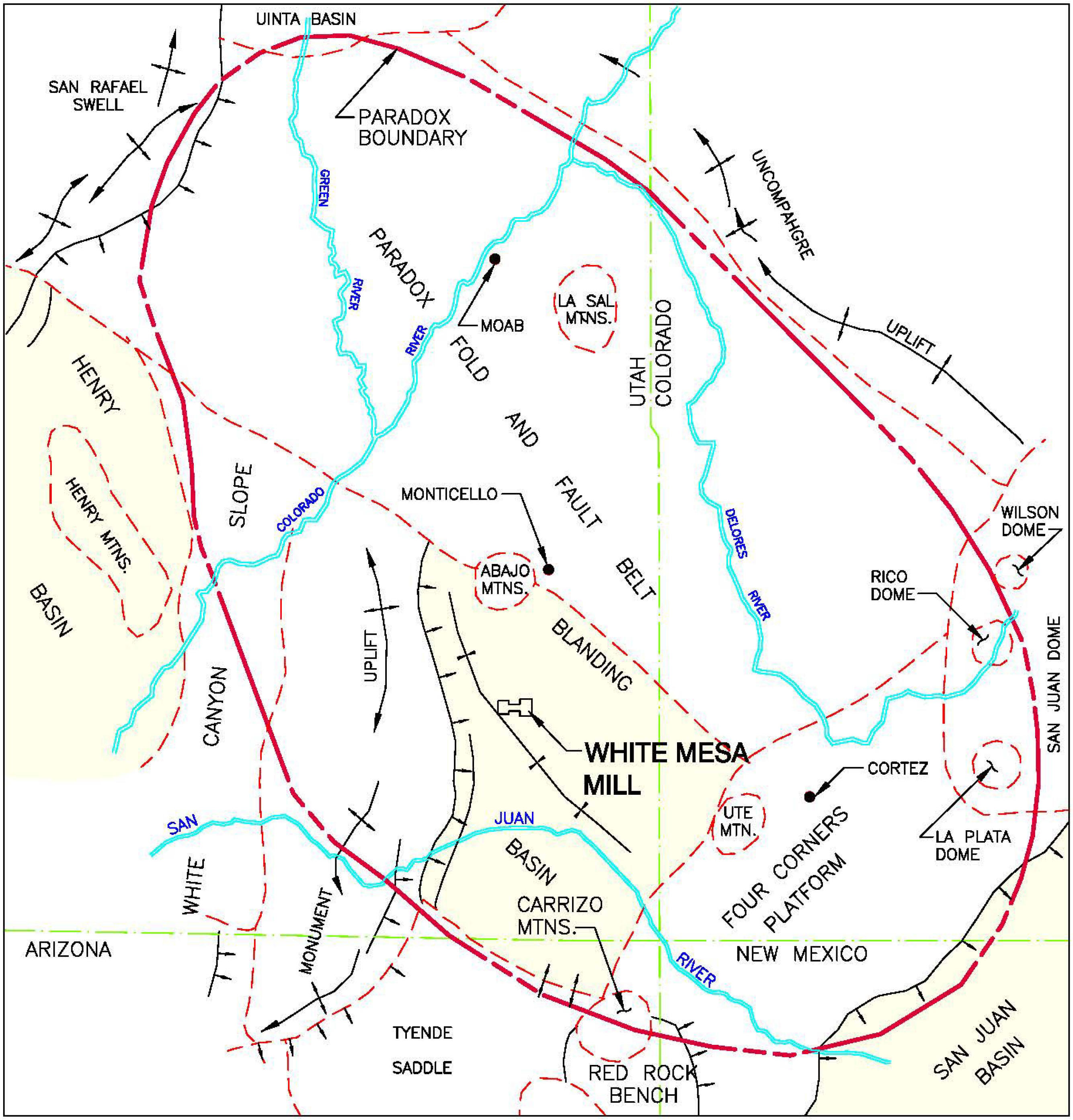
Canyon Lands has undergone epeirogenic uplift and subsequent major erosion has produced the region's characteristic angular topography reflected by high plateaus, mesas, buttes, structural benches, and deep canyons incised into flat-laying sedimentary rocks of pre-Tertiary age. Elevations range from approximately 3,000 feet (914 meters) in the bottom of the deeper canyons along the southwestern margins of the section to more than 11,000 feet (3,353 meters) in the topographically anomalous laccolithic Henry, Abajo and La Sal Mountains to the northeast. Except for the deeper canyons and isolated mountain peaks, an average elevation in excess of 500 feet (1,524 meters) persists over most of the Canyon Lands section.

On a more localized regional basis, the Mill site is located near the western edge of the Blanding Basin, sometimes referred to as the Great Sage Plain (Eardly, 1958), lying east of the north-south trending Monument Uplift, south of the Abajo Mountains and adjacent to the northwesterly-trending Paradox Fold and Fault Belt (Figure 1.6-1). Topographically, the Abajo Mountains are the most prominent feature in the region, rising more than 4,000 feet (1,219 meters) above the broad, gently rolling surface of the Great Sage Plain.

The Great Sage Plain is a structural slope, capped by the resistant Burro Canyon formation and the Dakota Sandstone, almost horizontal in an east-west direction but descends to the south with a regional slope of about 2,000 feet (610 meters) over a distance of nearly 50 miles (80 kilometers). Though not as deeply or intricately dissected as other parts of the Canyon Lands, the plain is cut by numerous narrow and vertical-walled south-trending valleys 100 to more than 500 feet (30 to 152+ meters) deep. Water from the intermittent streams that drain the plain flow southward to the San Juan River, eventually joining the Colorado River and exiting the Canyon Lands section through the Grand Canyon.

1.6.1.2 Rock Units (1978 ER Section 2.4.1.1)

The sedimentary rocks exposed in southeastern Utah have an aggregate thickness of about 6,000 to 7,000 feet (1,829 to 2,134 meters) and range in age from Pennsylvanian to Late Cretaceous. Older unexposed rocks are known mainly from oil well drilling in the Blanding Basin and Monument Uplift. These wells have encountered correlative Cambrian to Permian rock units of markedly differing thicknesses but averaging over 5,000 feet (1,524 meters) in total thickness (Witkind, 1964). Most of the wells drilled in the region have bottomed in the Pennsylvanian Paradox Member of the Hermosa formation. A generalized stratigraphic section of rock units ranging in age from Cambrian through Jurassic and Triassic (?), as determined from oil-well logs, is shown in Table 1.6-1. Descriptions of the younger rocks, Jurassic through Cretaceous, are based on field mapping by various investigators and are shown in Table 1.6-2.



LEGEND

BOUNDARY OF TECTONIC DIVISION

MONOCLINE SHOWING TRACE OF AXIS AND DIRECTION OF DIP

ANTICLINE SHOWING TRACE OF AXIS AND DIRECTION OF PLUNGE

SYNCLINE SHOWING TRACE OF AXIS AND DIRECTION OF PLUNGE

Figure 1.6-1

Colorado Plateau Geologic Map

W:\USA\Utah\Mill\dwgs\Reclamation Plans\RecPlan4.0\Figure 1.6-1 Colo Plateau Geology.dwg Figure 1.6-1 23/11/2009 dsledd

Table 1.6-1
Generalized Stratigraphic Section of Subsurface Rocks Based on Oil-Well Logs (Table 2.6-1 UMETCO)

Era	Age	Stratigraphic Unit	Thickness* (ft.)	Description
MESOZOIC		Glen Canyon Group:		
	Jurassic and Triassic (?)	Navajo Sandstone	300 - 400	Buff to light gray, massive, cross-bedded, friable sandstone
	Triassic (?)	Kayenta Formation	100 - 150	Reddish-brown sandstone and mudstone and occasional conglomerate lenses
	Triassic	Wingate Sandstone	250 - 350	Reddish-brown, massive, cross-bedded, fine-grained sandstone
		Chinle Formation:		
		Undivided	600 - 700	Variegated claystone with some thin beds of siltstone and limestone
		Moss Back Member	0 - 100	Light colored, conglomeratic sandstone and conglomerite
		Shinarump Member	0 - 20	Yellowish-gray, fine to coarse-grained sandstone: conglomeratic sandstone and conglomerate
		Unconformity		
	Middle (?) and Lower Triassic	Moenkopi Formation	50 - 100	Reddish-brown mudstone and fine-grained sandstone
		Unconformity		
PALEOZOIC	Permian	Cutler Formation:		
		Organ Rock Member	0 - 600	Reddish-brown, sandy mudstone
		Cedar Mesa Sandstone Member	1100 - 1400	Reddish-brown, massive, fine to medium-grained sandstone
	Pennsylvanian and Permian (?)	Rico Formation	450	Red and gray calcareous, sandy shale: gray limestone and sandstone
	Pennsylvanian	Hermosa Formation:		
		Upper Member	1000 - 1200	Gray, massive limestone: some shale and sandstone
		Paradox Member	1200	Halite, anhydrite, gypsum, shale, and siltstone
		Lower Member	200	Limestone, siltstone, and shale
		Unconformity		
	Mississippian	Leadville Limestone	500	White to tan sucrose to crystalline limestone
	Devonian	Ouray Limestone	100	Light gray and tan, thin-bedded limestone and dolomite
		Zilbert Formation	200	Gray and brown dolomite and limestone with thin beds green shale and sandstone
		Unconformity		
	Cambrian	Ophir Formation and Tintic Quartzite	600	Gray and brown limestone and dolomite, feldspathic sandstone and arkose

* To convert feet to meters, multiply by 0.3043. Average thickness given if range is not shown.

Table 1.6-2
Generalized Stratigraphic Section of Exposed Rocks in the Project Vicinity (Table 2.6-2 UMETCO)

ERA	SYSTEM	SERIES (Age)		STRATIGRAPHIC UNIT	THICKNESS* (ft.)	LITHOLOGY
CENOZOIC	QUATERNARY	Holocene to Pleistocene		Alluvium	2 - 25+	Silt, sand and gravel in arroyos and stream valleys.
CENOZOIC	QUATERNARY	Holocene to Pleistocene		Colluvium and Talus	0 - 15+	Slope wash, talus and rock rubble ranging from cobbles and boulders to massive blocks fallen from cliffs and outcrops of resistant rock.
CENOZOIC	QUATERNARY	Holocene to Pleistocene		Loess	0 - 22+	Reddish-brown to light-brown, unconsolidated, well-sorted silt to medium-grained sand; partially cemented with caliche in some area; reworked partly by water.
				Unconformity		
MESOZOIC	CRETACEOUS	Upper Cretaceous		Mancos Shale	0 - 11(?)	Gray to dark-gray, fissile, thin-bedded marine shale with fossiliferous sandy limestone in lower strata.
MESOZOIC	CRETACEOUS	Upper Cretaceous		Dakota Sandstone	30 - 75	Light yellowish-brown to light gray-brown, thick bedded to cross-bedded sandstone, conglomeratic sandstone; interbedded this lenticular gray carbonaceous claystone and impure coal; local course basal conglomerate.
				Unconformity		
MESOZOIC	CRETACEOUS	Lower Cretaceous		Burro Canyon Formation	50 - 150	Light-gray and light-brown, massive and cross-bedded conglomeratic sandstone and interbedded green and gray-green mudstone; locally contains thin discontinuous beds of silicified sandstone and limestone near top.
				Unconformity (?)		
MESOZOIC	Jurassic	Upper Jurassic	Morrison Formation	Brushy Basin Member	200 - 450	Variegated gray, pale-green, reddish-brown, and purple bentonitic mudstone and siltstone containing thin discontinuous sandstone and comglomerate lenses.
MESOZOIC	Jurassic	Upper Jurassic	Morrison Formation	Westwater Canyon Member	0 - 250	Interbedded yellowish- and greenish-gray to pinkish-gray, fine- to course-grained arkosic sandstone and greenish-gray to reddish-brown sandy shale and mudstone.
MESOZOIC	Jurassic	Upper Jurassic	Morrison Formation	Recapture Member	0 - 200	Interbedded reddish-gray to light brown fine-to medium-grained sandstone and reddish-gray silty and sandy claystone.
MESOZOIC	Jurassic	Upper Jurassic	Morrison Formation	Salt Wash Member	0 - 350	Interbedded yellowish-brown to pale reddish-brown fine-grained to conglomeritic sandstones and greenish- and reddish-gray mudstone.
				Unconformity		
MESOZOIC	Jurassic	Upper Jurassic	San Rafael Group	Bluff Sandstone	0 - 150+	White to grayish-brown, massive, cross-bedded, fine- to medium-grained eolian sandstone.
MESOZOIC	Jurassic	Upper Jurassic	San Rafael Group	Summerville Formation	25 - 125	Thin-bedded, ripple-marked reddish-brown muddy sandstone and sandy shale.
MESOZOIC	Jurassic	Upper Jurassic	San Rafael Group	Entrada Sandstone	150 - 180	Reddish-brown to grayish-white, massive, cross-bedded, fine- to medium-grained sandstone.
MESOZOIC	Jurassic	Middle Jurassic	San Rafael Group	Carmel Formation	20 - 100+	Irregularly bedded reddish-brown muddy sandstone and sandy mudstone with local thin beds of brown to gray limestone and reddish- to greenish-gray shale.
				Unconformity		

*To convert feet to meters, multiply feet by 0.3048.

Paleozoic rocks of Cambrian, Devonian and Mississippian ages are not exposed in the southeastern Utah region. Most of the geologic knowledge regarding these rocks was learned from the deeper oil wells drilled in the region, and from exposures in the Grand Canyon to the southwest and in the Uinta and Wasatch Mountains to the north. A few patches of Devonian rocks are exposed in the San Juan Mountains in southwestern Colorado. These Paleozoic rocks are the result of periodic transgressions and regressions of epicontinental seas and their lithologies reflect a variety of depositional environments.

In general, the coarse-grained feldspathic rocks overlying the Precambrian basement rocks grade upward into shales, limestones and dolomites that dominate the upper part of the Cambrian. Devonian and Mississippian dolomites, limestones and interbedded shales unconformably overlay the Cambrian strata. The complete absence of Ordovician and Silurian rocks in the Grand Canyon, Uinta Mountains, southwest Utah region and adjacent portions of Colorado, New Mexico and Arizona indicate that the region was probably epeirogenically positive during these times.

The oldest stratigraphic unit that crops out in the region is the Hermos formation of Middle and Late Pennsylvanian age. Only the uppermost strata of this formation are exposed, the best exposure being in the canyon of the San Juan River at the "Goosenecks" where the river traverses the crest of the Monument uplift. Other exposures are in the breached centers of the Lisbon Valley, Moab and Castle Valley anticlines. The Paradox Member of the Hermosa formation is sandwiched between a relatively thin lower unnamed member consisting of dark-gray shale siltstone, dolomite, anhydrite, and limestone, and an upper unnamed member of similar lithology but having a much greater thickness. Composition of the Paradox Member is dominantly a thick sequence of interbedded slate (halite), anhydrite, gypsum, and black shale. Surface exposures of the Paradox in the Moab and Castle Valley anticlines are limited to contorted residues of gypsum and black shale.

Conformably overlying the Hermosa is the Pennsylvanian and Permian (?) Rico formation, composed of interbedded reddish-brown arkosic sandstone and gray marine limestone. The Rico represents a transition zone between the predominantly marine Hermosa and the overlying continental Cutler formation of Permian age.

Two members of the Cutler probably underlying the region south of Blanding are, in ascending order, the Cedar Mesa Sandstone and the Organ Rock Tongue. The Cedar Mesa is a white to pale reddish-brown, massive, cross-bedded, fine- to medium-grained eolian sandstone. An irregular fluvial sequence of reddish-brown fine-grained sandstones, shaly siltstones and sandy shales comprise the Organ Rock Tongue.

The Moenkopi formation, of Middle (?) and Lower Triassic age, unconformably overlies the Cutler strata. It is composed of thin, evenly-bedded, reddish to chocolate-brown, ripple-marked, cross-laminated siltstone and sandy shales with irregular beds of massive medium-grained sandstone.

A thick sequence of complex continental sediments known as the Chinle formation unconformably overlies the Moenkopi. For the purpose of making lithology correlations in oil wells this formation is divided into three units: The basal Shinarump Member, the Moss Back Member and an upper undivided thick sequence of variegated reddish-brown, reddish- to greenish-gray, yellowish-brown to light-brown bentonitic claystones, mudstones, sandy siltstone, fine-grained sandstone, and limestones. The basal Shinarump is dominantly a yellowish-grey, fine- to coarse-grained sandstone, conglomeratic sandstone and conglomerate characteristically filling ancient stream channel scours eroded into the Moenkopi surface. Numerous uranium deposits have been located in this member in the White Canyon mining district to the west of Comb Ridge. The Moss Back is typically composed of yellowish- to greenish-grey, fine- to medium-grained sandstone, conglomeratic sandstone and conglomerate. It commonly comprises the basal unit of the Chinle where the Shinarump was not deposited, and in a like manner, fills ancient stream channels scoured into the underlying unit.

In the Blanding Basin the Glen Canyon Group consists of three formations which are, in ascending order, the Wingate Sandstone, the Kayenta and the Navajo Sandstone. All are conformable and their contacts are gradational. Commonly cropping out in sheer cliffs, the Late Triassic Wingate Sandstone is typically composed of buff to reddish-brown, massive, cross-bedded, well-sorted, fine-grained quartzose sandstone of eolian origin. Late Triassic (?) Kayenta is fluvial in origin and consists of reddish-brown, irregularly to cross-bedded sandstone, shaly sandstone and, locally, thin beds of limestone and conglomerate. Light yellowish-brown to light-gray and white, massive, cross-bedded, friable, fine- to medium-grained quartzose sandstone typifies the predominantly eolian Jurassic and Triassic (?) Navajo Sandstone.

Four formations of the Middle to Late Jurassic San Rafael Group unconformably overly the Navajo Sandstone. These strata are composed of alternating marine and non-marine sandstones, shales and mudstones. In ascending order, the formations are the Carmel formation, Entrada Sandstone, Summerville formation, and Bluff Sandstone. The Carmel usually crops out as a bench between the Navajo and Entrada Sandstones. Typically reddish-brown muddy sandstone and sandy mudstone, the Carmel locally contains thin beds of brown to gray limestone and reddish- to greenish-gray shale. Predominantly eolian in origin, the Entrada is a massive cross-bedded fine- to medium-grained sandstone ranging in color from reddish-brown to grayish-white that crops out in cliffs or hummocky slopes. The Summerville is composed of regular thin-bedded, ripple-marked, reddish-brown muddy sandstone and sandy shale of marine origin and forms steep to gentle slopes above the Entrada. Cliff-forming Bluff Sandstone is present only in the southern part of the Monticello district thinning northward and pinching out near Blanding. It is a white to grayish-brown, massive, cross-bedded eolian sandstone.

In the southeastern Utah region the Late Jurassic Morrison formation has been divided in ascending order into the Salt Wash, Recapture, Westwater Canyon, and Brushy Basin Members. In general, these strata are dominantly fluvial in origin but do contain lacustrine sediments. Both the Salt Wash and Recapture consist of alternating mudstone and sandstone; the Westwater Canyon is chiefly sandstone with some sandy mudstone and claystone lenses, and the heterogenous Brushy Basin consists of variegated bentonitic mudstone and siltstone containing scattered thin limestone, sandstone, and conglomerate lenses. As strata of the Morrison formation are the oldest rocks exposed in the Mill area vicinity and are one of the two principal uranium-bearing formations in southeast Utah, the Morrison, as well as younger rocks, are described in more detail in Section 1.6.2.2.

The Early Cretaceous Burro Canyon formation rests unconformably (?) on the underlying Brushy Basin Member of the Morrison formation. Most of the Burro Canyon consists of light-colored, massive, cross-bedded fluvial conglomerate, conglomerate sandstone and sandstone. Most of the conglomerates are near the base. Thin, even-bedded, light-green mudstones are included in the formation and light-grey thin-bedded limestones are sometimes locally interbedded with the mudstones near the top of the formation.

Overlying the Burro Canyon is the Dakota Sandstone of Upper Cretaceous age. Typical Dakota is dominantly yellowish-brown to light-gray, thick-bedded, quartzitic sandstone and conglomeratic sandstone with subordinate thin lenticular beds of mudstone, gray carbonaceous shale and, locally, thin seams of impure coal. The contact with the underlying Burro Canyon is unconformable whereas the contact with the overlying Mancos Shale is gradational from the light-colored sandstones to dark-grey to black shaly siltstone and shale.

Upper Cretaceous Mancos Shale is exposed in the region surrounding the project vicinity but not within it. Where exposed and weathered, the shale is light-gray or yellowish-gray, but is dark, to olive-gray where fresh. Bedding is thin and well developed; much of it is laminated.

Quaternary alluvium within the project vicinity is of three types: alluvial silt, sand and gravels deposited in the stream channels; colluvium deposits of slope wash, talus, rock rubble and large displaced blocks on slopes below cliff faces and outcrops of resistant rock; and alluvial and windblown deposits of silt and sand, partially reworked by water, on benches and broad upland surfaces.

1.6.1.3 Structure and Tectonics (1978 ER Section 2.4.1.3)

According to Shoemaker (1954 and 1956), structural features within the Canyon Lands of southeastern Utah may be classified into three main categories on the basis of origin or mechanism of the stress that created the structure. These three categories are: (1) structures related to large-scale regional uplifting or downwarping (epeirogenic deformation) directly related to movements in the basement complex (Monument Uplift and the Blanding Basin); (2) structures resulting from the plastic deformation of thick sequences of evaporite deposits, salt plugs and salt anticlines, where the structural expression at the surface is not reflected in the basement complex (Paradox Fold and Fault Belt); and (3) structures that are formed in direct response to stresses induced by magmatic intrusion including local laccolithic domes, dikes and stocks (Abajo Mountains).

Each of the basins and uplifts within the Mill area region is an asymmetric fold usually separated by a steeply dipping sinuous monocline. Dips of the sedimentary beds in the basins and uplifts rarely exceed a few degrees except along the monocline (Shoemaker, 1956) where, in some instances, the beds are nearly vertical. Along the Comb Ridge monocline, the boundary between the Monument Uplift and the Blanding Basin, approximately eight miles (12.9 kilometers) west of the Mill area, dips in the Upper Triassic Wingate sandstone and in the Chinle formation are more than 40 degrees to the east.

Structures in the crystalline basement complex in the central Colorado Plateau are relatively unknown but where monoclines can be followed in Precambrian rocks they pass into steeply dipping faults. It is probable that the large monoclines in the Canyon Lands section are related to flexure of the layered sedimentary rocks under tangential compression over nearly vertical normal or high-angle reverse faults in the more rigid Precambrian basement rocks (Kelley, 1955; Shoemaker, 1956; Johnson and Thordarson, 1966).

The Monument Uplift is a north-trending, elongated, upwarped structure approximately 90 miles (145 kilometers) long and nearly 35 miles (56 kilometers) wide. Structural relief is about 3,000 feet (914 meters) (Kelley, 1955). Its broad crest is slightly convex to the east where the Comb Ridge monocline defines the eastern boundary. The uniform and gently descending western flank of the uplift crosses the White Canyon slope and merges into the Henry Basin (Figure 1.6-1).

East of the Monument Uplift, the relatively equidimensional Blanding Basin merges almost imperceptibly with the Paradox Fold and Fault Belt to the north, the Four Corners Platform to the southeast and the Defiance Uplift to the south. The basin is a shallow feature with approximately 700 feet (213 meters) of structural relief as estimated on top of the Upper Triassic Chinle formation by Kelley (1955), and is roughly 40 to 50 miles (64 to 80 kilometers) across. Gentle folds within the basin trend westerly to northwesterly in contrast to the distinct northerly orientation of the Monument Uplift.

Situated to the north of the Monument Uplift and Blanding Basin is the most unique structural feature of the Canyon Lands section, the Paradox Fold and Fault Belt. This tectonic unit is dominated by northwest trending anticlinal folds and associated normal faults covering an area about 150 miles (241 kilometers) long and 65 miles (104 kilometers) wide. These anticlinal structures are associated with salt flowage from the Pennsylvanian Paradox Member of the Hermosa formation and some show piercement of the overlying younger sedimentary beds by plug-like salt intrusions (Johnson and Thordarson, 1966). Prominent valleys have been eroded along the crests of the anticlines where salt piercements have occurred or collapses of the central parts have resulted in intricate systems of step-faults and grabens along the anticlinal crests and flanks.

The Abajo Mountains are located approximately 20 miles (32 kilometers) north of the Mill area on the more-or-less arbitrary border of the Blanding Basin and the Paradox Fold and Fault Belt (Figure 1.6-1). These mountains are laccolithic domes that have been intruded into and through the sedimentary rocks by several stocks (Witkind, 1964). At least 31 laccoliths have been identified. The youngest sedimentary rocks that have been intruded are those of Mancos Shale of Late Cretaceous age. Based on this and other vague and inconclusive evidence, Witkind (1964), has assigned the age of these intrusions to the Late Cretaceous or early Eocene.

Nearly all known faults in the region of the Mill area are high-angle normal faults with displacements on the order of 300 feet (91 meters) or less (Johnson and Thordarson, 1966). The largest known faults within a 40-mile (64 kilometer) radius around Blanding are associated with the Shay graben on the north side of the Abajo Mountains and the Verdure graben on the south side. Respectively, these faults trend northeasterly and easterly and can be traced for approximate distances ranging from 21 to 34 miles (34 to 55 kilometers) according to Witkind (1964). Maximum displacements reported by Witkind on any of the faults are 320 feet (98 meters). Because of the extensions of Shay and Verdure fault systems beyond the Abajo Mountains and other geologic evidence, the age of these faults is Late Cretaceous or post-Cretaceous and antedate the laccolithic intrusions (Witkind, 1964).

A prominent group of faults is associated with the salt anticlines in the Paradox Fold and Fault Belt. These faults trend northwesterly parallel to the anticlines and are related to the salt emplacement. Quite likely, these faults are relief features due to salt intrusion or salt removal by solution (Thompson, 1967). Two faults in this region, the Lisbon Valley fault associated with the Lisbon Valley salt anticline and the Moab fault at the southeast end of the Moab anticline have maximum vertical displacements of at least 5,000 feet (1,524 meters) and 2,000 feet (609 meters), respectively, and are probably associated with breaks in the Precambrian basement crystalline complex. It is possible that zones of weakness in the basement rocks represented by faults of this magnitude may be responsible for the beginning of salt flowage in the salt anticlines, and subsequent solution and removal of the salt by groundwater caused collapse within the salt anticlines resulting in the formation of grabens and local complex block faults (Johnson and Thordarson, 1966).

The longest faults in the Colorado Plateau are located some 155 to 210 miles (249 to 338 kilometers) west of the Mill area along the western margin of the High Plateau section. These faults have a north to northeast echelon trend, are nearly vertical and downthrown on the west in most places. Major faults included in this group are the Hurricane, Toroweap-Sevier, Paunsaugunt, and Paradise faults. The longest fault, the Toroweap-Sevier, can be traced for about 240 miles (386 kilometers) and may have as much as 3,000 feet (914 meters) of displacement (Kelley, 1955).

From the later part of the Precambrian until the middle Paleozoic the Colorado Plateau was a relatively stable tectonic unit undergoing gentle epeirogenic uplifting and downwarping during which seas transgressed and regressed, depositing and then partially removing layers of sedimentary materials. This period of stability was interrupted by northeast-southwest tangential compression that began sometime during late Mississippian or early Pennsylvanian and continued intermittently into the Triassic. Buckling along the northeast margins of the shelf produced northwest-trending uplifts, the most prominent of which are the Uncompahgre and San Juan Uplifts, sometimes referred to as the Ancestral Rocky Mountains. Clearly, these positive features are the earliest marked tectonic controls that may have guided many of the later Laramide structures (Kelley, 1955).

Subsidence of the area southwest of the Uncompahgre Uplift throughout most of the Pennsylvanian led to the filling of the newly formed basin with an extremely thick sequence of evaporites and associated interbeds which comprise the Paradox Member of the Hermosa formation (Kelley, 1958). Following Paradox deposition, continental and marine sediments buried the evaporite sequence as epeirogenic movements shifted shallow seas across the region during the Jurassic, Triassic and much of the Cretaceous. The area underlain by the Paradox Member in eastern Utah and western Colorado is commonly referred to as the Paradox Basin (Figure 1.6-1). Renewed compression during the Permian initiated the salt anticlines and piercements, and salt flowage continued through the Triassic.

The Laramide orogeny, lasting from Late Cretaceous through Eocene time, consisted of deep-seated compressional and local vertical stresses. The orogeny is responsible for a north-south to northwest trend in the tectonic fabric of the region and created most of the principal basins and uplifts in the eastern-half of the Colorado Plateau (Grose, 1972; Kelley, 1955).

Post-Laramide epeirogenic deformation has occurred throughout the Tertiary; Eocene strata are flexed sharply in the Grand Hogback monocline, fine-grained Pliocene deposits are tilted on the flanks of the Defiance Uplift, and Pleistocene deposits in Fisher Valley contain three angular unconformaties (Shoemaker, 1956).

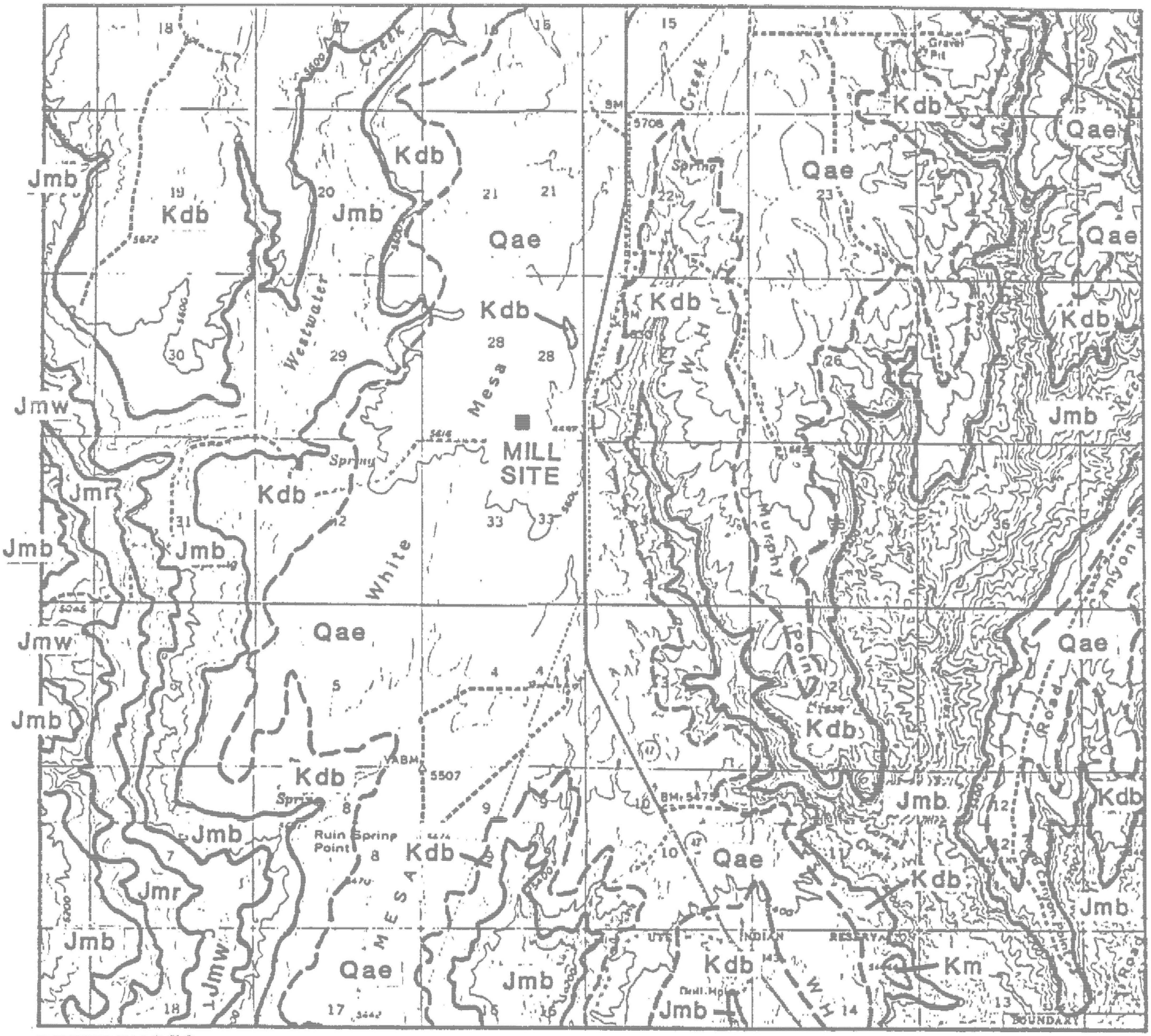
1.6.2 Blanding Site Geology

The following descriptions of physiography and topography; rock units; structure; relationship of earthquakes to tectonic structure; and potential earthquake hazards to the Mill area are reproduced from the 1978 ER for ease of reference and as a review of the Mill site geology (see Figure 1.6-2).

1.6.2.1 Physiography and Topography (1978 ER Section 2.4.2.1)

The Mill site is located near the center of White Mesa, one of the many finger-like north-south trending mesas that make up the Great Sage Plain. The nearly flat upland surface of White Mesa is underlain by resistant sandstone caprock which forms steep prominent cliffs separating the upland from deeply entrenched intermittent stream courses on the east, south and west.

Surface elevations across the Mill site range from about 5,550 to 5,650 feet (1,692 to 1,722 meters) and the gently rolling surface slopes to the south at a rate of approximately 60 feet per mile (18 meters per 1.6 kilometer).



REFERENCES: GEOLOGY, IN PART, AFTER HAYNES ET AL., 1962. BASE MAP PREPARED FROM PORTIONS OF THE BLANDING, BRUSHY BASIN WASH, BLUFF, AND MONTEZUMA CREEK U.S.G.S. 15-MINUTE TOPOGRAPHIC QUADRANGLES.

EXPLANATION

Qae	LOESS
Km	MANCOS SHALE
Kdb	DAKOTA AND BURRO CANYON FORMATIONS (UNDIFFERENTIATED)
Jmb	MORRISON FORMATION: BRUSHY BASIN MEMBER
Jmw	WESTWATER CANYON MEMBER
Jmr	RECAPTURE MEMBER
——— — —	CONTACT, DASHED WHERE APPROXIMATE

N.

3000 0 3000 6000

SCALE IN FEET

After Umetco 1988

ENERGY FUELS

Project: WHITE MESA MILL

County: San Juan State: Utah

FIGURE 1.6-2

WHITE MESA MILLSITE
GEOLOGY OF SURROUNDING AREA

Date: Nov. 2009 Design: Drafted By: RAH

Maximum relief between the mesa's surface and Cottonwood Canyon on the west is about 750 feet (229 meters) where Westwater Creek joins Cottonwood Wash. These two streams and their tributaries drain the west and south sides of White Mesa. Drainage on the east is provided by Recapture Creek and its tributaries. Both Cottonwood Wash and Recapture Creeks are normally intermittent streams and flow south to the San Juan River. However, Cottonwood Wash has been known to flow perennially in the project vicinity during wet years.

1.6.2.2 Rock Units (1978 ER Section 2.4.2.2)

Only rocks of Jurassic and Cretaceous ages are exposed in the vicinity of the Mill site. These include, in ascending order, the Upper Jurassic Salt Wash, Recapture, Westwater Canyon, and Brushy Basin Members of the Morrison formation; the Lower Cretaceous Burro Canyon formation; and the Upper Cretaceous Dakota Sandstone. The Upper Cretaceous Mancos Shale is exposed as isolated remnants along the rim of Recapture Creek valley several miles southeast of the Mill site and on the eastern flanks of the Abajo Mountains some 20 miles (32 kilometers) north but is not exposed at the Mill site. However, patches of Mancos Shale may be present within the Mill site boundaries as isolated buried remnants that are obscured by a mantle of alluvial windblown silt and sand.

The Morrison formation is of particular economic importance in southeast Utah since several hundred uranium deposits have been discovered in the basal Salt Wash Member (Stokes, 1967).

In most of eastern Utah, the Salt Wash Member underlies the Brushy Basin. However, just south of Blanding in the project vicinity the Recapture Member replaces an upper portion of the Salt Wash and the Westwater Canyon Member replaces a lower part of the Brushy Basin. A southern limit of Salt Wash deposition and a northern limit of Westwater Canyon deposition has been recognized by Haynes et al. (1972) in Westwater Canyon approximately three to six miles (4.8 to 9.7 kilometers), respectively, northwest of the Mill site. However, good exposures of Salt Wash are found throughout the Montezuma Canyon area 13 miles (21 kilometers) to the east.

The Salt Wash Member is composed dominantly of fluvial fine-grained to conglomeratic sandstones, and interbedded mudstones. Sandstone intervals are usually yellowish-brown to pale reddish-brown while the mudstones are greenish- and reddish-gray. Carbonaceous materials ("trash") vary from sparse to abundant. Cliff-forming massive sandstone and conglomeratic sandstone in discontinuous beds make up to 50 percent or more of the member. According to Craig et al. (1955), the Salt Wash was deposited by a system of braided streams flowing generally east and northeast. Most of the uranium-vanadium deposits are located in the basal sandstones and conglomeratic sandstones that fill stream-cut scour channels in the underlying Bluff Sandstone, or where the Bluff Sandstone has been removed by pre-Morrison erosion, in similar channels cut in the Summerville formation. Mapped thicknesses of this member range from zero to approximately 350 feet (0-107 meters) in southeast Utah. Because the Salt Wash pinches out in a southerly direction in Recapture Creek three miles (4.8 kilometers) northwest of the Mill site and does not reappear until exposed in Montezuma Canyon, it is not known for certain that the Salt Wash actually underlies the site.

The Recapture Member is typically composed of interbedded reddish-gray, white, and light-brown fine- to medium-grained sandstone and reddish-gray, silty and sandy claystone. Bedding is gently to sharply lenticular. Just north of the Mill site, the Recapture intertongues with and grades into the Salt Wash and the contact between the two cannot be easily recognized. A few spotty occurrences of uriniferous mineralization are found in sandstone lenses in the southern part of the Monticello district and larger deposits are known in a conglomeratic sandstone facies some 75 to 100 miles (121 to 161 kilometers) southeast of the Monticello district. Since significant ore deposits have not been found in extensive outcrops in more favorable areas, the Recapture is believed not to contain potential resources in the Mill site (Johnson and Thordarson, 1966).

Just north of the Mill site, the Westwater Canyon Member intertongues with and grades into the lower part of the overlying Brushy Basin Member. Exposures of the Westwater Canyon in Cottonwood Wash are typically composed of interbedded yellowish- and greenish-gray to pinkish-gray, lenticular, fine- to coarse-grained arkosic sandstone and minor amounts of greenish-gray to reddish-brown sandy shale and mudstone. Like the Salt Wash, the Westwater Canyon Member is fluvial in origin, having been deposited by streams flowing north and northwest, coalescing with streams from the southwest depositing the upper part of the Salt Wash and the lower part of the Brushy Basin (Huff and Lesure, 1965). Several small and scattered uranium deposits in the Westwater Canyon are located in the extreme southern end of the Monticello district. Both the Recapture Member and the Westwater Canyon contain only traces of carbonaceous materials, are believed to be less favorable host rocks for uranium deposition (Johnson and Thordarson, 1966) and have very little potential for producing uranium reserves.

The lower part of the Brushy Basin is replaced by the Westwater Canyon Member in the Blanding area but the upper part of the Brushy Basin overlies this member. Composition of the Brushy Basin is dominantly variegated bentonitic mudstone and siltstone. Bedding is thin and regular and usually distinguished by color variations of gray, pale-green, reddish-brown, pale purple, and maroon. Scattered lenticular thin beds of distinctive green and red chert-pebble conglomeratic sandstone are found near the base of the member, some of which contain uranium-vanadium mineralization in the southernmost part of the Monticello district (Haynes et al., 1972). Thin discontinuous beds of limestone and beds of grayish-red to greenish-black siltstone of local extent suggest that much of the Brushy Basin is probably lacustrine in origin.

For the most part, the Great Sage Plain owes its existence to the erosion of resistant sandstones and conglomerates of the Lower Cretaceous Burro Canyon formation. This formation unconformably (?) overlies the Brushy Basin and the contact is concealed over most of the Mill area by talus blocks and slope wash. Massive, light-gray to light yellowish-brown sandstone, conglomeratic sandstone and conglomerate comprise more than two-thirds of the formation's thickness. The conglomerate and sandstone are interbedded and usually grade from one to the other. However, most of the conglomerate is near the base. These rocks are massive cross-bedded units formed by a series of interbedded lenses, each lens representing a scour filled with stream-deposited sediments. In places the formation contains greenish-gray lenticular beds of mudstone and claystone. Most of the Burro Canyon is exposed in the vertical cliffs separating the relatively flat surface of White Mesa from the canyons to the west and east. In some places the resistant basal sandstone beds of the overlying Dakota Sandstone are exposed at the top of the cliffs, but entire cliffs of Burro Canyon are most common. Where the sandstones of the Dakota rest on sandstones and conglomerates of the Burro Canyon, the contact between the two is very difficult to identify and most investigators map the two formations as a single unit (Figure 1.6-2). At best, the contact can be defined as the top of a silicified zone in the upper part of the Burro Canyon that appears to be remnants of an ancient soil that formed during a long period of weathering prior to Dakota deposition (Huff and Lesure, 1965).

The Upper Cretaceous Dakota Sandstone disconformably overlies the Burro Canyon formation. Locally, the disconformity is marked by shallow depressions in the top of the Burro Canyon filled with Dakota sediments containing angular to sub-rounded rock fragments probably derived from Burro Canyon strata (Witkind, 1964) but the contact is concealed at the Mill site. The Dakota is composed predominantly of pale yellowish-brown to light gray, massive, intricately cross-bedded, fine- to coarse-grained quartzose sandstone locally well-cemented with silica and calcite; elsewhere it is weakly cemented and friable. Scattered throughout the sandstone are lenses of conglomerate, dark-gray carbonaceous mudstones and shale and, in some instances, impure coal. In general, the lower part of the Dakota is more conglomeratic and contains more cross-bedded sandstone than the upper part which in normally more thinly bedded and marine-like in appearance. The basal sandstones and conglomerates are fluvial in origin, whereas the carbonaceous mudstones and shales were probably deposited in back water areas behind beach ridges in front of the advancing Late Cretaceous sea (Huff and Lesure, 1965). The upper sandstones probably represent littoral marine deposits since they grade upward into the dark-gray siltstones and marine shales of the Mancos Shale.

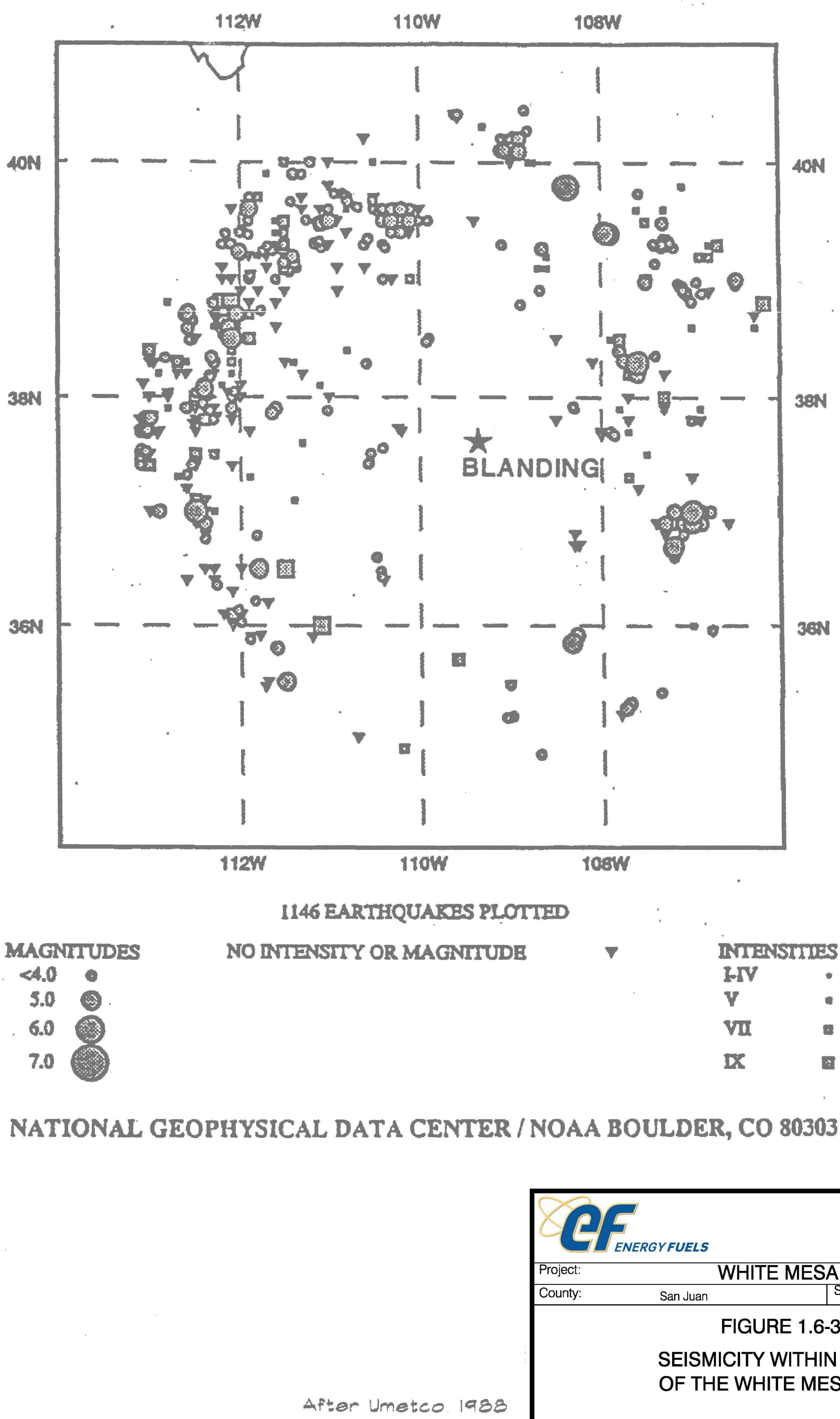
The Mancos shale is not exposed in the project vicinity. The nearest exposures are small isolated remnants resting conformably on Dakota Sandstone along the western rim above Recapture Creek 4.3 to 5.5 miles (6.9 to 8.9 kilometers) southeast of the Mill site. Additional exposures are found on the eastern and southern flanks of the Abajo Mountains approximately 16 to 20 miles (26 to 32 kilometers) to the north. It is possible that thin patches of Mancos may be buried at the Mill site but are obscured by the mantle of alluvial windblown silt and sand covering the upland surface. The Upper Cretaceous Mancos shale is of marine origin and consists of dark- to olive-gray shale with minor amounts of gray, fine-grained, thin-bedded to blocky limestone and siltstone in the lower part of the formation. Bedding in the Mancos is thin and well developed, and much of the shale is laminated. Where fresh, the shale is brittle and fissile and weathers to chips that are light- to yellowish-gray. Topographic features formed by the Mancos are usually subdued and commonly displayed by low rounded hills and gentle slopes.

A layer of Quaternary to Recent reddish-brown eolian silt and fine sand is spread over the surface of the Mill site. Most of the loess consists of subangular to rounded frosted quartz grains that are coated with iron oxide. Basically, the loess is massive and homogeneous, ranges in thickness from a dust coating on the rocks that form the rim cliffs to more than 20 feet (6 meters), and is partially cemented with calcium carbonate (caliche) in light-colored mottled and veined accumulations which probably represent ancient immature soil horizons.

1.6.2.3 Structure (1978 ER Section 2.4.2.3)

The geologic structure at the Mill site is comparatively simple. Strata of the underlying Mesozoic sedimentary rocks are nearly horizontal; only slight undulations along the caprock rims of the upland are perceptible and faulting is absent. In much of the area surrounding the Mill site the dips are less than one degree. The prevailing regional dip is about one degree to the south. The low dips and simple structure are in sharp contrast to the pronounced structural features of the Comb Ridge Monocline to the west and the Abajo Mountains to the north.

The Mill area is within a relatively tectonically stable portion of the Colorado Plateau noted for its scarcity of historical seismic events. The epicenters of historical earthquakes from 1853 through 1986 within a 200-mile (320 km) radius of the site are shown in Figure 1.6-3. More than 1,146 events have occurred in the area, of which at least 45 were damaging; that is, having an intensity of VI or greater on the Modified Mercalli Scale. A description of the Modified Mercalli Scale is given in Table 1.6-3. All intensities mentioned herein refer to this table. Table 1.6-3 also shows a generalized relationship between Mercalli intensities and other parameters to which this review will refer. Since these relationships are frequently site specific, the table values should be used only for approximation and understanding. Conversely, the border between the Colorado Plateau and the Basin and Range Province and Middle Rocky Mountain



ENERGY FUELS

Project:	WHITE MESA MILL		
County:	San Juan	State:	Utah

FIGURE 1.6-3

SEISMICITY WITHIN 320 KM OF THE WHITE MESA MILL

Date: Nov. 2009	Design:	Drafted By: RAH

W:\USA\Utah\Mill\dwgs\Reclamation Plans\RecPlan4.0\Figure 1.6-3 Seismic 320km.dwg Seismic 320 23/11/2009 dsledd

Table 1.6-3 Modified Mercalli Scale

Modified Mercalli Scale, 1956 Version[a]				
	Intensity	Effects	v. † cm/s	g ‡
M§	I.	Not felt. Marginal and long-period effects of large earthquakes (for details see text).		
3	II.	Felt by persons at rest on upper floors, or favorably placed.		
	III.	Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.		0.0035-0.007
4	IV.	Hanging objects swing. Vibration like passing of heavy trucks or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV wooden walls and frame creak.		0.007-0.015
	V.	Felt outdoors: direction estimated. Sleepers wakened. Liquids disturbed. Some spilled. Small unstable objects displaced or upset. Doors swing close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.	1-3	0.015-0.035
5	VI.	Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc. off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken (visibly, or heard to rustle - CFR).	3-7	0.035-0.07
6	VII.	Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments - CFR). Some cracks in masonry C. Waves on ponds: water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.	7-20	0.07-0.15
	VIII.	Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none is masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.	20-80	0.15-0.35
7	IX.	General panic. Masonry D destroyed, masonry C heavily damaged. Sometimes with complete collapse, masonry B seriously damaged. (General damage to foundations - CFR). Frame structures, if not bolted, shifted off foundations. Frames rocked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated areas sand and mud ejected, earthquake fountains, sand craters.	.80-200	0.35-0.7
8	X.	Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.	200-500	0.7-1.2
	XI.	Rails bent greatly. Underground pipelines completely out of service.		>1.2
	XII.	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.	From Fig. 11.14	

Note: Masonry A, B, C, D. To avoid ambiguity of language, the quality of masonry, brick or otherwise, is specified by the following lettering (which has no connection with the conventional Class A, B, C construction).

- Masonry A : Good workmanship, mortar, and design reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.
- Masonry B: Good workmanship and mortar; reinforced, but not designed to resist lateral forces.
- Masonry C: Ordinary workmanship and mortar; no extreme weaknesses such as non-ded-ia corners, but masonry is neither reinforced nor designed against horizontal forces.
- Masonry D : Week materials such as adobe, poor mortar, low standards of workmanship, week horizontally.

[a]From Richter (1958). [1]Adapted with permission of W. H. Freeman and Company by Hunt (1984).
†Average peak ground velocity, cm/s.
‡Average peak acceleration (away from source).
§Magnitude correlation.

Province some 155 to 240 miles (249 to 386 km) west and northwest, respectively, from the site is one of the most active seismic belts in the western United States.

Only 63 non-duplicative epicenters have been recorded within a 120 mile (200 km) radius of the Mill area (Figure 1.6-4). Of these, 50 had an intensity IV or less (or unrecorded) and two were recorded as intensity VI. The nearest event occurred in the Glen Canyon National Recreation Area approximately 38 miles (63 km) west-northwest of the Mill area. The next closest event occurred approximately 53 miles (88 km) to the northeast. Just east of Durango, Colorado, approximately 99 miles (159 km) due east of the Mill area, an event having local intensity of V was recorded on August 29, 1941 (Hadsell, 1968). It is very doubtful that these events would have been felt in the vicinity of Blanding.

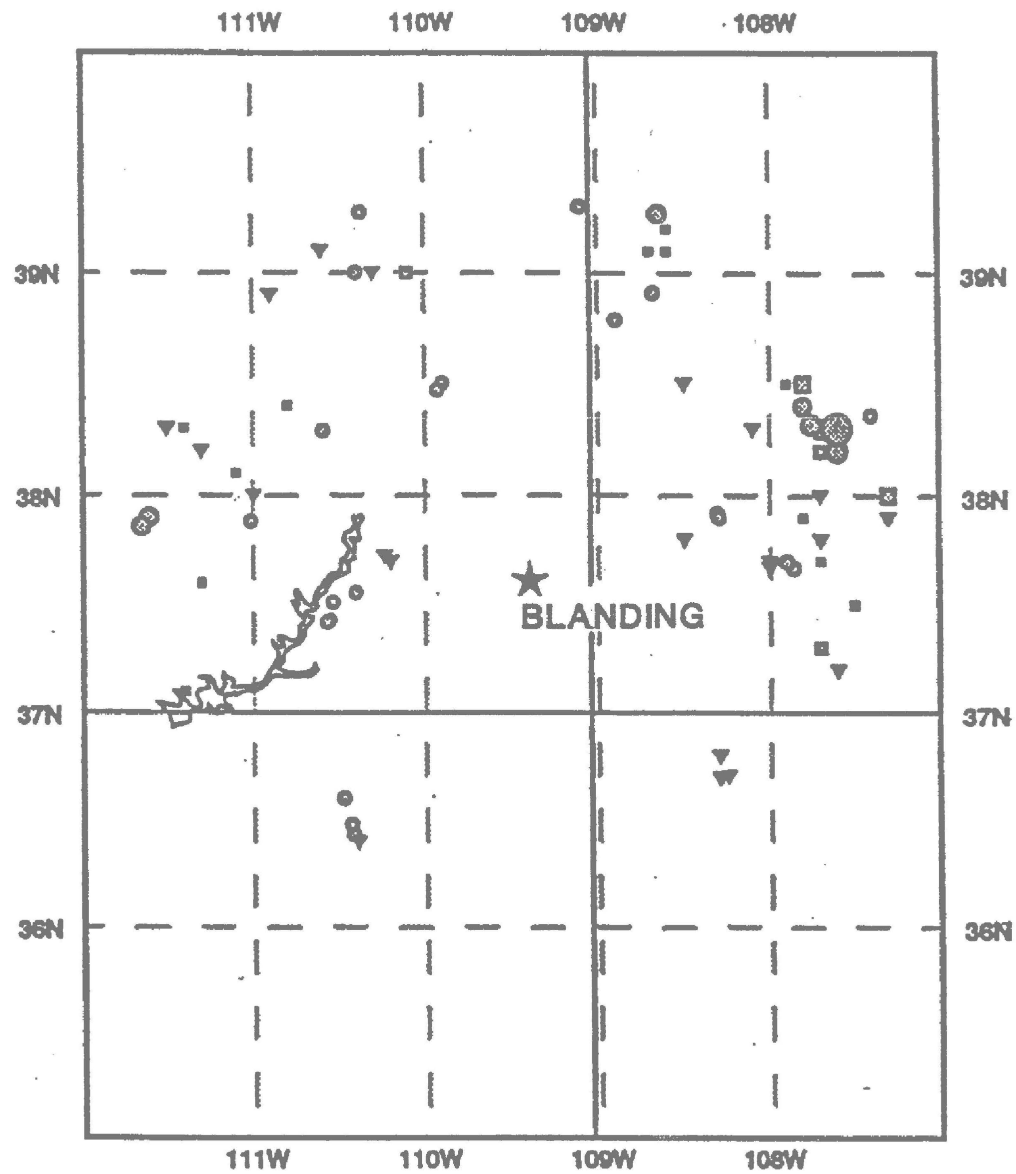
Three of the most damaging earthquakes associated with the seismic belt along the Colorado Plateau's western border have occurred in the Elsinore-Richfield are about 168 miles (270 km) northwest of the Mill site. All were of intensity VIII. On November 13, 1901, a strong shock caused extensive damage from Richfield to Parowan. Many brick structures were damaged; rockslides were reported near Beaver. Earthquakes with the ejection of sand and water were reported, and some creeks increased their flow. Aftershocks continued for several weeks (von Hake, 1977). Following several weeks of small foreshocks, a strong earthquake caused major damage in the Monroe-Elsinore-Richfield area on September 29, 1921. Scores of chimneys were thrown down, plaster fell from ceilings, and a section of a new two-story brick wall collapsed at Elsinore's schoolhouse. Two days later, on October 1, 1921, another strong tremor caused additional damage to the area's structures. Large rockfalls occurred along both sides of the Sevier Valley and hot springs were discolored by iron oxides (von Hake, 1977). It is probable that these shocks may have been perceptible at the Mill site but they certainly would not have caused any damage.

Seven events of intensity VII have been reported within 320 kilometers (km) around Blanding, Utah, which is the area shown in Figure 1.6-3. Of these, only two are considered to have any significance with respect to the Mill site. On August 18, 1912, an intensity VII shock damaged houses in northern Arizona and was felt in Gallup, New Mexico, and southern Utah. Rock slides occurred near the epicenter in the San Francisco Mountains and a 50-mile (80 km) earth crack was reported north of the San Francisco Range (Cater, 1970). Nearly every building in Dulce, New Mexico, was damaged to some degree when shook by a strong earthquake on January 22, 1966. Rockfalls and landslides occurred 10 to 15 miles (16 to 24 km) west of Dulce along Highway 17 where cracks in the pavement were reported (Hermann et al., 1980). Both of these events may have been felt at the Mill site but, again, would certainly not have caused any damage. Figure 1.6-4 shows the occurrence of seismic events within 200 km of Blanding.

1.6.2.4 Relationship of Earthquakes to Tectonic Structures

The majority of recorded earthquakes in Utah have occurred along an active belt of seismicity that extends from the Gulf of California, through western Arizona, central Utah, and northward into western British Columbia. The seismic belt is possibly a branch of the active rift system associated with the landward extension of the East Pacific Rise (Cook and Smith, 1967). This belt is the Intermountain Seismic Belt shown in Figure 1.6-5 (Smith, 1978).

It is significant to note that the seismic belt forms the boundary zone between the Basin and Range - Great Basin Provinces and the Colorado Plateau - Middle Rocky Mountain Provinces. This block-faulted zone is about 47 to 62 miles (75 to 100 km) wide and forms a tectonic transition zone between the relatively simple structures of the Colorado Plateau and the complex fault-controlled structures of the Basin and Range Province (Cook and Smith, 1967).



103 EARTHQUAKES PLOTTED

MAGNITUDES
<4.0
5.0
6.0
7.0

NO INTENSITY OR MAGNITUDE

INTENSITIES
I-IV
V
VII
IX

NATIONAL GEOPHYSICAL DATA CENTER / NOAA BOULDER, CO 80303

After Umetco, 1988

ENERGY FUELS

Project: WHITE MESA MILL

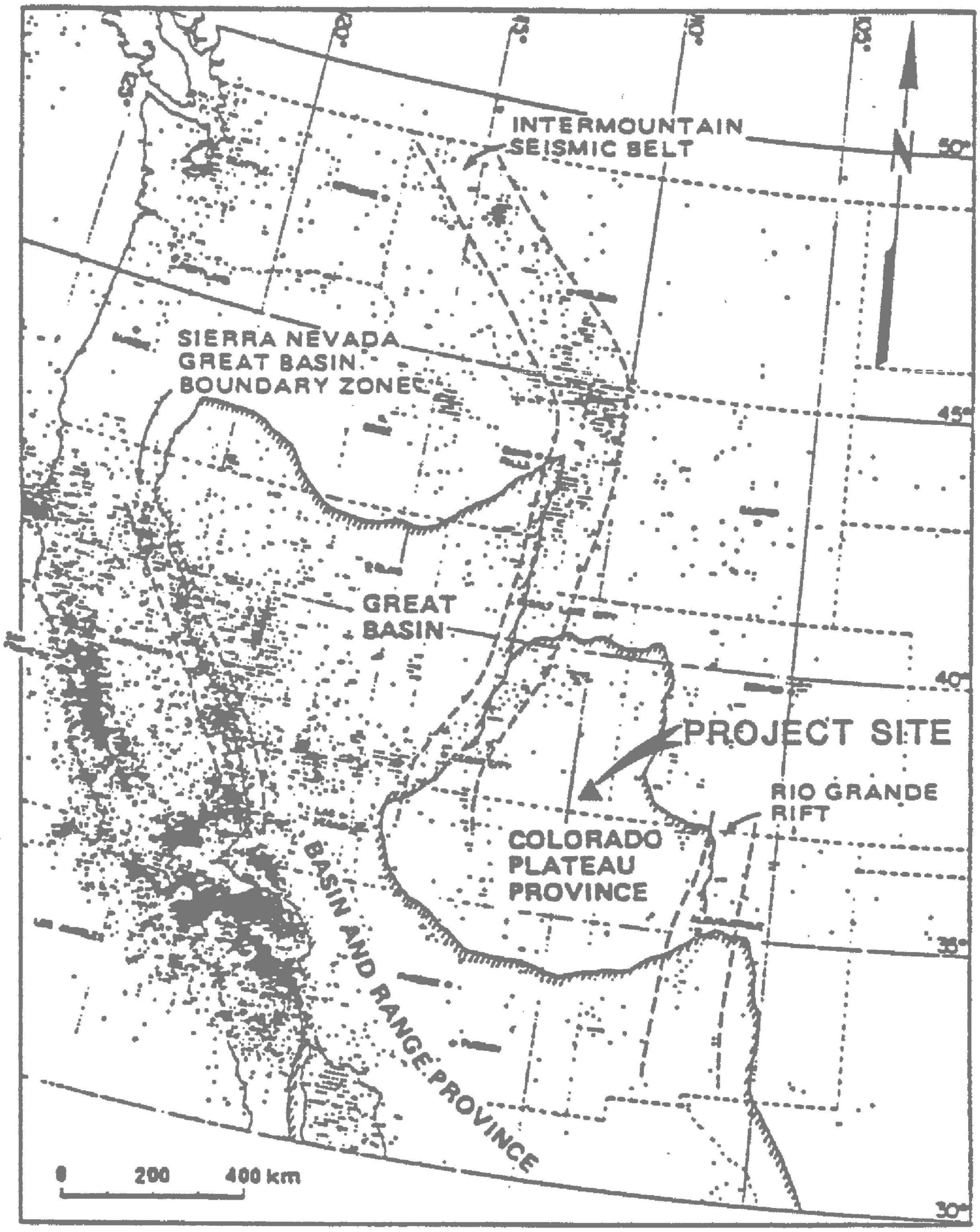
County: San Juan State: Utah

FIGURE 1.6-4

SEISMICITY WITHIN 200 KM OF THE WHITE MESA MILL

Date: Nov. 2009 Design: Drafted By: RAH

W:\USA\Utah\Mill\dwgs\Reclamation Plans\RecPlan4.0\Figure 1.6-4 Seismic 200km.dwg Seismic 200 23/11/2009 dsledd



Modified from Smith, 1978

SHOWS RELATIONSHIP OF THE COLORADO PLATEAU PROVINCE TO MARCANAL BELTS

After Umetco. 1988

ENERGY FUELS

Project:	WHITE MESA MILL
County: San Juan	State: Utah

FIGURE 1.6-5

SEISMICITY OF THE WESTERN UNITED STATES 1950 TO 1976

Date: Nov. 2009	Design:	Drafted By: RAH

W:\USA\Utah\Mill\dwgs\Reclamation Plans\RecPlan4.0\Figure 1.6-5 Seismic WUSA.dwg Seismic WUSA 23/11/2009 dsledd

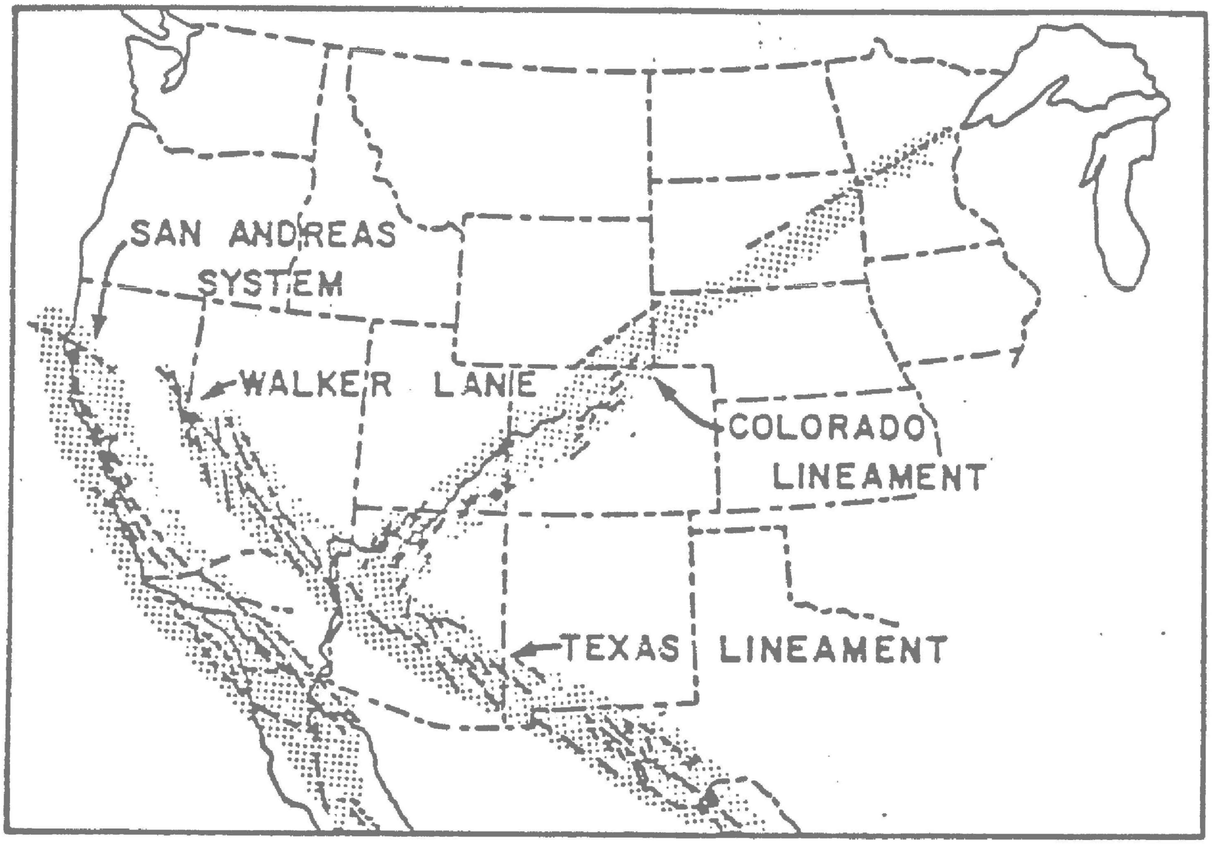
Another zone of seismic activity is in the vicinity of Dulce, New Mexico, near the Colorado border. This zone, which coincides with an extensive series of tertiary intrusives, may also be related to the northern end of the Rio Grande Rift. This rift is a series of fault-controlled structural depressions extending southward from southern Colorado through central New Mexico and into Mexico. The rift is shown on Figure 1.6-5 trending north-south to the east of the Mill area.

Most of the events south of the Utah border of intensity V and greater are located within 50 miles (80 km) of post-Oligocene extrusives. This relationship is not surprising because it has been observed in many other parts of the world (Hadsell, 1968).

In Colorado, the Rio Grande Rift zone is one of three siesmotectonic provinces that may contribute energy to the study area. Prominent physiographic expression of the rift includes the San Luis Valley in southern Colorado. The valley is a half-graben structure with major faulting on the eastern flank. Extensional tectonics is dominant in the area and very large earthquakes with recurrence intervals of several thousand years have been projected (Kirkham and Rogers, 1981). Mountainous areas to the west of the Rio Grande rift province include the San Juan Mountains. These mountains are a complex domicia uplift with extensive Oligocene and Miocene volcanic cover. Many faults are associated with the collapse of the calderas and apparently have not moved since. Faults of Neogene age exist in the eastern San Juan Mountains that may be related to the extension of the Rio Grande rift. Numerous small earthquakes have been felt or recorded in the western mountainous province despite an absence of major Neogene tectonic faults (Kirkham and Rogers, 1981).

The third seismotectonic province in Colorado, that of the Colorado Plateau, extends into the surrounding states to the west and south. In Colorado, the major tectonic element that has been recurrently active in the Quaternary is the Uncompahgre uplift. Both flanks are faulted and earthquakes have been felt in the area. The faults associated with the Salt Anticlines are collapsed features produced by evaporite solution and flowage (Cater, 1970). Their non-tectonic origin and the plastic deformation of the salt reduce their potential for generating even moderate-sized earthquakes (Kirkham and Rogers, 1981).

Case and Joesting (1972) have called attention to the fact that regional seismicity of the Colorado Plateau includes a component added by basement faulting. They inferred a basement fault trending northeast along the axis of the Colorado River through Canyonlands. This basement faulting may be part of the much larger structure that Hite (1975) examined and Warner (1978) named the Colorado lineament (Figure 1.6-6). This 1,300-mile (2,100 km) long lineament that extends from northern Arizona to Minnesota is suggested to be a Precambrian wrench-fault system formed some 2.0 to 1.7 billion years before present. While it has been suggested that the Colorado lineament is a source zone for larger earthquakes (m = 4 to 6) in the west-central United States, the observed spatial relationship between epicenters and the trace of the lineament does not prove a casual relation (Brill and Nuttli, 1983). In terms of contemporary seismicity, the lineament does not act as a uniform earthquake generator. Only specific portions of the proposed structure can presently be considered seismic source zones and each segment exhibits seismicity of distinctive activity and character (Wong, 1981). This is a reflection of the different orientations and magnitudes of the stress fields along the lineament. The interior of the Colorado Plateau forms a tectonic stress province, as defined by Zoback and Zoback (1980), that is characterized by generally east-west tectonic compression. Only where extensional stresses from the Basin and Range province of the Rio Grande rift extend into the Colorado Plateau would the Colorado lineament in the local area be suspected of having the capability of generating a large magnitude earthquake (Wong, 1984). At present, the well-defined surface expression of regional extension is far to the west and far to the east of the Mill area.



SOURCE: WARNER, 1978

After Umetco, 1988

ENERGY FUELS

Project: WHITE MESA MILL

County: San Juan | State: Utah

FIGURE 1.6-6

COLORADO LINEAMENT

Date: Nov. 2009 | Design: | Drafted By: RAH

W:\USA\Utah\Mill\dwgs\Reclamation Plans\RecPlan4.0\Figure 1.6-6 Colorado Lineament.dwg CO Lineament 23/11/2009 dsledd

Work by Wong (1984) has helped define the seismicity of the whole Colorado Plateau. He called attention to the low level (less than local magnitude, ML = 3.6) but high number (30) of earthquakes in the Capitol Reef Area from 1978 to 1980 that were associated with the Waterpocket fold and the Cainville monocline, two other major tectonic features of the Colorado Plateau. Only five earthquakes in the sequence were of ML greater than three, and fault plane solutions suggest the swarm was produced by normal faulting along northwest-trending Precambrian basement structures (Wong, 1984). The significance of the Capitol Reef seismicity is its relatively isolated occurrence within the Colorado Plateau and its location at a geometric barrier in the regional stress field (Aki, 1979). Stress concentration that produces earthquakes at bends or junctures of basement faults as indicated by this swarm may occur at other locations in the Colorado Plateau Province. No inference that earthquakes such as those at Capitol Reef are precursors for larger subsequent events is implied.

1.6.2.5 Potential Earthquake Hazards to Mill Area

The Mill site is located in a region known for its scarcity of recorded seismic events. Although the seismic history for this region is barely 135 years old, the epicentral pattern, or fabric, is basically set and appreciable changes are not expected to occur. Most of the larger seismic events in the Colorado Plateau occurred along its margins rather than in the interior central region. Based on the region's seismic history, the probability of a major damaging earthquake occurring at or near the Mill site is remote. Studies by Algermissen and Perkins (1976) indicate that southeastern Utah, including the site, is in an area with a 90 percent probability that a horizontal acceleration of four percent gravity (0.04g) would not be exceeded within 50 years. In 2002, the USGS updated the National Seismic Hazard Maps (NSHM), which show peak ground and spectral accelerations at 2 percent and 10 percent probability of exceedance in 50 years. From these maps, it is determined that there is a 98 percent probability that a horizontal acceleration of 0.09g would not be exceeded within 50 years (Tetra Tech, 2006). Furthermore, an updated seismic hazard analysis performed by Tetra Tech (2010) for the site determined that there is a 98 percent probability that a horizontal acceleration of 0.15g would not be exceeded within a 200-year design life of the tailings management cells. The Tetra Tech (2010) report is included in Appendix D.

1.6.3 Site-Specific Probabilistic Seismic Hazard Analysis

A site-specific probabilistic seismic hazard analysis (PSHA) (MWH, 2015a) was conducted for the White Mesa Mill site. The PSHA was performed to better understand the likelihood of potential earthquake sources, to correlate results with previous analyses conducted for the site, and to evaluate the contribution of the seismic sources (e.g. deaggregation). This analysis assessed the site-specific seismic hazard using Ground Motion Prediction Equations (GMPEs) to estimate seismically induced ground motions at the site. Seismic hazard analyses were previously conducted for the design of the Cell 4A and 4B facilities (Tetra Tech, 2006; Tetra Tech, 2010) and in response to DWMRC review of EFRI responses to interrogatories on the Reclamation Plan (MWH, 2012). These analyses indicated that the seismic hazard at the site is dominated by background events in the Colorado Plateau.

The PSHA is based on a seismotectonic model and source characterization of the site and surrounding area. The study evaluated a 200-mile radius surrounding the site. The seismotectonic model identified three general seismic sources in the study area: 1) seismicity of the Intermountain Seismic Belt (ISB), 2) seismicity of the Colorado Plateau (CP), and 3) crustal faults that meet the NRC minimum criteria. Each source zone was characterized to establish input parameters for the seismic hazard analyses. The PSHA was performed using HAZ43 (2014) software developed by Dr. Norman Abrahamson. Operational and long-term design recommendations were developed based on the results from this PSHA and previous seismic investigations at the site.

This study concluded that the maximum horizontal acceleration value at the Mill site for a seismic event associated with an average return period of 10,000 years is 0.15g. Based on this maximum horizontal acceleration, a pseudo-static coefficient of 0.10g was used for seismic stability analyses of the reclaimed tailings impoundments (presented in Appendix A).

1.7 Biota (1978 ER Section 2.9)

1.7.1 Terrestrial (1978 ER Section 2.9.1)

1.7.1.1 Flora (1978 ER Section 2.9.1.1)

The natural vegetation presently occurring within a 25-mile (40-km) radius of the site is very similar to that of the potential, being characterized by pinyon-juniper woodland intergrading with big sagebrush (*Artemisia tridentata*) communities. The pinyon-juniper community is dominated by Utah juniper (*Juniperus osteosperma*) with occurrences of pinyon pine (*Pinus edulis*) as a codominant or subdominant tree species. The understory of this community, which is usually quite open, is composed of grasses, forbs, and shrubs that are also found in the big sagebrush communities. Common associates include galleta grass (*Hilaria jamesii*), green ephedra (*Ephedra viridis*), and broom snakewood (*Gutierrezia sarothrae*). The big sagebrush communities occur in deep, well-drained soils on flat terrain, whereas the pinyon-juniper woodland is usually found on shallow rocky soil of exposed canyon ridges and slopes.

Seven community types are present on the Mill site (Table 1.7-1 and Figure 1.7-1). Except for the small portions of pinyon-juniper woodland and the big sagebrush community types, the majority of the plant communities within the site boundary have been disturbed by past grazing and/or treatments designed to improve the site for rangeland. These past treatments include chaining, plowing, and reseeding with crested wheatgrass (*Agropyron desertorum*). Controlled big sagebrush communities are those lands containing big sagebrush that have been chained to stimulate grass production. In addition, these areas have been seeded with crested wheatgrass. Both grassland communities I and II are the result of chaining and/or plowing and seeding with crested wheatgrass. The reseeded grassland II community is in an earlier stage of recovery from disturbance than the reseeded grassland I community. The relative frequency, relative cover, relative density, and importance values of species sampled in each community are presented in Dames and Moore, (1978b), Table 2.8-2. The percentage of vegetative cover in 1977 was lowest on the reseeded grassland II community (10.7 percent) and highest on the big sagebrush community (33 percent) (Table 1.7-2).

Based upon dry weight composition, most communities on the site were in poor range condition in 1977 (Dames & Moore, 1978b, Tables 2.8-3 and 2.8-4). Pinyon-juniper, big sagebrush, and controlled big sagebrush communities were in fair condition. However, precipitation for 1977 at the Mill site was classed as drought conditions (Dames & Moore, 1978b, Section 2.8.2.1). Until July, no production was evident on the site.

Based on the work completed by Dames & Moore in the 1978 ER, no designated or proposed endangered plant species occur on or near the Mill site (Dames & Moore, 1978b, Section 2.8.2.1). Of the 65 proposed endangered species in Utah at that time, six have documented distributions on San Juan County. A review of the habitat requirements and known distributions of these species by Dames & Moore in the 1978 ER indicated that, because of the disturbed environment, these species would probably not occur on the Mill site. The Navajo Sedge has been added to the list as a threatened species since the 1978 ER.

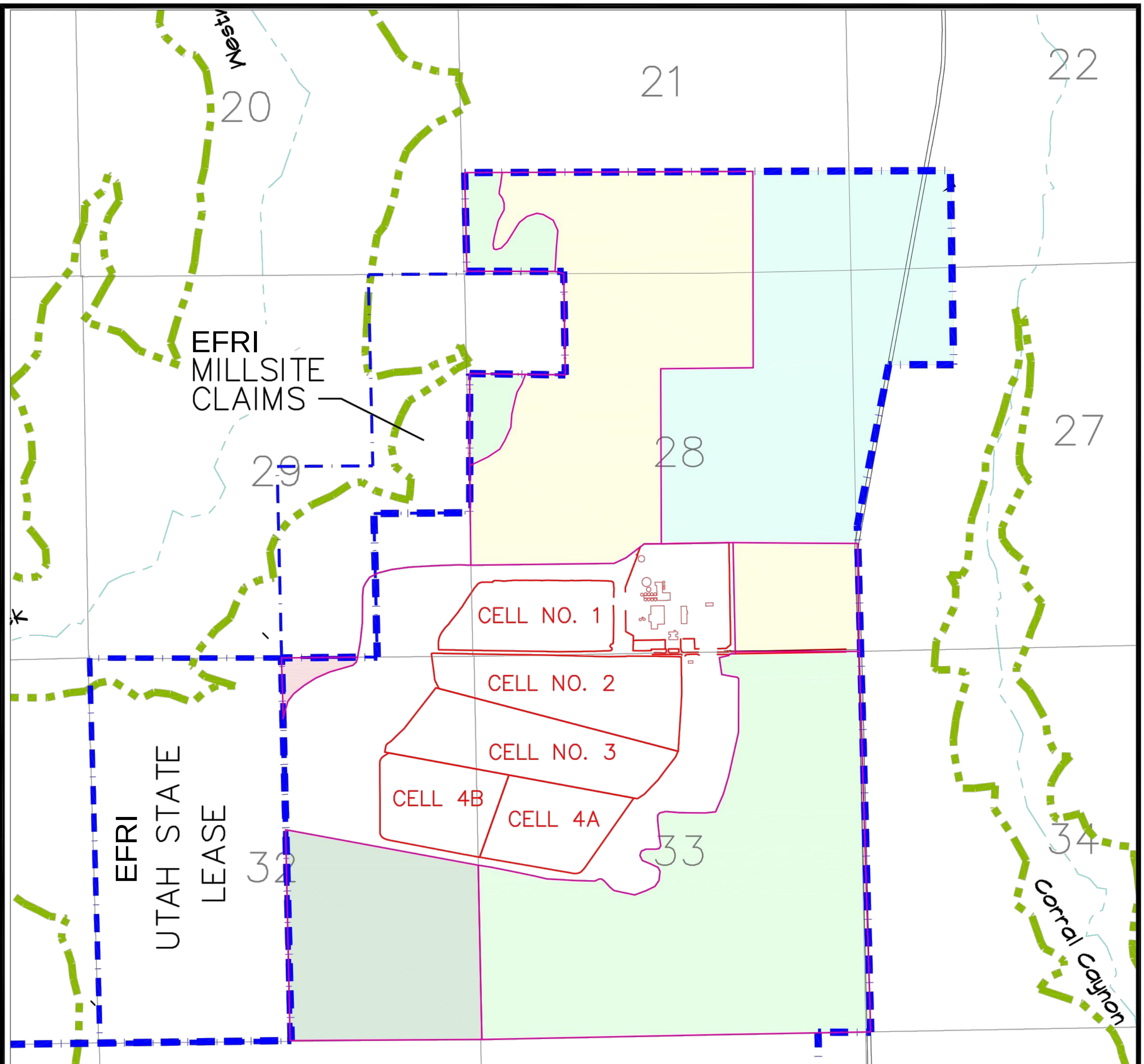
Table 1.7-1
Community Types and Expanse Within the Project site Boundary

Community Type	Expanse	
	Ha	Acres
Pinyon-juniper Woodland	5	13
Big Sagebrush	113	278
Reseeded Grassland I	177	438
Reseeded Grassland II	121	299
Tamarisk-salix	3	7
Controlled Big Sagebrush	230	569
Disturbed	17	41

Table 1.7-2
Ground Cover For Each Community Within the Project Site Boundary

Community Type	Percentage of Each Type of Cover		
	Vegetative Cover	Litter	Bare Ground
Pinyon-juniper Woodland[a]	25.9	15.6	55.6
Big Sagebrush	33.3	16.9	49.9
Reseeded Grassland I	15.2	24.2	61.0
Reseeded Grassland II	10.7	9.5	79.7
Tamarisk-salix	12.0	20.1	67.9
Controlled Big Sagebrush	17.3	15.3	67.4
Disturbed	13.2	7.0	80.0

[a]Rock covered 4.4% of the ground.



Pinyon - Juniper
Reseeded Grassland I
Reseeded Grassland II
Big Sagebrush
Controlled Big Sagebrush
Disturbed

N

1,000' 0 1,000' 2,000'
SCALE: 1" = 2,000'

ENERGY FUELS

REVISIONS	
Date	By
11-09	DLS
07-11	GM

Project: White Mesa Mill
County: San Juan State: UT
Location:

VEGETATION COMMUNITY TYPES
ON THE WHITE MESA MILL SITE
FIGURE 1.7-1

Author: Date: May 1999 Drafted By: RAH

\\dmcfs0\MASTER DRAWINGS\USA\Utah\Mill\dwgs\Reclamation Plans\Rev_07-2011\Work01_Harold\Fig.1.7-1_Vegetation.dwg Layout1 GMoseley

In completing the 2002 EA, NRC staff contacted wildlife biologists from the BLM and the Utah Wildlife Service to gather local information on the occurrences of additional species surrounding the Mill. In the 2002 EA, NRC staff concluded that the Navajo Sedge has not been observed in the area surrounding Blanding, and is typically found in areas of moisture (2002 EA).

In June 2012, the area surrounding the Mill site was surveyed for plant composition to supplement data presented in Dames & Moore (1978b). Survey results confirmed that two principal plant community types in the vicinity of the Mill site. These plant communities are Big Sagebrush shrubland and Juniper woodland. In addition to these two principal plant community types, there are a number of disturbed areas in different stages of successional development. These areas reflect past disturbances such as sagebrush removal (chaining and plowing) and seeding and intense grazing, as evidenced by a complete lack of any understory species in some areas. The vegetation survey conducted in 2012 provides information of species that exist on the Mill site and their relative importance in terms of plant cover. All areas surveyed in 2012 show that big sagebrush (*Artemisia tridentata*) is the dominant species and subdominants are either broom snakeweed (*Gutierrezia sarothroae*) or galleta (*Hilaria jamesii*). Additional discussion on this survey is provided in Appendix A.

1.7.1.2 Fauna (1978 ER Section 2.9.1.2)

Wildlife data have been collected through four seasons at several locations on the site. The presence of a species was based on direct observations, trappings and signs such as the occurrence of scat, tracks, or burrows. A total of 174 vertebrate species potentially occur within the vicinity of the mill (Dames & Moore, 1978b, Appendix D), 78 of which were confirmed (Dames & Moore, 1978b, Section 2.8.2.2).

Although seven species of amphibians are thought to occur in the area, the scarcity of surface water limits the use of the site by amphibians. The tiger salamander (*Ambystoma tigrinum*) was the only species observed. It appeared in the pinyon-juniper woodland west of the Mill site (Dames & Moore, 1978b, Section 2.8.2.2).

Eleven species of lizards and five snakes potentially occur in the area. Three species of lizards were observed: the sagebrush lizard (*Sceloparas graciosus*), western whiptail (*Cnemidophorus tigris*), and the short-horned lizard (*Phrynosoma douglassi*) (Dames & Moore, 1978b, Section 2.8.2.2). The sagebrush and western whiptail lizard were found in sagebrush habitat, and the short-horned lizard was observed in the grassland. No snakes were observed during the field work.

Fifty-six species of birds were observed in the vicinity of the Mill site (Table 1.7-3). The abundance of each species was estimated by using modified Emlen transects and roadside bird counts in various habitats and seasons. Only four species were observed during the February sampling. The most abundant species was the horned lark (*Eremophila aepestis*) followed by the common raven (*Corvus corax*), which were both concentrated in the grassland. Avian counts increased drastically in May. Based on extrapolation of the Emlen transect data, the avian density on grassland of the Mill site during spring was about 123 per 100 acres (305 per square kilometer). Of these individuals, 94 percent were horned larks and western meadowlarks (*Sturnella neglecta*). This density and species composition are typical of rangeland habitats. In late June the species diversity declined somewhat in grassland but peaked in all other habitats. By October the overall diversity decreased but again remained the highest in grassland.

Table 1.7-3
Birds Observed in the Vicinity of the White Mesa Project

Species	Relative Abundance and Status[a]	Species	Relative Abundance and Status[a]
Mallard	CP	Pinyon Jay	CP
Pintail	CP	Bushtit	CP
Turkey Vulture	US	Bewick's Wren	CP
Red-tailed Hawk	CP	Mockingbird	US
Golden Eagle	CP	Mountain Bluebird	CS
Marsh Hawk	CP	Black-tailed Gnatcatcher	H
Merlin	UW	Ruby-crowned Kinglet	CP
American Kestrel	CP	Loggerhead Shrike	CS
Sage Grouse	UP	Starling	CP
Scaled Quail	Not Listed	Yellow-rumped Warbler	CS
American Coot	CS	Western Meadowlark	CP
Killdeer	CP	Red-winged Blackbird	CP
Spotted Sandpiper	CS	Brewer's Blackbird	CP
Mourning Dove	CS	Brown-headed Cowbird	CS
Common Nighthawk	CS	Blue Grosbeak	CS
White-throated Swift	CS	House Finch	CP
Yellow-bellied Sapsucker	CP	American Goldfinch	CP
Western Kingbird	CS	Green-tailed Towhee	CS
Ash-throated Flycatcher	CS	Rufous-sided Towhee	CP
Say's Phoebe	CS	Lark Sparrow	CS
Horned Lark	CP	Black-throated Sparrow	CS
Violet-green Swallow	CS	Sage Sparrow	UC
Barn Swallow	CS	Dark-eyed Junco	CW
Cliff Swallow	CS	Chipping Sparrow	CS
Scrub Jay	CP	Brewer's Sparrow	CS
Black-billed Magpie	CP	White-crowned Sparrow	CS
Common Raven	CP	Song Sparrow	CP
Common Crow	CW	Vesper Sparrow	CS

[a]W. H. Behle and M. L. Perry, *Utah Birds*, Utah Museum of Natural History, University of Utah, Salt Lake City, 1975.

Relative Abundance	Status
C = Common	P = Permanent
U = Uncommon	S = Summer Resident
H = Hypothetical	W = Winter Visitant

Source: Dames & Moore (1978b), Table 2.8-5

Raptors are prominent in the western United States. Five species were observed in the vicinity of the site (Table 1.7-3). Although no nests of these species were located, all (except the golden eagle, *Aquila chrysaetos*) have suitable nesting habitat in the vicinity of the site. The nest of a prairie falcon (*Falco mexicanus*) was found about 3/4 mile (1.2 km) east of the site. Although no sightings were made of this species, members tend to return to the same nests for several years if undisturbed (Dames & Moore, 1978b, Section 2.8.2.2).

Of several mammals that occupy the site, mule deer (*Odocoileus hemionus*) is the largest species. The deer inhabit the project vicinity and adjacent canyons during winter to feed on the sagebrush and have been observed migrating through the site to Murphy Point (Dames & Moore, 1978b, Section 2.8.2.2). Winter deer use of the project vicinity, as measured by browse utilization, is among the heaviest in southeastern Utah [25 days of use per acre (61 days of use per hectare) in the pinyon-juniper-sagebrush habitats in the vicinity of the Mill site]. In addition, this area is heavily used as a migration route by deer traveling to Murphy Point to winter. Daily movement during winter periods by deer inhabiting the area has also been observed between Westwater Creek and Murphy Point. The present size of the local deer herd is not known.

Other mammals present at the site include the coyote (*Canis latrans*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cineroargenteus*), striped skunk (*Mephitis mephitis*), badger (*taxidea taxus*), longtail weasel (*Mustela frenata*), and bobcat (*Lynx rufus*). Nine species of rodents were trapped or observed on the site, the deer mouse (*Peromyscus maniculatus*) having the greatest distribution and abundance. Although desert cottontails (*Sylvilagus auduboni*) were uncommon in 1977, black-tailed jackrabbits (*Lepus californicus*) were seen during all seasons.

In the 2002 EA, NRC staff noted that, in the vicinity of the site, the U.S. Fish and Wildlife Service had provided the list set out in Table 3.12-1 of the 2002 EA, of the endangered, threatened, and candidate species that may occur in the area around the site.

Table 1.7-4
Endangered, Threatened and Candidate Species in the Mill Area

Common Name	Scientific Name	Status
Navajo Sedge	*Carex specuicola*	Threatened
Bonytail Chub	*Gila elegans*	Endangered
Colorado Pikeminnow	*Ptychocheilus Lucius*	Endangered
Humpback Chub	*Gila cypha*	Endangered
Razorback Sucker	*Xyrauchen texanus*	Endangered
Bald Eagle	*Haliaeetus leucocephalus*	Threatened
California Condor	*Gymnogyps californianus*	Endangered
Gunnison Sage Grouse	*Centrocercus minimus*	Candidate
Mexican Spotted Owl	*Strix occidentalis lucida*	Threatened
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	Endangered
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*	Candidate
Black-footed Ferret	*Mustela nigripes*	Endangered

Source: 2002 EA (NRC, 2002)

The 2002 EA also noted that, in addition, the species listed on Table 3.12-2 of the 2002 EA may occur within the Mill area that are managed under Conservation Agreements/Strategies.

Table 1.7-5
Species Managed Under Conservation Agreements/Strategies at the Mill Area

Common Name	Scientific Name
Colorado River Cutthroat Trout	*Oncorhynchus clarki pleuriticus*
Gunnison Sage Grouse	*Centrocercus minimus*

Source: 2002 EA (NRC, 2002)

For the 2002 EA, NRC staff contacted wildlife biologists from the BLM and the Utah Wildlife Service to gather local information on the occurrences of these additional species surrounding the Mill. NRC staff made the following conclusions (2002 EA p. 4):

> While the ranges of the bald eagle, peregrine falcon, and willow flycatcher encompass the project area, their likelihood of utilizing the site is extremely low. The black-footed ferret has not been seen in Utah since 1952, and is not expected to occur any longer in the area. The California Condor has only rarely been spotted in the area of Moab, Utah, (70 miles north) and around Lake Powell (approximately 50 miles south). The Mexican Spotted Owl is only found in the mountains in Utah, and is not expected to be on the Mesa. The Southwestern Willow Flycatcher, Western Yellow-billed Cuckoo, and Gunnison Sage Grouse are also not expected to be found in the immediate area around the Mill site.

1.7.2 Aquatic Biota (*1978 ER Section 2.9.2*)

Aquatic habitat at the Mill site ranges temporally from extremely limited to nonexistent due to the aridity, topography and soil characteristics of the region and consequent dearth of perennial surface water. Two small stock watering ponds, are located on the Mill site a few hundred yards from the ore pad area (see Figure 1.5-3). One additional small "wildlife pond", east of Cell 4A, was completed in 1994 to serve as a diversionary feature for migrating waterfowl (see Figure 1.5-3). Although more properly considered features of the terrestrial environment, they essentially represent the total aquatic habitat on the Mill site. These ponds probably harbor algae, insects, other invertebrate forms, and amphibians.

They also provide a water source for small mammals and birds. Similar ephemeral catch and seepage basins are typical and numerous to the northeast of the Mill site and south of Blanding.

Aquatic habitat in the project vicinity is similarly limited. The three adjacent streams (Corral Creek, Westwater Creek, and an unnamed arm of Cottonwood Wash) are only intermittently active, carrying water primarily in the spring during increased rainfall and snowmelt runoff, in the autumn, and briefly during localized but intense electrical storms. Intermittent water flow most typically occurs in April, August, and October in those streams. Again, due to the temporary nature of these steams, their contribution to the aquatic habitat of the region is probably limited to providing a water source for wildlife and a temporary habitat for insect and amphibian species.

In the 2002 EA, NRC staff concluded that (p. 4) no populations of fish are present on the project site, nor are any known to exist in the immediate area of the site. Four species of fish designated as endangered or threatened (the Bonytail Chub, Colorado Pikeminnow, Humpback Chub and Razorback Sucker) occur in the San Juan River 18 miles south of the site, which Dames & Moore noted in the 1978 ER (Section 2.8.2) is the closest habitat suitable for these species. NRC staff further concluded that there are no discharges of

Mill effluents to surface waters, and therefore, no impacts are expected for the San Juan River due to operations of the Mill.

1.7.3 Background Radiation (*2007 ER, Section 3.13.1*)

All living things are continuously exposed to ionizing radiation from a variety of sources including cosmic and cosmogenic radiation from space and external radiation from terrestrial radionuclides such as uranium, thorium and potassium-40 that occur in the earth's crust, in building materials, in the air we breathe, the food we eat, the water we drink and in our bodies.

Some exposures, such as that from potassium-40, are controlled by our body's metabolism and are relatively constant throughout the world, but exposures from sources such as uranium and thorium in soils and especially from radon in homes can vary greatly, by more than a factor of ten, depending on location.

In order to provide a context for exposures potentially attributable to radioactive emissions from processing ores and alternate feed materials at the Mill, this section provides some general background information on exposures to natural background radiation worldwide, in the United States and in the Colorado Plateau region where the Mill is located.

1.7.3.1 The World

In general terms, the worldwide breakdown of natural background radiation sources can be summarized as follows (UNSCEAR, 2000):

Cosmic and Cosmogenic	39 mrem/yr
Terrestrial	48 mrem/yr
Inhaled (Radon)	126 mrem/yr
Ingested	29 mrem /yr
Total (Average)	**242 mrem/yr (116 mrem/yr excluding radon)**

According to the United Nations Scientific Committee on the Effects of Atomic Radiation ("UNSCEAR"), the actual doses can vary considerably from the nominal values listed above, and around the world vary from this value by more than a factor of 10. For example, the dose from cosmic and cosmogenic radiation varies with altitude. The higher the altitude, the less is the protection offered by the earth's atmosphere. The dose from external gamma radiation can vary greatly depending on the levels of uranium and thorium series radionuclides in the local soil. One example is the elevated gamma fields seen on natural sands containing heavy minerals as for example in regions around the Indian Ocean, in Brazil, and New Jersey. The high variability in indoor radon concentrations is a major source of the variation in natural background dose. The variability in the dose from radon arises from many factors, including: variability in soil radium concentrations from place to place; variation both over time and location in housing stock, heating and ventilating systems; and variations in individual habits. The worldwide average ambient (i.e. outdoor) radon concentration is about 10 Bq/m^3 (UNSCEAR, 2000) and the world average concentration of U-238 and Th-232 in soils is about 0.7 pCi/g (25 Bq/kg) (NRC, 1994).

The definition of "background radiation" in 10 CFR 20.1003 specifically includes global fallout as it exists in the environment from the testing of nuclear explosive devices or from past nuclear accidents such as Chernobyl that contribute to background radiation and are not under the control of the licensee. The calculation of background radiation in Section 3.13.1 of the 2007 ER is conservative because it does not include such fallout in background radiation for the Mill site.

1.7.3.2 United States

In the United States, nominal average levels of natural background radiation are as follows (National Council of Radiation Protection and Measurements ("NCRP"), 1987):

Cosmic and Cosmogenic	28 mrem/yr
Terrestrial	28 mrem/yr
Inhaled (Radon)	200 mrem/yr
Ingested	40 mrem /yr
Total (Average)	**296 mrem/yr (96 mrem/yr excluding radon)**

As shown above, in the United States, the average annual dose from natural background radiation is about 296 mrem/yr (including radon). The actual annual dose from natural background varies by region within the United States. For example, the average dose from external terrestrial radiation for a person living on the Colorado Plateau is in the order of 63 mrem/yr, which is considerably higher than the average dose from terrestrial radiation for a person living in Florida, where the average annual dose from external terrestrial radiation is only about 16 mrem/yr. (NRC, 1994; NCRP, 1987). In the United States, outdoor radon levels vary widely from about 0.1 pCi/l in New York City to about 1.2 pCi/L in Colorado Springs (NCRP, 1987), generally consistent with nominal worldwide values noted in the previous section.

1.7.4 Mill Site Background (*1978 ER Section 2.10*)

Radiation exposure in the natural environment is due to cosmic and terrestrial radiation and to the inhalation of radon and its daughters. Measurements of the background environmental radioactivity were made at the Mill site using thermoluminescent dosimeters ("TLDs"). The results indicate an average total body dose of 142 millirems per year, of which 68 millirems is attributable to cosmic radiation and 74 millirems to terrestrial sources. The cosmogenic radiation dose is estimated to be about 1 millirem per year. Terrestrial radiation originates from the radionuclides potassium-40, rubidium-87, and daughter isotopes from the decay of uranium-238, thorium-232, and, to a lesser extent, uranium-235. The dose from ingested radionuclides is estimated at 18 millirems per year to the total body. The dose to the total body from all sources of environmental radioactivity is estimated to be about 161 millirems per year.

The concentration of radon in the area is estimated to be in the range of 500 to 1,000 pCi/m^3, based on the concentration of radium-226 in the local soil. Exposure to this concentration on a continuous basis would result in a dose of up to 625 millirems per year to the bronchial epithelium. As ventilation decreases, the dose increases; for example, in unventilated enclosures, the comparable dose might reach 1,200 millirems per year.

The medical total body dose for Utah is about 75 millirems per year per person. The total dose in the area of the mill from natural background and medical exposure is estimated to be 236 millirems per year.

1.7.5 Current Monitoring Data

The most recent data for gamma, vegetation, air and stack sampling, groundwater, surface water, meteorological monitoring, and soil sampling discussed in the following sections are found in the Semi-Annual Effluent Report for July through December 2015. See Section 2.3.2.1 for a more detailed discussion of the environmental monitoring programs at the Mill.

1.7.5.1 Environmental Radon

Environmental radon concentrations are determined by using Track Etch detectors. There is one detector at each of eight environmental monitoring stations with a duplicate at BHV-2. See the Semi-Annual Effluent reports, for maps showing these locations.

1.7.5.2 Environmental Gamma

Gamma radiation levels are determined by optically stimulated luminescence dosimeters ("OSLs"). The OSLs are placed at the eight environmental stations located around the perimeter boundary of the Mill site discussed above. The badges are exchanged quarterly. Recent data are presented in the Semi-Annual Effluent Report for July through December 2015.

1.7.5.3 Vegetation Samples

Vegetation samples are collected at three locations around the Mill periphery. The sampling locations are northeast, northwest, and southwest of the Mill facility. Vegetation samples are collected three times per year. Recent vegetation results are included in the Semi-Annual Effluent Report for July through December 2015. No trends are apparent, as concentrations at each sampling location have remained consistent.

1.7.5.4 Environmental Air Monitoring and Stack Sampling

Air monitoring at the Mill is conducted at seven high volume (40 standard cubic feet per minute) stations located around the periphery of the Mill. These locations are shown on Figure 2.3-2. BHV-1 and BHV-8 are located at the northern Mill boundary. BHV-2 is further north at the nearest residence. BHV-4 is south of Cell 3, BHV-5 is just south of the ore storage pad on the eastern boundary of the Mill property, BHV-6 is located on a vector between the Mill site and the White Mesa Ute Community, and BHV-7 is located on the eastern boundary of the Mill north of BHV-5. The Semi-Annual Effluent Reports contain air monitoring data. The results of the quarterly stack samples are also presented in the Semi-Annual Effluent Reports.

Pursuant to NRC License Amendment No. 41 for the Mill's Source Material License No. SUA-1358, air particulate radionuclide monitoring at BHV-3 was discontinued at the end of the third quarter of 1995. Tables in the Semi-Annual Effluent Reports show the radionuclide concentrations at each location. No trends are evident.

1.7.5.5 Surface Water

The results of surface water monitoring are presented in the Semi-Annual Effluent Reports. Cottonwood Creek is sampled semi-annually and Westwater Creek is sampled on an annual basis. No trends are apparent.

1.7.5.6 Meteorological Monitoring

The Semi-Annual Air Quality and Meteorology Monitoring Report for July 1, 2015 through December 31, 2015 was provided by McVehil-Monnett and is available at the Mill.

2 EXISTING FACILITY

The following sections describe the construction history of the Mill; the Mill and Mill tailings management facilities; Mill operations including the Mill circuit and tailings management; and both operational and environmental monitoring.

2.1 Facility Construction History

The Mill is a uranium/vanadium mill that was developed in the late 1970s by Energy Fuels Nuclear, Inc. ("EFN") as an outlet for the many small mines that are located in the Colorado Plateau and for the possibility of milling Arizona Strip ores. At the time of its construction, it was anticipated that high uranium prices would stimulate ore production. However, prices started to decline about the same time as Mill operations commenced.

As uranium prices fell, producers in the region were affected and mine output declined. After about two and one-half years, the Mill ceased ore processing operations altogether, began solution recycle, and entered a total shutdown phase. In 1984, a majority ownership interest was acquired by Union Carbide Corporation's ("UCC") Metals Division which later became Umetco Minerals Corporation ("Umetco"), a wholly-owned subsidiary of UCC. This partnership continued until May 26, 1994 when EFN reassumed complete ownership. In May 1997, Denison (then named International Uranium (USA) Corporation) and its affiliates purchased the assets of EFN. EFRI purchased Denison in July 2012 and is the current owner of the facility.

2.1.1 Mill and Mill Tailings System

The Source Materials License Application for the Mill was submitted to the NRC on February 8, 1978. Between that date and the date the first ore was fed to the Mill grizzly on May 6, 1980, several actions were taken including: increasing Mill design capacity, permit issuance from the United States Environmental Protection Agency ("EPA") and the State of Utah, archeological clearance for the Mill and tailings system, and an NRC pre-operational inspection on May 5, 1980.

Construction on the Mill tailings system began on August 1, 1978 with the movement of earth from the area of Cell 2. Cell 2 was completed on May 4, 1980, Cell 1 on June 29, 1981, and Cell 3 on September 2, 1982. In January 1990 an additional cell, designated Cell 4A, was completed and initially used solely for solution storage and evaporation. Cell 4A was only used for a short time and then taken out of service because of concerns about the synthetic lining system. In 2007, Cell 4A was retrofitted with a new State of Utah approved lining system and was authorized to begin accepting process solutions in September 2008. Cell 4A was put back into service in October 2008. Cell 4B was constructed in 2010 and authorized to begin accepting process solutions in February 2011.

2.2 Facility Operations

In the following subsections, an overview of Mill operations and operating periods are followed by descriptions of the operations of the Mill circuit and tailings management facilities.

2.2.1 Operating Periods

The Mill was operated by EFN from the initial start-up date of May 6, 1980 until the cessation of operations in 1983. Umetco, as per agreement between the parties, became the operator of record on January 1, 1984.

The Mill was shut down during all of 1984. The Mill operated at least part of each year from 1985 through 1990. Mill operations again ceased during the years of 1991 through 1994. EFN reacquired sole ownership on May 26, 1994, and the Mill operated again during 1995 and 1996. After acquisition of the Mill by Denison and its affiliates several local mines were restarted and the Mill processed conventional ore during 1999 and early 2000. With the resurgence in uranium and vanadium prices in 2003, Denison reopened several area mines and again began processing uranium and vanadium ores in April 2008. Mill operations were suspended in May 2009, and resumed in March 2010. Conventional ore processing was again suspended in July 2011, resumed in November 2011 through March 2012, and suspended in April 2012. Denison became EFRI after July 25, 2012. Conventional ore processing resumed from August 2012 through June 2013, was suspended in July 2013, resumed May 2014 through August 2014, and was suspended again in September 2014. Typical employment figures for the Mill are approximately 110 during uranium-only operations and 150 during uranium/vanadium operations.

Commencing in the early 1990s through today, the Mill has processed alternate feed materials from time to time when the Mill has not been processing conventional ores. Alternate feed materials are uranium-bearing materials other than conventionally mined uranium ores. The Mill installed an alternate feed circuit in 2009 that allows the Mill to process certain alternate feed materials simultaneously with conventional ores.

2.2.2 Mill Circuit

While originally designed for a capacity of 1,500 dry tons per day (dtpd), the Mill capacity was boosted to the present rated design of 1,980 dtpd prior to commissioning.

The Mill uses an atmospheric hot acid leach followed by counter current decantation (CCD). This in turn is followed by a clarification stage which precedes the solvent extraction (SX) circuit. Kerosene containing iso-decanol and tertiary amines extracts the uranium and vanadium from the aqueous solution in the SX circuit. Salt and soda ash are then used to strip the uranium and vanadium from the organic phase.

After extraction of the uranium values from the aqueous solution in SX, uranium is precipitated with anhydrous ammonia, dissolved, and re-precipitated to improve product quality. The resulting precipitate is then washed and dewatered using centrifuges to produce a final product called "yellowcake." The yellowcake is dried in a multiple hearth dryer and packaged in drums weighing approximately 800 to 1,000 lbs. for shipping to converters.

After the uranium values are stripped from the pregnant solution in SX, the vanadium values are transferred to tertiary amines contained in kerosene and concentrated into an intermediate product called vanadium product liquor (VPL). An intermediate product, ammonium metavanadate (AMV), is precipitated from the VPL using ammonium sulfate in batch precipitators. The AMV is then filtered on a belt filter and, if necessary, dried. Normally, the AMV cake is fed to fusion furnaces where it is converted to the Mill's primary vanadium product, V_2O_5 tech flake, commonly called "black flake."

The same basic process steps used for the recovery of uranium from conventional ores are used for the recovery of uranium from alternate feed materials, with some variations depending on the particular alternate feed material.

The Mill processed 1,511,544 tons of conventional ore and other materials from May 6, 1980 to February 4, 1983. During the second operational period from October 1, 1985 through December 7, 1987, 1,023,393 tons of conventional ore were processed. During the third operational period from July 1988 through

November 1990, 1,015,032 tons of conventional ore were processed. During the fourth operational period from August 1995 through January 1996, 203,317 tons of conventional ore were processed. In the fifth operational period, from May 1996 through September 1996, the Mill processed 3,868 tons of calcium fluoride alternate feed material. From 1997 to early 1999, the Mill processed 58,403 tons from several additional alternate feed stocks.

With rising uranium prices in the late 1990s, company mines were reopened in 1997, and 87,250 tons of conventional ore were processed in 1999 and early 2000. In 2002 and 2003, the Mill processed 266,690 tons of alternate feed material from government cleanup projects. An additional 40,866 tons of alternate feed materials were processed in 2007. An additional 1,401 tons of alternate feed materials were processed from 2008 through July 2011. From April 2008 through July 2011 the Mill processed an additional 722,843 tons of conventional ore. The Mill processed 340,058 and 24,036 tons of conventional ore and alternate feed materials, respectively, between August 2011 and March 2016.

Inception to date material processed through March 2016 totals 5,298,701 tons. This total is for all processing periods and feeds combined.

2.2.3 Tailings Management Facilities

Tailings produced by the Mill from conventional ores typically contain 30 percent moisture by weight, have an in-place dry density of 86.3 pounds per cubic foot (calculated from Cell 2 volume and tons placed), have a size distribution with a significant -200 to -325 mesh size fraction, and have a high acid and flocculent content. Tailings from alternate feed materials that are similar physically to conventional ores, which comprise most of the tons of alternate feed materials processed to date at the Mill, are similar to the tailings for conventional ores. Tailings from some of the higher grade, lower volume alternate feed materials may vary somewhat from the tailings from conventional ores, primarily in moisture and density content.

The tailings facilities at the Mill currently consist of five cells as follows:

- Cell 1, constructed with a 30 mil PVC earthen-covered liner, is used for the evaporation of process solutions (Cell 1 was previously referred to as Cell 1-I).
- Cell 2, constructed with a 30 mil PVC earthen-covered liner, is used for the storage of barren tailings sands. This Cell is full and has been partially reclaimed.
- Cell 3, constructed with a 30 mil PVC earthen-covered liner, is used for the storage of barren tailings sands and process solutions, but currently only receives mill waste and byproduct material in accordance with License provisions. This cell is partially filled and has been partially reclaimed.
- Cell 4A, constructed with a geosynthetic clay liner, a 60 mil HDPE liner, a 300 mil HDPE geonet drainage layer, a second 60 mil HDPE liner, and a slimes drain network over the entire cell bottom. This cell was placed into service in October 2008 and is used for storage of barren tailings sands and evaporation of process solutions.
- Cell 4B, constructed with a geosynthetic clay liner, a 60 mil HDPE liner, a 300 mil HDPE geonet drainage layer, a second 60 mil HDPE liner, and a slimes drain network over the entire cell bottom. This cell was placed into service in February 2011, is used for evaporation of process solutions, and has not been used for tailings storage.

Total estimated design capacity of Cells 2, 3, 4A, and 4B is approximately eight million tons. Figures 1.5-4 and 1.5-5 show the locations of the tailings management system cells.

2.2.3.1 Tailings Management

Constructed in shallow valleys or swale areas, the lined tailings facilities provide storage below the existing grade and reduce potential exposure. Because the cells are separate and distinct, individual tailings cells may be reclaimed as they are filled to capacity. This phased reclamation approach minimizes the amount of tailings exposed at any given time and reduces potential exposure to a minimum.

Slurry disposal has taken place in Cells 2, 3 and 4A. Tailings placement in Cell 2 and Cell 3 was accomplished by means of the final grade method, described below.

The final grade method used in Cell 2 and Cell 3 calls for the slurry to be discharged until the tailings surface comes up to near final grade. The discharge points are set up in the east end of the cell, and the final grade surface is advanced to the slimes pool area. Coarse tailings sand from the discharge points is graded into low areas to reach the final disposal elevation. When the slimes pool is reached, the discharge points are then moved to the west end of the cell and worked back to the middle. An advantage to using the final grade method is that maximum beach stability is achieved by (1) allowing water to drain from the sands to the maximum extent, and (2) allowing coarse sand deposition to help provide stable beaches. Another advantage is that radon release and dust prevention measures (through the placement of the initial layer of the final cover) are applied as expeditiously as possible.

Slurry disposal in Cell 4A is from several pre-determined discharge points located around the north and east sides of the cell. Slurry discharge is only allowed on skid pads, or protective HDPE sheets, to prevent damage to the synthetic lining system. Once tailings solids have reach the maximum elevation around the perimeter of the cell, discharge points can be moved toward the interior of the cell. Slurry disposal in Cell 4B will be conducted in the same manner as Cell 4A. Cell 4B is currently only accepting process solutions.

2.2.3.2 Liquid Management

As a zero-discharge facility, the Mill must evaporate all of the liquids utilized during processing. This evaporation currently takes place in four areas:

- Cell 1, which is used for solutions only
- Cell 3, in which tailings and solutions exist
- Cell 4A, in which tailings and solutions exist
- Cell 4B, presently used for solutions only

The original engineering design indicated a net water gain into the cells would occur during Mill operations. As anticipated, this has been proven to be the case. In addition to natural evaporation, spray systems have been used at various times to enhance evaporative rates and for dust control. To minimize the net water gain, solutions are recycled back for use in the Mill circuit from the active tailings cells to the maximum extent possible. Solutions from Cells 1, 3, 4A, and 4B are brought back to the CCD circuit where metallurgical benefit can be realized. Recycle to other parts of the Mill circuit are not feasible due to the acidic condition of the solution.

2.3 Monitoring Programs

2.3.1 Monitoring and Reporting Under the Mill's GWDP

2.3.1.1 Groundwater Monitoring

a) Plugged and Excluded Wells

Wells MW-6, MW-7, and MW-8 were plugged because they were in the area of Cell 3, as was MW-13, in the Cell 4A area. Wells MW-9 and MW-10 are dry and have been excluded from the monitoring program. MW-16 is dry and has been plugged as part of the tailings Cell 4B construction.

b) Groundwater Monitoring at the Mill Prior to Issuance of the GWDP

At the time of renewal of the License by NRC in March 1997 and up until issuance of the GWDP in March 2005, the Mill implemented a groundwater detection monitoring program to ensure compliance to 10 CFR Part 40, Appendix A, in accordance with the provisions of the License. The detection monitoring program was in accordance with the report entitled, *Points of Compliance, White Mesa Uranium Mill*, prepared by Titan Environmental Corporation, submitted by letter to the NRC dated October 5, 1994 (Titan, 1994b). Under that program, the Mill sampled monitoring wells MW-5, MW-11, MW-12, MW-14, MW-15 and MW-17, on a quarterly basis. Samples were analyzed for chloride, potassium, nickel and uranium, and the results of such sampling were included in the Mill's Semi-Annual Effluent Monitoring Reports that were filed with the NRC up until August 2004 and with the DWMRC subsequent thereto.

Between 1979 and 1997, the Mill monitored up to 20 constituents in up to 13 wells. That program was changed to the Points of Compliance Program in 1997 because NRC had concluded that:

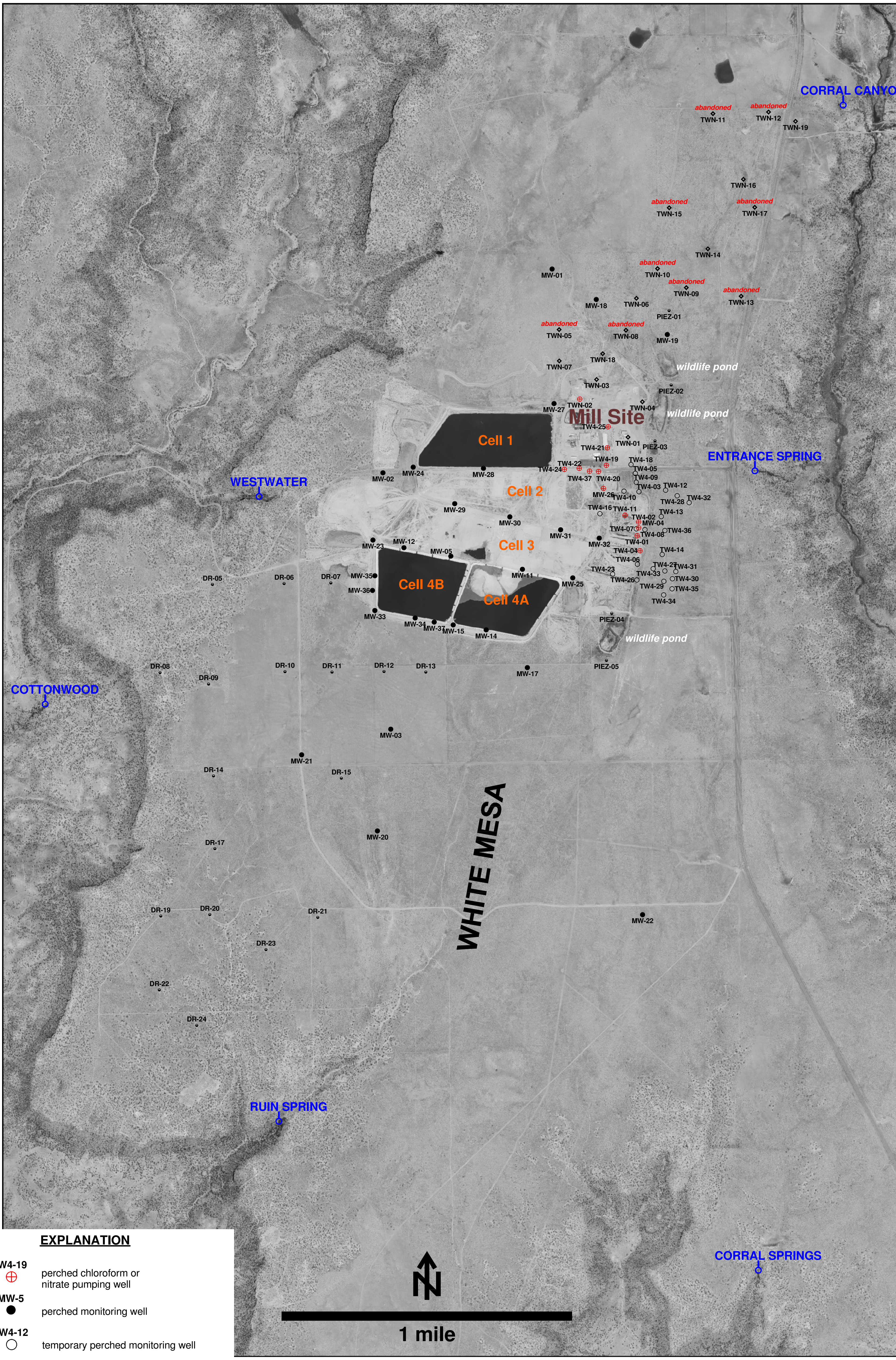
- The Mill and tailings system had produced no impacts to the perched zone or deep aquifer
- The most dependable indicators of water quality and potential cell failure were considered to be chloride, nickel, potassium and natural uranium

c) Issuance of the GWDP

On March 8, 2005, the DWMRC issued the GWDP, which includes a groundwater monitoring program that supersedes and replaces the groundwater monitoring requirements set out in the License. Groundwater monitoring under the GWDP commenced in March 2005, the results of which are included in the Mill's *Quarterly Groundwater Monitoring Reports* that are submitted to the DWMRC.

d) Current Ground Water Monitoring Program at the Mill Under the GWDP

The current groundwater monitoring program at the Mill under the GWDP consists of monitoring at 25 point of compliance monitoring wells: MW-1, MW-2, MW-3, MW-3A, MW-5, MW-11, MW-12, MW-14, MW-15, MW-17, MW-18, MW-19, MW-23, MW-24, MW-25, MW-26, MW-27, MW-28, MW-29, MW-30, MW-31, MW-32 MW-35, MW-36, and MW-37. The locations of these wells are indicated on Figure 2.3-1.



EXPLANATION

Symbol	Description
TW4-19	perched chloroform or nitrate pumping well
MW-5	perched monitoring well
TW4-12	temporary perched monitoring well
TWN-7	temporary perched nitrate monitoring well
PIEZ-1	perched piezometer
RUIN SPRING	seep or spring

HYDRO GEO CHEM, INC.

WHITE MESA SITE PLAN SHOWING LOCATIONS OF PERCHED WELLS AND PIEZOMETERS

APPROVED	DATE	REFERENCE	FIGURE
		H:/718000/ ReclamationPlan/Uwelloc0316_Rec.srf	2.3-1

Part I.E.1.(c) of the GWDP requires that each point of compliance well must be sampled for the constituents listed in Table 2.3-1.

Table 2.3-1
Groundwater Monitoring Constituents Listed in Table 2 of the GWDP

Nutrients:		
Ammonia (as N)	Nitrate & Nitrite (as N)	
Heavy Metals:		
Arsenic	Lead	Thallium
Beryllium	Manganese	Tin
Cadmium	Mercury	Uranium
Chromium	Molybdenum	Vanadium
Cobalt	Nickel	Zinc
Copper	Selenium	
Iron	Silver	
Radiologics:		
Gross Alpha		
Volatile Organic Compounds:		
Acetone	Chloroform	Tetrahydrofuran
Benzene	Chloromethane	Toluene
2-Butanone (MEK)	Dichloromethane	Xylenes (total)
Carbon Tetrachloride	Naphthalene	
Others:		
Field pH (S.U.)	Chloride	TDS
Fluoride	Sulfate	

Further, Part I.E.1.(d) of the GWDP requires that, in addition to pH, the following field parameters must also be monitored:

- Depth to groundwater
- Temperature
- Specific conductance
- Redox potential

and that, in addition to chloride and sulfate, the following general organics must also be monitored:

- Carbonate, bicarbonate, sodium, potassium, magnesium, calcium, and total anions and cations

Sample frequency depends on the speed of ground water flow in the vicinity of each well. Parts I.E.1(b) and (c) of the GWDP provide that quarterly monitoring is required for all wells where local groundwater average linear velocity has been found by the DWMRC to be equal to or greater than 10 feet/year, and semi-annual monitoring is required where the local groundwater average linear velocity has been found by the DWMRC to be less than 10 feet/year.

Based on these criteria, MW-11, MW-14, MW-25, MW-26, MW-30, MW-31, MW-35, MW-36 and MW-37 are monitored quarterly. Semi-annual monitoring is required at MW-1, MW-2, MW-3, MW-3A, MW-5, MW-12, MW-15, MW-17, MW-18, MW-19, MW-23, MW-24, MW-27, MW-28, MW-29 and MW-32.

In addition MW-20 and MW-22, which have been classified as general monitoring wells are sampled semi-annually.

2.3.1.2 Deep Aquifer

The culinary well (one of the supply wells) is completed in the Navajo aquifer, at a depth of approximately 1,800 feet below the ground surface. Due to the fact that the deep confined aquifer at the site is hydraulically isolated from the shallow perched aquifer (see the discussion in Sections 1.5.1.1 and 1.5.1.2) no monitoring of the deep aquifer is required under the GWDP.

2.3.1.3 Seeps and Springs

Pursuant to Part I.E.6 of the GWDP, EFRI has a *Sampling Plan for Seeps and Springs in the Vicinity of the White Mesa Uranium Mill*, Revision: 0, March 17, 2009 (EFRI, 2009, the “SSSP”) (and as modified on June 10, 2011, Revision 1 – submitted to UDEQ for review) that requires the Mill to perform groundwater sampling and analysis of all seeps and springs found downgradient or lateral gradient from the tailings management cells.

Under the SSSP, seeps and springs sampling is conducted on an annual basis between May 1 and July 15 of each year, to the extent sufficient water is available for sampling, at five identified seeps and springs near the Mill. The sampling locations were selected to correspond with those seeps and springs sampled for the initial Mill site characterization performed in the 1978 ER, plus additional sites located by EFRI, the BLM and Ute Mountain Ute Indian Tribe representatives.

Samples are analyzed for all groundwater monitoring parameters found in Table 2.3-1 and the general inorganic constituents specified for groundwater monitoring in Part I.E.1 (d). The laboratory procedures used to complete the analyses are those utilized for groundwater sampling. In addition to these laboratory parameters, the pH, temperature, redox potential, and conductivity of each sample will be measured and recorded in the field. Laboratories selected by EFRI to perform analyses of seeps and springs samples will be required to be certified by the State of Utah in accordance with UAC R317-6-6.12.A.

The seeps and springs sampling events are subject to the current Mill’s QAP, unless otherwise specifically modified by the SSSP to meet the specific needs of this type of sampling.

2.3.1.4 Discharge Minimization Technology and Best Available Technology Standards and Monitoring

a) General

Part I.D. of the GWDP sets out a number of Discharge Minimization Technology ("DMT") and Best Available Technology ("BAT") standards that must be followed. Part I.E. of the GWDP sets out the Groundwater Compliance and Technology Performance Monitoring requirements, to ensure that the DMT and BAT standards are met. These provisions of the GWDP, along with the *White Mesa Mill Discharge Minimization Technology (DMT) Monitoring Plan*, 4/15 Revision: 12.3 (the "DMT Plan") (EFRI, 2015a), the *White Mesa Mill Tailings Management System* (EFRI, 2015b), the Cell 4A and 4B BAT Monitoring, Operations and Maintenance Plan and other plans and programs developed pursuant to such Parts of the GWDP, set out the methods and procedures for inspections of the facility operations and for detecting failure of the system.

In addition to the programs discussed above, the following additional DMT and BAT performance standards and associated monitoring are required under Parts I.D and I.E. of the GWDP.

b) Tailings Cell Operation

Part I.D.2 of the GWDP provides that authorized operation and maximum disposal capacity in each of the existing tailings cells shall not exceed the levels authorized by the License and that under no circumstances shall the freeboard be less than three feet, as measured from the top of the flexible membrane liner ("FML"). Part I.E.7(a) of the GWDP requires that the wastewater pool elevations in Cells 1 and 3 must be monitored weekly to ensure compliance with the maximum wastewater elevation criteria mandated by Condition 10.3 of the License. Parts I.E.8 (a)(4) and I.E.12.(a)(4) provide that authorized operation and maximum disposal capacity in Cells 4A and 4B shall not exceed the levels authorized GWDP (as noted in the DMT Plan) and that under no circumstances shall the freeboard be less than three feet, as measured from the top of the FML. The requirements to meet freeboard elevation limits in Cell 3 and Cell 4A were eliminated upon approval to use Cell 4B. The solution elevation measurements in Cell 4A are not required for compliance with freeboard limits but are required for the calculation of the daily allowable volume of fluids pumped from Cell 4A LDS and are collected for this purpose.

Part I.D.2 further provides that any modifications by EFRI to any approved engineering design parameter at these existing tailings cells requires prior Directorapproval, modification of the GWDP and issuance of a construction permit.

c) Slimes Drain Monitoring

Part I.D.3(b)(1) of the GWDP requires that EFRI must at all times maintain the average wastewater head in the slimes drain access pipe to be as low as reasonably achievable (ALARA) in each tailings disposal cell, in accordance with the approved DMT Plan. Compliance will be achieved when the average annual wastewater recovery elevation in the slimes drain access pipe, determined pursuant to the currently approved DMT Plan meets the conditions in Equation 1 specified in Part I.D.3(b)(1) of the GWDP.

Part I.E.7(b) of the GWDP requires that EFRI must monitor and record quarterly the depth to wastewater in the slimes drain access pipes as described in the currently approved DMT Plan at Cell 2, and upon commencement of de-watering activities, at Cell 3, in order to ensure compliance with Part I.D.3(b)(1) of the GWDP.

d) Maximum Tailings Waste Solids Elevation

Part I.D.3(c) of the GWDP requires that upon closure of any tailings cell, EFRI must ensure that the maximum elevation of the tailings waste solids does not exceed the top of the FML.

e) Wastewater Elevation in Roberts Pond

Roberts Pond has been permanently removed from service. Excavation activities have been completed and pursuant to DWMRC correspondence dated March 5, 2015, routine monitoring is no longer necessary.

f) Inspection of Feedstock Storage Area

Part I.D.3(f) of the GWDP requires that open-air or bulk storage of all feedstock materials at the Mill facility awaiting Mill processing must be limited to the eastern portion of the Mill site (the "ore pad") described by the coordinates set out in that Part of the GWDP, and that storage of feedstock materials at the facility outside of this defined area, must meet the requirements of Part I.D.11 of the GWDP. Part I.D.11 requires that EFRI must store and manage feedstock materials outside the defined ore storage pad in accordance with the following minimum performance requirements:

(i) Feedstock materials will be stored at all times in water-tight containers, and

(ii) Aisle ways will be provided at all times to allow visual inspection of each and every feedstock container, or

(iii) Each and every feedstock container will be placed inside a water-tight overpack prior to storage, or

(iv) Feedstock containers shall be stored on a hardened surface to prevent spillage onto subsurface soils, and that conforms with the following minimum physical requirements:

A. A storage area composed of a hardened engineered surface of asphalt or concrete, and

B. A storage area designed, constructed, and operated in accordance with engineering plans and specifications approved in advance by the Director. All such engineering plans or specifications submitted shall demonstrate compliance with Part I.D.4 of the GWDP, and

C. A storage area that provides containment berms to control stormwater run-on and run-off, and

D. Stormwater drainage works approved in advance by the Director, or

E. Other storage facilities and means approved in advance by the Director.

Part I.E.7(d) of the GWDP requires that EFRI conduct weekly inspections of all feedstock storage areas to:

(i) Confirm that the bulk feedstock materials are maintained within the approved feedstock storage area specified by Part I.D.3(f) of the GWDP; and

(ii) Verify that all alternate feedstock materials located outside the approved feedstock storage area are stored in accordance with the requirements found in Part I.D.11 of the GWDP.

Part I.E.7(e) further provides that EFRI must conduct weekly inspections to verify that each feed material container complies with the requirements of Part I.D.11 of the GWDP.

The Mill’s procedures for weekly inspection of the ore pad is contained in Section 3.2 of the DMT Plan.

g) Monitor and Maintain Inventory of Chemicals

Part I.D.3(g) of the GWDP requires that for all chemical reagents stored at existing storage facilities and held for use in the milling process, EFRI must provide secondary containment to capture and contain all volumes of reagent(s) that might be released at any individual storage area. Response to spills, cleanup thereof, and required reporting must comply with the provisions of the Mill’s *Emergency Response Plan*, as stipulated by Part I.D.10 of the GWDP. Part I.D.3(g) further provides that for any new construction of reagent storage facilities, such secondary containment and control must prevent any contact of the spilled or otherwise released reagent or product with the ground surface.

Part I.E.9 of the GWDP requires that EFRI must monitor and maintain a current inventory of all chemicals used at the facility at rates equal to or greater than 100 kg/yr. This inventory must be maintained on-site, and must include:

(iii) Identification of chemicals used in the milling process and the on-site laboratory; and

(iv) Determination of volume and mass of each raw chemical currently held in storage at the facility.

2.3.1.5 BAT Performance Standards for Cell 4A

a) BAT Operations and Maintenance Plan

Part I.D.6 and I.D.13 of the GWDP provides that EFRI must operate and maintain Cell 4A and Cell 4B respectively so as to prevent release of wastewater to groundwater and the environment in accordance with the Mill’s Cell 4A BAT Monitoring, Operations and Maintenance Plan. The Mill’s *Cell 4A and 4B BAT Monitoring, Operations and Maintenance Plan*, 07/11 Revision: EFRI 2.3 includes the following performance standards:

(i) The fluid head in the leak detection system shall not exceed 1 foot above the lowest point in the lower membrane liner

(ii) The leak detection system maximum allowable daily leak rate shall not exceed 24,160 gallons/day for Cell 4A and 26,145 gallons/day for Cell 4B

(iii) After EFRI initiates pumping conditions in the slimes drain layer in Cell 4A or Cell 4B, EFRI will provide continuous declining fluid heads in the slimes drain layer, in a manner equivalent to the requirements found in Part I.D.3(b) for Cells 2 and 3

(iv) Under no circumstances shall the freeboard be less than 3-feet in Cell 4B, as measured from the top of the FML

b) Implementation of Monitoring Requirements Under the BAT Operations and Maintenance Plan

The *Cell 4A and 4B BAT Monitoring, Operations and Maintenance Plan* also requires EFRI to perform the following monitoring and recordkeeping requirements:

(i) Weekly Leak Detection System (LDS) Monitoring - including:

A. EFRI must provide continuous operation of the leak detection system pumping and monitoring equipment, including, but not limited to, the submersible pump, pump controller, head monitoring, and flow meter equipment approved by the Director. Failure of any pumping or monitoring equipment not repaired and made fully operational within 24-hours of discovery shall constitute failure of BAT and a violation of the GWDP.

B. EFRI must measure the fluid head above the lowest point on the secondary FML by the use of procedures and equipment approved by the Director. Under no circumstance shall fluid head in the leak detection system sump exceed a 1-foot level above the lowest point in the lower FML, not including the sump.

C. EFRI must measure the volume of all fluids pumped from the leak detection system. Under no circumstances shall the average daily leak detection system flow volume exceed 24,160 gallons/day for Cell 4A or 26,145 for Cell 4B.

D. EFRI must operate and maintain wastewater levels to provide a 3-foot minimum of vertical freeboard in tailings Cell 4B. Such measurement must be made to the nearest 0.1 foot.

(ii) Slimes Drain Recovery Head Monitoring

Immediately after the Mill initiates pumping conditions in the Cell 4A or Cell 4B slimes drain system, quarterly recovery head tests and fluid level measurements will be made in accordance with the requirements of Parts I.D.3(b) and I.E.7(b) of the GWDP and any plan approved by the Director.

2.3.1.6 Stormwater Management and Spill Control Requirements

Part I.D.10 of the GWDP requires that EFRI will manage all contact and non-contact stormwater and control contaminant spills at the facility in accordance with the Mill's stormwater best management practices plan. The Mill's *Stormwater Best Management Practices Plan*, *Revision 1.5* (EFRI, 2016) includes the following provisions:

a) Protect groundwater quality or other waters of the state by design, construction, and/or active operational measures that meet the requirements of the Ground Water Quality Protection Regulations found in UAC R317-6-6.3(G) and R317-6-6.4(C)

b) Prevent, control and contain spills of stored reagents or other chemicals at the Mill site

c) Cleanup spills of stored reagents or other chemicals at the Mill site immediately upon discovery

d) Report reagent spills or other releases at the Mill site to the Director in accordance with UAC 19-5-114

2.3.1.7 Tailings and Slimes Drain Sampling

Part I.E.10 of the GWDP requires that, on an annual basis, EFRI must collect wastewater quality samples from each wastewater source at each tailings cell at the facility, including surface impounded wastewaters, and slimes drain wastewaters, pursuant to the Mill's *Sampling and Analysis Plan for Tailings Cells, Leak Detections Systems and Slimes Drains*, Revision 2.1, July 2012 (the "Tailings Management System SAP"). All such sampling must be conducted in August of each year.

The purpose of the Tailings Management System SAP is to characterize the source term quality of all Mill tailings system wastewaters, including impounded wastewaters or process waters in the Mill tailings system, and wastewater or leachates collected by internal slimes drains. The Tailings Management System SAP requires:

- Collection of samples of the liquid from the tailings management system cells and the slimes drain of each cell that has commenced de-watering activities.
- Samples of liquid and slimes drain material will be analyzed at an offsite contract laboratory and subjected to the analytical parameters included in Table 2 of the GWDP (see Table 2.3-1) and general inorganics listed in Part I.E.1(d)(2)(ii) of the GWDP, as well as semi-volatile organic compounds.
- A detailed description of all sampling methods and sample preservation techniques to be employed.
- The procedures used to analyze these samples will be standard analytical methods used for groundwater sampling as specified in the Mill's QAP.
- The contracted laboratory will be certified by the State of Utah in accordance with UAC R317-6-6.12A.
- 30-day advance notice of each annual sampling event must be given, to allow the DWMRC to collect split samples of all sources.

The tailings management and slimes drain sampling events are subject to the Mill's QAP, unless otherwise specifically modified by the Tailings Management System SAP to meet the specific needs of this type of sampling.

2.3.2 Monitoring and Inspections Required Under the License

2.3.2.1 Environmental Monitoring

The environmental monitoring program is designed to assess the effect of Mill process and disposal operations on the unrestricted environment. Delineation of specific equipment and procedures is presented in the most current version of the Mill's *Environmental Protection Manual*.

c) Ambient Air Monitoring

(i) Ambient Particulate

Airborne radionuclide particulate sampling is performed at seven locations, termed BHV-1, BHV-2, BHV-4, BHV-5, BHV-6, BHV-7, and BHV-8. With the approval of the NRC and effective November 1995, BHV-3 was removed from the active air particulate monitoring program. At that time, the Mill proposed (and NRC determined) that a sufficient air monitoring database had been compiled at station BHV-3 to establish a representative airborne particulate radionuclide background for the Mill. BHV-6 was installed by the Mill at the request of the White Mesa Ute Community. This station began operation in July 1999 and provides airborne particulate information in the southerly direction between the Mill and the White Mesa Ute Community. Figure 2.3-2 shows the locations of these air particulate monitoring stations.

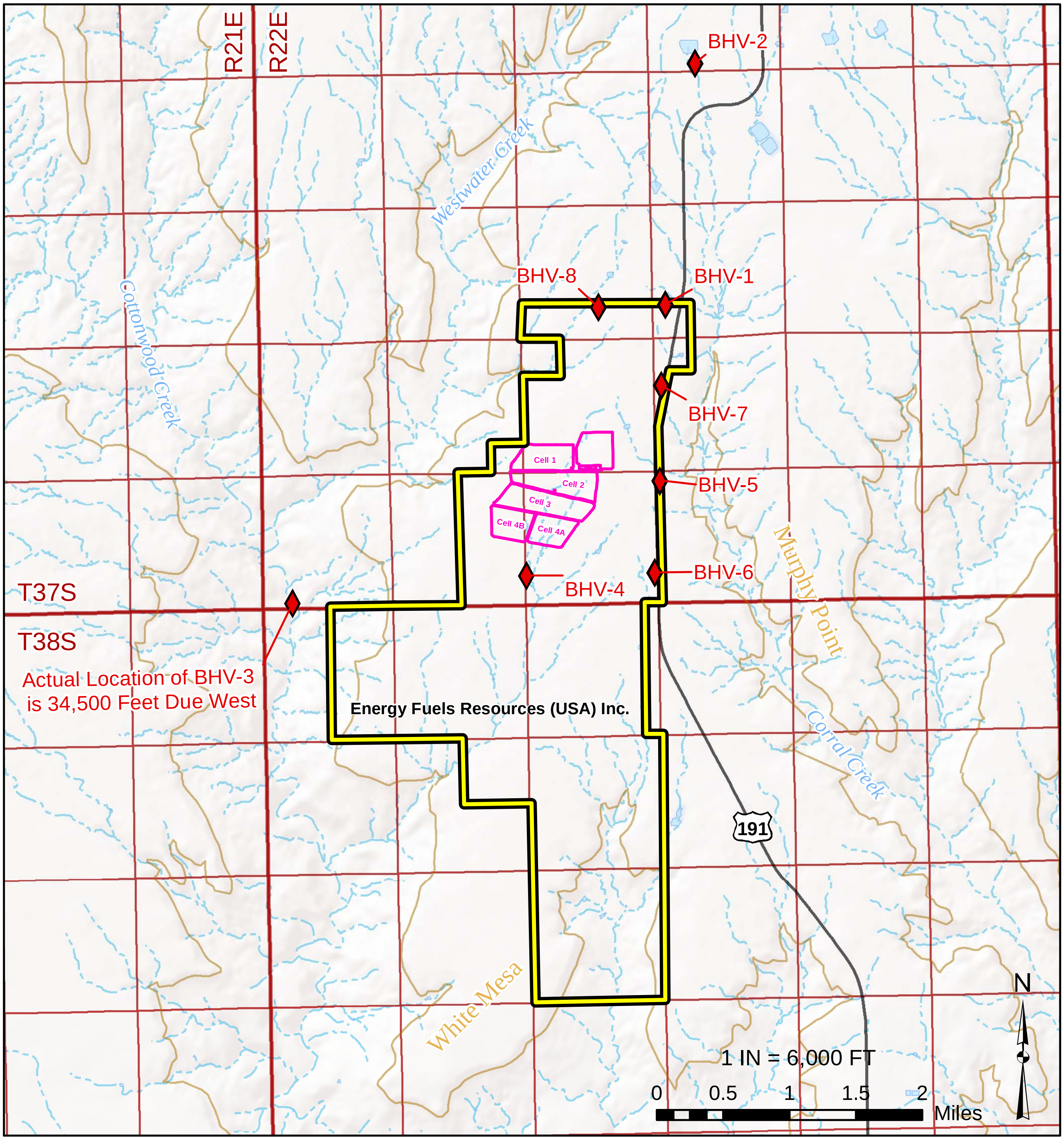
The present sampling system consists of high volume particulate samplers utilizing mass flow controllers to maintain an air flow rate of approximately 32 standard cubic feet per minute. Samplers are operated continuously with a goal for on-stream operating period at ninety percent. Filter replacement is weekly with quarterly site composite for particulate radionuclide analysis. Analysis is done for U-natural, Th-230, Ra-226, Pb-210, and Th-232.

See the current Semi-Annual Effluent Monitoring Report for a summary of monitoring results for airborne particulate.

(ii) Ambient Radon

With the approval of the NRC, Radon-222 monitoring at the BHV stations was discontinued in 1995, due to the unreliability of monitoring equipment available at that time to detect the new 10 CFR standard of 0.1 pCi/l. From that time until the present, the Mill demonstrated compliance with the requirements of R313-15-301 by calculation authorized by the NRC in September 1995 and as contemplated by R313-15-302 (2) (a).

This calculation was performed by use of the MILDOS code for estimating environmental radiation doses for uranium recovery operations (Strenge and Bender 1981) in 1991 in support of the Mill's 1997 license renewal and more recently in 2007 in support of the 2007 License Renewal Application, by use of the updated MILDOS AREA code (Yuan et al., 1998). The analysis under both the MILDOS and MILDOS AREA codes assumed the Mill to be processing high grade Arizona Strip ores at full capacity, and calculated the concentrations of radioactive dust and radon at individual receptor locations around the Mill. Specifically, the modeling under these codes assumed the following conditions:



Legend

- Air Monitoring Station
- Property Boundary
- Tailings Cell
- Road
- Canyon Rim
- Township and Range
- Section
- Pond
- Drainage

Coordinate System: NAD 1983 StatePlane Utah South FIPS 4303 Feet

ENERGY FUELS

REVISIONS		Project: WHITE MESA MILL	
Date:	By:	County: San Juan	State: Utah
		Location: -	
		PARTICULATE MONITORING STATIONS FIGURE 2.3-2	
		Author: areither	Date: 2/13/2015	Drafted By: areither

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- 730,000 tons of ore per year
- Average grade of 0.53 percent U_3O_8
- Yellowcake production of 4,380 tons of U_3O_8 per year (8.8 million pounds U_3O_8 per year).

Based on these conditions, the MILDOS and MILDOS AREA codes calculated the combined total effective dose equivalent from both air particulate and radon at the current nearest residence (approximately 1.2 miles north of the Mill), i.e., the individual member of the public likely to receive the highest dose from Mill operations, as well as at all other receptor locations, to be below the ALARA goal of 10 mrem/yr for air particulate alone as set out in R313-15-101(4). Mill operations are constantly monitored to ensure that operating conditions do not exceed the conditions assumed in the above calculations. If conditions are within those assumed above, radon has been calculated to be within regulatory limits. If conditions exceed those assumed above, then further evaluation will be performed in order to ensure that doses to the public continue to be within regulatory limits. Mill operations to date have never exceeded the License conditions assumed above.

In order to determine whether or not detection equipment has improved since 1995, EFRI voluntarily began ambient Radon-222 monitoring at the BHV stations in 2013. Radon-222 monitoring is completed using track etch detectors with an effective reporting limit of 0.06 pCi/L. The Radon-222 data collected from 2013 through present are presented in the Semi-Annual Effluent Monitoring Reports. Amendment 7 of the Mill Radioactive Materials License expanded the Mill's effluent monitoring programs in 2014. Amendment 7 included expanding the monitoring programs to require the collection of Radon-222 data at all of the BHV stations.

d) External Radiation

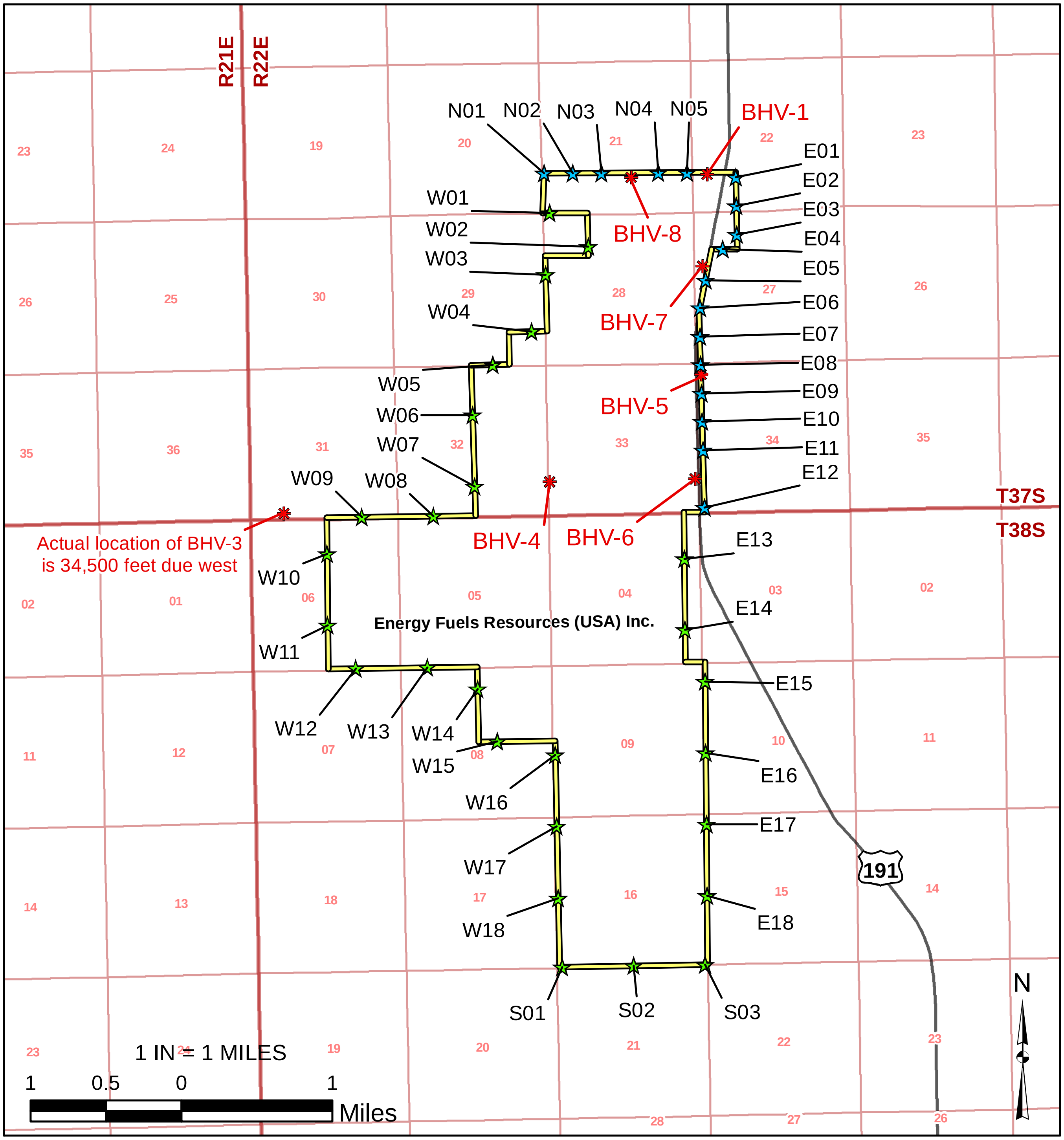
Optically Stimulated Luminescence ("OSL") badges, as supplied by Landauer, Inc., or equivalent, are utilized at all of the high volume air monitoring stations to determine ambient external gamma exposures (see Figure 2.3-2). System quality assurances are determined by placing a duplicate monitor at one site continuously. Exchanges of OSL badges are on a quarterly basis. Measurements obtained from location BHV-3 have been designated as background due to BHV-3's remoteness from the Mill site (BHV-3 is located approximately 3.5 miles west of the Mill site). For further procedural information see Section 4.3 of the most recent version of the Mill's *Environmental Protection Manual*. See the current Semi-Annual Effluent Monitoring Report for a summary monitoring results for external radiation.

e) Soil and Vegetation

(i) Soil Monitoring

As mentioned above, specific changes to the individual monitoring programs, including the soil sampling program, has been made as a result of Amendment 7 to the Radioactive Materials License.

Soil samples from the top 2 inches of surface soils are collected annually at each of the 52 locations (see Figure 2.3-3). and the soil samples are analyzed for U-natural, Ra-226, Pb-210, and Th-232. For further procedural information see Section 4.1 of the most current version of the Mill's *Environmental Protection Manual*. See Section 3.13.1.7.1 of the 2007 ER and the current Semi-Annual Effluent Monitoring Report for a summary of the historic results for soil monitoring. The 2007 ER concludes that the results of sampling are low, less than the unrestricted release limits.



Legend

Proposed Soil Monitoring Location

- 1,000 Feet
- 2,500 Feet
- Air Monitoring Station
- Property Boundary
- Road
- Township and Range
- Section

Coordinate System: NAD 1983 StatePlane Utah South FIPS 4303 Feet

ENERGY FUELS

REVISIONS		Project: WHITE MESA MILL	
Date:	By:	County: San Juan	State: Utah
		Location: -	
		FIGURE 2.3-3	
		SOIL MONITORING LOCATIONS	
		Author: areither	Date: 2/16/2016 · Drafted By: areither

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(ii) Vegetation Monitoring

Forage vegetation samples are collected three times per year from animal grazing locations to the northeast (near BHV-l (the meteorological station)), northwest (to the immediate west of the site) and southwest (by BHV-4) of the Mill site. Samples are obtained during the grazing season, in the late fall, early spring, and in late spring. A minimum of three kilograms of vegetation are submitted from each site for analysis of U-natural, Ra-226, Pb-210, and Th-232. For further procedure information see Section 4.2 of the most current version of the Mill's *Environmental Protection Manual*. See Section 3.13.7(d) of the 2007 ER and the current Semi-Annual Effluent Monitoring Report for a summary of the historic results for vegetation monitoring. The most recent results indicate no increase in uptake of U-natural, Ra-226 Th-232, and Pb-210 in vegetation.

d) Meteorological

Meteorological monitoring is performed at a site near BHV-1. The sensor and recording equipment are capable of monitoring wind velocity and direction, from which the stability classification is calculated. Data integration duration is one-hour with hourly recording of mean speed, mean wind direction, and mean wind stability (as degrees sigma theta).

The data from the meteorological station is retrieved monthly by down loading onto a Campbell Scientific data module, or the equivalent. The data module is sent to an independent meteorological contractor where the module is downloaded to a computer record, and the data is correlated and presented in a Semi-Annual Meteorological Report.

Monitoring for precipitation consists of a daily log of precipitation using a standard NOAA rain gauge, or the equivalent, installed near the administrative office, consistent with NOAA specifications.

Windrose data is summarized in a format compatible with MILDOS and UDAD specifications for 40 CFR 190 compliance. For further procedural information see Section 1.3 of the most current version of the Mill's *Environmental Protection Manual*. A windrose for the site is set out in Figure 1.1-1.

e) Point Emissions

Stack emission monitoring from yellowcake facilities follows EPA Method 5 procedures and occurs on the following schedule shown in Table 2.3-2.

Table 2.3-2
Stack Sampling Requirements

Frequency	Grizzly Baghouse Stack	North and/or South Yellowcake Dryer Stacks	Yellowcake Packaging Baghouse Stack	Vanadium Dryer Stack	Vanadium Packaging Stack
Quarterly	If operating, U-nat, Th-230, Ra-226, Pb-210, Th-232, Ra-228, and Th-228.	If operating, U-nat, Th-230, Ra-226, Pb-210, Th-232, Ra-228, and Th-228.	If operating, U-nat, Th-230, Ra-226, Pb-210, Th-232, Ra-228, and Th-228.	If operating, U-nat, Th-230, Ra-226, Pb-210, Th-232, Ra-228, and Th-228.	If operating, U-nat, Th-230, Ra-226, Pb-210, Th-232, Ra-228, and Th-228.

Monitored data includes scrubber system operation levels, process feed levels, particulate emission concentrations, isokinetic conditions, and radionuclide emission concentrations. For further procedure information see Section 1.4 of the most current version of the Mill's *Environmental Protection Manual*. Stack emission data are summarized in the Semi-Annual Effluent Monitoring Report.

f) Surface Water Monitoring

Surface water monitoring is conducted at two locations adjacent to the Mill facility known as Westwater Canyon and Cottonwood Creek. Grab samples are obtained annually from Westwater and quarterly from Cottonwood. For Westwater Creek, samples of sediments will be collected if a water sample is not available. Field monitored parameters and laboratory monitored parameters are listed in Table 2.3-3. For further procedural information see Section 2.1 of the most current version of the Mill's *Environmental Protection Manual*. See the current Semi-Annual Effluent Monitoring Report for a summary monitoring results for surface water.

Table 2.3-3
Operational Phase Surface Water Monitoring Program

Monitoring Sites

Westwater Creek and Cottonwood Creek

Field Requirements

1. temperature C
2. Specific Conductivity umhos at 25 C
3. pH at 25 C
4. redox potential
5. sample date
6. sample ID Code

Vendor Laboratory Requirements

Semiannual*	Quarterly
One gallon Unfiltered and Raw	One gallon Unfiltered and Raw
One gallon Unfiltered, Raw and preserved to pH <2 with HNO_3	One gallon Unfiltered, Raw and Preserved to pH <2 with HNO_3
Total Dissolved Solids	Total Dissolved Solids
Total Suspended Solids	Total Suspended Solids
Gross Alpha	
Suspended Unat	
Dissolved Unat	
Suspended Ra-226	
Dissolved Ra-226	
Suspended Th-230	
Dissolved Th-230	

*Semiannual sample must be taken a minimum of four months apart. Annual Westwater Creek sample is analyzed for semi-annual parameters.
Radionuclides and LLDs reported in µCi/ml

2.3.2.2 Additional Monitoring and Inspections Required Under the License

Under the License daily, weekly, and monthly inspection reporting and monitoring are required by NRC Regulatory Guide 8.31, *Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities will be As Low As is Reasonable Achievable*, Revision 1, May 2002 ("Reg Guide 8.31"), by Section 2.3 of the Mill's ALARA Program and by the DMT Plan, over and above the inspections described above that are required under the GWDP. A copy of the Mill's ALARA Program is included as Appendix I to the 2007 License Renewal Application.

a) Daily Inspections

Three types of daily inspections are performed at the Mill under the License:

(i) Radiation Staff Inspections

Paragraph 2.3.1 of Reg. Guide 8.31 provides that the Mill's Radiation Safety Officer ("RSO") or designated health physics technician should conduct a daily walk-through (visual) inspection of all work and storage areas of the Mill to ensure proper implementation of good radiation safety procedures, including good housekeeping that would minimize unnecessary contamination. These inspections are required by Section 2.3.1 of the Mill's ALARA Program, and are documented and on file in the Mill's Radiation Protection Office.

(ii) Operating Foreman Inspections

30 CFR Section 56.18002 of the Mine Safety and Health Administration regulations requires that a competent person designated by the operator must examine each working place at least once each shift for conditions which may adversely affect safety or health. These daily inspections are documented and on file in the Mill's Radiation Protection Office.

(iii) Daily Tailings Inspection

Section 2 of the DMT Plan requires that during Mill operation, the Shift Foreman, or other person with the training specified in Appendix B of the Tailings Management System, designated by the RSO, will perform an inspection of the tailings line and tailings area at least once per shift, paying close attention for potential leaks and to the discharges from the pipelines. Observations by the Inspector are recorded on the appropriate line on the Mill's Daily Inspection Data form.

b) Weekly Inspections

Three types of weekly inspections are performed at the Mill under the License:

(i) Weekly Inspection of the Mill Forms

Paragraph 2.3.1 of Reg. Guide 8.31 provides that the RSO and the Mill foreman should, and Section 2.3.2 of the Mill's ALARA Program provides that the RSO and Mill foreman, or their respective designees, shall conduct a weekly inspection of all Mill areas to observe general radiation control practices and review required changes in procedures and equipment. Particular attention is to be focused on areas where potential exposures to personnel might exist and in areas of operation or locations where contamination is evident.

(ii) Weekly Ore Storage Pad Inspection Forms

Section 3 of the DMT Plan requires that weekly feedstock storage area inspections will be performed by the Radiation Safety Department, to confirm that the bulk feedstock materials are stored and maintained within the defined area of the ore pad and that all alternate feed materials located outside the defined ore pad area are maintained within water tight containers. The results of these inspections are recorded on the Mill's Ore Storage/Sample Plant Weekly Inspection Report.

(iii) Weekly Tailings and DMT Inspection

Section 3 of the DMT Plan require that weekly inspections of the tailings area and DMT requirements be performed by the radiation safety department.

c) Monthly Reports

Two types of monthly reports are prepared by Mill staff:

(i) Monthly Radiation Safety Reports

At least monthly, the RSO reviews the results of daily and weekly inspections, including a review of all monitoring and exposure data for the month and provides to the Mill Manager a monthly report containing a written summary of the month's significant worker protection activities (Section 2.3.4 of the Mill's ALARA Program).

(ii) Monthly Tailings Inspection Reports

The Tailings Management System Plan requires that a Monthly Inspection Data form be completed for the monthly tailings inspection. This inspection is typically performed in the fourth week of each month and is in lieu of the weekly tailings inspection for that week.

Mill staff also prepares a monthly summary of all daily, weekly, monthly and quarterly tailings inspections.

d) Quarterly Tailings Inspections

The Tailings Management System Plan requires that the RSO or his designee perform a quarterly tailings inspection.

e) Annual Evaluations

The following annual evaluations are performed under the License, as set out in Section 6 of the Tailings Management System Plan.

(i) Annual Technical Evaluation

An annual technical evaluation of the tailings management system must be performed by a registered professional engineer (PE), who has experience and training in the area of geotechnical aspects of retention structures. The technical evaluation includes an on-site inspection of the tailings management system and a thorough review of all tailings records for the past year. The Technical Evaluation also includes a review and summary of the annual movement monitor survey (see paragraph (ii) below).

All tailings management system components and corresponding dikes are inspected for signs of erosion, subsidence, shrinkage, and seepage. The drainage ditches are inspected to evaluate surface water control structures.

In the event tailings capacity evaluations were performed for the receipt of alternate feed material during the year, the capacity evaluation forms and associated calculation sheets will be reviewed to ensure that the maximum tailings capacity estimate is accurate. The amount of tailings added to the system since the last evaluation will also be calculated to determine the estimated capacity at the time of the evaluation.

As discussed above, tailings inspection records consist of daily, weekly, monthly, and quarterly tailings inspections. These inspection records are evaluated to determine if any freeboard limits are being approached. Records will also be reviewed to summarize observations of potential concern. The evaluation also involves discussion with the Environmental and/or Radiation Technician and the RSO regarding activities around the tailings area for the past year. During the annual inspection, photographs of the tailings area are taken. The training of individuals is also reviewed as a part of the Annual Technical Evaluation.

The registered engineer obtains copies of selected tailings inspections, along with the monthly and quarterly summaries of observations of concern and the corrective actions taken. These copies are then included in the *Annual Technical Evaluation Report*.

The *Annual Technical Evaluation Report* must be submitted by November 15th of every year to the Director and to the Directing Dam Safety Engineer, State of Utah, Natural Resources.

(ii) Annual Movement Monitor Survey

A movement monitor survey is conducted by a licensed surveyor semi-annually for the first three years, and annually thereafter during the second quarter of each year. The movement monitor survey consists of surveying monitors along dikes 4A-W, 4A-S and 4B-S to detect any possible settlement or movement of the dikes. The data generated from this survey is reviewed and incorporated into the *Annual Technical Evaluation Report* of the tailings management system.

(iii) Annual Leak Detection Fluid Samples

In the event solution has been detected in a leak detection system in Cells 1, 2 or 3, a sample will be collected on an annual basis. This sample will be analyzed according to the conditions set forth in License Condition 11.3.C. The results of the analysis will be reviewed to determine the origin of the solution.

3 TAILINGS RECLAMATION PLAN

This section provides an overview of the Mill location and property; details the facilities to be reclaimed; and describes the design criteria applied in this Plan. Drawings are presented as an attachment to this report. Technical specifications are presented in Attachment A. Attachment B presents the quality assurance and quality control plan for construction activities. Attachment C presents cost estimates for reclamation (based on the Existing Cover Design). Attachment D presents the most current Radiation Protection Manual for Reclamation Activities. Attachment E provides documents on the approved Existing Cover Design that was presented in Reclamation Plan Revision 3.2b (Denison, 2011b).

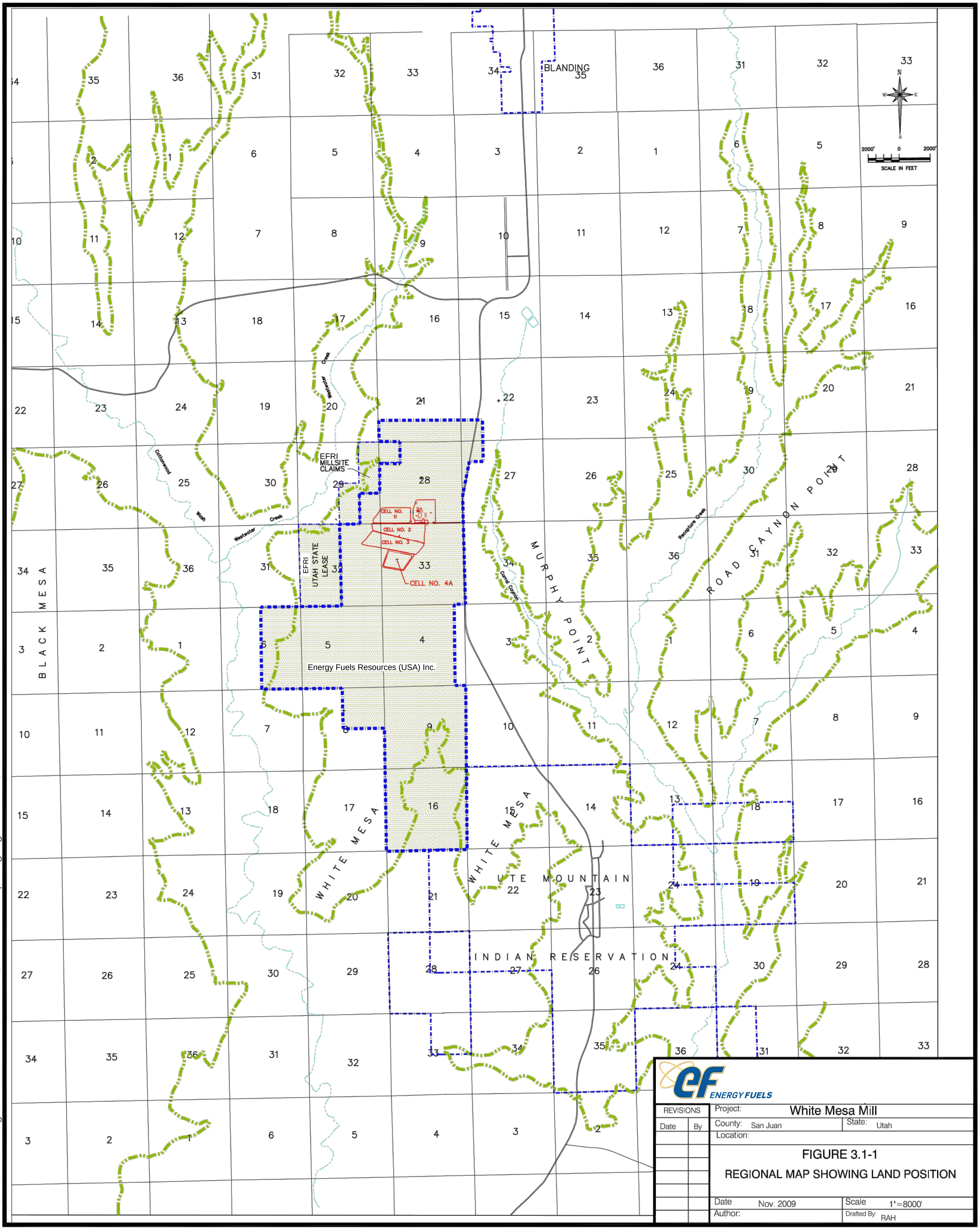
The Reclamation Plan is written assuming the tailings management system Cells 2, 3, 4A, and 4B will receive tailings to the maximum permitted tailings elevations. Cell 4B is used for evaporation of process solutions and has not been used for tailings storage. The Plan has been written assuming Cell 4B will be used in the future for tailings storage.

If Cell 4B is not used in the future for tailings storage, Cell 4B can be reclaimed for clean closure. Any remaining solutions would be pumped to the last active tailings Cell. The liner system would be removed and disposed in the last active tailings cell. The exterior embankments would then be regraded. This design is not presented in this report.

3.1 Location and Property Description

The Mill is located approximately six miles south of Blanding, Utah on US Highway 191 on a parcel of land encompassing all or part of Sections 21, 22, 27, 28, 29, 32, and 33 of T37S, R22E, and Sections 4, 5, 6, 8, 9, and 16 of T38S, R22E, Salt Lake Base and Meridian described as follows (Figure 3.1-1):

> The south half of the south half of Section 21; the southeast quarter of the southeast quarter of Section 22; the northwest quarter of the northwest quarter and lots 1 and 4 of Section 27 all that part of the southwest quarter of the northwest quarter and the northwest quarter southwest quarter of Section 27 lying west of Utah State Highway 163; the northeast quarter of the northwest quarter, the south half of the northwest quarter, the northeast quarter and the south half of Section 28; the southeast quarter of the southeast quarter of Section 29; the east half of Section 32 and all of Section 33, Township 37 South, Range 22 East, Salt Lake Base and Meridian. Lots 1 through 4, inclusive, the south half of the north half, the southwest quarter, the west half of the southeast quarter, the west half of the east half of the southeast quarter and the west half of the east half of the east half of the southeast quarter of Section 4; Lots 1 through 4, inclusive, the south half of the north half and the south half of Section 5 (all); Lots 1 and 2, the south half of



ENERGY FUELS

REVISIONS	Project: White Mesa Mill	
Date / By	County: San Juan	State: Utah
	Location:	
	FIGURE 3.1-1 REGIONAL MAP SHOWING LAND POSITION	
	Date Nov. 2009	Scale 1"=8000'
	Author:	Drafted By: RAH

W:\USA\Utah\Mill\dwgs\Reclamation Plans\RecPlan4.0\Land Location Maps.dwg Figure 3.1-1 03/11/2009 dsledd the northeast quarter and the south half of Section 6 (E1/2); the northeast quarter of Section 8; all of Section 9 and all of Section 16, Township 38 South, Range 22 East, Salt Lake Base and Meridian. Additional land is controlled by 46 Mill site claims. Total land holdings are approximately 5,415 acres.

3.2 Facilities to be Reclaimed

See the Drawings for a general layout of the Mill yard and related facilities and the restricted area boundary.

3.2.1 Summary of Facilities to be Reclaimed

The facilities to be reclaimed include the following:

- Cell 1 (evaporation). Cell 1 was previously referred to as Cell 1-I.
- Cells 2, 3, and 4A (tailings).
- Cell 4B (This cell is currently used for evaporation. The reclamation design assumes this cell will be used for tailings in the future).
- Mill buildings and equipment.
- On-site contaminated areas.
- Off-site contaminated areas (i.e., potential areas affected by windblown tailings).

The reclamation of the above facilities will include the following:

- Placement of contaminated soils, crystals, and synthetic liner material and any contaminated underlying soils from Cell 1 into the last active tailings cell
- Placement of a liner system on a portion of the Cell 1 impoundment area to be used for disposal of contaminated materials and debris from the Mill site, if needed
- Decommissioning Cell 1
- Placement of materials and debris from Mill decommissioning into the last active tailings cell or Cell 1 Disposal Area
- Placement of an engineered multi-layer cover over the entire area of Cells 2, 3, 4A, 4B, and the Cell 1 Disposal Area
- Construction of runoff control and diversion channels as necessary
- Reclamation of Mill and ancillary areas
- Reclamation of borrow sources

3.2.2 Tailings and Evaporative Cells

The following subsections describe the cover design and reclamation procedures for Cells 1, 2, 3, 4A, and 4B. Complete engineering details and text are presented in the Updated Tailings Cover Design Report included as Appendix A to this Reclamation Plan.

Cell 2 final cover construction will take place before final cover construction on other cells at the White Mesa Mill. Cell 2 final cover construction will occur in two phases and includes a performance monitoring test section (Primary Test Section) containing a lysimeter constructed in the southeast portion of Cell 2 concurrently with the Phase 1 cover placement. A Supplemental Test Section has been constructed north of the tailings management cells relating to vegetative cover and erosion control. The plan for implementing final cover placement on Cell 2 and performance assessment and monitoring is presented in Appendix A. Cell 2 Phase 1 cover placement began in May 2016 and was completed in 2017. The Primary Test Section was constructed in the fall of 2016. The Supplemental Test Section was constructed in the fall of 2017.

3.2.2.1 Soil Cover Design

A conceptual ET cover design was proposed by EFRI for the White Mesa Mill tailings management cells in the Infiltration and Contaminant Transport Modeling (ICTM) reports (MWH 2007 and 2010) submitted to the DWMRC to fulfill the White Mesa Mill's Ground Water Discharge Permit No. UGW370004.

EFRI stated their intent to submit an ET cover design as part of their license renewal in a meeting with DWMRC on October 5, 2010 after review of the DWMRC Reclamation Plan, Version 4.0 Interrogatories – Round 1 (DRC, 2010). The proposed conceptual ET cover design was provided to DWMRC on October 7, 2010 and was essentially the same as presented in the 2010 Infiltration and Contaminant Transport Model report (MWH, 2010). The ET cover proposed and evaluated as described in the Updated Tailings Cover Design Report (Appendix A) is designed as 9.5 feet thick for Cells 1, 4A, and 4B, 10 feet thick for Cell 3, and 10.5 feet thick for Cell 2. The difference in cover thickensses is based on radon emanation analyses. The cover system consists of the following materials outlined below by individual layers and thicknesses from top to bottom:

- Layer 4 - 0.5 ft (15 cm) thick Erosion Protection Layer (gravel-admixture or topsoil)
- Layer 3 - 3.5 ft (107 cm) thick Growth Medium Layer acting as a Water Storage/Biointrusion/Frost Protection/Secondary Radon Attenuation Layer (loam to sandy clay)
- Layer 2 – 3.0 to 4.0 ft (91 to 122 cm) thick Compacted Cover acting as the Primary Radon Attenuation Layer (highly compacted loam to sandy clay)
- Layer 1 - 2.5 ft (76 cm) thick (minimum) Interim Fill Layer acting as a Secondary Radon Attenuation and Grading Layer (loam to sandy clay)

All the layers combined comprise the monolithic ET cover system. Layer 1 was placed in stages on Cell 2 and the majority of Cell 3 as interim cover. Layer 1 will be placed on the remaining area of Cell 3, all of the Cell 1 Disposal Area, and Cells 4A and 4B. It is assumed that this material was or will be dumped and minimally compacted by construction equipment to approximately 80 percent of standard Proctor density. Layer 1 will provide the platform for the remaining cover system and act as a secondary radon attenuation layer. Layer 2 will be compacted cover layer and act as the primary radon attenuation layer. It will be 3 - 4 feet thick (3 feet for Cells 1, 4A, and 4B, 3.5 feet for Cell 3, and 4 feet for Cell 2) and compacted to 95 percent of standard Proctor density. Layer 3 will be the growth medium layer. Layer 3 will also act as a secondary radon attenuation layer and a protection layer for the primary radon attenuation layer (Layer 2). Layer 3 will be 3.5 feet thick and placed at 85 percent of standard Proctor density to optimize water storage and rooting characteristics for plant growth. Layer 4 will be a 0.5-foot thick erosion protection layer. This layer will consist of topsoil in areas where the cover is sloped at 0.5 percent and topsoil-gravel admixture in areas where the cover is sloped at 1 percent. The topsoil-gravel admixture will consist of topsoil (75 percent) mixed with 1-inch minus gravel (25 percent).

The majority of the cover will be constructed from materials available from within the site boundaries. As a part of the soil cover, erosion protection will be placed as the top layer of the cover to stabilize slopes and provide long-term erosion resistance (see Appendix A for characterization of cover materials). The erosion protection materials will be obtained from off-site sources.

The key state and federal performance criteria for tailings cover design and reclamation include:

- Attenuate radon flux to a rate of 20 pCi/m2-s, averaged over each entire cell
- Minimize infiltration into the reclaimed tailings cells
- Maintain a design life of up to 1,000 years and at least 200 years
- Provide long-term isolation of the tailings, including slope stability and geomorphic durability to withstand erosional forces of wind and runoff (up to the probable maximum precipitation event) as well as design to accommodate seismic events (up to the peak ground acceleration from the maximum credible earthquake)
- Designs to accommodate minimum reliance on active maintenance

Several models/analyses were utilized in simulating the soil cover effectiveness: radon flux attenuation, infiltration, freeze/thaw effects, erosion protection, static and pseudostatic slope stability analyses, biointrusion, tailings dewatering, liquefaction, and settlement. These analyses and results are discussed in detail in Sections 3.3.2 through 3.3.10, and calculations are also shown in the Updated Tailings Cover Design Report (Appendix A).

The final grading plans are presented in the Drawings. As indicated in the Drawings, the drainage on the top surface of the ET cover at Cells 1, 2, and 3 is designed at a 0.5 percent slope, with portions of Cell 2 top surface at a 1 percent slope and portions of Cells 4A and 4B top surfaces at 0.8 percent slope. The external side slopes will be graded to five horizontal to one vertical (5H:1V).

3.2.2.2 Cell 1

Cell 1, used during Mill operations solely for evaporation of process liquids, is the northernmost existing cell and is located immediately west of the Mill. It is also the highest cell in elevation, as the natural topography slopes to the south. The drainage area above and including the cell is 216 acres. This includes drainage from the Mill site.

Cell 1 will be evaporated to dryness. The synthetic liner and raffinate crystals will then be removed and placed in the tailings cells. Any contaminated soils below the liner will be removed and also placed in the tailings cells. Based on current regulatory criteria, the current plan calls for excavation of the residual radioactive materials to be designed to ensure that the concentration of radium-226 in land averaged over any area of 100 square meters does not exceed the background level by more than:

- 5 pCi/g, averaged over the first 15 cm of soil below the surface
- 15 pCi/g, averaged over a 15 cm thick layer of soil more than 15 cm below the surface

A portion of Cell 1 (i.e., the Cell 1 Disposal Area), adjacent to and running parallel to the downstream cell dike, may be used for permanent disposal of contaminated materials and debris from the Mill site decommissioning and windblown cleanup. The actual area of the Cell 1 Disposal Area needed for storage of additional material will depend on the status of Cells 3, 4A, and 4B at the time of final Mill decommissioning. A portion of the Mill area decommissioning material may be placed in Cells 3, 4A or 4B if space is available, but for purposes of the reclamation design the entire quantity of contaminated materials from the Mill site decommissioning is assumed to be placed in the Cell 1 Disposal Area, which will subsequently be covered with the ET cover. This results in approximately 10 acres of the Cell 1 area constituting the Cell 1 Disposal Area and being utilized for permanent tailings storage. The remaining area of Cell 1 will then be breached and converted to a sedimentation basin. All runoff from the covered Cell 1 Disposal Area, the Mill area and the area immediately north of Cell 1 will be routed into the sedimentation basin and will discharge onto the natural ground via the channel located at the southwest corner of the basin. The channel is designed to accommodate the PMF flood. Hydraulic and erosional analyses are provided in Appendix A. The channel will be a bedrock channel with a 0.1 percent channel slope, 150-foot bottom width, and 3 horizontal: 1 vertical sideslopes.

3.2.2.3 Cell 2

Cell 2 has been filled with tailings and will be covered with the ET cover to a minimum cover thickness of 10.5 feet. The final cover will drain at a slope of 0.5 to 1 percent to the north and south as shown in the Drawings.

The cover will be as described in Section 3.2.2.1 above and will consist of a 2.5 feet of interim fill, followed by 4 feet of compacted cover, overlain by 3.5 feet of growth medium. Half a foot of topsoil or gravel-admixture will be utilized as armor against erosion at the surface of the cover. External side slopes will be graded to a 5:1 slope and will have 6 inches of angular riprap on the cover surface for erosion protection. A rock apron with dimensions as shown in the Drawings will be constructed at the transition areas of the toes of the side slopes of Cell 2.

3.2.2.4 Cell 3

Cell 3 will be filled with tailings, debris and contaminated soils and covered with the same ET cover system and erosion protection as Cell 2, except the total thickness will be 10 feet with a compacted cover layer of 3.5 feet.

3.2.2.5 Cells 4A and 4B

Cells 4A and 4B are designed to be filled with tailings, debris and contaminated soils and will be covered with the same ET cover system as Cell 2 and Cell 3, except the total thickness will be 9.5 feet with a compacted cover layer of 3 feet. The south external side slopes will be graded to 5H:1V and will have 8 inches of angular riprap on the cover surface for erosion protection. A rock apron with dimensions as shown on the drawings will be constructed at the south side slopes of Cells 4A and 4B. The east and west external side slopes will be graded to 5H:1V and have the same erosion protection as the east and west sides slopes of Cells 2 and 3.

3.3 <u>Design Criteria</u>

As required by Part I.H.11 of the GWDP, EFRI has completed an infiltration and contaminant transport model of the final tailings cover system to demonstrate the long-term ability of the ET cover to protect nearby groundwater quality. The ET cover design and basis presented in Appendix A will be used for this version of the Plan.

The design criteria summaries in this section are adapted from the Updated Tailings Cover Design Report. A copy of the Tailings Cover Design Report is included as Appendix A. It contains all of the calculations used in design and summarized in this section.

3.3.1 Regulatory Criteria

Information contained in 10 CFR Part 20, 10 CFR Part 40 and Appendix A to 10 CFR Part 40 (which are incorporated by reference into UAC R313-24-4), and 40 CFR Part 192 were used as criteria in final designs under this Plan. In addition, the following documents also provided guidance:

- Benson, C.H. W.H. Albright, D.O. Fratta, J.M. Tinjum, E. Kucukkirca, S.H. Lee, J. Scalia, P.D. Schlicht, and X. Wang, 2011. Engineered Covers for Waste Containment: Changes in Engineering Properties and Implications for Long-Term Performance Assessment (in four volumes). NUREG/CR-7028, Prepared for the U.S. Nuclear Regulatory Commission, Washington, D.C., December.
- Johnson, T.L., 2002. "Design of Erosion Protection for Long-Term Stabilization." U.S. Nuclear Regulatory Commission (NRC), *NUREG-1623*. September.
- Nelson, J.D. , S.R. Abt, R.L. Volpe, D. Van Zye, N.E. Hinkle, and W.P. Staub, 1986. Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments, NUREG/CR-4620. June.
- U. S. Department of Energy (DOE), 1988. Effect of Freezing and Thawing on UMTRA Covers, Albuquerque, New Mexico, October.
- U.S. Department of Energy (DOE), 1989. UMTRA-DOE Technical Approach Document, Revision II, UMTRA-DOE/AL 050425.0002. December.
- U.S. Nuclear Regulatory Commission (NRC), 1984. Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, NUREG/CR-3533
- U.S. Nuclear Regulatory Commission (NRC), 1989. Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers, Regulatory Guide 3.64.
- U.S. Nuclear Regulatory Commission (NRC), 1990. "Final Staff Technical Position, Design of Erosion Protective Covers for Stabilization of Uranium Mill Tailings Sites," August.
- U.S. Nuclear Regulatory Commission (NRC), 2003. Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites under Title II of the Uranium Mill Tailings Radiation Control Act of 1978. NUREG-1620, Revision 1, June.

As mentioned above, the requirements set out in Part I.D.8 of the GWDP require that the cover system for each tailings cell will be designed and constructed to meet the following minimum performance requirements for a period of not less than 200 years:

- Minimize the infiltration of precipitation or other surface water into the tailings, including, but not limited to the radon barrier

- Prevent the accumulation of leachate head within the tailings waste layer that could rise above or over-top the maximum FML elevation internal to any disposal cell, i.e. create a "bathtub" effect
- Ensure that groundwater quality at the compliance monitoring wells does not exceed the GWQSs or GWCLs specified in Part I.C.1 and Table 2 of the GWDP

3.3.2 Radon Flux Attenuation

Analyses of radon attenuation through the monolithic ET cover have been performed, and incorporate the current cover design, final grading plan, and results of geotechnical testing of material properties. Emanation of radon-222 from the top surface of the proposed cover system for the tailings cells was calculated using the NRC RADON model (NRC, 1989). The model was used to confirm that the designed cover system can achieve the State of Utah's long-term radon emanation standard for uranium mill tailings (Utah Administrative Code, Rule 313-24), 20 picocuries per square meter per second (pCi/m^2-s). The analyses were conducted following the guidance presented in NRC publications NUREG/CR-3533 (NRC, 1984) and Regulatory Guide 3.64 (NRC, 1989). Results of the analyses show that the proposed cover system can reduce the rate of radon-222 emanation to less than 20 pCi/m^2-s, averaged over the entire area of each tailings cell. A complete description of the radon attenuation analyses conducted for the ET cover system is included in Appendix A.

3.3.3 Infiltration Analysis

Infiltration modeling was conducted for the monolithic ET cover and a complete description of the analyses were provided in the ICTM Report (MWH, 2010). The modeling was updated to address DWMRC comments on the ICTM Report (DRC, 2012; 2013) and to incorporate additional geotechnical and hydrologic data collected in as part of field investigations conducted in 2010 and 2012 for cover borrow material and in 2013 for in situ tailings. The updated infiltration modeling results were presented in EFRI (2012b) and EFRI (2015c). The evaluation of infiltration of precipitation through the cover system was evaluated with the computer program HYDRUS-1D (Simunek et al., 2009). The modeling used historical daily meteorological data for precipitation and evapotranspiration over a 57-year climate period, as well as assumptions that were either conservative or based on anticipated conditions. Given the flat nature of the cover (less than 1 percent slope), no run-on- or runoff-based processes were assumed to occur. As a result, precipitation applied to the cover surface was removed through evaporation or transpiration, retained in the soil profile as storage, or transmitted downward as infiltration.

The model-predicted average long-term water flux rate through the cover system is 2.3 mm/yr. Additional model scenarios were analyzed to evaluate the sensitivity of the soil properties, climate, and reduced vegetation parameters. The range of average long-term water flux rates for these scenarios varied from 1.9 to 8.6 mm/yr. The model-predicted water flux rates through the monolithic ET cover indicate that the available cover storage capacity should be sufficient to significantly reduce infiltration through the cover system. A complete description of the infiltration analyses conducted for the monolithic ET cover is provided in MWH (2010) with updates provided in EFRI (2012b, 2015c), and is summarized in Appendix A to this Reclamation Plan.

3.3.4 Freeze/Thaw Evaluation

A freeze/thaw analysis was performed for the monolithic ET cover system, utilizing geotechnical properties of materials specified for use in construction of the cover. The calculations of frost penetration at the site were performed with the computer program ModBerg (CRREL), which uses a built-in weather database, as well as user-defined soil parameters.

The freeze/thaw calculations estimate the total depth of frost penetration for the cover system as 32 inches (2.67 ft). The frost penetration depth is not anticipated to exceed the depth of Layers 3 and 4 of the cover system (combined depth of 4 ft). The physical and hydraulic properties of these cover system layers after construction are expected to be close to long-term properties from pedogenic processes, such that post-construction changes due to freeze/thaw should be minimal. A complete description of the freeze/thaw analyses conducted for the proposed cover system is presented in the Updated Tailings Cover Design Report, attached as Appendix A to this Reclamation Plan.

3.3.5 Soil Cover Erosion Protection

The erosional stability of the reclaimed tailings cells was evaluated in terms of long-term water erosion under extreme storm conditions. The analyses were conducted in general accordance with NRC guidelines (NRC, 1990; Johnson, 2002). A description of the analyses performed is presented in Appendix A.

The components of erosion protection for the reclaimed tailings cells consist of the following:

- The cover on the top surface of Cells 1, 2, and 3, with slopes of 0.5 percent, would be constructed as a vegetated slope, with 6 inches of topsoil.
- The portions of Cell 2 with a top surface of 1 percent slope, and the portions of Cells 4A and 4B with 0.8 percent slope, would be constructed as a vegetated slope with 6 inches of topsoil mixed with 25 percent (by weight) gravel (maximum diameter of 1 inch).
- Erosion protection of external (5H:1V) side slopes would be provided by various sized angular and rounded riprap with layer thicknesses ranging from 6 to 8 inches and median particle sizes ranging from 1.7 to 5.3 inches. A 6-inch layer of filter material would be placed between the erosional protection layer and underlying soil layer in locations with riprap greater than 1.7 inches. A narrow zone of this filter will also be placed at the interface between the riprap (greater than 1.7 inches) on the external side slopes and the cover surface erosion protection layer.
- The toe of embankment slopes will have erosional protection and scour protection on the west and east sides of the cells provided by a rock apron measuring approximately 10 inches deep and 5 feet wide, with a median particle size of 3.4 inches. On the south side of cells 4A and 4B, and east side of Cell 4A, the rock apron would be approximately 3 feet in depth, 13 feet in width, and have a median particle size of 10.6 inches. On the north side slope of the Cell 1 disposal area, the rock apron would be approximately 3 feet deep, 11 feet wide, and have a median particle size of 9 inches.
- The Sedimentation Basin area will be graded to 0.1 percent slope and constructed as a vegetated slope with 6 inches of topsoil.
- The Diversion Channel will be excavated into bedrock.

3.3.6 Slope Stability Analysis

Static (long-term) and pseudo-static slope stability analyses were performed for two critical cross sections through the tailings embankments. The analyses were performed using limit equilibrium methods with the computer program SLOPE/W (Geo-Slope, 2007). A complete description of the input parameters and assumptions used in the analyses is provided in Appendix A. Material strength parameters used for the analyses were based on historical laboratory testing on tailings and clay materials (Advanced Terra Testing, 1996; Chen and Associates, 1987; D'Appolonia, 1982; and Western Colorado Testing, 1999), laboratory testing conducted in 2010 and 2012 on potential cover borrow materials (see Attachment B of EFRI, 2012a), laboratory testing conducted in 2013 on tailings (MWH, 2015b) and typical published values.

The mean Peak Ground Acceleration (PGA) for reclaimed conditions is 0.15g based on the site specific PSHA (MWH, 2015a). This PGA represents the seismic loading from the Maximum Credible Earthquake (MCE). The seismic coefficient used for the pseudo static stability analysis was 0.10 g (equal to 2/3 of the PGA).

The calculated factors of safety range from 2.6 to 3.9 and 1.7 to 2.5 for static and pseudo-static loading conditions, respectively. The calculated factors of safety for both the long-term static condition and the pseudo-static condition exceed the required values of 1.5 and 1.1 respectively (NRC, 2003).

3.3.7 Tailings Dewatering

Cells 2, 3, 4A, and 4B are constructed to allow tailings dewatering. Dewatering analyses have been conducted for these tailings management cells assuming the cells receive tailings to the maximum permitted tailings elevation. Dewatering analyses for Cells 2 and 3 were conducted by MWH and are presented in Appendix A. Dewatering analyses for Cells 4A and 4B were conducted by Geosyntec (2007a, 2007b). The pertinent excerpts from MWH (2010), Geosyntec (2007a, 2007b), and DRC (2008) are included in Appendix A.

Water levels in Cells 2 and 3 were measured during the October 2013 tailings investigation (MWH, 2015b). Results of the investigation indicated migration of water towards the sump in Cell 2. This was expected since water has been pumped from the Cell 2 sump since 2008. Dewatering of Cell 3 has not yet started and the October 2013 investigation reflected this, with measured water levels a few feet below the tailings surface.

To monitor changes in water levels due to dewatering prior to and after final cover placement, installation of standpipe piezometers was recommended across the cells prior to the first phase of final cover placement and extension of the piezometers during final cover placement. These piezometers will provide information on the rate and extent of dewatering of the tailings. The piezometers are primarily located adjacent to the settlement monuments to minimize damage to the piezometers during cover construction, while providing sufficient locations to evaluate the water levels. Water levels are recommended to be monitored at the same frequency and duration as the settlement monuments. Piezometer locations for Cell 2 are shown in Appendix L of the Updated Tailings Cover Design Report.

3.3.8 Settlement and Liquefaction Analyses

Settlement analyses and evaluation of liquefaction potential for the tailings were performed for the tailings cells. A discussion of the analyses and results are provided in Appendix A.

One-dimensional settlement analyses were conducted to evaluate settlement due to placement of final cover, dewatering of the tailings cells, long-term static (creep) settlement, and seismically induced (seismic) settlement. The results of these analyses of specific locations were used to evaluate differential settlement and the potential for cover cracking. The CPT locations in Cell 2 and 3 from the October 2013 tailings investigation (MWH, 2015b) were selected as the locations for the settlement analyses. Parameters used for the settlement analyses are summarized in Appendix A. Tailings profiles and properties are based on results presented in MWH (2015a). Parameters for cover materials are based on cover material testing conducted in 2010 and 2012 (summarized in Appendix A). Evaluation of total settlement due to final cover placement and dewatering indicates potential future settlement during active maintenance ranging from 0.9 to 1.6 feet.

The majority of this settlement is expected occur after Phase 1 cover construction with the remaining settlement occurring soon after Phase 2 cover construction. During this time, additional fill may be placed in low areas to maintain positive drainage of the cover surface. The estimated total predicted future long-term settlement that could occur (due to creep and seismic settlement) after the maintenance period is complete ranges from approximately 0.3 to 0.7 feet. Estimates of total long-term settlement were calculated by summing the static creep and seismic settlement estimates. As such, these estimates are considered somewhat conservative, as they are not independent (i.e. as long-term static creep progresses, void ratio reduction will occur and the potential for seismic settlement will reduce over time as a result). The estimated differential settlement after completion of active maintenance is sufficiently low that slope reversal and ponding is not expected to occur on a cover slope of 0.5 to 1.0 percent. In addition, the results indicate that cracking of the highly-compacted radon barrier due to settlement-induced strains is not expected.

Liquefaction analyses were performed to evaluate the risk of earthquake-induced liquefaction of the tailings. Two methods (Idriss and Boulanger, 2008; Youd et al., 2001) were used for the analyses. Material properties were obtained from results of laboratory tests on tailings samples collected during the October 2013 tailings investigation of Cells 2 and 3 (MWH, 2015b). Other parameters used were based on CPT data measured during the October 2013 tailings investigation. Results of the site-specific PSHA (MWH, 2015a) were used in the analyses and include a PGA of 0.15g for an approximate 10,000-year return period, with the mean seismic source being a magnitude (Mw) 5.5 event occurring 20 km from the site. Computed factors of safety against liquefaction range from 2.0 to 2.8. Based on the calculated factors of safety, the tailings are not susceptible to earthquake-induced liquefaction.

3.3.9 Vegetation and Biointrusion

The plant species proposed for the cover system consist of native perennial grasses, forbs, and shrubs. The use of these species in reclamation of the tailing management cells provide a permanent or sustainable plant cover because of the highly adapted nature of these species to existing site conditions, their tolerance to environmental stresses such as drought, fire, and herbivory, and their ability to effectively reproduce over time. These species can coexist and fully utilize plant resources to minimize the establishment of invasive weeds and deep rooted woody species on the site. Once established, the proposed seed mixture produce a grass-forb-shrub community of highly adapted and productive species that can effectively compete with undesirable species. A complete discussion of cover vegetation is provided in Appendix A.

The proposed cover system is designed to minimize both plant root and burrowing animal intrusion through the use of thick layers of soil cover (total thickness 9.5 to 10.5 ft) in combination with a highly compacted layer placed at a depth that is below the expected rooting and burrowing depths of species that may inhabit the site. Root growth and animal burrowing into the highly compacted radon attenuation layer (beginning at a depth of 4 ft) will be restricted because of the high density of this material (compaction to 95 percent relative compaction based on the standard Proctor test). In addition, both root density and the size of roots decrease at a rapid rate with rooting depth, further limiting the potential for root growth into the compacted radon attenuation layer of the cover system. A complete discussion of the biointrusion evaluation through the ET cover is presented in Appendix A.

3.3.10 Cover Material/Cover Material Volumes

Material volumes required for construction of the interim cover, final cover, and erosion protection are provided in Table 3.3-1. The quantities of materials available for construction of the cover are also provided in Table 3.3-1. A summary of the volumes of borrow stockpiles was provided in Appendix A. Sufficient quantities are available from on-site sources for the topsoil and random fill materials. The bedding and gravel materials would be obtained from off-site commercial sources. Three commercial sources have been identified as potential sources for the bedding and gravel materials. The potential off-site sources were listed in Appendix A. Sufficient quantities of material are available from the off-site sources identified.

Table 3.3-1. Reclamation Cover Material Quantity Summary

Material	Quantity Required for Reclamation (cy)	Quantity Available (Identified Sources) (cy)
Topsoil (for Erosion Protection Layer)	195,000	284,100 (on-site stockpiles)
Gravel (1-inch minus for Erosion Protection Layer)	24,000	Sufficient quantity available (off-site commercial source)
Random Fill (total for additional Layer 1 material, Layer 2, and Layer 3)	3,500,000	3,596,621 (on-site stockpiles)
Riprap (for 5H:1V side slopes and rock aprons)	38,000	Sufficient quantity available (off-site commercial source)
Riprap Bedding/Filter Layer	16,000[1]	Sufficient quantity available (off-site commercial source)

Note: Based on 6-inch thick medium sand bedding/filter layer beneath riprap.

4 MILL DECOMMISSIONING PLAN

The preliminary plans for decommissioning of the Mill are presented in the plan included as Appendix B to this Reclamation Plan. This information has been updated since the previous Reclamation Plan, Revision 5.0 (Denison, 2011c). The Preliminary Decommissioning Plan attached as Appendix B includes a description of the following activities to be performed during the decommissioning process:

- Development and implementation of health and safety procedures
- Execution of pre-decommissioning activities
- Demolition of above-ground and under-ground facilities, and placement of these materials in the Cell 1 Disposal Area or the last active tailings cell
- Excavation of contaminated subsoils from the process area and placement in the Cell 1 Disposal Area or the last active tailings cell
- Clean-up of windblown contamination and placement in the Cell 1 Disposal Area or the last active tailings cell
- Regrading and revegetation

The Plan further describes the requirements prior to demolition and the procedures to be used for specific locations within the process area, as well as requirements for personnel training, environmental monitoring, and management of water and contaminants. The work should be conducted under the EFRI Radiation Protection Manual, as directed by the site Radiation Safety Officer.

The EFRI Radiation Protection Manual for Reclamation is included as Attachment D to this Reclamation Plan.

5 REVERSION TO EXISTING COVER DESIGN

5.1 Background

On November 11, 2015, the UDEQ Division of Waste Management and Radiation Control (DWMRC) recommended EFRI develop a plan to begin reclamation of the tailings management system cells. This plan would consist of placing the cover system presented in this Plan (the "Proposed Cover System") on Cell 2 and demonstrating acceptable cover performance via a performance monitoring program.

Per the Stipulation and Consent Agreement (SCA) in development between EFRI and DWMRC, Cell 2 reclamation is planned to occur in 2 phases. Phase 1 is comprised of Layers 1 and 2 of the Proposed Cover System, and will be placed on Cell 2 along with a Primary Test Section that contains all of the Proposed Cover System, including the vegetative cover. The Primary Test Section along with a Supplemental Test Section (located off of Cell 2, and relating only to vegetative cover and erosion control) will be tested over a period of approximately 7 years (the "Cell 2 Test Period").

Under the SCA, the Cell 2 Primary Test Section and Supplemental Test Section will have to meet required performance criteria to verify the effectiveness of the Proposed Cover System and initiate Phase 2 cover placement.

5.2 Proposed Cover Design Meets all Applicable Regulatory Criteria

If the Primary Test Section and Supplemental Test Section demonstrate that the Proposed Cover System meets all applicable regulatory criteria, then:

a) Cell 2

Phase 2, comprised of Layer 3, Layer 4 and the vegetative cover of the Proposed Cover System, will be placed on Cell 2, in accordance with the SCA and Section 6.0 below;

b) Other Tailings Management System Cells being Reclaimed during Cell 2 Test Period

In the event that any other tailings management system cells are to be reclaimed during the Cell 2 Test Period, such tailings impoundments will be reclaimed by placing Phase 1 of the Proposed Cover System on the cell, and then waiting until the Cell 2 test is completed. Thereafter, reclamation of the cells will be completed in the same manner as Cell 2, in accordance with the SCA and Section 6.0 below; and

c) Other Tailings Management System Cells Being Reclaimed after Cell 2 Test Period

Upon final reclamation in accordance with Section 6.0 below, the other tailings management system cells, which had not commenced reclamation during the Cell 2 test period, would be reclaimed with the Proposed Cover System.

5.3 Proposed Cover Design Does not Meet all Applicable Regulatory Criteria

If the Cell 2 Primary Test Section and Supplemental Test Section fail to meet the required performance criteria and follow up actions (to be identified in the SCA), then:

a) Cell 2

EFRI will complete Cell 2 Phase 2 cover placement by placing Layers 2, 3, and 4 of the Existing Cover System presented in Reclamation Plan Revision 3.2b (Denison, 2011b) (the "Existing Cover System") on top of the Phase 1 layers, as follows:

i. the Cell 2 Phase 1 cover system (which includes the Proposed Cover System Layers 1 and 2) would remain in place;

ii. the Existing Cover System Layer 2, comprised of 1 ft (30.5cm) Radon Barrier (compacted clay), would be placed on top of the Cell 2 Phase 1 cover;

iii. The Existing Cover System Layer 3 comprised of 2 ft (61 cm) Frost Barrier (random fill), would be placed on top of the Existing Cover System Layer 2; and

iv. the Existing Cover System Layer 4, comprised of 3 in (7.6 cm) Rock Armor would be placed on top of Existing Cover System Layer 3.

b) Other Tailings Management System Cells being Reclaimed during Cell 2 Test Period

In the event that any other tailings management system cells are to be reclaimed during the Cell 2 Test Period, such cells will be reclaimed by placing Phase 1 of the Proposed Cover System on the cells, and then waiting until the Cell 2 test is completed. Thereafter, reclamation of the cell will be completed in the same manner as Cell 2, in accordance with the SCA and Section 6.0 below. If Phase 1 of the Proposed Cover System is not completed during the Cell 2 Test Period for any such cells, then such cells may be reclaimed with the Existing Cover System; and

c) Other Tailings Management System Cells Being Reclaimed after Cell 2 Test Period

Upon final reclamation in accordance with Section 6.0 below, the other tailings management system cells which had not commenced reclamation during the Cell 2 Test Period, would be reclaimed with the Existing Cover System.

6 MILESTONES AND SCHEDULE COMMITMENTS FOR RECLAMATION

6.1. Background

Utah Administrative Code R313-24-4, incorporating by reference 10 CFR Part 40 Appendix A Criterion 6A ("**Criterion 6A**") paragraph (1), provides that: "For impoundments containing uranium byproduct materials, the final radon barrier must be completed as expeditiously as practicable considering technological feasibility after the pile or impoundment ceases operation in accordance with a written, Commission-approved reclamation plan. (The term as expeditiously as practicable considering technological feasibility as specifically defined in the Introduction of this appendix includes factors beyond the control of the licensee.) Deadlines for completion of the final radon barrier and, if applicable, the following interim milestones must be established as a condition of the individual license: windblown tailings retrieval and placement on the pile and interim stabilization (including dewatering or the removal of freestanding liquids and re-contouring). The placement of erosion protection barriers or other features necessary for long-term control of the tailings must also be completed in a timely manner in accordance with a written, Commission-approved reclamation plan."

As contemplated by Criterion 6A, this Section sets out the interim milestones and deadlines for completion of the final radon barrier for individual tailings impoundments (referred to in this Section as "tailings impoundments" or "conventional impoundments") at the Mill after each such impoundment begins final closure. It also sets out milestones for the removal and disposal of non-conventional impoundments (referred to in this Section as "evaporation ponds" or "non-conventional impoundments") after each such impoundment begins final closure, as well as additional milestones applicable to final Mill site closure. A table that summarizes all of these milestones is included in Section 6.2.6 below.

Also included below are schedule commitments for other events or actions which are not "milestones" required under Criterion 6A, but instead are schedule commitments to be achieved in order to ensure that those events or actions are completed in a timely manner. As these schedule commitments are not milestones they do not come under the specific provisions of paragraph (2) of Criterion 6A. However, a general timeliness standard for completing those items is retained. The licensee must complete those actions in a timely way, and the Director has the authority to take action if necessary in this regard. As these schedule commitments are not milestones required under Criterion 6A(1), they are not included in the table set out in Section 6.2.5 below.

6.2. Milestones and Schedule Commitments

6.2.1. General

(a) Definition of "Operation"

"Operation" means that an impoundment is being used for the continued placement of uranium byproduct material or tailings or is in standby status for such placement. An impoundment is in operation from the day that uranium byproduct material or tailings are first placed in the impoundment until the day that final closure begins.

(b) When Final Closure of an Impoundment Begins

Final closure of an impoundment begins when the owner or operator provides written notice to the EPA and to the Director that:

i) In the case of a conventional impoundment (i.e., a tailings impoundment), the impoundment is no longer receiving uranium byproduct material or tailings, is no longer on standby status for such receipt and is being managed under an approved reclamation plan for that impoundment or facility closure plan; and

ii) In the case of a non-conventional impoundment (e.g., an evaporation pond), the impoundment is no longer required for evaporation or holding purposes, is no longer on standby for such purposes and is being managed under an approved reclamation plan for that impoundment or facility closure plan.

An approved reclamation plan prepared and approved in accordance with 10 CFR part 40, Appendix A is considered a reclamation plan for purposes of this paragraph 6.2.1(b).

(c) The Existing Tailings Management System at the Mill

The tailings management system at the Mill currently consists of three tailings impoundments: Cell 2, which is not in operation and is in final closure, and Cells 3 and 4A, which are in operation. Cell 1 is an evaporation pond. Cell 4B is currently being used as an evaporation pond and will continue to be used as an evaporation pond until it first starts to receive tailings sands or other byproduct material (other than solutions) for disposal. Future cells may commence as evaporation ponds, and will continue as evaporation ponds until they first receive tailings sands or other byproduct material (other than solutions) for disposal, at which time they will become tailings impoundments.

(d) The Proposed Cover Design and Existing Cover Design

This Plan presents a proposed evapotranspiration (ET) cover (the "**Proposed Cover Design**") as a component of the reclamation plan for the tailings impoundments, to replace the rock armor cover design (the "**Existing Cover Design**") set out in Appendix D to the Reclamation Plan Version 3.2b (Denison, 2011b).

The Stipulation and Consent Agreement described in Section 6.2.1(e) below and Section 5.0 above describe a set of circumstances under which the Final Cover Design could be the Existing Cover Design rather than the Proposed Cover Design. Section 5.0 of this Plan describes the manner in which EFRI would revert from the Proposed Cover Design to the Existing Cover Design if so required by the Stipulation and Consent Agreement.

i) The Proposed Cover Design

The Proposed Cover Design will have a minimum thickness of 9.5 feet, and will consist of the following layers listed below from top to bottom:

- Layer 4 - 0.5 ft (15 cm) thick Erosion Protection Layer (topsoil-gravel admixture or topsoil)
- Layer 3 - 3.5 ft (107 cm) thick Water Storage/Biointrusion/Frost Protection/Secondary Radon Attenuation Layer (loam to sandy clay)
- Layer 2 – 3.0 - 4.0 ft (91 to 122 cm) thick Primary Radon Attenuation Layer (highly compacted loam to sandy clay)
- Layer 1 - 2.5 ft (76 cm) thick (minimum) Secondary Radon Attenuation and Grading Layer (loam to sandy clay)

All the layers combined comprise the monolithic ET cover system.

ii) The Existing Cover Design

The Existing Cover Design will have a minimum thickness of 6 feet, and will consist of the following layers listed below from top to bottom:

- Layer 4 -- 3 in (7.6 cm) Rock Armor
- Layer 3 -- 2 ft (61 cm) Frost Barrier Layer (random fill)
- Layer 2 -- 1 ft (30.5) Radon Barrier (compacted clay)
- Layer 1 -- Minimum 3 ft (91.4 cm) Platform Fill (random fill)

(e) The Stipulation and Consent Agreement

EFRI and the Director of the UDEQ DWMRC have entered into a Stipulation and Consent Agreement (the "**SCA**"), which sets out the terms on which the Mill will test the effectiveness of the Proposed Cover Design and, together with Section 5.0 of this Plan, the circumstances in which the approved Cover Design for reclamation of tailings impoundments could be a variation of the Proposed Cover Design or the Existing Cover Design, rather than the Proposed Cover Design.

6.2.2. Deadlines, Interim Milestones and Schedule Commitments for Closure of Cell 2

The deadlines and interim milestones and schedule commitment dates for closure of Cell 2 are set out in the SCA. The requirements set out in the SCA are incorporated by reference into this Plan as if set out in this Plan. The final radon barrier for Cell 2 (Layers 1 and 2 under the Proposed Cover Design) has been put in place. Radon flux measurements taken since the final radon barrier has been placed onto Cell 2 have been well below the 20 pCi/m^2s standard set out in Criterion 6A.

6.2.3. Milestones and Schedule Commitments for Closure of a Conventional Impoundment (i.e., a Tailings Impoundment), other than Cell 2

A conventional impoundment (i.e., tailings impoundment), other than Cell 2, may begin final closure at any time, including while the Mill facility as a whole remains in operation as well as during or after final Mill site decommissioning and closure. Once final closure of a conventional impoundment begins as specified in Section 6.2.1 b) above, the final radon barrier for the impoundment shall be completed as expeditiously as practicable thereafter considering technological feasibility (including taking into consideration factors beyond the control of the licensee) in accordance with this Plan and the deadlines, milestones and schedule commitments set out below:

(a) Interim Stabilization (Including Dewatering or the Removal of Freestanding Liquids and Re-contouring) of the Tailings Impoundment.

i) Removal of Freestanding Liquids

Commencing on the date the impoundment begins final closure in accordance with Section 6.2.1 b) above, the addition of liquids to the tailings impoundment, other than by natural precipitation, will cease, and free standing liquids will be allowed to dry out by natural evaporation. To the extent reasonably practicable, and if excess evaporative capacity is available in other cells in the tailings management system, the Mill will transfer solutions out of the tailings impoundment and into other tailings impoundments and/or evaporation ponds in order to enhance evaporation and removal of solutions from the impoundment. This item must be completed within one year after the impoundment begins final closure. This deadline is a milestone as required by Criterion 6A(1), and is subject to the provisions of Criterion 6A(2).

ii) Re-contouring

Re-contouring of the tailings impoundment, in accordance with Drawings and Attachment A (Technical Specifications) of this Plan ("**Re-contouring**"), will commence upon removal of freestanding liquids from the impoundment and must be completed within two years after the impoundment begins final closure. This deadline is a milestone as required by Criterion 6A(1), and is subject to the provisions of Criterion 6A(2).

iii) Commencement of Dewatering

Dewatering of the impoundment shall commence upon completion of re-contouring of the impoundment, and shall continue until the impoundment is dewatered as contemplated by item 6.2.3(a)(vii) below. This deadline is a milestone as required by Criterion 6A(1), and is subject to the provisions of Criterion 6A(2).

iv) Placement of Layer 1

Upon completion of re-contouring of the impoundment, EFRI will complete placement of Layer 1 (Secondary Radon Attenuation and Grading Layer under the Proposed Cover Design or Platform Fill under the Existing Cover Design, as applicable) on the impoundment, in accordance with this Plan. This item must be completed within three years after the date the impoundment begins final closure. This deadline is a milestone as required by Criterion 6A(1), and is subject to the provisions of Criterion 6A(2).

v) Placement of Layer 2 (Final Radon Barrier)

Upon EFRI being satisfied that there have been decreasing trends in settlement followed by a maximum of 0.1 feet (30 mm) of cumulative settlement over 12 months (for at least 90 percent of the settlement monuments), or at such earlier time as EFRI may determine, EFRI shall commence placing Layer 2 (the Primary Radon Attenuation Layer under the Proposed Cover Design or the Radon Barrier under the Existing Cover Design, as applicable) on the impoundment. This item must be completed as expeditiously as practicable considering technological feasibility (including factors beyond the control of the licensee), but in any event within seven years after the impoundment begins final closure. This deadline is a milestone as required by Criterion 6A(1), and is subject to the provisions of Criterion 6A(2).

vi) Placement of Layer 3

After placement of Layer 2, EFRI will place Layer 3 (the Water Storage/Biointrusion/Frost Protection/Secondary Radon Attenuation Layer under the Proposed Cover Design or the Frost Barrier Layer under the Existing Cover Design, as applicable) on the impoundment. Timing of commencement of this item will be at the discretion of EFRI, and Layer 3 may be placed prior to or after completion of dewatering. The schedule commitment for this item is to have it completed within the later of (A) seven years after the impoundment begins final closure and (B) two years after completion of placement of Layer 2 on the impoundment, or such later date as may be approved by the Director. This item is not a milestone required under Criterion 6A(1) because it follows placement of the final radon barrier and is not required for that action, and because there is a separate milestone for dewatering. Instead, this item is included as a schedule commitment to be achieved in order to ensure that the activity is completed in a timely manner. As this schedule commitment is not a milestone it does not come under the specific provisions of paragraph (2) of Criterion 6A. However, a general timeliness standard for completing this activity is retained. EFRI must complete this activity in a timely way, and the Director has the authority to take action if necessary in this regard.

vii) Completion of Dewatering

Dewatering shall be considered to be complete when, after the placement of Layer 2 and Layer 3 (if Layer 3 is placed prior to completion of dewatering) decreasing trends in settlement followed by a maximum of 0.1 feet (30 mm) of cumulative settlement over 12 months (for at least 90 percent of the settlement monuments) have occurred. This item must be completed within the later of (A) seven years after the impoundment begins final closure and (B) two years after completion of placement of Layer 2 on the impoundment. This deadline is a milestone as required by Criterion 6A(1), and is subject to the provisions of Criterion 6A(2).

viii) Placement of Layer 4 Under the Proposed Cover Design

Placement of Layer 4 under the Proposed Cover Design (Erosion Protection Layer) on the impoundment will commence after the completion of dewatering (this item does not apply to the Existing Cover Design). The schedule commitment for this item is to have it completed within the later of (A) eight years after the impoundment begins final closure and (B) two years after completion of placement of Layer 3 on the impoundment, or such later time as may be approved by the Director. This item is not a milestone required under Criterion 6A(1), because it follows placement of the final radon barrier and is not required for that activity. Instead, this item is included as a schedule commitment to be achieved in order to ensure that the activity is completed in a timely manner. As this schedule commitment is not a milestone it does not come under the specific provisions of paragraph (2) of Criterion 6A. However, a general timeliness standard for completing this activity is retained. EFRI must complete this activity in a timely way, and the Director has the authority to take action if necessary in this regard.

ix) Vegetative Cover

If the Cover Design, as approved by the Director in accordance with the procedures described in the SCA and Section 5.0 of this Plan, is the Proposed Cover Design or otherwise calls for vegetative cover on the impoundment, then revegetation of the cover will take place at the completion of placement of Layer 4 (Erosion Protection Layer) on the impoundment, in accordance with the revegetation plan set out in Appendix J to the Updated Cover Design Report. All required seeding for re-vegetation will commence in the first available growing season after the completion of placement of Layer 4 (Erosion Protection Layer) on the impoundment, as determined by the Director, and will be completed by the end of such growing season, or such later time as may be approved by the Director. This item is not a milestone required under Criterion 6A(1), because it follows placement of the final radon barrier and is not required for that activity. Instead, this item is included as a schedule commitment to be achieved in order to ensure that the activity is completed in a timely manner. As this schedule commitment is not a milestone it does not come under the specific provisions of paragraph (2) of Criterion 6A. However, a general timeliness standard for completing this activity is retained. EFRI must complete this activity in a timely way, and the Director has the authority to take action if necessary in this regard.

x) Rock Armor

If the Cover Design, as approved by the Director in accordance with the procedures described in the SCA and Section 5.0 of this Plan, is the Existing Cover Design or includes Layer 4 (Rock Armor) of the Existing Cover Design, then rock armor shall be placed on the tailings impoundment, in accordance with Reclamation Plan 3.2b (Denison, 2011b). In addition, rock armor is required for the exterior slopes of the impoundment under the Proposed Cover Design. Such placement, will commence within one year after completion of dewatering on the impoundment in accordance with Section 5.0 of this Plan, and will be completed within 180 days thereafter, or such later date as may be approved by the Director. This item is not a milestone required under Criterion 6A(1), because it follows placement of the final radon barrier and is not required for that activity. Instead, this item is included as a schedule commitment to be achieved in order to ensure that the activity is completed in a timely manner. As this schedule commitment is not a milestone it does not come under the specific provisions of paragraph (2) of Criterion 6A. However, a general timeliness standard for completing this activity is retained. EFRI must complete this activity in a timely way, and the Director has the authority to take action if necessary in this regard.

(b) Leaving a Portion of an Impoundment Open for Disposal of On-site Generated Trash or 11e.(2) Byproduct Material from ISR Operations

The License authorizes a portion of a specified impoundment to accept uranium byproduct material or such materials that are similar in physical, chemical, and radiological characteristics to the uranium mill tailings and associated wastes already in the pile or impoundment, from other sources, during the closure process, and on-site generated trash, provided that this does not result in a delay or impediment to emplacement of the final radon barrier over the remainder of the impoundment in a manner that will achieve levels of radon-222 releases not exceeding 20 pCi/m^2s averaged over the entire impoundment. Reclamation of the disposal area, as appropriate, must be completed in a timely manner after disposal operations cease in accordance with paragraph (1) of Criterion 6A; however, these actions are not required to be completed as part of meeting the deadline for final radon barrier construction for the impoundment.

(c) Windblown Tailings Retrieval and Placement on the Impoundment

As the Mill facility as a whole may still be in operation at the time the impoundment is being reclaimed, there may not be a need to retrieve any windblown tailings for placement on the impoundment at the time of final closure of the impoundment. Those activities will be required during final decommissioning of the entire Mill facility. Accordingly, the milestones associated with those activities are set out in Section 6.2.5 below.

6.2.4. Milestones and Schedule Commitments for Closure of a Non-Conventional Impoundment (e.g., an Evaporation Pond)

A non- conventional impoundment (e.g., an evaporation pond), may begin final closure at any time, including while the Mill facility as a whole remains in operation as well as during or after final Mill site decommissioning and closure. Once final closure of a non-conventional impoundment begins as specified in Section 6.2.1 b) above, final closure of the impoundment shall be accomplished in accordance with this Plan and the deadlines, milestones and schedule commitments set out below:

(a) Removal of Free-Standing Liquids from Evaporation Ponds

Commencing on the date the impoundment begins final closure in accordance with Section 6.2.1 b) above, the addition of liquids to the impoundment, other than by natural precipitation, will cease, and free standing liquids will be allowed to dry out by natural evaporation. To the extent reasonably practicable, and if excess evaporative capacity is available in other conventional or non-conventional impoundments in the tailings management system, the Mill will transfer solutions out of the impoundment and into other impoundments in order to enhance evaporation and removal of solutions from the impoundment. This item must be completed within five years after the impoundment begins final closure. Although this deadline is not a milestone required under Criterion 6A(1), because it is not linked to the placement of a final radon barrier in a non-operational tailings impoundment, EFRI agrees that for purposes of this Plan it shall be treated as a milestone as required by Criterion 6A(1), and as a result EFRI agrees that it will be subject to the provisions of Criterion 6A(2).

(b) Removal of Liners, Sediments and any Contaminated Soils from Evaporation Ponds

Upon removal of the free-standing liquids from the impoundment, the licensee shall commence removal of all liners, sediments and any contaminated soils from and under the impoundment and dispose of such materials into one or more conventional impoundments. This item must be completed within the earlier of (A) seven years after the impoundment begins final closure, and (B) three years after the removal of all free-standing liquids from the impoundment. Although this deadline is not a milestone required under Criterion 6A(1), because it is not linked to the placement of a final radon barrier in a non-operational tailings impoundment, EFRI agrees that for purposes of this Plan it shall be treated as a milestone as required by Criterion 6A(1), and as a result EFRI agrees that it will be subject to the provisions of Criterion 6A(2).

6.2.5. Additional Milestone for Final Mill Closure

If the Mill facility as a whole has commenced final reclamation, as defined in this Plan, then the following additional milestone shall apply after that time:

(a) Mill Demolition and Windblown Tailings Retrieval and Placement in a Tailings Impoundment

Mill demolition and windblown tailings retrieval, as contemplated by Attachment A (Technical Specifications) of this Plan and disposal into one or more tailings impoundments shall commence upon commencement of final closure of the entire Mill site ("Mill Final Closure"), and shall be completed within four years after commencement of Mill Final Closure. This deadline is a milestone as required by Criterion 6A(1), and is subject to the provisions of Criterion 6A(2).

It should be noted that individual conventional and non-conventional impoundments may begin final closure before, during or after commencement or completion of Mill Final Closure, and the decision to begin final closure on any particular impoundment is not tied to Mill Final Closure. The milestones and schedule commitments in Sections 6.2.3 and 6.2.4 above apply to final closure of conventional and non-conventional impoundments once they begin final closure in accordance with Section 6.2.1(b) above, whether during Final Mill Closure or otherwise. Further, as a tailings impoundment will be considered to be in operation so long as it is receiving byproduct material, which includes Mill decommissioning materials, windblown, slimes drain dewatering solutions etc., and an evaporation pond will be considered to be in operation so long as it is required for evaporation or holding purposes, it is expected that one or more tailings impoundments and evaporation ponds will continue in operation during all or part of the Mill decommissioning process. One or more impoundments may also continue in operation for licensed activities, such as direct disposal of 11e.(2) byproduct material from In Situ Recovery uranium operations or other licensed activities, after completion of Mill Final Closure.

6.2.6. Summary Table of Milestones

The following table summarizes all of the milestones required by Criterion 6A(1), all of which are described in more detail above.

As the schedule commitments described in detail above are not milestones required under Criterion 6A(1), they are not included in the following table.

	Milestone	**Reclamation Plan 5.1B Section Number**	**Start**	**End**
1. Milestones for Closure of an Individual Conventional Impoundment (Tailings Impoundment) at any Time				
1.1.	Removal of Free Standing Liquids	6.2.3(a)(i)	Date final closure of the impoundment begins in accordance with Section 6.2.1(b)	One year after impoundment begins final closure
1.2.	Re-contouring	6.2.3(a)(ii)	Upon removal of free standing liquids	Two years after impoundment begins final closure
1.3.	Commence Dewatering	6.2.3(a)(iii)	Upon completion of Re-contouring	NA

	Milestone	Reclamation Plan 5.1B Section Number	Start	End
1.4.	Placement of Layer 1 (Secondary Radon Attenuation and Grading Layer under the Proposed Cover Design or Platform Fill under the Existing Cover Design, as applicable)	6.2.3(a)(iv)	Upon completion of re-contouring	Three years after impoundment begins final closure
1.5.	Placement of Layer 2 (Final Radon Barrier) (the Primary Radon Attenuation Layer under the Proposed Cover Design or the Radon Barrier under the Existing Cover Design, as applicable)	6.2.3(a)(v)	Upon EFRI being satisfied that there have been decreasing trends in settlement followed by a maximum of 0.1 feet (30 mm) of cumulative settlement over 12 months (for at least 90 percent of the settlement monuments), or at such earlier time as EFRI may determine	As expeditiously as practicable considering technological feasibility (including factors beyond the control of the licensee), but in any event within seven years after impoundment begins final closure
1.6.	Completion of Dewatering	6.2.3(a)(vii))	NA	Within later of (A) seven years after impoundment begins final closure and (B) two years after completion of placement of Layer 2
2. Milestones for Closure of a Non-Conventional Impoundment (Evaporation Pond) at any Time				
2.1.	Removal of Free Standing Liquids	6.2.4(a)(i)	Date final closure of the impoundment begins in accordance with Section 6.2.1(b)	Five years after impoundment begins final closure
2.2.	Removal of Liners, Sediments and any Contaminated Soils from Impoundment	6.2.4(a)(ii)	Upon removal of the free-standing liquids from the impoundment	Earlier of (A) seven years after the impoundment begins final closure, and (B) three years after the removal of all free-standing liquids from the impoundment

	Milestone	Reclamation Plan 5.1B Section Number	Start	End
3. Additional Milestone Applicable to Mill Final Closure				
	Mill Demolition and Windblown Tailings Retrieval and Placement in a Tailings Impoundment	6.2.5(a)	Upon commencement of Mill Final Closure	Four years after Commencement of Mill Final Closure

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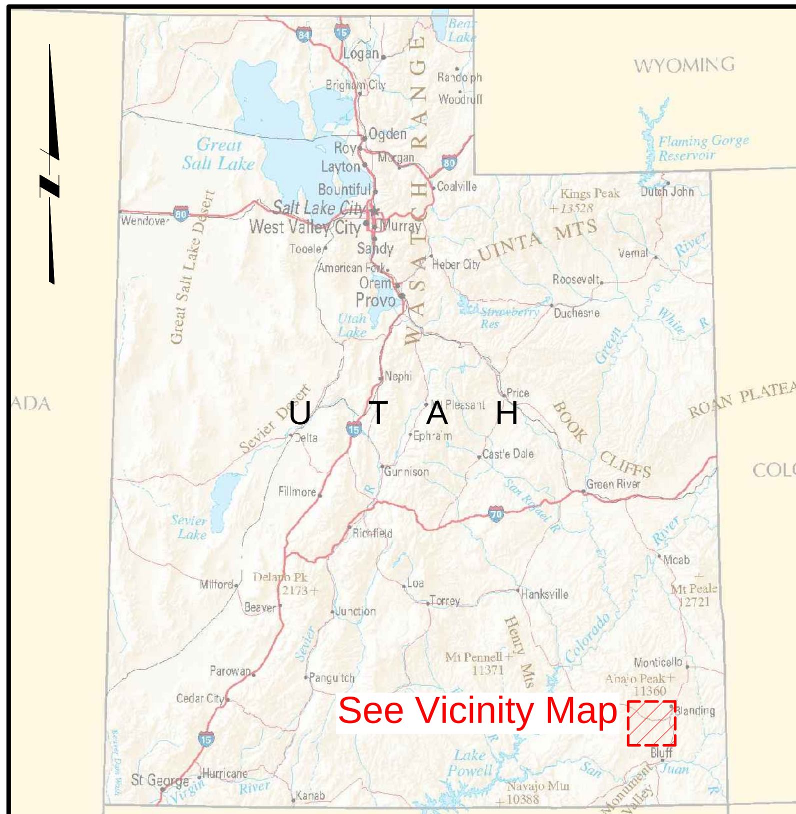
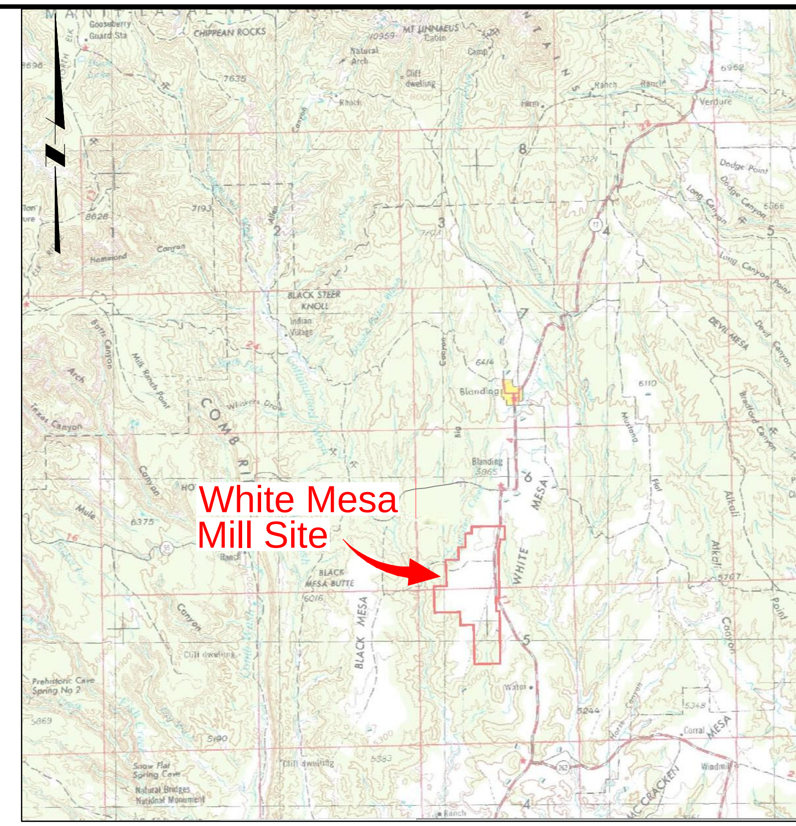
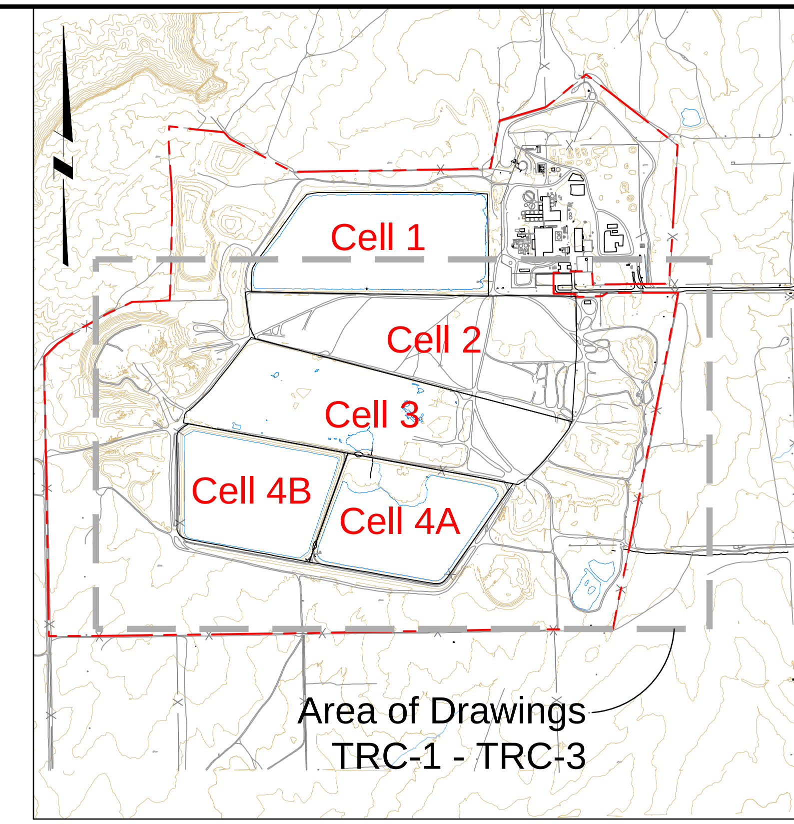


LOCATION MAP
NOT TO SCALE



VICINITY MAP
NOT TO SCALE



SITE MAP
NOT TO SCALE

NOTE:
DRAWINGS REC-0 THROUGH REC-3 PRESENT THE OVERALL RECLAMATION PLANS FOR THE ENTIRE WHITE MESA MILL SITE. DRAWINGS TRC-1 THROUGH TRC-10 PRESENT THE RECLAMATION PLANS FOR THE CELLS USED FOR TAILINGS DISPOSAL OR PROCESS WATER EVAPORATION (CELLS 1, 2, 3, 4A, AND 4B).

CELLS 1 AND 4B ARE CURRENTLY USED FOR PROCESS WATER EVAPORATION. THE RECLAMATION PLANS REFLECTED IN THESE DRAWINGS ARE BASED ON POTENTIAL USE OF CELL 4B IN THE FUTURE FOR TAILINGS DISPOSAL.

INDEX OF DRAWINGS

SHEET	TITLE	REV
REC-0	TITLE SHEET AND PROJECT LOCATION MAP	C
REC-1	PLAN VIEW OF RECLAMATION FEATURES	C
REC-2	MILL SITE AND ORE PAD AREA GRADING PLAN	C
REC-3	SEDIMENTATION BASIN DETAIL	C
TRC-1	INTERIM FILL GRADING PLAN	C
TRC-2	COMPACTED COVER GRADING PLAN	C
TRC-3	FINAL COVER SURFACE LAYOUT	C
TRC-4	RECLAMATION COVER EROSION PROTECTION	C
TRC-5	COVER OVER CELL 4A & 4B CROSS SECTIONS	C
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TRC-7	COVER OVER CELL 2 CROSS SECTIONS	C
TRC-8	COVER OVER CELL 2 CROSS SECTION	C
TRC-9	RECLAMATION COVER DETAILS (SHEET 1 OF 2)	C
TRC-10	RECLAMATION COVER DETAILS (SHEET 2 OF 2)	C

WHITE MESA MILL SITE RECLAMATION

prepared for

ENERGY FUELS RESOURCES (USA) INC.

SAN JUAN COUNTY, UTAH

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
C	ISSUED FOR RECLAMATION PLAN REVISION 5.1	KR	MD	12-16
B	ISSUED WITH EFRI 2015 RESPONSES TO FEB 2013 DRC REVIEW COMMENTS	DM	MD	08-15
A	ISSUED FOR RECLAMATION PLAN REVISION 5.0	DM	RS	08-11

DESIGNED BY	M DAVIS	12-16
DRAWN BY	K REED	12-16
CHECKED BY	C STRACHAN	12-16
APPROVED BY	C STRACHAN	12-16
PROJECT MANAGER	M DAVIS	12-16
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH
PROJECT: WHITE MESA MILL SITE RECLAMATION
TITLE: TITLE SHEET AND PROJECT LOCATION MAP

MWH

SHEET: REC-0
REVISION: C
FILE NAME: WMM COVER
DATE: DEC 2016

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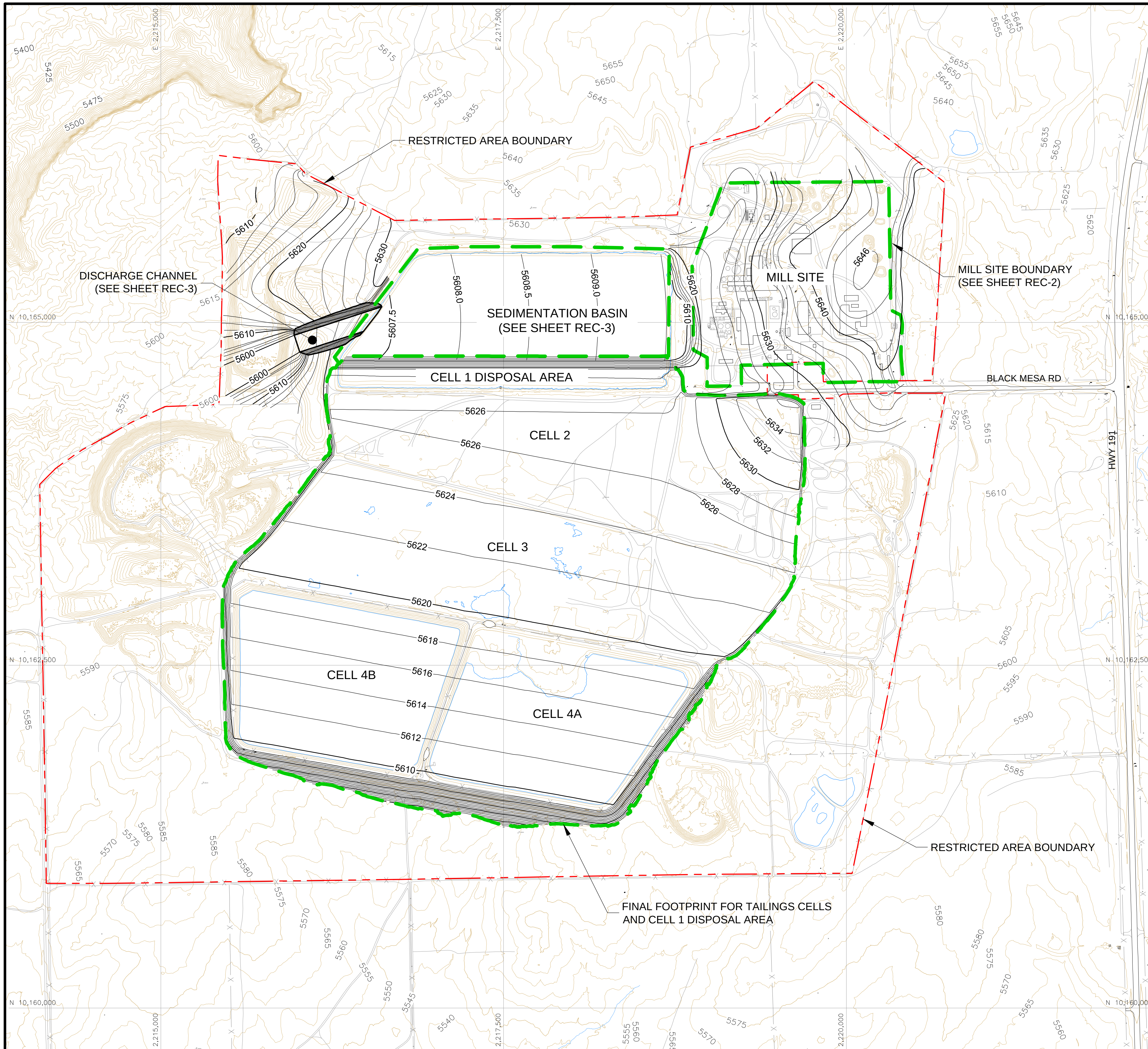

LEGEND:

5605	EXISTING GROUND SURFACE CONTOUR AND ELEVATION, FEET (SEE REFERENCE)
5605	FINAL GRADING SURFACE CONTOUR AND ELEVATION, FEET
	EXISTING ROAD
	EXISTING WATER
	EXISTING TRAIL
—x—	EXISTING FENCE
□	EXISTING STRUCTURE

0 400' 800'

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
C	ISSUED FOR RECLAMATION PLAN REVISION 5.1	KR	MD	12–16
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ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL SITE RECLAMATION

TITLE: PLAN VIEW OF RECLAMATION FEATURES

MWH

SHEET: REC-1 | REVISION: C

FILE NAME: WMM REC-1 | DATE: DEC 2016

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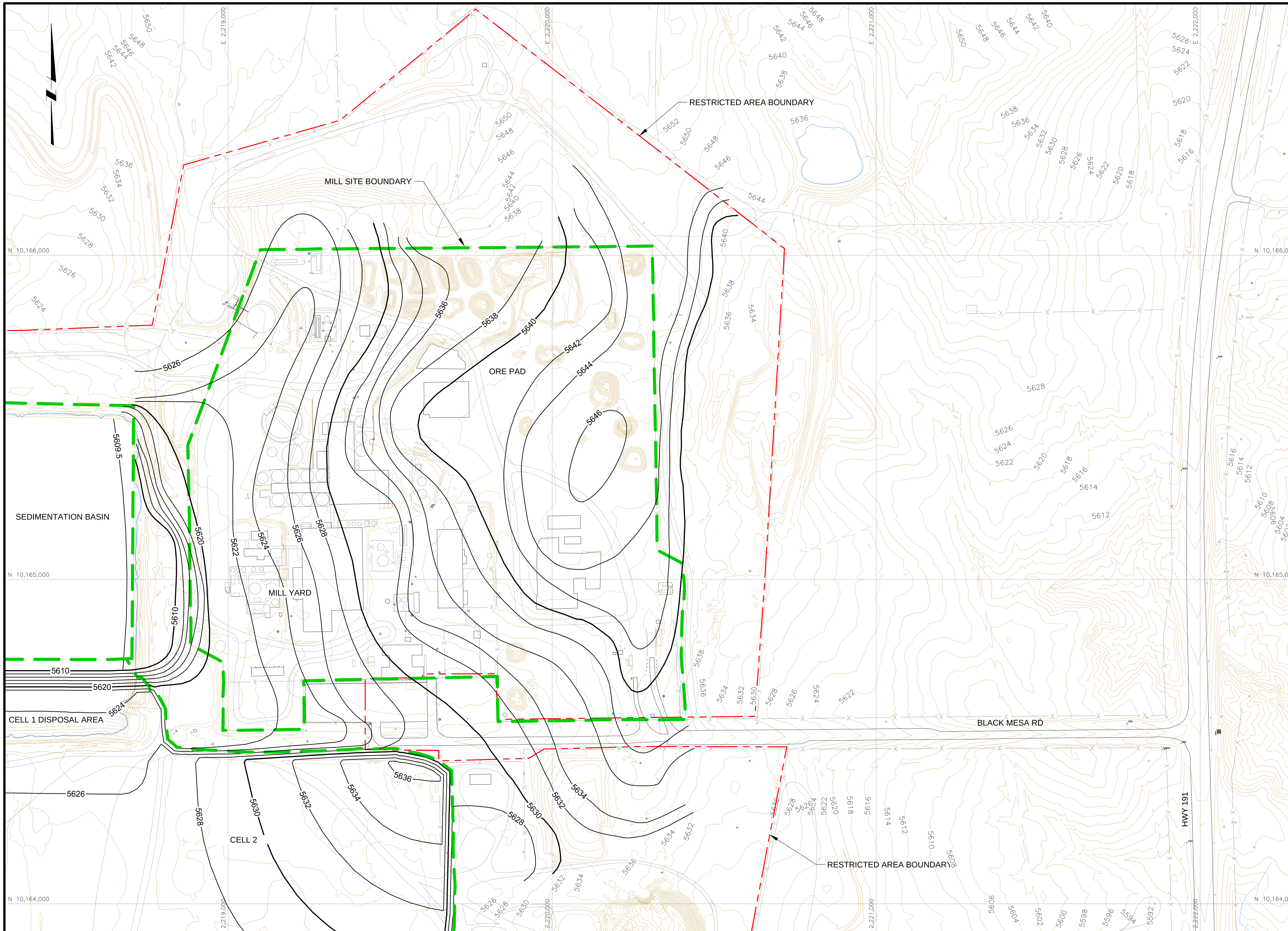

LEGEND:

5605	EXISTING GROUND SURFACE CONTOUR AND ELEVATION, FEET (SEE REFERENCE)
5605	FINAL GRADING SURFACE CONTOUR AND ELEVATION, FEET
	EXISTING ROAD
	EXISTING WATER
	EXISTING TRAIL
—X—	EXISTING FENCE
	EXISTING STRUCTURE

NOTES:

1. ADAPTED FROM DENISON MINES (USA) CORPORATION FIGURE A–3.2–1. TITLE: MILL SITE AND ORE PAD FINAL GRADING PLAN, DATED FEBRUARY, 1997.
2. ACTUAL FIELD CONDITIONS MAY VARY FROM FEATURES SHOWN.
3. ACTUAL FINAL CONTOURS WILL DEPEND ON EXTENT OF EXCAVATION DICTATED BY RESULTS OF FIELD RADIOMETRIC SURVEYS.

0 150' 300'

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
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CLIENT APPROVAL		
CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL SITE RECLAMATION

TITLE: MILL SITE AND ORE PAD AREA GRADING PLAN

MWH

SHEET: REC-2
REVISION: C
FILE NAME: WMM REC-2
DATE: DEC 2016

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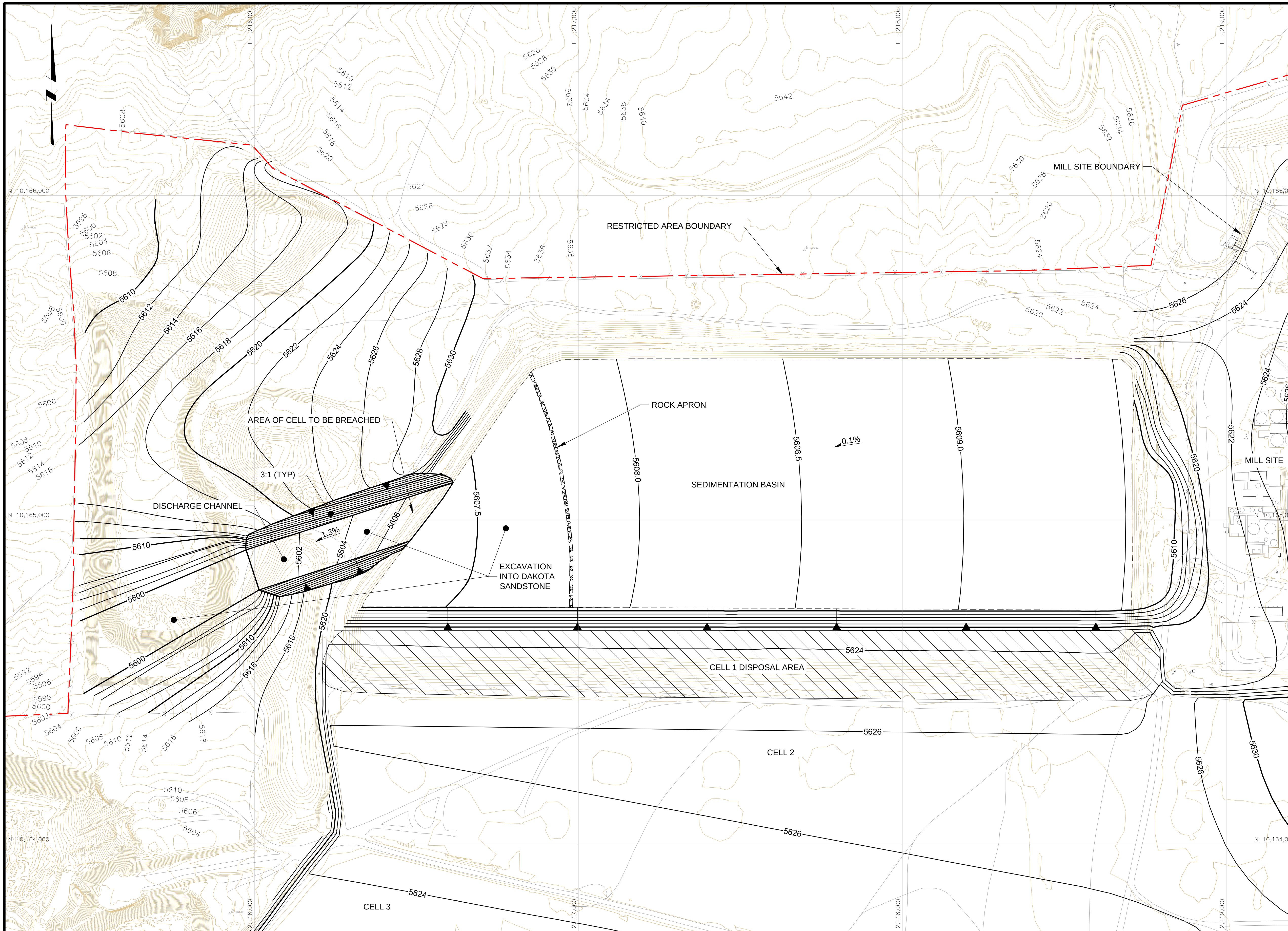

LEGEND:

5605	EXISTING GROUND SURFACE CONTOUR AND ELEVATION, FEET (SEE REFERENCE)
5605	FINAL GRADING SURFACE CONTOUR AND ELEVATION, FEET
	EXISTING ROAD
	EXISTING WATER
	EXISTING TRAIL
X	EXISTING FENCE
	EXISTING STRUCTURE

NOTES:

1. ADAPTED FROM DENISON MINES (USA) CORPORATION FIGURE A-3.2-1. TITLE: MILL SITE AND ORE PAD FINAL GRADING PLAN, DATED FEBRUARY, 1997.

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CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL SITE RECLAMATION

TITLE: SEDIMENTATION BASIN DETAIL

MWH

SHEET: REC-3 | REVISION: C

FILE NAME: WMM REC-3 | DATE: DEC 2016

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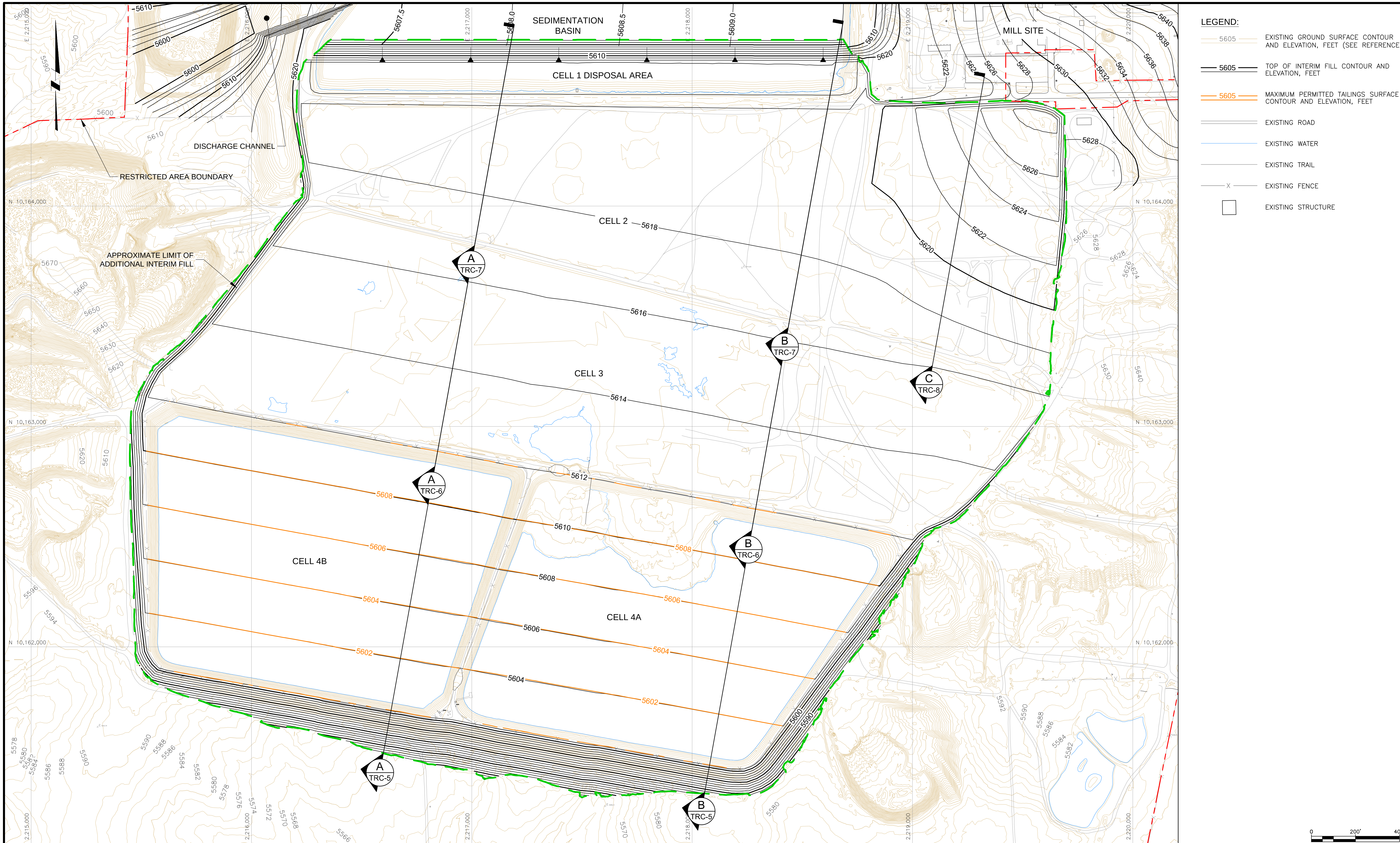

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CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL SITE RECLAMATION

TITLE: INTERIM FILL GRADING PLAN

MWH

SHEET: TRC-1 | REVISION: C

FILE NAME: WMM TRC-1 | DATE: DEC 2016

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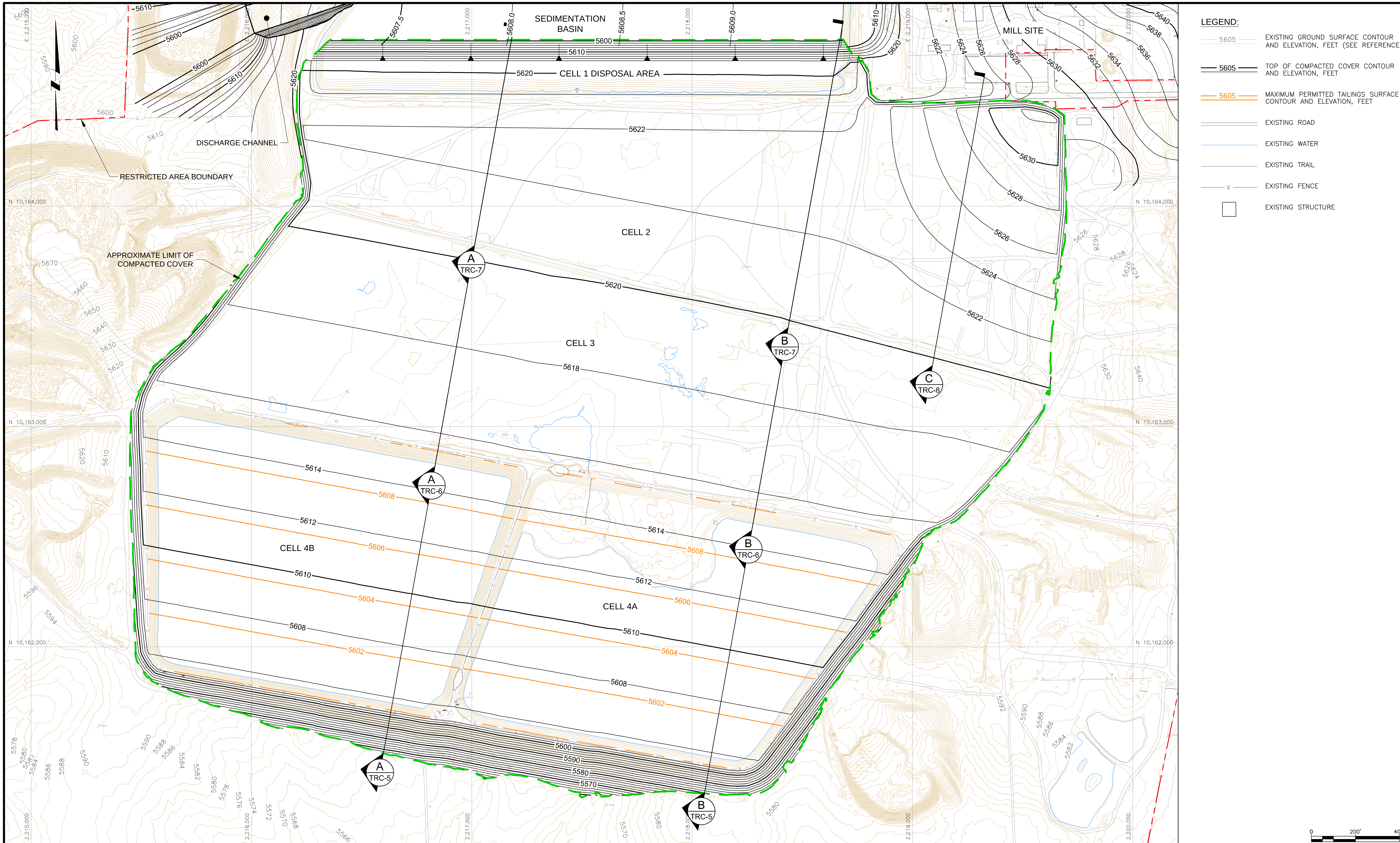

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ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL SITE RECLAMATION

TITLE: COMPACTED COVER GRADING PLAN

MWH

SHEET: TRC-2 | REVISION: C | FILE NAME: WMM TRC-2 | DATE: DEC 2016

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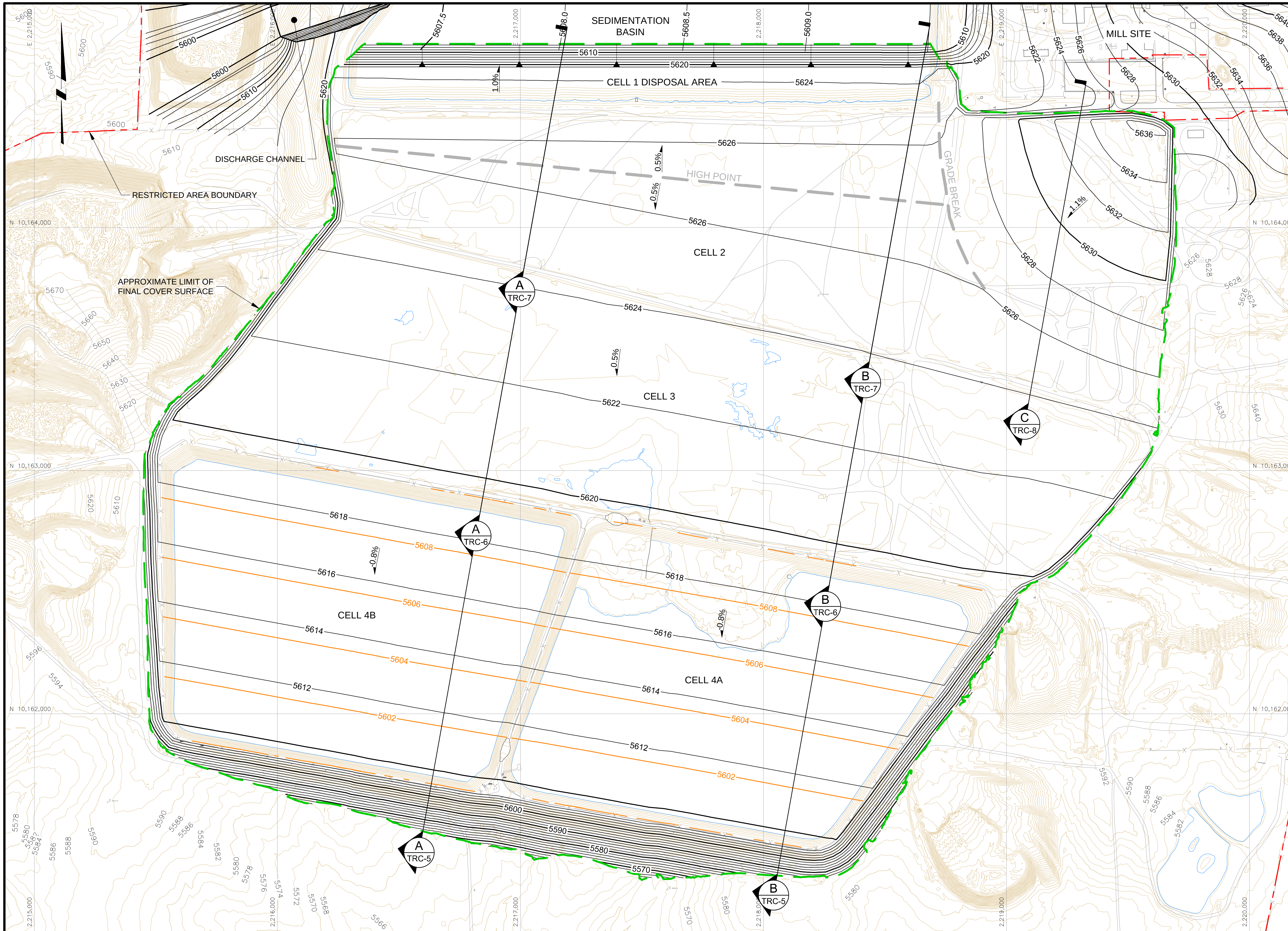

LEGEND:

5605	EXISTING GROUND SURFACE CONTOUR AND ELEVATION, FEET (SEE REFERENCE)
5605	TOP OF FINAL COVER CONTOUR AND ELEVATION, FEET
5605	MAXIMUM PERMITTED TAILINGS SURFACE CONTOUR AND ELEVATION, FEET
	EXISTING ROAD
	EXISTING WATER
	EXISTING TRAIL
X	EXISTING FENCE
	EXISTING STRUCTURE

ISSUE REV	DESCRIPTION	TECH	ENG	DATE
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ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL SITE RECLAMATION

TITLE: FINAL COVER SURFACE LAYOUT

MWH

SHEET: TRC-3 | REVISION: C
FILE NAME: WMM TRC-3 | DATE: DEC 2016

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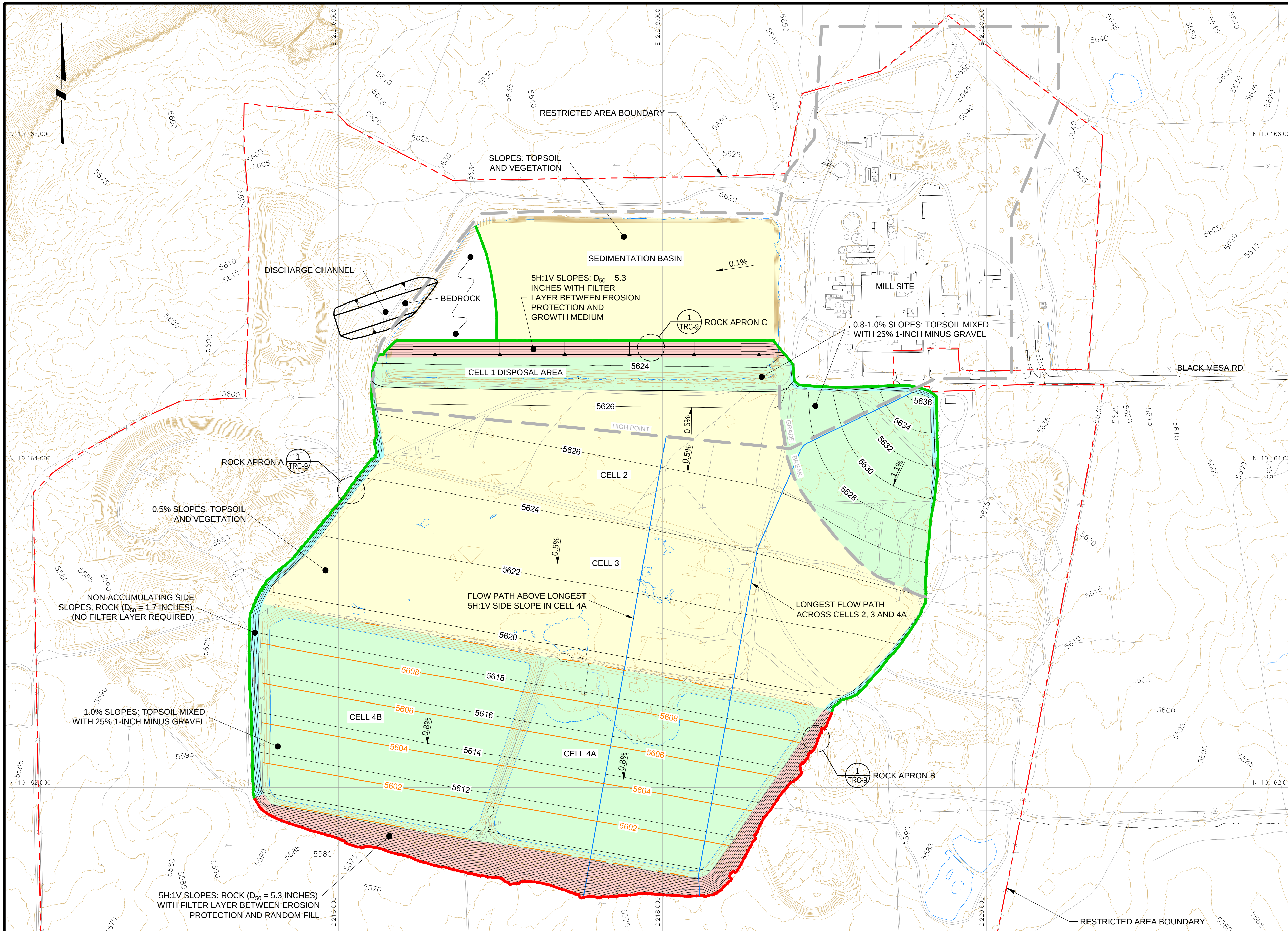

LEGEND:

- 5605 — EXISTING GROUND SURFACE CONTOUR AND ELEVATION, FEET (SEE REFERENCE)
- 5605 — TOP ON INTERIM FILL CONTOUR AND ELEVATION, FEET
- 5605 — MAXIMUM PERMITTED TAILINGS SURFACE CONTOUR AND ELEVATION, FEET
- EXISTING ROAD
- EXISTING WATER
- EXISTING TRAIL
- EXISTING FENCE
- EXISTING STRUCTURE

FINAL COVER SURFACE

- TOPSOIL AND VEGETATION
- TOPSOIL WITH GRAVEL AND VEGETATION
- ROCK

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
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CLIENT APPROVAL		
CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH
PROJECT: WHITE MESA MILL SITE RECLAMATION
TITLE: RECLAMATION COVER EROSION PROTECTION

MWH

SHEET: TRC-4
REVISION: C
FILE NAME: WMM TRC-4
DATE: DEC 2016

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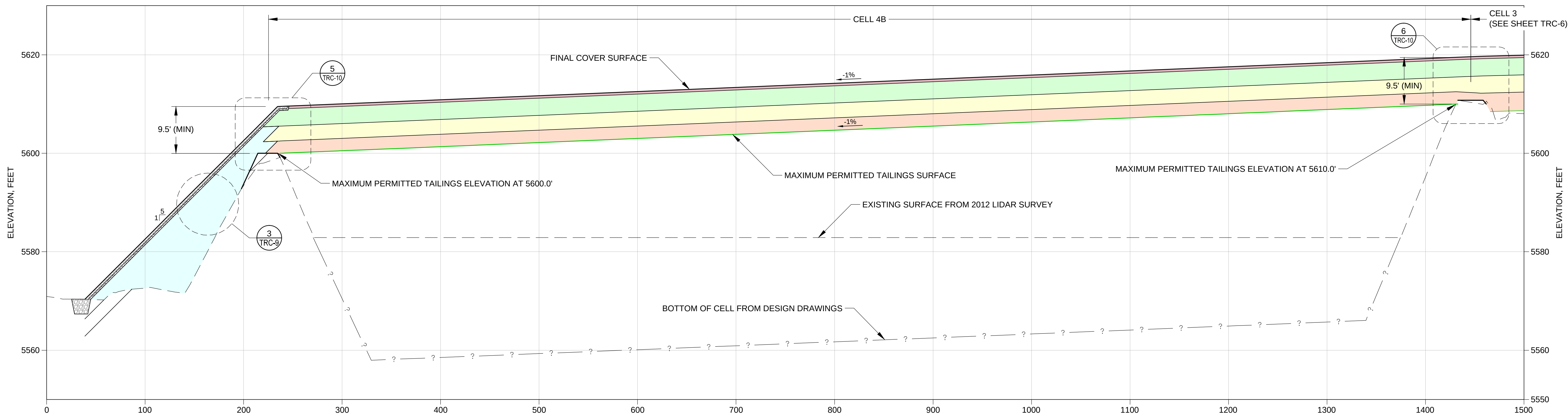
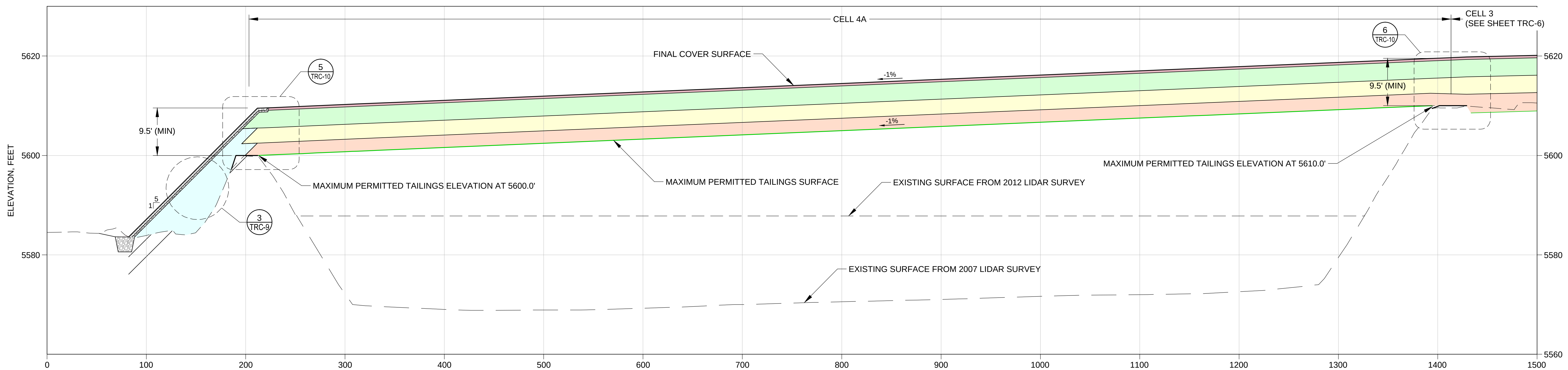


A
TRC-3
TAILINGS COVER

HORZ 0 50 100
VERT 0 10 20
SCALE IN FEET
VERTICAL EXAGGERATION = 5X



B
TRC-3
TAILINGS COVER

HORZ 0 50 100
VERT 0 10 20
SCALE IN FEET
VERTICAL EXAGGERATION = 5X

LEGEND:

- EROSION PROTECTION
- GROWTH MEDIUM
- COMPACTED COVER
- INTERIM FILL
- RANDOM FILL
- RIPRAP
- RIPRAP FILTER

ISSUE REV	DESCRIPTION	TECH	ENG	DATE
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DRAWN BY	K REED	12–16
CHECKED BY	C STRACHAN	12–16
APPROVED BY	C STRACHAN	12–16
PROJECT MANAGER	M DAVIS	12–16
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL SITE RECLAMATION

TITLE: COVER OVER CELL 4A & 4B CROSS SECTIONS

MWH

SHEET: TRC-5 | REVISION: C
FILE NAME: WMM TRC-5 | DATE: DEC 2016

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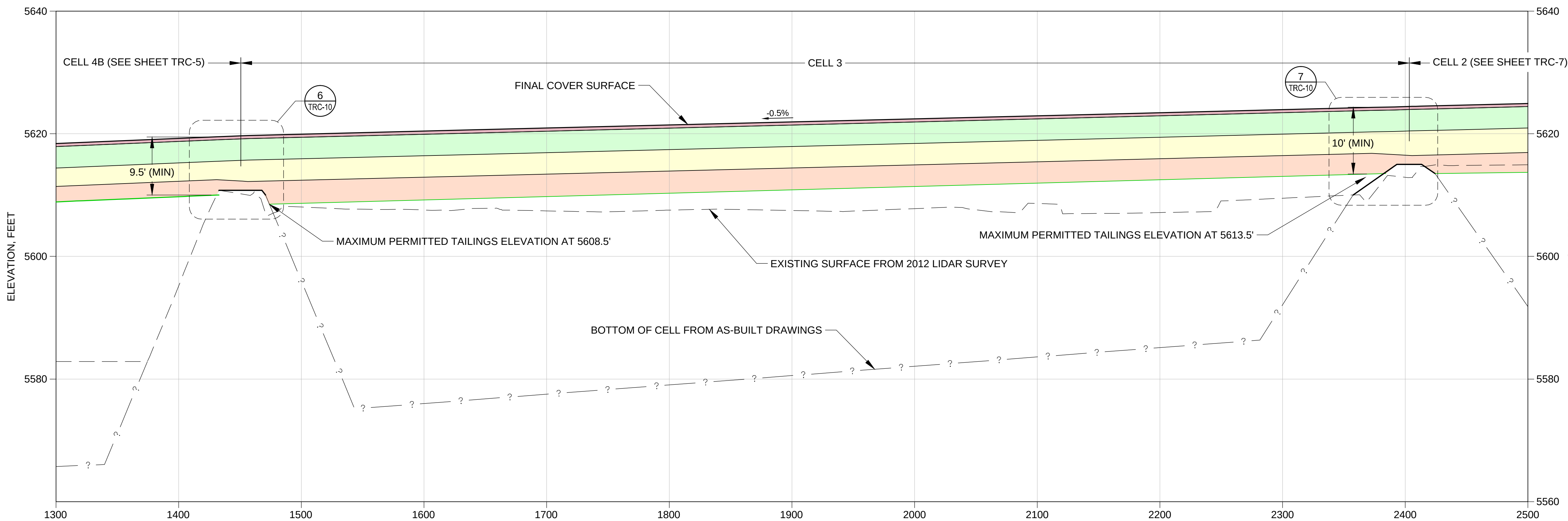
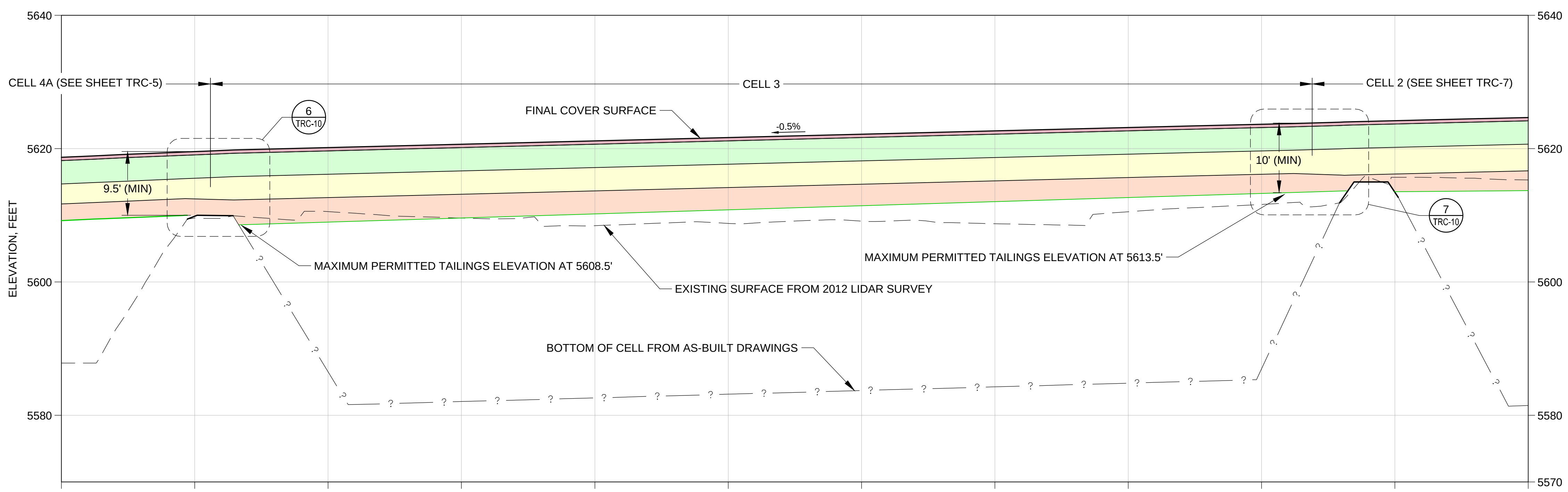


A TRC-3 TAILINGS COVER

HORZ 0 50 100
VERT 0 10 20
SCALE IN FEET
VERTICAL EXAGGERATION = 5X



B TRC-3 TAILINGS COVER

HORZ 0 50 100
VERT 0 10 20
SCALE IN FEET
VERTICAL EXAGGERATION = 5X

LEGEND:

- EROSION PROTECTION
- COMPACTED COVER
- GROWTH MEDIUM
- INTERIM FILL

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APPROVED BY	C STRACHAN	04-16
PROJECT MANAGER	M DAVIS	04-16
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

ENERGY FUELS

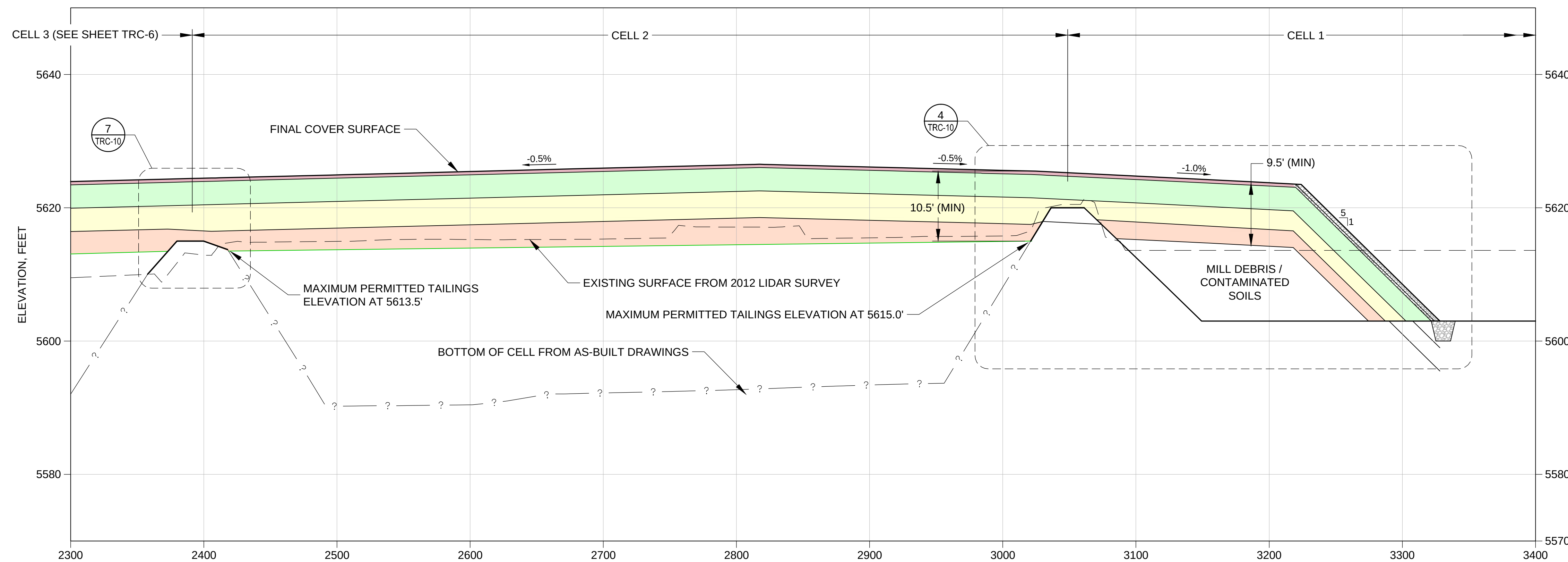
PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL SITE RECLAMATION

TITLE: COVER OVER CELL 3 CROSS SECTIONS

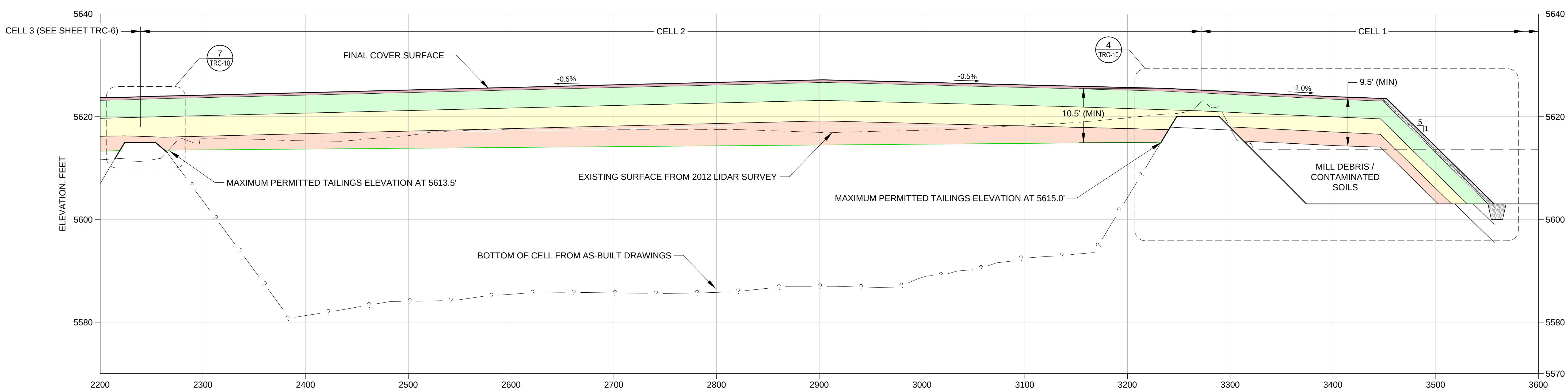
MWH

SHEET: TRC-6
REVISION: C
FILE NAME: WMM TRC-5
DATE: DEC 2016



A TRC-3 TAILINGS COVER

HORZ 0 50 100
VERT 0 10 20
SCALE IN FEET
VERTICAL EXAGGERATION = 5X



B TRC-3 TAILINGS COVER

HORZ 0 50 100
VERT 0 10 20
SCALE IN FEET
VERTICAL EXAGGERATION = 5X

LEGEND:

EROSION PROTECTION
GROWTH MEDIUM
COMPACTED COVER
INTERIM FILL
RIPRAP
RIPRAP FILTER

ISSUE REV	DESCRIPTION	TECH	ENG	DATE
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CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH
PROJECT: WHITE MESA MILL SITE RECLAMATION
TITLE: COVER OVER CELL 2 CROSS SECTIONS

MWH

SHEET: TRC-7
REVISION: C
FILE NAME: WMM TRC-5
DATE: DEC 2016

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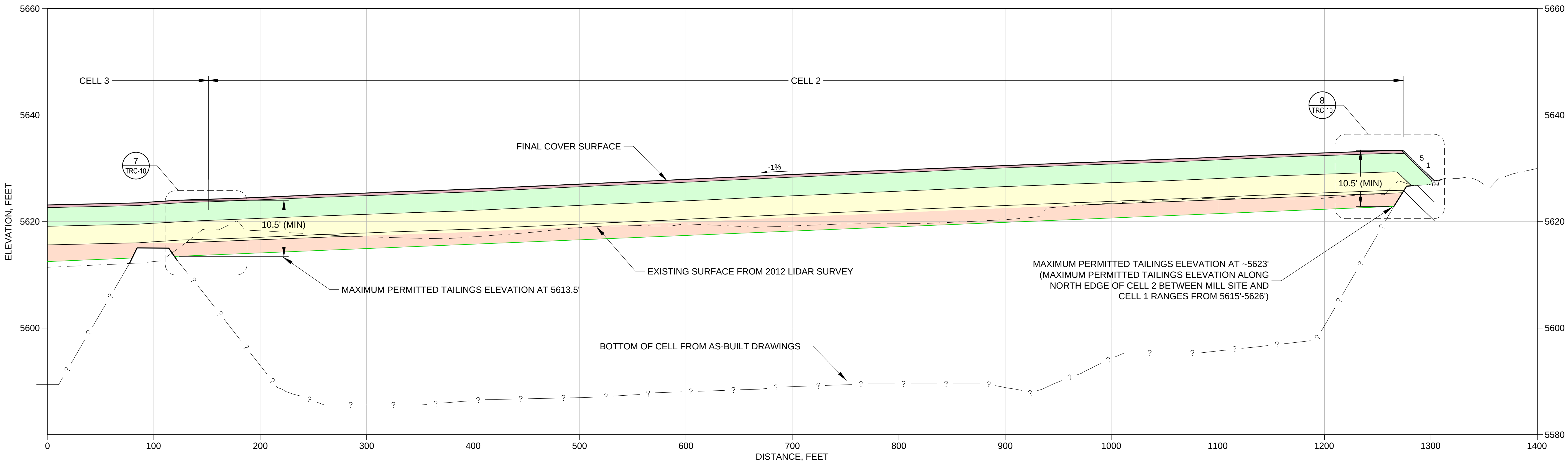

C
TRC-3

TAILINGS COVER

HORZ 0 50 100
VERT 0 10 20
SCALE IN FEET
VERTICAL EXAGGERATION = 5X

LEGEND:

- EROSION PROTECTION
- COMPACTED COVER
- GROWTH MEDIUM
- INTERIM FILL

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PROJECT MANAGER	M DAVIS	04–16
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

ENERGY FUELS

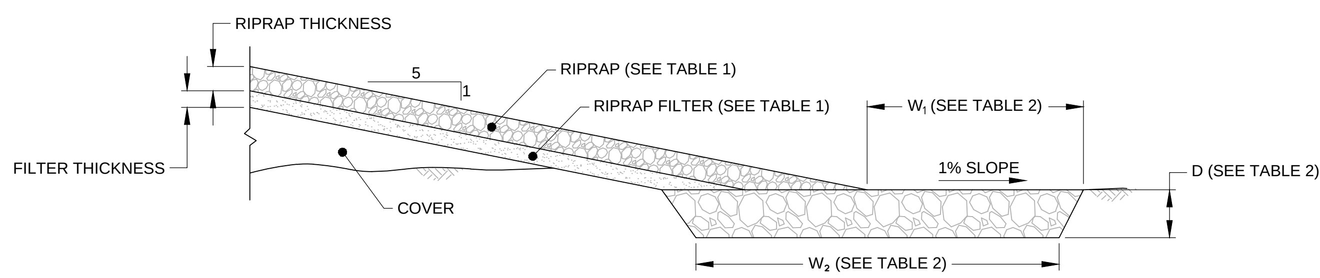
PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL SITE RECLAMATION

TITLE: COVER OVER CELL 2 CROSS SECTION

MWH

SHEET	REVISION
TRC-8	C
FILE NAME: WMM TRC-5	DATE: DEC 2016



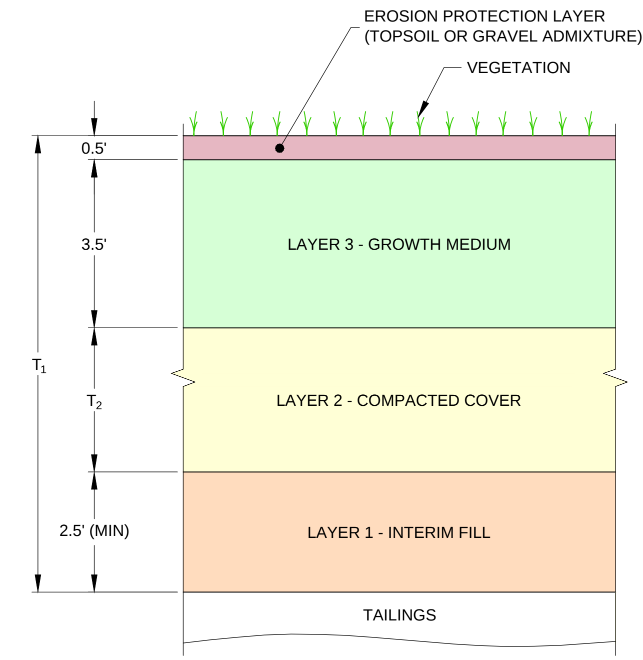
ELEVATION

1 / TRC-4 ROCK APRON AT BASE OF TOE CELL OUTSLOPES

NOT TO SCALE

TABLE 1 - RIPRAP ON SIDE SLOPES				
SIDE SLOPE AREA	RIPRAP D_{50}		FILTER	
	D_{50}	THICKNESS	D_{100}	THICKNESS
EAST & WEST SIDES	1.7"	6"	(NOT NEEDED)	-
CELL 4A & 4B SOUTHERN	5.3"	8"	3"	6"
CELL 1 DISPOSAL AREA	5.3"	8"	3"	6"

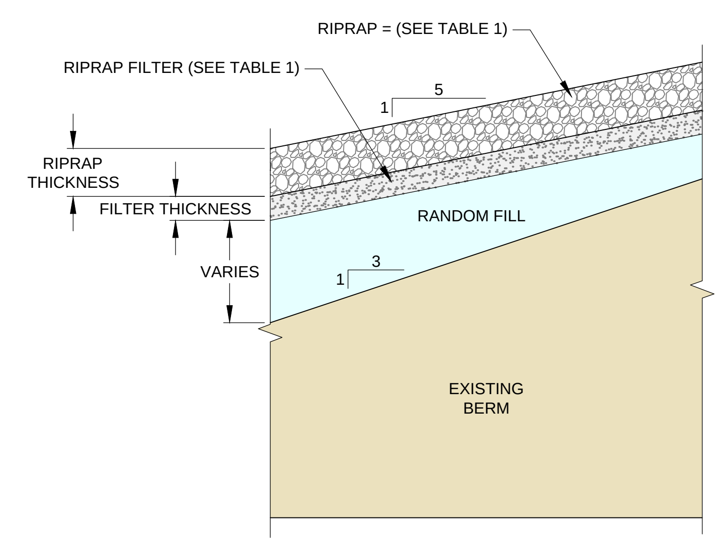
TABLE 2 - ROCK APRON SCHEDULE				
ROCK APRON TYPE	APRON RIPRAP D_{50}	(MINIMUM)		
		W_1	W_2	DEPTH (D)
A	3.4"	4.5'	5.0'	1'
B	10.6"	13.5'	13'	3'
C	9.0"	11.5'	11'	3'



COVER THICKNESS TABLE		
CELL	COVER (T_1)	RADON ATTENUATION LAYER (T_2)
1	9.5'	3.0'
2	10.5'	4.0'
3	10.0'	3.5'
4A & 4B	9.5'	3.0'

2 / - COVER DETAIL FOR TOP SURFACE OF TAILINGS CELLS 2-4 AND CELL 1 DISPOSAL AREA

NOT TO SCALE



LEGEND:

- EROSION PROTECTION
- GROWTH MEDIUM
- COMPACTED COVER
- INTERIM FILL
- RANDOM FILL
- EXISTING BERM
- RIPRAP

3 / - COVER DETAIL FOR SIDE SLOPES

NOT TO SCALE

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ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
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ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

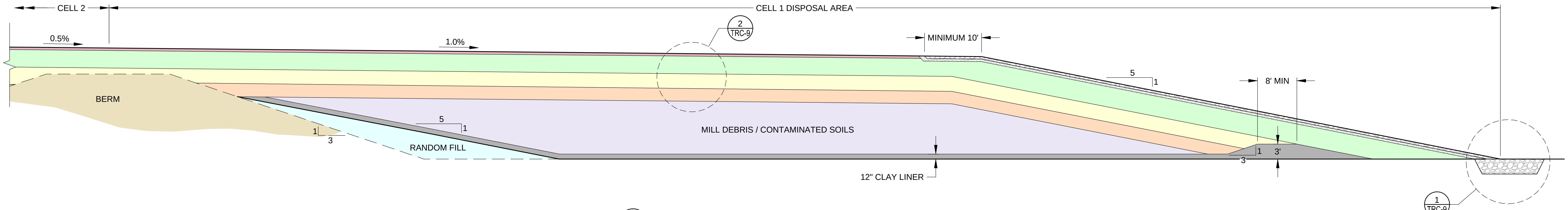
PROJECT: WHITE MESA MILL SITE RECLAMATION

TITLE: RECLAMATION COVER DETAILS (SHEET 1 OF 2)

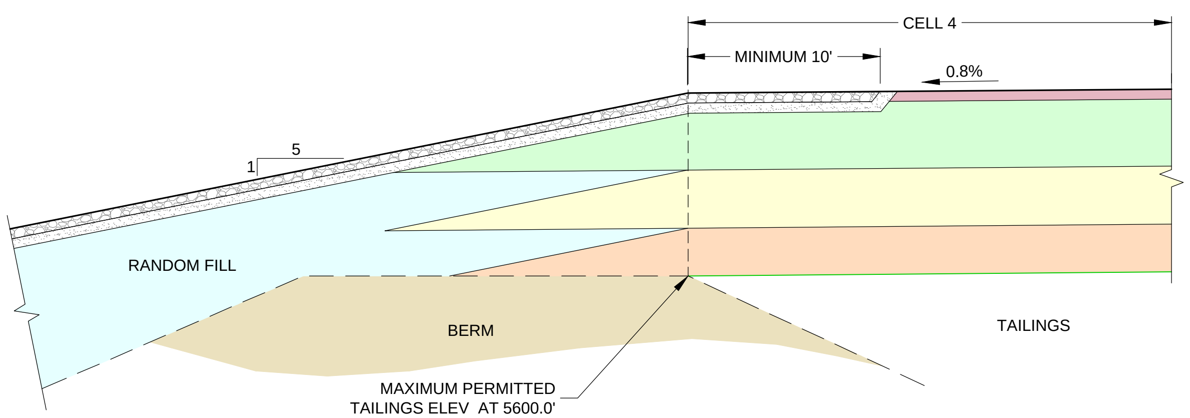
MWH

SHEET: TRC-9 | REVISION: C

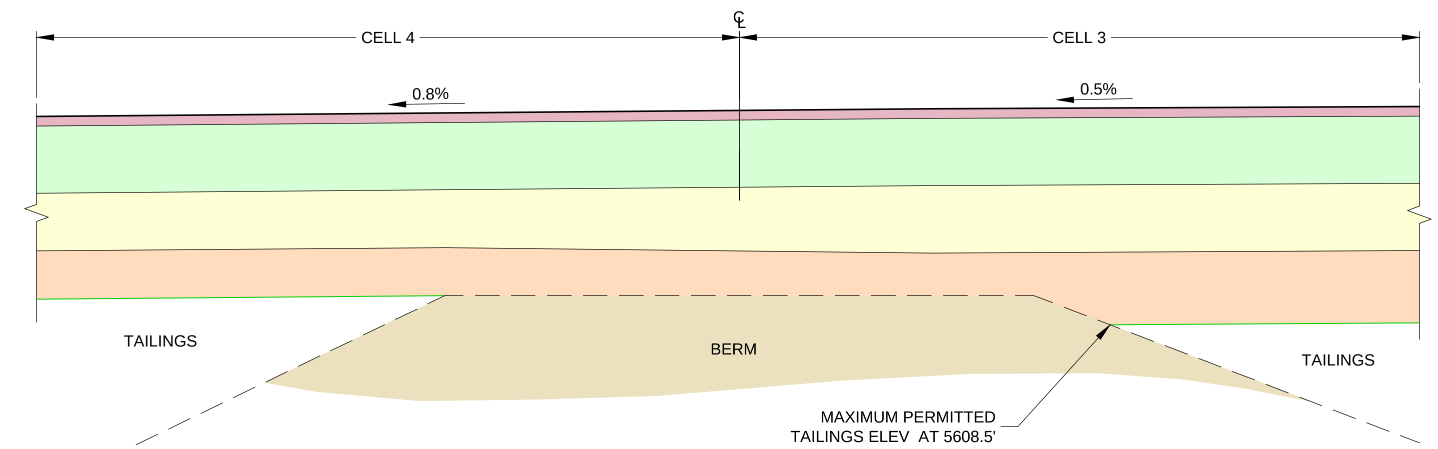
FILE NAME: WMM TRC-9 | DATE: DEC 2016



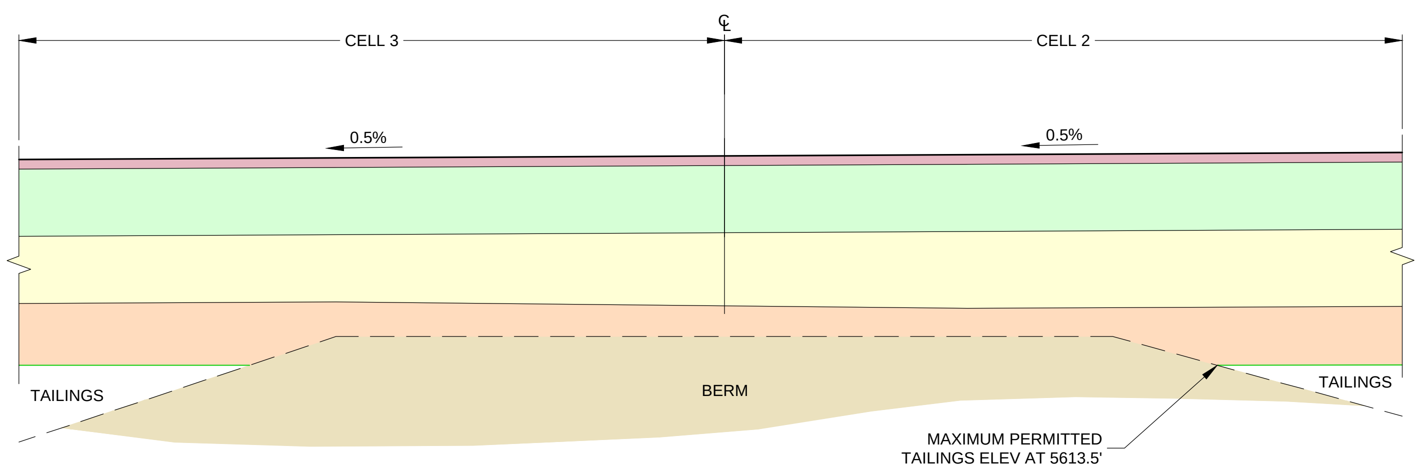
4 TRC-7 COVER DETAIL FOR CELL 1 DISPOSAL AREA



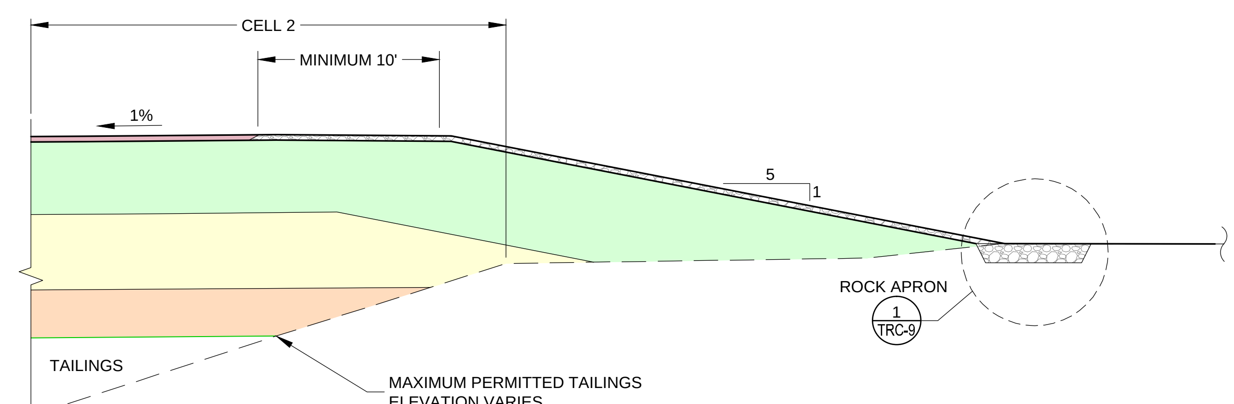
5 TRC-5 COVER DETAIL OVER BERM - SOUTHERN EDGE CELL 4



6 TRC-5 6 TRC-6 COVER DETAIL OVER BERM - BETWEEN CELL 4 AND CELL 3



7 TRC-6 7 TRC-7 7 TRC-8 COVER DETAIL OVER BERM - BETWEEN CELL 3 AND CELL 2



8 TRC-8 COVER DETAIL OVER BERM - NORTHEASTERN EDGE OF CELL 2

LEGEND:

- EROSION PROTECTION
- GROWTH MEDIUM
- COMPACTED COVER
- INTERIM FILL
- RANDOM FILL
- MILL DEBRIS/ CONTAMINATED SOILS
- CLAY
- RIPRAP
- RIPRAP FILTER

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ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL SITE RECLAMATION

TITLE: RECLAMATION COVER DETAILS (SHEET 2 OF 2)

MWH

SHEET	REVISION	FILE NAME	DATE
TRC-10	C	WMM TRC-10	DEC 2016

ATTACHMENT A

TECHNICAL SPECIFICATIONS FOR

RECLAMATION OF WHITE MESA MILL FACILITY

BLANDING, UTAH

TABLE OF CONTENTS

1.0 SPECIAL PROVISIONS

1.1 Scope of Document

The following technical specifications have been prepared for reclamation and decommissioning of the Energy Fuels Resources (USA) Inc. (”EFRI”), White Mesa Uranium Mill Facility (“Mill”) in Blanding, Utah. These technical specifications have been prepared for review and approval by the Utah Department of Environment Quality (“DEQ”), Division of Waste Management and Radiation Control (“DWMRC”) and are submitted as an attachment to the Reclamation Plan. The design drawings for reclamation are attached and are designated as the “Drawings”. The Construction Quality Assurance/Quality Control Plan (“CQA/QC Plan”) referenced in this document is provided as Attachment B to the Reclamation Plan. The Technical Specifications have been written assuming tailings management Cells 2, 3, 4A, and 4B will receive tailings to the maximum permitted tailings elevations. Cell 2 is full and partially reclaimed. Cell 3 was used for tailings storage, but is currently only receiving mill waste. Cell 3 is partially full and partially reclaimed. Cell 4A is the only cell currently receiving tailings and is partially full. Cell 4B is used for evaporation of process solutions and has not been used for storage of tailings. The Technical Specifications have been written assuming Cell 4B will be used in the future for tailings storage.

These technical specifications have been written assuming (a) a contractor will conduct tailings impoundment reclamation under contract with EFRI and under EFRI’s direction (b) the work quality will be checked with independent (third-party) construction quality assurance, and (c) the tailings management system comprised of Cells 2, 3, 4A, and 4B will receive tailings to the maximum permitted tailings elevations.

1.2 Definitions and Roles

Construction Quality Assurance (CQA) – A planned and systematic pattern of means and actions designed to assure adequate confidence that the materials or services meet contractual and regulatory requirements and will perform satisfactorily in service. CQA refers to means and actions employed by the involved parties to assure conformity of the project work with the CQA/QC Plan, the Drawings, and the Technical Specifications.

Construction Quality Control (CQC) – Actions which provide a means to measure and regulate the characteristics of an item or service in relation to contractual and regulatory requirements. CQC refers to those actions taken by the Contractor, technicians, or other involved parties to verify that the materials and the workmanship meet the requirements of the CQA/QC Plan, the Drawings, and the Technical Specifications.

Technical Specifications – The document that prescribes the requirements and standards for the specific elements of the reclamation. The Technical Specifications will be prepared in final form prior to commencement of reclamation activities.

Drawings – The detailed project drawings to be used in conjunction with the Technical Specifications. The Drawings will be prepared in final form as construction drawings prior to reclamation.

Construction Project – The total authorized/approved reclamation project that requires several construction segments to complete.

Construction Segment – A portion of the total construction project involving a specific area or type of work. Several construction segments will likely take place simultaneously during reclamation.

Construction Task – A basic construction feature of a construction segment involving a specific construction activity.

ASTM Standards – The latest versions of the American Society for Testing and Materials specifications, procedures and methods.

For the Technical Specifications, EFRI is referred to as the **Owner**, with overall responsibility for closure, as well as site reclamation.

The on-site **Construction Manager** is responsible for the conduct, direction and supervision of all reclamation activities as detailed in the Drawings and Technical Specifications.

The **Design Engineer** is responsible for the design of the various elements of the reclamation project and for preparing the Drawings and Technical Specifications.

The **Contractor** is defined as the group (or groups) selected by the Owner and responsible for conducting the work tasks outlined in Section 1.3 under the direction of, and under contract with the Owner.

The **Surveyor** is a party, independent from the Owner or Contractor, who is responsible for surveying, documenting, and verifying the location of all significant components of the work.

The **CQA/QC Consultant** is a party, independent from the Owner or Contractor, who is responsible for observing, testing, and documenting the various activities comprising the Reclamation Project in accordance with the CQA/QC Plan, the Technical Specifications and the Drawings.

The **CQA Officer** will be responsible for overall implementation and management of the CQA/QC Plan for the reclamation project.

The **CQA Site Manager** will be appointed by the CQA Consultant to provide day-to-day, on-site oversight of the CQA/CQC activities. The CQA Site Manager could be an employee of the Owner or a third-party consultant.

The CQA Consultant will utilize various **QC Technicians** to assist the on-site CQA Site Manager to perform specific tasks throughout the project to verify the adequacy of construction materials and procedures.

The **Document Control Officer** will be appointed by the Construction Manager to assist with managing the various documents that will be produced throughout the project.

The **CQA Laboratory** is a party, independent from the Owner and Contractor, responsible for conducting tests of soils and other project materials in accordance with ASTM and other applicable standards in either an on-site or off-site laboratory.

The **DWMRC Project Manager** will represent the DWMRC's interests in the reclamation project.

The CQA/QC Plan (Attachment B of the Reclamation Plan) contains more detailed descriptions of the project roles.

1.3 Scope of Work

The work outlined in these Technical Specifications consists of execution of the following tasks associated with reclamation of the tailings management system and associated site reclamation.

- Preparation of borrow areas for material excavation by removal of vegetation; and stripping, salvaging, and stockpiling of topsoil;
- Preparation of material staging and stockpile areas by removal of vegetation; stripping, salvaging, and stockpiling of topsoil; and providing for storm water diversion and internal water collection;
- Removal of raffinates and PVC liner materials from Cell 1 and placement within the last active tailings cell;
- Construction of a clay-lined disposal cell (Cell 1 Disposal Area) along the Cell 1 containment dike for disposal of mill demolition debris and contaminated soils;
- Construction of a sedimentation basin in the location of Cell 1 (does not include the Cell 1 Disposal Area);
- Excavation of process area structure foundations, paved areas, concrete pads and roadways, and placement of these materials in the disposal cell;
- Excavation of contaminated subsoils from the process area, and placement in the last active tailings cell or the Cell 1 Disposal Area.
- Construction of the cover system over the tailings cells, with placement of topsoil and/or topsoil-gravel admixture over the disposal cell cover surface.
- Regrading and placement of topsoil over excavated areas, stockpile and staging areas, and other disturbed areas of the site.
- Establishment of vegetation on the disposal cell surface and surrounding reclaimed areas on site.

The Technical Specifications have been written assuming tailings management Cells 2, 3, 4A, and 4B will receive tailings to the maximum permitted tailings elevations. Cell 2 is full and partially reclaimed. Cell 3 was used for tailings storage, but is currently only receiving mill waste. Cell 3 is partially full and partially reclaimed. Cell 4A is the only cell currently receiving tailings and is partially full. Cell 4B is used for evaporation of process solutions and has not been used for storage of tailings. The Technical Specifications have been written assuming Cell 4B will be used in the future for tailings storage.

Work not included in these Technical Specifications consists of salvage of facility equipment, demolition of facility structures, groundwater monitoring and remediation, and post-reclamation performance monitoring.

1.4 Applicable Regulations and Standards

The work will be conducted to conform with applicable Federal, State, and County environmental and safety regulations, as well as applicable conditions in the Owner's radioactive materials license. Geotechnical testing procedures will follow applicable ASTM standards, as documented in the most current edition of standards in force at the start of work. Personnel safety procedures and monitoring will be conducted in accordance with the Owner's Radiation Protection Manual for Reclamation Activities and as directed by the Radiation Safety Officer ("RSO").

1.5 Permits

The work will be conducted under the Owner's existing radioactive materials license and State of Utah Air Quality Approval Order (DAQE-AN0112050018-11, issue date March 3, 2011). The Contractor will be responsible for applying for, and obtaining (permit fees included), all other necessary permits required to complete the work outlined in these Technical Specifications.

1.6 Inspection and Quality Assurance

In general, the QA/QC Plan details the Owner's organizational structure and responsibilities, qualifications of personnel, operating procedures and instructions, record keeping and document control, and quality control in the sampling procedure and outside laboratory. The Plan will adopt the existing quality assurance/quality control procedures utilized in compliance with the existing license.

The RSO (and approved assistants as needed) will conduct on-site training, and full-time personnel monitoring, and inspection of construction activities while the site reclamation work is in progress. The RSO (and assistants) will be independent representatives of and appointed by the Owner. The responsibilities and duties of the RSO shall be as outlined in the Owner's Protection Manual for Reclamation.

The CQA Site Manager (and approved assistants as needed) will provide on-site inspection of all construction activities and quality assurance testing outlined in these Technical Specifications and the CQA/QC Plan while the construction work is in progress. The CQA Site Manager and assistants will be independent representatives of and appointed by the Owner. The inspection and CQA testing conducted by the CQA Site Manager will be under the supervision of the Reclamation Project Manager. Inspection and CQA testing will include the tasks described in the CQA/QC Plan and listed below.

a. Observation of construction practices and procedures for conformance with the Technical Specifications.
b. Testing material characteristics to ensure that earthen materials used in the construction conform to the requirements in the Technical Specifications.
c. Documentation of construction activities, test locations, samples, and test results.
d. Notification of results from quality assurance testing to the Owner and the Contractor.
e. Documentation of field design modifications or approved construction work that deviates from the Technical Specifications.

The CQA Site Manager will record the documentation outlined above on a daily basis. The Reclamation Project Manager will approve deviations from the Technical Specifications (if necessary), with notification to the Owner and DWMRC or other appropriate Utah state regulatory agency personnel. Quality control procedures have been developed for reclamation and presented in Attachment B of this Reclamation Plan. Procedures will be used for testing, sampling, and inspection functions.

1.7 Construction Documentation

During construction, the CQA Site Manager will record documentation of construction inspection work on a daily basis. Documentation will include the following items.

a. Work performed by the Contractor.
b. CQA testing and surveying work conducted.
c. Discussions with the Owner and the Contractor.
d. Key decisions, important communications, or design modifications.
e. General comments including: weather conditions, work area surface conditions, and visitors to the site.

All earthwork test results will be documented on a daily basis, with a copy of the results given to the CQA Site Manager by the end of the following working day after the testing.

The CQA Site Manager or his representative will take photographs of key construction activities and critical items for documentation.

A final construction completion report, documenting the as-built conditions of the tailings impoundment reclamation components will be submitted to DWMRC at the end of construction. This report will include the following items.

a. All design modifications or changes to the Technical Specifications that were made during construction.

b. An as-built layout of the facility prior to, and at the completion of reclamation construction.

c. An as-built layout of other reclaimed areas of the site.

d. Documentation of soil cleanup verification work (soil radiation survey and soil sampling and analyses) in areas of contaminated soil excavation.

e. Documentation of the revegetation work (soil amendments, seed mix, and vegetation establishment).

1.8 Design Modifications

Design modifications (due to unanticipated site conditions or field improvements to the design) will be made following the protocol outlined below.

a. Communication of modification with the Reclamation Project Manager.
b. Submittal to, and review by, DWMRC for approval prior to implementation.
c. Documentation of modification(s) in the construction completion report.

1.9 Environmental Requirements

The Contractor shall store materials, confine equipment, and maintain construction operations according to applicable laws, ordinances, or permits for the project site. Fuel, lubricating oils, and chemicals shall be stored and dispensed in such a manner as to prevent or contain spills and prevent said liquids from reaching local streams or groundwater. If quantities of fuel, lubricating oils or chemicals exceed the threshold quantities specified in Utah regulations, the Contractor shall prepare and follow a Spill Prevention Control and Countermeasures Plan (SPCCP), as prescribed in applicable Utah regulations. The Owner will approve said plan. Used lubricating oils shall be disposed of or recycled at an appropriate facility. The Contractor shall be responsible for disposal of all waste associated with the project work.

1.10 Water Management

The Contractor shall construct and maintain all temporary diversion and protective works required to divert storm water from around work areas. The Contractor shall furnish, install, maintain, and operate all equipment required to keep excavations and other work areas free from water in order to construct the facilities as specified.

Water required by the Contractor for dust suppression or soil-moisture conditioning will be obtained from the Owner.

1.11 Historical and Archeological Considerations

The Contractor shall immediately notify the Owner if materials of potential historical or archeological significance are discovered or uncovered. The Owner may stop work in a specific area until the materials can be evaluated for historical, cultural, or archeological significance. All materials determined to be of significance will be protected during the work, as determined by appropriate regulatory agencies, including removal or adjustment of work areas.

1.12 Health and Safety Requirements

Work outlined in these Technical Specifications will be conducted under the Owner's Radiation Protection Manual for Reclamation Activities, as directed by the RSO.

The Contractor shall suspend construction or demolition operations or implement necessary precautions whenever (in the opinion of the Reclamation Project Manager or RSO) unsatisfactory conditions exist due to rain, snow, wind, cold temperatures, excessive water, or unacceptable traction or bearing capacity conditions. The CQA Site Manager, Reclamation Project Manager, and RSO each have the authority to stop Contractor work if unsafe conditions or deviations from Technical Specifications are observed.

1.13 Personnel Monitoring

Programs currently in place for monitoring of exposures to employees will remain in effect throughout the time period during which tailings cell reclamation, mill decommissioning and clean up of windblown contamination are conducted. These programs will include personnel monitoring and the ongoing bioassay program. Access control will be maintained at the Restricted Area boundary to ensure employees and equipment are released from the site in accordance with the current License conditions. In general, no changes to the existing programs are expected and reclamation activities are not expected to increase exposure potential beyond the current levels. The Owner will assign an employee to act as RSO responsible for assuring site workers comply with the Owner's Radiation Protection Manual for Reclamation Activities and the requirements set forth in the Owner's radioactive materials license.

1.14 Environmental Monitoring

Existing environmental monitoring programs will continue during the time period in which reclamation and decommissioning is conducted as applicable. This includes monitoring of surface and groundwater, airborne particulates, radon, soils and vegetation, according to the existing License conditions as applicable. As site features are reclaimed, monitoring programs for those features may cease. Any changes will be approved by DWMRC prior to the cessation of monitoring. In general, no changes to the extent of the existing programs are expected because reclamation activities are not expected to increase exposure potential beyond the current levels.

2.0 SITE CONDITIONS

2.1 Site Location

The White Mesa Mill site is located about 6 miles south of Blanding, Utah in San Juan County, along County Road 191.

2.2 Climate and Geology

The climate of southeastern Utah is classified as dry to arid continental. Although varying somewhat with elevation and terrain, the climate in the vicinity of the Mill can be considered as semi-arid with normal annual precipitation of about 13.3 inches. The mean annual relative humidity is about 44 percent and is normally highest in January and lowest in July. The average annual Class A pan evaporation rate is 68 inches (NOAA, 1977), with the largest evaporation rate typically occurring in July. (Denison, 2009)

The Mill is located within the Blanding Basin of the Colorado Plateau physiographic province. The average elevation of the site is approximately 5,600 ft (1,707 m) above mean sea level (amsl). Typical of large portions of the Colorado Plateau province, the rocks underlying the site are relatively undeformed. The site is underlain by unconsolidated alluvium and indurated sedimentary rocks consisting primarily of sandstone and shale. The alluvial materials consist mostly of aeolian silts and fine-grained aeolian sands with a thickness varying from a few feet to as much as 25 to 30 ft (7.6 to 9.1 m) across the site. The alluvium is underlain by the Dakota Sandstone and Burro Canyon Formation, which are sandstones having total thicknesses ranging from approximately 100 to 140 ft (31 to 43 m). (Denison, 2009)

2.3 Past Operations

The mill is a uranium/vanadium mill that was developed in the late 1970's by Energy Fuels Nuclear, Inc. (“EFN”) as an outlet for the many small mines located in the Colorado Plateau and for the possibility of milling Arizona strip ores. Construction on the tailings area began on August 1, 1978. The Mill was operated by EFN from the initial start-up date of May 6, 1980 until the cessation of operations in 1983 and then intermittently under different ownership through present-day. Denison (then named International Uranium (USA) Corporation), and its affiliates, purchased the assets of EFN in May 1997. Energy Fuels Resources (USA), Inc. purchased the facility in 2012 and is the current owner.

2.4 Facilities Demolition

Demolition of equipment, structures, and associated facilities at the Mill site will be conducted according to applicable conditions of the radioactive materials license, the demolition plan for the facility, and the Owner's Radiation Protection Manual for Reclamation Activities. Facilities demolition is not included in this document.

2.5 Disposed Materials

Materials to be placed in the disposal and tailings cells consists of process waste materials, structural debris, underlying liner materials, and subsoils from planned site cleanup activities. Additional detail on each material type is outlined later in the Technical Specifications. The four major types of materials are outlined below:

- Raffinate Crystals – located in Cell 1
- Synthetic Liner – PVC liner from Cell 1
- Contaminated Soils - soils located in and around the Mill site with concentrations exceeding prescribed unity rule concentrations (see Section 6)
- Mill Debris – all equipment and structures from the demolition of the mill

2.6 Construction Materials

Construction materials for the disposal cell liner, cover system, and for erosion protection of the cover and discharge channel will include soils and aggregates from on-site and off-site sources. These materials are outlined below.

2.6.1 Liner Materials

The disposal cell will be constructed, prior to the placement of contaminated soils and mill demolition debris, with a compacted clay liner. The soils will be obtained from suitable materials stockpiled on site during cell construction.

2.6.2 Random Fill

Random fill will be used within the disposal cell and tailings cells, placed on and around mill material and debris and placed for the components of the cover system. Fill materials will be obtained from soils stockpiled on site.

2.6.3 Topsoil

Topsoil for the surface of the disposal cell and surrounding areas to be revegetated will be obtained from on-site stockpile areas.

2.6.4 Topsoil-Gravel Admixture

A mixture of gravel and topsoil will be used in select areas on the cover. The sources of rock are nearby commercial sources of alluvial gravel. Topsoil-gravel admixture shall meet the particle-size distribution requirements outlined in Section 8.

2.6.5 Riprap

A layer of riprap will be placed on the side slopes and on the perimeter apron of the disposal cell as well as within the discharge channel. The sources of riprap are nearby commercial sources of alluvial gravel and cobbles. Riprap shall meet the particle-size distribution and durability requirements outlined in Section 8, and shall meet requirements for rock durability outlined in NRC (1990) and Johnson (1999, 2002).

2.6.6 Filter Materials

Filter layer materials will be obtained from an off-site local commercial source or from select on-site borrow areas.

2.6.7 Granular Materials

Granular materials will be used for filter material and may also be used for subsurface fill for the cell base. These materials will be obtained from off-site commercial sources of alluvial sand and gravel.

2.7 Staging and Stockpile Areas

Areas on site identified as staging areas or stockpile locations will be approved by the Owner. These areas will be constructed and used in a manner consistent with the Owner's plans for storm water management. The Contractor shall maintain proper erosion control measures for stockpiles and may be required to cover piles in situations where precipitation is anticipated.

2.8 Access and Security

Access to the site will be controlled at gated entrances in the existing restricted area fencing. All gated entrances and security for the Mill property will be maintained by the Owner.

2.9 Utilities

Utilities on site will be maintained by the Owner outside of work areas (areas to be demolished or reclaimed). Utilities inside of work areas will be provided and maintained by the Contractor.

2.10 Sanitation Facilities

The Contractor, in accordance with the Owner's Radiation Protection Manual for Reclamation Activities, will maintain sanitation facilities required during construction.

3.0 WORK AREA PREPARATION

3.1 General

This section describes the preparation of site areas for reclamation. This work will be conducted according to applicable sections of the Owner's Radiation Protection Manual for Reclamation Activities.

3.2 Water Management

Preparation for work in the site area will include water management tasks outlined below.

a. Removal of raffinate crystals from Cell 1.

Breaching of the Cell 1 dike for constructing the cell as a sedimentation basin. Re-routing runoff from the mill area and areas immediately north of the cell into the sedimentation basin for discharge onto the natural ground via the channel to be located at the southwest corner of the basin.

Diversion of clean area storm water runoff from work areas (where facilities demolition and material excavation will take place) and from the disposal cell footprint area.

Collection of storm water runoff from within the work areas and the disposal cell footprint for treatment and permitted discharge, or for disposed material compaction or dust control. The planned storage location for this affected storm water is the sedimentation pond.

Isolation of water used for processing operations associated with reclamation from storm water runoff. Water from processing operations or other contaminated water will not be used for disposal cell construction.

3.3 Cell Construction

A clay-lined disposal area will be constructed within Cell 1 (Cell 1 Disposal Area) for permanent disposal of contaminated material and debris from Mill site decommissioning. The disposal area will be located immediately north of the existing dike between Cells 1 and 2. The disposal footprint area will be lined with a compacted clay liner prior to placement of contaminated materials and installation of the final reclamation cover. If there is not sufficient debris, rubble and contaminated soil to fill the Cell 1 Disposal Area as designed, the footprint of the Cell 1 Disposal Area can be reduced to decrease the horizontal dimension extending out from Cell 2 and the lateral extent of the disposed materials, to be closer to the base of the Cell 2 dike. If a design modification is required for the Cell 1 Disposal Area, it will be submitted to DWMRC for review and approval, and these Technical Specifications will be revised accordingly.

3.4 Soil Borrow Areas

Fill cover and liner materials for the disposal cell will be excavated from suitable materials stockpiled in identified borrow areas on site. Specific soil borrow areas will be selected based on haul distance to the disposal cell, ease of excavation of cover material, geotechnical characteristics, uniformity of the borrow material, and acceptable radiological and geochemical characteristics.

Borrow area preparation will consist of setup for storm water management (Section 3.2) and clearing and stripping (Section 3.5).

3.5 Clearing and Stripping

In work areas with vegetation, preparation work will include tasks outlined below.

3.5.1 Clearing

Clearing of vegetation and grubbing of roots will be in identified work areas. Clearing and grubbing shall not extend beyond 20 feet from the edge of the work area, unless as shown on the Drawings or as approved by the Reclamation Project Manager.

Vegetation from clearing and grubbing may be shredded or chipped to form mulch. Alternative methods of on-site or off-site disposal or burning of stripped vegetation shall be conducted only as approved by the Reclamation Project Manager.

3.5.2 Stripping

Stripping of salvageable topsoil (if present) shall be done within the entire work area. Stripping of topsoil shall not extend beyond 10 feet from the edge of the work area, unless approved by the Reclamation Project Manager. The depth of stripping of reclamation soil shall be based on the presence of suitable topsoil and approved by the Reclamation Project Manager. Water shall be applied to the areas of excavation and soil salvage to minimize dust generation.

Topsoil shall be stockpiled in approved areas. The final stockpile surface shall be graded and smoothed to minimize erosion and facilitate interim revegetation of the stockpile surfaces.

4.0 CELL 1 DISPOSAL AREA BASE CONSTRUCTION

4.1 General

This section outlines work associated with construction of the disposal cell base (Cell 1 Disposal Area) for receipt of materials (as described in Section 7.0) within Cell 1. The Cell 1 Disposal Area will be constructed as shown on the Drawings and outlined in these Technical Specifications.

4.2 Materials Description

4.2.1 Subgrade Fill

The disposal cell footprint is likely to have an irregular surface from contaminated material excavation. Low areas of the excavated surface shall be filled with subgrade fill to form a smooth, competent foundation for clay liner construction (shown on the Drawings).

Subgrade fill will consist of off-site granular materials, or soils and weathered sedimentary rock from approved on-site excavation areas. Subgrade fill shall have a maximum size of 6 inches and shall be free from roots, branches, rubbish, and process area debris.

4.2.2 Clay Liner Material

Clay liner material shall have a maximum particle size of one inch, and shall be free from roots, branches, rubbish, and process area debris. Clay liner material shall have a minimum of 40 percent passing the No. 200 sieve and a minimum plasticity index (PI) of 15 percent.

4.3 Work Description

4.3.1 Foundation Preparation

The footprint of the disposal cell shall form a competent foundation for clay liner and cover construction. The surface of the disposal cell footprint shall be filled with subgrade fill (where required) in low areas to form a smooth, competent foundation for clay liner and cover construction. The final filled surface shall be compacted with approved construction equipment to provide a foundation surface with uniform density for clay liner placement.

4.3.2 Disposal Cell Foundation Area

The footprint of the disposal cell is established along the north side of the dike between Cells 1 and 2 (shown on the Drawings).

4.3.3 Subgrade Fill Placement

Subgrade fill (Section 4.2.1) shall be placed in lifts with a maximum loose thickness of 12 inches and compacted in excavated areas of the disposal cell footprint to meet desired grades and elevations for the disposal cell foundation.

4.3.4 Clay Liner Material Placement

Clay liner material (Section 4.2.2) shall be placed in lifts with a maximum loose thickness of 6 inches to form a continuous layer with a total minimum compacted layer thickness of 12 inches. Clay liner material shall be placed over the prepared subgrade surface of the disposal cell (Section 4.3.1).

Compaction of the clay liner material shall be done with a sheepsfoot or tamping-foot roller of sufficient weight to achieve the required compaction specifications. Compaction of the clay liner material shall not be achieved solely through the use of rubber-tired equipment.

If the moisture content of any layer of clay liner is outside of the allowable placement moisture content range specified (Section 4.4.2), the material shall be moistened and/or reworked with a harrow, scarifier, or other suitable equipment to a sufficient depth to provide relatively uniform moisture content and a satisfactory bonding surface before the next layer of clay material is placed. If the compacted surface of any layer of clay liner material is too wet (due to precipitation) for proper compaction of the fill material to be placed thereon, it shall be reworked with a harrow, scarifier or other suitable equipment to dry out the layer and reduce the moisture content to within the required limits, and re-compacted.

Clay liner construction shall minimize lenses, pockets, streaks or layers of material differing substantially in texture, gradation or moisture content from the surrounding material. Oversized material will be controlled through observation of placement by a qualified individual with authority to stop work and reject material being placed and by culling oversized material from the fill.

No clay liner material will be placed when either the materials, or the underlying material, is frozen or when ambient temperatures do not permit the placement or compaction of the materials to the specified density without developing frost lenses in the fill.

Any holes in the clay liner material resulting from testing shall be repaired by hand by filling with clay fill, or by filling with bentonite powder which is hydrated to fully seal the hole.

4.4 Performance Standards and Testing

Lifts of material with tested dry densities less than the specified values will be reworked by the Contractor as necessary and re-compacted until the specified dry density is attained. Material that is too dry or too wet to permit bonding of layers during compaction will be reworked by the Contractor until the moisture content is within the specified limits.

4.4.1 Subgrade Testing

Subgrade fill shall be placed in lifts not exceeding 8 inches in loose thickness. Each lift shall be compacted to a minimum of 90 percent of standard Proctor (ASTM D698) density and within 3 percent of the optimum moisture content for the material.

Where required, checking of compaction of compacted subgrade fill and the final subgrade surface will consist of a minimum of one field density test per 1,000 cubic yards of material compacted. A minimum of two tests will be taken for each day that more than 150 cubic yards of material is placed. A minimum of one test per lift and at least one test for every full shift of compaction operations will be taken.

Field density tests will be compared with standard Proctor tests (ASTM D698 Method A or C). Where required, standard Proctor or Maximum Index Density tests will be conducted at a frequency of at least one test per 10,000 cubic yards of material compacted, or when material characteristics show significant variation.

Field density testing will be conducted with the sand cone test (ASTM D1556) or a nuclear density gauge (ASTM D6938, or as modified by the CQA Site Manager). Correlation of nuclear density gauge results will be by comparison with results from sand cone test(s) and laboratory testing for water content(s) using the oven drying method (ASTM D2216) on similar material.

4.4.2 Clay Liner Testing

Each lift of clay liner material shall be compacted to at least 95 percent of the maximum dry density for the material, as determined by the standard Proctor test (ASTM D698). During compaction, the material shall be within 2 percent of the optimum moisture content for the material, as determined by the standard Proctor test. If water addition is required to achieve this range of moisture contents, the added water shall be thoroughly mixed into the material prior to compaction.

Material specifications for the clay liner material will be confirmed by gradation testing conducted by approved personnel. Testing will consist of No. 200 sieve wash and maximum particle size testing (ASTM D422), and Atterberg limits testing (ASTM D4318) on samples of clay liner materials, at a frequency of at least one test per 2,000 cubic yards of fill placed, or when material characteristics show a significant variation.

Compaction of the clay liner material will be checked with a minimum of one field density test per 500 cubic yards of material compacted. A minimum of two tests will be taken for each day that more than 150 cubic yards of material is placed. A minimum of one test per lift and at least one test for every full shift of compaction operations will be taken.

Field density tests will be compared with standard Proctor tests (ASTM D698 Method A or C) on the same material. Standard Proctor tests will be conducted at a frequency of at least one test per 5,000 cubic yards of material compacted, or when material characteristics show significant variation.

Field density testing will be conducted with the sand cone test (ASTM D1556) or a nuclear density gauge (ASTM D6938, or as modified by the CQA Site Manager). Correlation of nuclear density gauge results will be by comparison with results from sand cone test(s) and laboratory testing for water content(s) using the oven drying method (ASTM D2216) on similar material.

4.4.3 Grading Tolerances

The completed grading for the clay liner shall be within 1.0 foot (horizontally) of the lines as designed, and within 0.1 foot (vertically) of the elevations as designed. The final surfaces shall be smoothed to avoid abrupt changes in surface grade or areas of runoff concentration. The layer thicknesses shall meet the required minimum thicknesses.

5.0 DISCHARGE CHANNEL GRADING

5.1 General

This section outlines specifications for the work associated with excavating the discharge channel from Cell 1. Portions of the grading for the sedimentation basin may be in soil, while other areas may require rock excavation. Although the rock may be rippable, the Contractor should prepare for non-rippable rock in some of the excavation areas.

5.2 Work Description

5.2.1 Discharge Channel Excavation

The discharge channel shall be excavated to the slopes and grades and channel widths shown on the Drawings. Discharge channel excavation will include breaching of the dike on the west side of Cell 1. Riprap will not be required to armor the discharge channel where the channel is excavated into competent sedimentary rock, as verified in the field by the CQA Site Manager.

5.2.2 Grading Tolerances

Completed grading in soil for the sedimentation basin shall be within 1.0 foot (horizontally) of the lines as designed, and within 0.1 foot (vertically) of the elevations as designed. Final surfaces shall be smoothed to avoid abrupt changes in surface grade or areas of runoff concentration.

The completed grading in rock for the discharge channel and portions of the sedimentation basin shall be within 2.0 foot (horizontally) of the lines as designed, and within 0.5 foot (vertically) of the elevations as designed. The final excavated rock surfaces of the discharge channel will be below design grades and shall not be filled to make grade.

6.0 MILL DECOMMISSIONING

The following subsections describe decommissioning plans for the mill buildings and equipment, the mill site, and associated windblown contamination.

6.1 Mill Buildings and Equipment

The uranium and vanadium processing areas of the Mill, including all equipment, structures and support facilities, will be decommissioned by demolition and disposed of in tailings or buried on site as appropriate. All equipment, including tankage and piping, agitation equipment, process control instrumentation and switchgear, and contaminated structures will be cut up, removed and buried in tailings prior to final cover placement. Concrete structures and foundations will be broken up and removed. Concrete foundations may be left in place and covered with soil as appropriate.

Decommissioned areas will include the following:

- Coarse ore bin and associated equipment, conveyors and structures
- Grind circuit including semi-autogeneous grind (SAG) mill, screens, pumps and cyclones
- Three pulp storage leach tanks to the east of the mill building, including all tankage, agitation equipment, pumps and piping
- Seven leach tanks inside the main mill building, including all agitation equipment, pumps and piping
- The counter-current decantation (CCD) circuit including all thickeners and equipment, pumps and piping
- Uranium precipitation circuit, including all thickeners, pumps and piping
- Two yellow cake dryers and all mechanical and electrical support equipment, including uranium packaging equipment
- Clarifiers to the west of the mill building including the preleach thickener (PLT), clarifier, and claricone area

- The boiler and all ancillary equipment and buildings
- The entire vanadium precipitation, drying and fusion circuit
- All external tankage not included in the previous list including reagent tanks for the storage of acid, ammonia, kerosene, water, dry chemicals, etc. and the vanadium oxidation circuit
- The ammonium sulfate pad
- The uranium and vanadium solvent extraction (SX) circuit including all SX and reagent tankage, mixers and settlers, pumps and piping
- The SX building
- The mill building
- The alternate feed processing circuit
- The decontamination pads
- The office building
- The shop and warehouse building
- The sample plant building
- The reagent storage building

The sequence of demolition will proceed so as to allow the maximum use of support areas of the facility such as the office and shop areas. It is anticipated that all major structures and large equipment will be demolished using hydraulic shears. This equipment will expedite the process, provide proper sizing of the materials for transport and placement, and reduce personnel exposure to radiation and other safety hazards during the demolition. Uncontaminated or decontaminated equipment to be considered for salvage and remediation equipment will be released in accordance with the terms of License Condition 9.10 and NUREG 1575 Supplement 1, Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual (MARSAME) (NRC, 2009) as appropriate and applicable. Contaminated soils from the Mill area will be disposed of in the tailings cells in accordance with Section 7.0.

6.2 Mill Site and Windblown Contamination

Areas with contamination around the Mill site are expected to be primarily surficial, except for the claricone and ammonium sulfate pad areas, and include the ore storage area and limited surface contamination of roads. Ore and alternate feed materials will have been previously removed from the ore stockpile area. Contaminated materials at the Mill site will be excavated and be disposed in the Cell 1 Disposal Area in accordance with Section 7.0. The depth of excavation will vary depending on the extent of contamination and will be based on the criteria in Section 7.2.3, except for the claricone and ammonium pad areas which had removal depths and extents outlined in letters submitted by EFRI to the DWMRC on 10/26/12 and 12/23/13, respectively. All other 11e.(2) byproduct materials will be disposed in the tailings cells.

The Owner proposes to reclaim the Mill and surrounding land areas within the property boundary by excavating and placing wastes, demolition debris and contaminated soils into a fenced and controlled permanent disposal area. The permanent disposal area, the current restricted area, and the property boundary, are delineated in Drawing REC-1. The Owner proposes to survey and release all areas within the property boundary, excluding the Cell 1 Disposal Area and Cells 2, 3, 4A, and 4B, for unrestricted use.

Contaminants of concern are Ra-226, Th-230 and natural uranium (U-nat). The evaluation and remediation will be dictated by Ra-226, which is the contaminant with the most restrictive cleanup standard (based on the SENES Consultants, Inc. letter to EFRI dated August 15, 2012; this letter was provided as Attachment I to EFRI's Supporting Documentation for Response to Utah DWMRC Interrogatory 13/1 (SENES 2012)). The correlation between Ra-226 and the remaining two contaminants will be developed as outlined in subsequent sections of these Technical Specifications. Verification of the remediation will be established through a Wilcoxon Rank Sum (WRS) test between the study areas and local background areas. The procedure for verification will follow guidance from NUREG-1575 Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC, 2000). The procedure will include:

- Scoping and characterization surveys: soil samples will be collected to develop a correlation between gamma radiation levels and the unity rule.
- Classification of land areas: to (MARSSIM) Class 1 through Class 3.
- Remediation of land areas driven by correlation-based prediction equation between gamma radiation and the unity rule for multiple radionuclides.
- Final Status Survey using the Wilcoxon Rank Sum (WRS) test with local background areas.

The procedure also follows the Data Quality Objective (DQO) process defined in the MARSSIM Guidance, as discussed in Section 6.6, and NUREG-1757 Volume 2 Consolidated Decommissioning Guidance, Characterization, Survey, and Determination of Radiological Criteria (NRC, 2006).

6.3 Scoping and Characterization Surveys

Areas contaminated through process activities or windblown contamination from the tailings areas will be remediated to meet applicable cleanup criteria for Ra-226, Th-230, and U-nat. Contaminated areas will be remediated such that the residual radionuclides remaining on the site, which are distinguishable from background, will not result in a dose that is greater than that which would result from the Ra-226 soil standard, that is, 5 pCi/g above background for the surface 15 cm soil layer and 15 pCi/g for the subsurface 15 cm soil layer, respectively as discussed in Section 6.6.3.3 and hereafter referred to as “5/15”.

An initial scoping survey for windblown contamination will be conducted based on analysis of pertinent past radiometric and land use information. Operational surveys of the areas surrounding the Mill and tailings area have indicated potential windblown contamination only to the north and east of the ore storage area, and to the southwest of Cell 3. The initial scoping survey will be conducted using calibrated gamma radiation instruments on 15 meter (15 m) transects. Additional surveys will be conducted in a halo, or buffer zone, around the projected impact area. The survey in the halo will be conducted using 25 m transects. Areas where no readings exceed 75 percent of the gamma radiation guideline value, as developed per Section 6.3.2, will be classified as unaffected, and will not require remediation. Areas where one or more readings exceed the gamma radiation guideline value will be further investigated to determine whether or not remediation is required.

Prior to initiating cleanup of windblown contamination, a statistically-based soil sampling program will be conducted in an area within or outside the property boundary that is similar to the areas to be remediated, to determine the average background Ra-226 concentration, or concentrations, to be ultimately used for the cleanup. Similarity, or representativeness, will be determined based on geology, soil type and soil chemistry.

Soil cleanup verification will be accomplished by use of calibrated gamma radiation instruments. Multiple instruments will be maintained and calibrated to ensure availability and consistency during remediation efforts (Section 6.3.4).

6.3.1 Scoping and Characterization Survey for the Subsurface

The subsurface will only be investigated in areas where the historical site assessment (HSA) demonstrates the possibility of contamination below the 15 cm depth. This does not include areas of windblown contamination, or the ore storage area (unless also affected by an event demonstrated by the HSA). The method for the subsurface investigation will include boreholes where soil sampling and downhole gamma radiation investigations may occur. This method will be developed based on the HSA.

6.3.2 Gamma Radiation to Unity Rule Correlation

The Owner plans to use radiation measurement instrumentation for soil background analyses, unity rule – gamma radiation correlations, verification data, and sensitivity analyses. Soil background analyses will be completed using MARSSIM methods (NRC, 2000) for background reference areas.

Soil samples taken during characterization for correlation will be analyzed by a certified laboratory to determine the on-site correlation between the gamma radiation readings and the concentration of Ra-226, Th-230 and U-nat, in the samples. Samples will be taken from:

- Areas known to be contaminated with only processed uranium materials (i.e. tailings sand and windblown contamination)
- Areas in which it is suspected that unprocessed uranium materials (i.e. ore pad and windblown areas downwind of the ore pad) are present

The actual number of samples used will depend on the correlation of the results between gamma radiation readings and the unity rule as discussed below. Windblown contamination to the northeast of the Mill area is primarily associated with the unprocessed ore from the ore storage pad. The slightly larger windblown contamination area to the southwest of the Mill area is primarily associated with the processed tailings. A minimum of 35 samples of windblown tailings (to the southwest), and 15 samples of windblown unprocessed ore materials (to the northeast) will be collected.

Sufficient samples will be collected for developing prediction equations to calculate the linear regression lines and the corresponding upper and lower 95 percent confidence levels for each of the instruments. The upper one-sided 95 percent confidence limit will be used for the guideline value for correlation between gamma radiation readings and Ra-226 concentration. Because the unprocessed materials are expected to have proportionally higher values of uranium in relation to the Ra-226 and Th-230 content, the correlation to the gamma radiation readings are expected to be slightly different than readings from areas known to be contaminated with only processed materials. Areas expected to have contamination from both processed and unprocessed materials will be evaluated using the more conservative correlation, or will be excavated to the Ra-226 standard which should ensure that the uranium is removed.

The samples will be judgmentally selected with Ra-226 concentration at three different intervals related to the guideline value (5 pCi/g above background):

- 25 percent of the guideline value
- Approximately the guideline value
- Approximately twice the guideline value for the area of interest

This selection will maximize the precision of the correlation relationship at 5.0 pCi/g above background. Background Ra-226 concentrations have been gathered over a 16-year period at sample station BHV-3 located upwind and 5 miles west of the Mill. The Ra-226 background concentration from this sampling location is 0.93 pCi/g. This value and the concentrations of U-nat and Th-230 assumed in equilibrium with the Ra-226 will be used as an interim value for the background concentration used only in the initial planning for this project (e.g. use of historical knowledge for preliminary setting of verification sample sizes). Background locations for the verification test will have the three contaminants measured at multiple locations.

Because Ra-226 has short-lived radioactive decay products that are strong gamma radiation emitters (namely Pb-214 and Bi-214), gamma radiation surveys can be effective for characterizing soil Ra-226 distributions across large areas, including on relatively small spatial scales. The well-established, effective, and widely-used analytical approach for spatially comprehensive characterization of Ra-226 concentrations in surface soils involves spatially intensive gamma radiation surveys combined with the use of gamma radiation and soil Ra-226 concentration correlations.

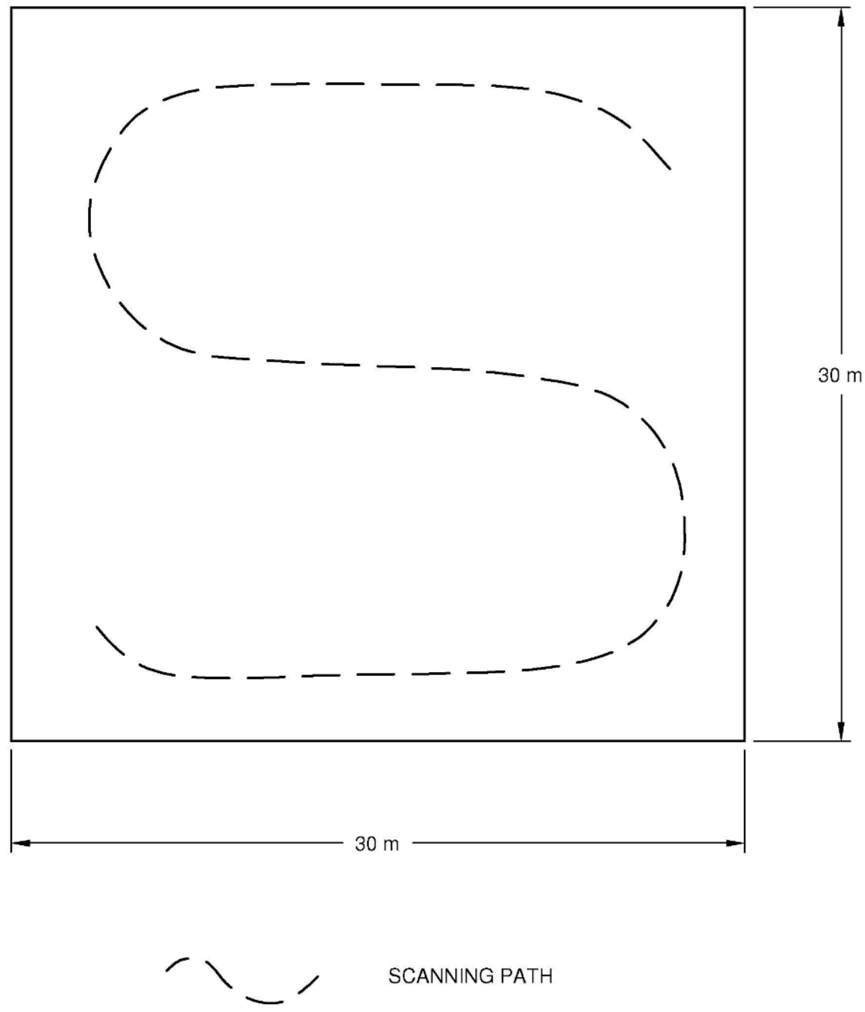
If a gamma radiation and Ra-226 concentration correlation is statistically significant, Ra-226 concentrations in surface soils can be predicted with reasonable accuracy based on gamma radiation readings collected at a high density of measurements across large areas. The same is true for other radionuclides, although correlative relationships tend to be less statistically significant and estimation uncertainty can be higher. The advantage of gamma radiation surveys is that a much higher density of measurements of terrestrial sources of gamma radiation is possible and when combined with gamma radiation/soil radionuclide correlation analysis, the approach produces a more comprehensive spatial characterization for comparisons against baseline conditions and evaluation of potential radiological contamination.

Fifteen soil samples will be collected in the restricted area to establish a correlation between the soil sampling analysis and the gamma radiation count. Additional measurement locations will be added, if necessary, to reach suitable precision, as defined in Section 6.6.3.7. The method that will be used in an effort to develop statistically significant gamma radiation/soil radionuclide correlations is as follows:

1. At each correlation plot, a 100 m^2 (10 m x 10 m) plot for correlation measurements and soil sampling will be established with pin flags. A gamma radiation scan will be performed across each correlation plot (5 m transects at a detector height of 18 inches). The average gamma radiation reading (e.g. cpm) from scan data across each correlation plot will be calculated and recorded in the field logbook, or developed using data collected from the gamma radiation scan. See Figure A-1 for the scan path.
2. Within each 10 m x 10 m correlation plot nine sub-samples of surface soils, one in the center, and eight against the edges of the plot, will be collected across the plot (at a depth of 15 cm) and composited into a single sample to represent average soil radionuclide characteristics across the correlation plot. Composite surface soil samples from each correlation plot will be submitted to a qualified commercial laboratory for analysis of U-nat, Ra-226, Th-230, Th-232 (by Ra-228), and K-40. The correlation plot scanning and sampling design for each location is illustrated in Figure A-1.
3. The laboratory chain of custody/analysis request form to be submitted with composite correlation plot soil samples will specify the following requirements:
    a. Thorough homogenization of each sample at the laboratory.
    b. Ra-226 analysis by EPA Method 901.1, modified for soil samples, with sample counting to be performed at least 21 days after sealing in the counting tin to ensure full ingrowth of Rn-222 and its decay products. Analysis of K-40 will also be conducted with EPA method 901.1, as will analysis of Ra-228 (to determine Th-232 concentrations under the assumption of radiological equilibrium).
    c. U-nat analysis by EPA Method 200.8 (ICP-MS) or equivalent, preferably with soil matrix digestion using EPA Method 3052 (microwave assisted acid digestion). EPA Method 3050B or equivalent digestive methods may alternatively be used; however, digestion will not be as complete.

d. Th-230 analysis by EPA Method 200.8 (ICP-MS) or equivalent, preferably with soil matrix digestion using EPA Method 3052 (microwave assisted acid digestion). Ten percent of the correlation plot samples will also be analyzed for Th-230 by alpha spectroscopy.

4. Upon receiving soil analysis results from the laboratory, regression analysis will be performed to determine, based on paired data from all correlation plots, if significant statistical correlations exists between average gamma radiation readings and soil Ra-226, U-nat, Th-230, Th-232 by Ra-228 and K-40 concentrations.



ENERGY FUELS	PROJECT: WHITE MESA MILL TAILINGS RECLAMATION	MWH
	TITLE: TYPICAL SCANNING PATH SCOPING SURVEY	DATE: SEP 2011 / FIGURE A-1 / FILE NAME: 1009740 SCAN PATH

6.3.3 Area Classification

The characterization and scoping surveys will be used to classify areas as either non-impacted or impacted areas. The impacted areas will be further classified into Classes 1-3 (NUREG-1575; NRC, 2000). The classification of the areas will determine the rigor required to survey and release the areas.

- Class 1 areas are areas which have, or had prior to remediation, a potential for radioactive contamination based on Mill operating history, or known contamination based on previous radiological surveys. Areas containing contamination in excess of the release criterion, specifically the Derived Concentration Guideline Level (DCGL) associated with the Wilcoxon Rank Sum Test ($DCGL_W$), established by the radium benchmark dose (RBD) approach in Section 6.6.3.3 prior to remediation should be classified as Class 1 areas. The concentration terms "$DCGL_W$", "release criterion", and "unity rule", have been used interchangeably throughout the remainder of these Technical Specifications. However, where a gamma radiation-based level is meant, the term "gamma guideline level" is used specifically.

- Class 2 areas are areas which have, or had prior to remediation, a potential for radioactive contamination or known radioactive contamination, but are not expected to exceed the $DCGL_W$.

- Class 3 areas are any impacted areas not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the $DCGL_W$, based on Mill operating history and previous radiological surveys.

Table 6.1 - Final Status Survey Unit Classification for Land Areas

Survey Unit Classification		Statistical Test	Elevated Measurement Comparison	Sampling and/or Direct Measurements	Suggested Area (m^2)	Scanning
Impacted	Class 1	Yes	Yes	Systematic	2000	100% Coverage
	Class 2	Yes	Yes	Systematic	10,000	10-100% Systematic
	Class 3	Yes	Yes	Random	No limit	Judgmental
Non-Impacted		No	No	No	None	None

6.3.4 Remediation

Remediation will only occur in survey units that cannot pass the release criterion ($DCGL_W$). Remediation will consist of excavation of soils and placement in the tailing cells, as stated in Section 7.2.3. Remedial action support surveys will be conducted to guide the remediation. Remedial action support surveys will be conducted in a manner similar to the Final Status Surveys (FSSs), described in Sections 6.4 and 6.6, to ensure that the remedial action achieves the $DCGL_W$. Excavation will continue until the gamma radiation guideline value is achieved for surface soils.

Upon completion of remediation, gamma radiation surveys will be conducted on the excavated area and areas surrounding the excavation.

6.4 Final Status Surveys

Areas of the site will be released through the final status survey (FSS) process (see Section 6.6). Survey units will be released through FSS reports provided to DWMRC for each survey unit. Survey units that require remediation will undergo the FSS process after remediation. Survey units must meet the release criterion set forth in this section. Each survey unit that meets the release criterion will be released, pending DWMRC approval.

6.4.1 Release Criterion

Release criteria have been established and are discussed in more detail in Section 6.6.

6.4.2 Statistical Test

The WRS test will be performed using the background reference data set and the systematic sample data set from the survey unit under investigation. The background reference data set will be added to the unity rule (1) prior to the statistical test being completed. The two data sets will be derived using the weighted sum for multiple radionuclides set forth in MARSSIM (NRC, 2000):

For surface soils:

$$\frac{A\ (pCi/g\ Ra226)}{5\ (pCi/g)} + \frac{B\ (pCi/g\ \ Unat)}{545\ (pCi/g)} + \frac{C\ (pCi/g\ \ Th230)}{46\ (pCi/g)} + 1$$

For subsurface soils:

$$\frac{A\ (pCi/g\ \ Ra226)}{15\ (pCi/g)} + \frac{B\ (pCi/g\ \ Unat)}{2908\ (pCi/g)} + \frac{C\ (pCi/g\ \ Th230)}{142\ (pCi/g)} + 1$$

For instance, if the background reference area surface soil data set showed that one sample contained 2.2 pCi/g Ra-226, 2.2 pCi/g U-nat, and 2.0 pCi/g Th-230, the sample would be represented in the WRS data set as the following:

$$\frac{2.2\ (pCi/g\ \ Ra226)}{5\ (pCi/g)} + \frac{2.2\ (pCi/g\ \ Unat)}{545\ (pCi/g)} + \frac{2.0\ (pCi/g\ \ Th230)}{46\ (pCi/g)} + 1 = 1.49$$

Thus, 1.49 (unitless) for this particular background sample would be used in the WRS comparison data set for the background reference area to be compared to the survey unit data. If this sample were from the survey unit, the value would be 0.49 (unitless).

The WRS test will be performed on the survey unit and background reference area using the method in MARSSIM. For Class 1 to Class 3 survey units, the null hypothesis is that the survey unit exceeds the release criterion. If the null hypothesis is rejected, the mean for the survey unit does not exceed the $DCGL_W$, and no area exceeds the DCGL Elevated Measurement Comparison ($DCGL_{EMC}$) then the survey unit is presumed to meet the release criterion and, pending DWMRC approval, released.

If an area in a survey unit exceeds the $DCGL_W$, the area of the contamination will be determined using a mixture of soil sampling and gamma radiation surveying.

A comparison to the EMC will be made to determine if the area presents a dose equal to, or lower than, the $DCGL_W$ scenario. This determination will be completed through the derivation of area factors based on the size of hypothetical areas of contamination. The area factor for a contaminated area will be multiplied by the $DCGL_W$ to determine the allowable contaminant concentration for that size of area, which still meets the unity rule. Area factors will be determined prior to FSS's and will be approved by DWMRC.

Areas of elevated activity that do not meet the $DCGL_{EMC}$ will be remediated.

6.5 Instrument Quality Assurance/Quality Control (QA/QC)

Field gamma radiation survey instrumentation will be sodium iodide (NaI) detectors. To the extent possible, the same instruments will be use throughout the characterization, remediation and final status survey. These instruments will be cross-calibrated to allow other identical instruments or similar instruments to be used. Individuals will be appropriately trained to use the selected instrumentation and the instrumentation will be suitable for its intended use. Instrumentation shall be operated in accordance with written procedures and manufacturers' manuals which will provide guidance to field personnel on the proper use and limitations of the instruments.

6.5.1 Calibration

The manufacturer's current calibration/maintenance records will be kept on site for review and inspection for all instruments used during the survey. Past calibration records will be retained for inclusion in the FSS report.

The records will include, at a minimum, the following:

- Equipment identification (name, model, and serial number)
- Manufacturer
- Date of calibration
- Calibration due date

Instrumentation must be maintained and calibrated to manufacturer's specifications to ensure that required traceability, sensitivity, accuracy, and precision of the equipment/instruments are maintained. Instruments will be maintained and calibrated in accordance with American National Standards Institute N323A (ANSI, 1997).

6.5.2 Source and Background Checks

Prior to and after daily use, instruments will be QC-checked by comparing the instrument's response to a designated gamma radiation source and to ambient background. Prior to commencement of field operations, a site reference location will be selected for the performance of these checks. Acceptable ranges (count rate) for each instrument will be established by performing a series of counts. The acceptable range will be ± 2 sigma of the mean of the series of counts. QC source checks will consist of one-minute integrated counts with the designated source position in a reproducible geometry, performed at the designated location. Background checks will be performed in an identical fashion with the source removed. Results of the background and QC checks will be recorded in a field logbook.

Instrument response to the designated QC check source will be plotted on control charts or in tabular form (spreadsheets) and evaluated against the average source and background readings established at the start of the field activities. A performance criterion of +/– 2 sigma of this average will be used as an investigation action level, and a repeat of the measurement will be performed. A performance criterion of +/– 3 sigma of this average will be used as a failure level requiring corrective action. Results exceeding this criterion will be investigated and appropriate corrections to instrument readings will be made if the response is affected by factors beyond personnel control, such as large humidity or temperature changes. The instrument(s) in question will be removed from service while investigations and corrective actions are in progress.

Instrument response to ambient background will be used to establish a mean background response for each instrument, to monitor gross fluctuations in background activity (e.g., from changes in barometric pressure and other, non-contaminant related causes), and to evaluate detector response. The background measurements are performed for the purpose of checking for detector contamination and electronic stability (especially cabling).

Instrument response to source checks are used to prove detector efficiency and electronics stability.

During QC checks, instruments shall be inspected for physical damage, current calibration and erroneous readings. The individual performing these tasks shall document the results in accordance with the instrument protocol within MARSSIM, as provided in Exhibit A-1. Instrumentation that does not meet the specified requirements of calibration, inspection, or response check will be removed from operation. If the instrument fails the QC response check, any data obtained to that point, but after the last successful QC check will be considered invalid due to potentially faulty instrumentation.

6.6 Data Quality Objectives

This plan was developed using guidance from MARSSIM to ensure surveys are conducted with the proper rigor, quality assurance, and statistical analysis to make proper decisions. A key step in the MARSSIM process is the development of DQOs. DQOs ensure collection of data of the right type, quality, and quantity to support decisions, the decommissioning process, and the achievement of the desired end state. The DQOs are outlined below, and include systematic processes to:

1) State the problem
2) Identify the goal of the characterization
3) Identify inputs to the decision
4) Define the study boundaries
5) Develop the decision rules/analytical approach
6) Define acceptable decision errors
7) Optimize the design

6.6.1 State the Problem

Ultimately, the mill will be decommissioned, the demolition and decommissioning waste disposed in the tailings cells, and the tailings system reclaimed as approved by DWMRC. The reclamation objective is to release the mill's land areas, other than the tailings area, for unrestricted use. Land areas may have radiological contamination from milling operations. The scanning procedure needs to identify and distinguish areas that can be released, from areas that must be remediated prior to being released. The data collected following excavation in remediation areas must also be suitable for use in the FSS to demonstrate that the clean-up criteria have been met.

6.6.2 Identify the Decisions

The decision process will be based on data from scoping and characterization surveys, gamma radiation correlation, remediation and final status surveys.

Survey and sampling data will be used to:

1) Assist in classification of survey units

2) Determine areas requiring remediation

3) Develop Final Status Surveys to verify that clean-up criterion has been met

6.6.3 Identify Inputs to the Decision

6.6.3.1 Characterization and Scoping

HSAs, scoping surveys, and characterization surveys will be used to determine the extent of the contamination as well as the presence of useable relationships/ratios between the radionuclides of background reference areas. The presence of useable relationships will be established in accordance with Section 4.5 of MARSSIM (NRC, 2000). Soil sampling will be conducted in the survey areas and samples will be analyzed for U-nat, Th-230 and Ra-226.

The background must be correctly characterized and a proper background reference area chosen to represent the background for the Mill soils. This will ensure that the soil will be cleaned up to the appropriate level. Goals of the characterization include selecting an appropriate background reference area(s) and appropriate background(s), and correctly comparing selected background(s) with the survey units. Multiple backgrounds may be selected for different survey units depending on the characterization and scoping surveys in conjunction with the HSA.

From MARSSIM Section 4.5, a site background reference area should have similar physical, chemical, geological, radiological, and biological characteristics as the survey unit being evaluated. Background reference areas are normally selected from non-impacted areas, but are not limited to natural areas undisturbed by human activities. In some situations, a reference area may be associated with the survey unit being evaluated, but cannot be potentially contaminated by site activities. For example, background measurements may be taken from core samples of a building or structure surface, pavement, or asphalt. The selected reference areas will be reviewed with DWMRC.

Systematic soil sampling will occur prior to the FSS, and samples will be analyzed for Ra-226, Th-230, and U-nat to determine background concentrations to be used for the cleanup. The soil sampling to determine the average background radionuclide concentrations to ultimately be used for the cleanup will be conducted prior to remediation. Background sampling will be conducted in a reference area within or outside of the property boundary that is similar to the area to be remediated.

Background reference areas will be chosen such that they are representative of the survey unit locations but are non-impacted from site operations. Representativeness shall be determined on the basis of geomorphology, geological, geochemical, and radiological, considerations.

6.6.3.2 Correlation

A correlation of the unity rule in the soil to the gamma radiation will be developed. This correlation will guide remediation and excavation. This correlation is explained in Section 6.3.2.

Remediation of the soil to meet the unity rule is described in Section 6.3.4. The final status survey reports will be the definitive source of information to describe the final impacts on the soil left by the Mill. The reports will detail how the cleanup met the Site Cleanup Criteria and show that each survey unit meets the cleanup criteria. The FSS reports will verify that the remediation has achieved the cleanup criteria.

6.6.3.3 Site Cleanup Criteria

The DCGLs for Ra-226 are set at 5 pCi/g for the surface 15 cm soil layer and 15 pCi/g for the subsurface 15 cm soil layer, respectively (hereafter referred to as "5/15") (See Attachment D for further discussion).

The DCGLs for radionuclides other than Ra-226 are derived from doses calculated for Ra-226 at 5/15 using the same exposure scenarios as were used to estimate the dose from Ra-226 at 5/15. This is referred to as the radium benchmark dose (RBD).

Generally, elevation of U-nat and Th-230 concentrations relative to Ra-226 is unexpected since the contaminated materials will either be ore (which are at or near secular equilibrium) or tailings where U-nat is reduced relative to the other uranium decay series radionuclides of interest. Possible exceptions are:

- Areas with raffinate crystals which may have higher Th-230 concentrations compared to Ra-226 concentrations
- Areas of spilled yellowcake product near the mill where U-nat may be elevated relative to Ra-226

The RBD approach was applied as described in Attachment D. The RESRAD (Version 6.5) code (Yu et al. 2001) was used to implement the RBD approach. As described in NUREG-1569 as Appendix E (NRC 2003, a Guidance document for NRC Commission Staff on the Radium Benchmark Dose Approach), NRC considers the RESRAD code as an acceptable code for application of the Ra-226 benchmark dose approach. In brief, radionuclides at their respective DCGLs result in the same benchmark dose as the Ra-226 DCGL.

The DCGLs for the radionuclides of interest for the surface and subsurface layers were calculated and are provided in Table 6.2. The scenario is for a rancher with the doses determined using the RESRAD Version 6.5 model. The default RESRAD dietary and inhalation data which apply for the adult are carefully selected from literature and are already considered to represent conservative parameter values. Details on the calculation of DCGL's are provided in Attachment D.

Table 6.2 - DCGL above background

DCGL (pCi/gram) above background		
Radionuclide	**Surface**	**Subsurface**
Ra-226	5	15
U-nat	545	2908
Th-230	46	142

Since there is more than one radionuclide of concern, the criteria for unrestricted use is applied using the unity rule such that the RBD is never exceeded.

In the equations below, the numerator is determined by subtracting the local background from the sample analysis following remediation. It is possible that the background may vary between survey units due to variation in soil types.

The unity rules are:

For surface soil:

$$\frac{A\ (pCi/g\ Ra226)}{5\ (pCi/g)} + \frac{B\ (pCi/g\ Unat)}{545\ (pCi/g)} + \frac{C\ (pCi/g\ \ Th230)}{46\ (pCi/g)} \leq 1$$

For subsurface soil:

$$\frac{A\ (pCi/g\ \ Ra226)}{15\ (pCi/g)} + \frac{B\ (pCi/g\ \ Unat)}{2908\ (pCi/g)} + \frac{C\ (pCi/g\ Th230)}{142\ (pCi/g)} \leq 1$$

MARSSIM requires that the median concentration in a survey unit be demonstrably lower than the $DCGL_W$ following remediation. This is accomplished with a WRS test between soil concentrations in the survey unit and appropriate background reference locations. For the WRS test, the actual concentrations are used for the survey unit rather than using the incremental concentrations, discussed previously in Section 6.4.2.

6.6.3.4 Gamma Radiation Surveys

Gamma radiation surveys will be conducted with a GPS-integrated system using 2-inch by 2-inch sodium iodide (NaI) detectors or the equivalent. Statistical correlations will be developed between the radiological soil sample analysis and the gamma radiation count rate. See Section 6.4.2 for the method for development and use of the gamma radiation correlation.

With the GPS-integrated method, high density gamma radiation scanning surveys will be done using the Ludlum 44-10 detectors at a height of 18 inches above the ground. The surveyor speed will be approximately 0.5 m/s.

For Class 1 survey units, transects will be 5 m apart and gamma radiation scanning surveys will continue up to 20 m outside the excavation with averages calculated on each 10-m by 10-m block. Class 1 survey units will scanned at a density to ensure that 95 percent of the 10-m by 10-m blocks have at least 20 gamma radiation measurements for blocks in and adjacent to the excavation areas with measurements in at least three of the four quadrants of the 10-m by 10-m block.

The remainder of the survey area outside the remediation area will be classified as Class 2 and will be surveyed at 10 m transects. The requirement for the remainder of the survey area, Class 2, will be that 95 percent of the blocks have at least 10 gamma radiation measurements.

The Class 3 area will include the buffer areas outside the area of contamination, and this area will be surveyed with planned transects of 50 m. Twenty percent or more of the 10-m by 10-m blocks will have at least 10 gamma radiation measurements.

The mean, median, and standard deviation of the 10-m by 10-m averages will be calculated by survey unit for data logged during the scanning surveys.

6.6.3.5 Gamma Radiation Guideline Level

The average gamma radiation count rate will be established over the 10-m by 10-m blocks. A correlation will be established between the gamma radiation level and the unity rule using co-located gamma radiation and soil concentration measurements. The gamma radiation guideline value will be the gamma radiation counts that equate to 0.8 (80 percent of unity rule) from the correlation equation. Locations where the gamma radiation guideline is exceeded will have additional gamma radiation surveys and potentially additional excavation before verification sampling.

6.6.3.6 Selection of Verification Samples

Following completion of excavation, if necessary, verification sampling will be carried out for each survey unit to allow a WRS test with background samples to confirm that the compliance criteria has been met. Ten sampling blocks will be determined from a random sampling approach for each survey unit. Following the final status gamma radiation survey, a minimum of 15 blocks in the survey unit will be measured to confirm the gamma radiation guideline level. For these 15 samples, the five 10- by 10-m blocks with the highest average gamma radiation will be sampled along with another 10 sample blocks randomly selected from the area.

The soil samples from the 10 randomly selected locations will be assessed to determine if the mean concentration in the survey unit is statistically below the unity rule with an alpha error of 0.05 using the MARSSIM WRS test.

The number of samples may be increased per Section 6.6.8.

6.6.3.7 Revision of Correlation

The verification sample measurements (soil analysis and mean gamma radiation counts) will be compared to the correlation to determine if the correlation is statistically valid. The correlation will be updated with the verification measurements if there is less than a 95 percent probability (p-value of 0.05) that the random verification data is less than $DCGL_W$. Verification measurements (soil sample and mean gamma radiation counts) will be taken with the same method as the correlation measurements.

6.6.3.7.1 Reporting

For each survey unit, the following will be reported:

1. Number of blocks remediated during remediation phase.
2. Number of blocks with subsequent remediation initiated by gamma radiation measurement.
3. Gamma radiation coverage compliance (i.e. percentage of blocks meeting number of measurement criteria).
4. Mean gamma radiation level averaged over the 10-m by 10-m blocks.
5. Mean and range of predicted unity rules based on gamma radiation survey.
6. Mean and range of measured unity rules based on verification sampling.

6.6.3.8 Field Data

The objectives of the survey and sampling activities are to identify the concentrations of residual radioactive material in the survey units so that the unity rule can be evaluated. This information will allow a determination of whether a survey unit is likely to be suitable for release. The average soil concentrations will be evaluated to verify that each radiological $DCGL_W$ is met.

6.6.4 Define the Study Boundaries

The soil in the restricted area will be surveyed for radiological contamination of U-nat, Th-230, and Ra-226. This does not include the tailings cells and unrestricted areas. Survey units will be established in the unrestricted area if, during the survey of the restricted area, contamination is found at the boundary of the restricted area or if there is reason to believe contamination is present in the unrestricted area.

6.6.5 Develop the Decision Rules/Analytical Approach

If soils exhibit widespread contamination above the $DCGL_W$, then removal of the soil will be necessary or the EMC process will need to be followed to ensure that areas of contamination will not exceed the $DCGL_W$ following excavation.

6.6.6 Define Acceptable Decision Errors

6.6.6.1 Statistical Tests

The WRS test will be used to compare background reference areas to survey units in the MARSSIM framework for the FSS reporting. The WRS test is a nonparametric test used to test for a difference in values between two populations; that is, one data population is hypothesized to consist of higher average values than the other data population.

MARSSIM suggests using the WRS test in cases where the contaminant is present in background at a significant fraction of the $DCGL_W$. Since the DCGL is 5 pCi/g for Ra-226 and the background is in the order of 1 pCi/g or more for Ra-226, the WRS test is the preferred test.

The soil concentrations from the 10 randomly selected locations as defined in Section 6.6.3.6 will be assessed with the WRS test to determine if the median concentration in the survey unit is statistically below the unity rule with an alpha error of 0.05 using the MARSSIM WRS test.

6.6.6.2 Hypothesis

The decisions necessary to determine compliance with the soil cleanup criteria are based on precise statistical statements called hypotheses, which are tested using the data from the survey unit.

<u>Null Hypotheses</u> - The situation that is presumed to exist is expressed as the null hypothesis (H_0), which states "*the median concentration in the survey unit exceeds the median concentration in the background reference area by more than the DCGL.*"

<u>Alternative Hypotheses</u> - For a given H_0, there is a specified alternative hypothesis (H_a), which is an expression of what is believed to be the situation if the null hypothesis is not true. The H_a states

"*the median concentration in the survey unit does not exceed the median concentration in the background reference area by more than the DCGL.*"

These hypotheses were chosen for the following two reasons: (1) the burden of proof is placed on the H_A and, (2) the survey unit will not be released until proven to meet the cleanup criterion. In order to pass the WRS using the above H_0, the median concentration of the systematic samples in the survey unit must be less than the $DCGL_W$ above background.

6.6.6.3 Error Types

Decision errors help to determine the number of samples required. Generally, more samples are required to generate lower decision errors (i.e., the fewer samples, the larger the uncertainty).

The statistical acceptability decisions are designed to avoid two kinds of errors:

- Releasing a survey unit which requires additional remediation
- Remediating a survey unit which is already below the $DCGL_W$

Two possible error types are associated with such decisions, Type I and Type II, which are described below.

Type I – which is also referred to as a false positive, occurs when H_0 is rejected when it is actually true. The probability of a Type I error is usually denoted by α. This error could result in higher potential doses to future site occupants than prescribed by the dose-based criterion. The maximum Type I error rate has been set at $\alpha = 0.05$ (there is less than 5 percent chance of error).

Type II - which is referred to as a false negative, occurs when H_0 is not rejected when it is actually false. The probability of a Type II error is usually denoted by β. Consequences of Type II errors include unnecessary remediation expense and project delays. The Type II error rate has been set at $\beta=0.10$ (there is less than 10 percent chance of error).

Statistical correlations will be developed between the unity rule and the gamma radiation measurements. The unity rule will be determined from measurement data for incremental concentrations at each sample location. The correlation between the unity rule and the gamma radiation measurement at the sample location will produce a prediction equation. MARSSIM requires that the mean concentration in a survey unit be demonstrably lower than criteria following remediation but does not require all sampling units, in this case the 10-m by 10-m areas, to be lower than the criteria. The precision goal for the relationship will be that the mean prediction uncertainty for the survey unit will be +/- 0.2 when the predicted unity rule is equal to “1”.

Protocols will be in place to ensure decision errors are kept to a minimum. For example, instrument quality assurance checks will be required and minimum detectable concentrations (MDCs) will be met.

The gamma radiation survey will be limited by the MDC for the 2-inch x 2-inch sodium iodide (NaI) detector which is approximately 104 Bq/Kg (2.8 pCi/gram) for Ra-226, MARSSIM Table 6.7. This MDC is dependent on the background which may raise or lower the MDC (NRC, 2000).

Table 6.3. Reported MDC’s from MARSSIM Table 6.7

Nuclide	MDC (Bq/kg)	MDC (pCi/gram)
U-Nat	2960	80
Th-230	78,400	2100
Ra-226 (with decay products in equilibrium)	104	2.8

6.6.7 Relative Shift and Number of Samples

The target decision errors are 0.05 and 0.10 for α andβ, respectively. The major contributor to the unity rule is Ra-226 since the criterion is much lower for Ra-226 compared to U-nat and Th-230. The lower bound of the gray region (LBGR) has been set to 0.8 as Ra-226 has a typical concentration that is only about 25 percent of the LBGR and the uncertainty will likely be of this order.

The preliminary estimate is that a relative shift of 2.0 based on the LBGR of 0.8 and an uncertainty of twice the background concentration. Using Table 5.3 of MARSSIM (NRC, 2000), the required number of samples is 8.

Should any area exceed the $DCGL_{EMC}$ or large areas exceed the $DCGL_{W}$, remediation of the affected areas would be completed prior to resampling.

6.6.8 Optimize the Design

Initially, gamma radiation scans will be conducted in the restricted areas of the Mill site. The data from these scans will be reviewed to determine the location of any hotspots. These hotspot locations will be sampled to determine the activity concentrations of U-nat, Th-230, and Ra-226. A prediction equation of the unity rule will provide the basis for scanning large areas effectively to direct focused remediation and to ensure that the cleanup criterion is met.

The statistical test (WRS test) could fail to show that the mean is below the criterion due to the initial number of verification samples, since there may be insufficient samples to achieve the desired decision error rates given the characteristics of the survey unit. In cases where data suggest that the concentration is below the criterion (e.g., the mean bases), additional samples would reduce the decision error and potentially allow the survey unit to pass. In this case, the mean and variability of the 10 randomly selected measurements will be used to determine MARSSIM's relative shift with the lower bound of the gray region equal to 0.8 of the unity rule. The α error will be set to 5 percent and the β error set to 10 percent to determine the required total number of samples. These samples would be collected and the WRS repeated on the larger data set.

6.7 Soil Sampling

6.7.1 Laboratory Approval

All samples will be analyzed for radionuclide activity concentration (pCi/g). All analyses will be performed by a DWMRC-approved/certified laboratory and a DOE-certified, or National Environmental Laboratory Accreditation Program (NELAP)-certified laboratory. The laboratory will analyze method blanks, matrix spike samples, laboratory control samples and replicates. Typical required detection levels will be less than or equal to one tenth of the DCGL for each radionuclide.

6.7.2 Data Validation

Laboratory analytical results from the final status survey will be validated and will be reviewed by the data validator for the following:

- Data completeness/sample integrity
- Holding times
- Calibration
- Alpha spectroscopy tracer analysis
- Laboratory and field blanks
- Laboratory control samples
- Laboratory and field duplicates
- Alpha spectroscopy matrix spikes
- Quantitation and detection limits
- Alpha spectroscopy chemical separation specificity
- Gamma radiation spectroscopy target radionuclide list identification
- Secular equilibrium verification, and result verification

Review of these parameters checks the quality of the data with respect to:

- Precision – which is a measure of the reproducibility of an analysis under a given set of conditions. Precision will be evaluated through a review of field duplicate and laboratory duplicate samples.

- Accuracy – which is a measure of the bias that exists in a measurement system. Accuracy will be evaluated through a review of laboratory control samples, matrix spike samples, method blanks, and tracer recoveries.

- Representativeness – which is a measure of the degree to which the sampling data accurately and precisely represent site conditions. Representativeness will be evaluated through a review of raw data and through a comparison of whether the proposed scoping survey was implemented.

- Comparability – which is a measure of the degree of confidence with which two data sets can be compared to each other. Comparability will be evaluated through an assessment of whether appropriate and acceptable analytical methods were used.

- Completeness – which is a measure of the amount of valid data obtained.

6.8 Employee Health and Safety

Programs currently in place for monitoring of exposures to employees will remain in effect throughout the time period during which tailings cell reclamation, mill decommissioning and clean up of windblown contamination are conducted. This will include personal monitoring and the ongoing bioassay program. Access control will be maintained at the Restricted Area boundary to ensure employees and equipment are released from the site in accordance with the current License conditions. In general, no changes to the existing programs are expected and reclamation activities are not expected to increase exposure potential beyond current levels.

6.9 Environment Monitoring

Existing environmental monitoring programs will continue during the time period in which reclamation and decommissioning is conducted. This includes monitoring of surface and groundwater, airborne particulates, radon, soils and vegetation according to the existing License conditions. In general, no changes to the existing programs are expected and reclamation activities are not expected to increase exposure potential beyond current levels.

6.10 Quality Assurance

In general, the QA/QC Plan details the Owner's organizational structure and responsibilities, personnel qualifications, operating procedures and instructions, record keeping and document control, sampling procedures and outside laboratory testing.

7.0 MATERIAL DISPOSAL

7.1 General

This section outlines work associated with placement of materials in the disposal cell area within Cell 1 (Cell 1 Disposal Area) and tailings cells (Cells 2 through 4).

7.2 Materials Description

The types of materials to be disposed of are outlined below.

7.2.1 Raffinate Crystals

After the residual liquid in Cell 1 has been evaporated, the raffinate crystals from Cell 1 will be excavated and disposed in one of the tailings disposal cells. The crystals are likely to have granular consistency, with larger crystal masses that may require breaking down for loading and transport (using the loading equipment).

7.2.2 Synthetic Liner

The existing PVC liner in Cell 1 will be removed and disposed of in one of the tailings disposal cells.

7.2.3 Contaminated Soils

During remediation, soils located in and around the Mill site that exceed the soil cleanup guideline value will be placed in one of the tailings disposal cells. Soils excavated from Cell 1 to meet design grades or exceed the soil cleanup guideline value shall be placed in one of the tailings disposal cells.

7.2.4 Mill Debris

The Mill debris will include equipment, such as tankage and piping, agitation equipment, process control instrumentation and switchgear, and contaminated structures (including concrete structures and foundations). Mill debris will be placed in the Cell 1 Disposal Area.

7.3 Work Description

Materials to be disposed in the cells will be spread over the working surface as much as possible to provide relatively uniform settlement and consolidation. In the disposal cell, a minimum of one foot of soil will be placed over the clay liner prior to placing any debris.

7.3.1 Raffinate Crystals

Raffinate crystals will be removed from Cell 1 and transported to the tailings cells. Placement of the crystals will be performed as a granular fill, with large-sized material broken to minus 6-inch size. Voids around large material will be filled with finer material. Actual placement procedures will be evaluated by the CQA Officer during construction as crystal materials are placed in the cells and modified with the agreement of the DWMRC.

7.3.2 Synthetic Liner

The PVC liner will be cut, folded (when necessary), removed from Cell 1, and transported to the tailings cells. The liner material will be spread as flat as practical over the designated area. After placement, the liner will be covered as soon as possible with at least one foot of soil, crystals or other materials for protection against wind uplift, as approved by the CQA Site Manager.

7.3.3 Contaminated Soils

The extent of contamination of the Mill site will be determined by gamma radiation scanning and the A correlation developed between gamma survey readings and the unity rule concentrations (Section 6). Gamma survey readings will be used to define cleanup areas and confirm cleanup. Soil sampling will be conducted to verify that the cleanup results meet soil cleanup guideline values.

Where surveys indicate the above criteria have not been achieved, the soil will be removed to meet the criteria. Soil excavated from Cell 1 will be transported to one of the tailings cells.

7.3.4 Mill Debris

Debris will be spread across the bottom of the disposal cell to avoid nesting and to reduce the volume of voids present in the disposed mass. Stockpiled soils and/or other approved materials will be placed over and into the debris in a sufficient lift thickness to fill the voids between the debris pieces. The CQA Site Manager will approve the use of materials other than stockpiled soils for filling voids.

7.3.5 Material Sizing and Preparation

Demolition debris to be placed in the Cell 1 Disposal Area will consist of equipment and structural material from facilities demolition. Demolition procedures are outlined in the Appendix B to the Reclamation Plan (Preliminary Mill Decommissioning Plan). Because of the wide variety in shape and size of demolition debris, material of odd shapes will be cut or dismantled to facilitate handling, loading, transport, and placement in the disposal cell. The maximum size of dismantled or cut materials will not exceed 20 feet in the longest dimension and a maximum volume of 30 cubic feet. Smaller dimensions may be necessary for loading, handling, hauling, and placement of material.

7.3.6 Incompressible Debris

Material that is not compressible (steel columns and beams, concrete, and other solid material) will be reduced in size for loading, hauling, and placement in the disposal cell. Incompressible debris shall be placed, oriented, or spread in a manner that minimizes void spaces below, between, and above these materials. Incompressible debris shall be placed on and covered with soils or similar materials (Section 7.2.3). Incompressible debris such as steel members shall be placed in the disposal cell with the longest dimension oriented horizontally.

Thick-walled pipe, conduit, tanks, vats, pressure vessels, and other hollow materials that cannot be crushed or dismantled shall be transported to the planned location within the disposal cell and oriented for filling and burial. The voids on the inside of the item will be filled with contaminated soil, clean fill soil, or grout (controlled low-strength material or flowable fill). Contaminated soil (Section 7.2.3) or clean fill will be placed outside of the items and compacted with standard compaction equipment (where possible) or hand-operated equipment to the compaction requirements in Section 7.4. Several lifts of compacted contaminated soil or clean fill may be necessary to fill around and cover these items.

For debris where internal voids cannot practically be filled with soil, a grouting program will be initiated to pump controlled low strength material (CLSM, flowable fill) into the voids. Debris will be grouped together and characterized as materials that will require grouting, so that a significant volume of debris can be grouted in a single action, rather than grouting individual lengths of pipe. Pipe sections could be stacked horizontally, or cut short enough to stand vertically in a safe manner. Grout will fill the voids within the grouped debris with a soil berm or trench used to contain the grout laterally around the perimeter of the selected debris.

If CLSM is required for the grouting of voids that cannot be filled with soil, the mix design for the grout will mimic, as closely as possible, the strength and hydraulic properties of the contaminated soil that will also be used for filling voids within the debris. The unconfined compressive strength of the CLSM will be between 30 and 150 psi, and unit weights will be approximately 100 to 120 pcf.

7.3.7 Compressible Debris

Materials that are compressible (such as thin-walled piping and thin-walled tanks) will be flattened or crushed in a designated staging area or in the disposal cell. Flattening or crushing will be done with a hydraulic excavator bucket or other attachments, or with a dozer or other steel-tracked equipment.

These materials shall be placed in the disposal cell and spread to form a lift with a maximum thickness of two feet. Placement shall be done in a manner resulting in materials lying flat and minimizing void spaces. Pipe shall be cut into lengths of approximately 10 feet or less for disposal. Pipe larger than 12 inches in diameter shall be longitudinally split or cut, or filled with grout.

7.3.8 Organic Debris

Organic materials (such as wood and paper) will be placed in the disposal cell in maximum lifts of 12 inches and mixed with the soil and other incompressible debris during placement to prevent pockets of organic material from being created. Organics mixed with soil for spreading will be limited to 30 percent by volume of the mixture.

7.3.9 Soils and Similar Materials

Soils and soil-like materials to be placed in the disposal cell will be from on-site areas identified by the Owner for excavation. Soil or soil-like material will be placed and compacted over each lift of debris (Section 7.2.4) or other materials in lifts not to exceed 2 feet in loose thickness and compacted prior to placement of additional lifts. Soils will also be used for interim soil cover to minimize exposure of demolition materials and other materials to air and meteoric water.

7.4 Performance Standards and Testing

7.4.1 Material Compaction – Debris Lifts

During construction, the compaction requirements for the raffinate crystals will be evaluated based on field conditions, material quantities, and compaction equipment. The compaction requirements will be determined by the CQA Site Manager and the Construction Manager or a designated representative, with the agreement of the Owner.

Each lift of debris (up to 2 feet thick) will be covered with soil (Section 7.3.9) (up to 2 feet in loose thickness). Each lift of soil or similar material will be compacted with a minimum of 6 passes with vibratory compaction equipment. The number of passes shall be confirmed with the actual compaction equipment on site with a field test section to establish a correlation between the field compaction method and 80 percent of maximum dry density for the soil, as determined by the standard Proctor test (ASTM D698).

The CQA Technicians will monitor and approve debris placement. In areas where voids are observed during placement, the Contractor shall re-excavate the area, fill any voids encountered with soil and recompact the materials, or grout the voids. The CQA Site Manager will recommend implementation of a grouting program where voids, either within a debris mass, or within a vessel, cannot be properly filled with soil using conventional equipment.

7.4.2 Material Compaction – Final Disposed Material Surface

The upper 12 inches of the final disposed material surface shall be compacted to 90 percent of the maximum dry density for the material, as determined by the standard Proctor test (ASTM D698).

7.4.3 Testing Frequency

Field density tests shall be compared with standard Proctor tests (ASTM D698 Method A or C) on the same material. Standard Proctor tests shall be conducted at a frequency of at least one test per 5,000 cubic yards of material compacted, or when material characteristics show significant variation.

Field density testing may be conducted with the sand cone test (ASTM D1556) or a nuclear density gauge (ASTM D6938, or as modified by the CQA Site Manager). Correlation of nuclear density gauge results shall be by comparison with results from sand cone test(s) and laboratory testing for water content(s) using the oven drying method (ASTM D2216) on similar material.

The frequency of the field density and moisture tests will be not less than one test per 2,000 cubic yards of compacted soil. A minimum of two tests will be taken for each day that more than 150 cubic yards of material is placed. A minimum of one test per lift and at least one test for every full shift of compaction operations will be taken.

7.4.4 Final Slope and Grades

The final disposed material surface shall have maximum side slopes of 5:1 (H:V) and a top surface sloping in the directions and grades shown on the Drawings. The side slopes and top surface shall be free from abrupt changes in grade or areas of runoff concentration. The final disposed material surface shall be compacted with approved construction equipment to form a smooth surface with uniform density for subsequent cover placement.

8.0 COVER CONSTRUCTION

8.1 General

This section outlines work associated with construction of the cell cover system. A multi-layered earthen cover will be placed over tailings Cells 2, 3 and 4A and a portion of Cell 1 used for disposal of contaminated materials (the Cell 1 Disposal Area).

8.2 Materials Description

8.2.1 Random Fill

The random fill for the interim fill, compacted cover, and growth medium layers will consist of on-site stockpiled soils from areas designated by the Owner. Random fill, except for the interim fill, shall have a maximum particle size of 6 inches, and a minimum of 10 percent passing the No. 200 sieve. Oversized material will be controlled through selective excavation at the stockpiles and through the utilization of a grader, bulldozer or other equipment to cull or break down oversized materials.

The source of these materials will be on-site stockpiles from previous cell construction activities. On-site stockpiles shall be approved for specific use by the Construction Manager and Design Engineer prior to use.

8.2.2 Organic Matter Amendment

Composted biosolids will be used to amend the physical and chemical properties of the random fill used to construct the growth medium layer (Section 8.3.7). Composted biosolids will be added to the upper 6 inches of the growth medium layer at a rate of 10 tons/acre.

8.2.3 Topsoil-Gravel Admixture

Gravel will be mixed with topsoil and placed on portions of the cover on Cells 2, 3, 4A, and 4B top surfaces (as shown on the Drawings) as the erosion protection layer. Topsoil-gravel admixture material shall be shall be free from roots, branches, rubbish, and debris.

The gravel portion of the topsoil-gravel admixture will consist of granular materials from approved off-site areas. The gravel portion of the topsoil-gravel admixture shall have a maximum particle size of 1 inch.

The topsoil portion of the topsoil-gravel admixture will consist of select material from the on-site topsoil borrow area (Section 3.4). The mixture shall be 25 percent gravel by weight.

8.2.4 Riprap

Riprap will be placed along the toe of the disposal cell and the tailings cells (as shown on the Drawings). Riprap will consist of granular materials from approved off-site sources. Riprap shall be shall be a screened product, free from roots, branches, rubbish, and debris.

Riprap shall meet NRC long-term durability requirements (a rock quality designation of 65 or more; Johnson, 2002). For a rock quality designation of 70 or higher, the particle-size specifications below shall be used. If actual rock quality designation is between 65 and 69, oversizing will be required.

Designated gradations for the riprap will be as specified on the Drawings. Riprap will be imported from off-site.

- Side Slope riprap shall have a minimum D_{50} as listed below and a minimum layer thickness of 1.5 times the D_{50} or the D_{100} of the riprap, whichever is greater:
    - 1.7 in. for non-accumulating flow side slopes
    - 5.3 in. for Cell 4A and Cell 4B southern side slopes
    - 5.3 in. for Cell 1 Disposal Area side slope
- Riprap used in the rock aprons shall have a minimum D_{50} as listed below and a minimum layer thickness of 1.5 times the D_{50} or the D_{100} of the riprap, whichever is greater
    - 3.4 in. for Rock Apron A

- 10.6 in. for Rock Apron B
- 9.0 in. for Rock Apron C

8.2.5 Filter Material

Filter material shall be shall be free from roots, branches, rubbish, and debris. The filter material shall meet the gradation specifications in Table 8.1.

Table 8.1 – Filter Material Gradation

Sieve Size	Percent Passing, By Weight
3-inch	100
No. 4	70-100
No. 20	40-60
No. 200	0-5

8.2.6 Topsoil

Topsoil will consist of select material from the designated, on-site topsoil borrow area (Section 3.4).

8.3 Work Description

The Contractor will place cover materials based on a schedule determined by the Owner and the Owner's analysis of settlement data, piezometer data and equipment mobility considerations. Settlement monitoring points will be established and monitored in accordance with Sections 8.3.1 to 8.3.3 and the Settlement Monitoring Plan approved by DWMRC for the site.

Cover construction shall minimize lenses, pockets, or layers of material differing substantially in texture, gradation or moisture content from the surrounding material. Oversized material will be controlled through selective excavation of stockpiled material, observation of placement by a qualified individual with authority to stop work and reject material being placed and by culling oversized material from the fill.

If the compacted surface of any layer of fill is too dry or smooth to bond properly with the layer of material to be placed thereon, it will be moistened and/or reworked with suitable equipment to a sufficient depth to provide relatively uniform moisture content and a satisfactory bonding surface before the next succeeding layer of fill is placed. If the compacted surface of any layer of fill in-place is too wet, due to precipitation, for proper compaction of the fill material to be placed thereon, the material will be reworked to reduce the moisture content to the specified range and recompacted.

No material will be placed when either the material being compacted, or the underlying material, is frozen or when ambient temperatures do not permit the placement or compaction of the materials to the specified density, without developing frost lenses in the fill.

8.3.1 Monitoring Interim Cover Settlement

The existing settlement monitoring points located within tailings disposal cells will be maintained by extending them through additional fill placement. For areas without settlement monitoring points, settlement monitoring points will be installed to monitor settlement of the interim cover surface and will be constructed as specified in the DWMRC approved Settlement Monitoring Plan. Settlement data will be collected and analyzed; and the reclamation techniques and schedule will be adjusted accordingly.

8.3.2 Monitoring Final Cover Settlement

After placement of final cover material, settlement plates will be extended or will be installed to monitor settlement of the final cover surface. The settlement plates will be constructed as specified in the DWMRC approved Settlement Monitoring Plan.

8.3.3 Monitoring Settlement Points

Settlement monument placement and data collection will be made in accordance with the DWMRC approved Settlement Monitoring Plan.

8.3.4 Interim Fill Layer

The interim fill layer will have a minimum thickness of 2.5 feet and will be placed over the tailings surface to form a stable working platform for subsequent controlled fill placement. This interim fill layer will be placed by pushing random fill material across the tailings such that the underlying tailings are displaced as little as possible. Interim fill will be placed in lifts of 12-inch maximum loose thickness to form a uniform subsoil layer for the cover system. A rough surface will be maintained on the surface of each lift.

8.3.5 Compacted Cover Layer

The compacted cover layer shall be constructed of random fill placed in lifts with a maximum loose thickness of 12 inches to form a continuous layer with a total minimum compacted layer thickness of 36 to 48 inches, as indicated in the Drawings. A rough surface will be maintained on the surface of each lift.

8.3.6 Growth Medium Layer

The growth medium layer shall be constructed of random fill placed to a minimum of 42 inches thick, above the compacted cover layer in lifts of 18-inch maximum loose thickness. If oversized material is observed during the excavation of fill material, it will be removed, as far as practicable, before it is placed in the fill. A rough surface will be maintained on the surface of all but the uppermost lift.

8.3.7 Organic Matter Amendment

Composted biosolids will be applied prior to the placement of the erosion protection layer (topsoil or the topsoil-gravel admixture). Composted biosolids will be uniformly spread over the surface of the growth medium layer and mixed to a depth of 6 inches.

8.3.8 Erosion Protection Layer: Topsoil-Gravel Admixture

The topsoil and the gravel admixture shall be 75 percent topsoil - 25 percent gravel admixture (by weight). The mixture shall be prepared (mixed) prior to transport to the placement areas. Gradation samples will be collected at the point of placement to verify the mixture's content. The

CQA Site manager will approve the Contractor's proposed method of mixing based on the gradation results during initial placement.

The mixture shall be placed in one loose lift to form a uniform layer with a final thickness of 6 inches on the slope surfaces of the disposal cell (shown on the Drawings). The topsoil-gravel admixture shall be spread with tracked equipment.

The erosion protection layer will not be amended for organic matter or nutrients to avoid the stimulation of undesirable weedy species.

Following placement of the topsoil-gravel admixture erosion protection layer, the area shall be harrowed to reduce any compaction that may have occurred during placement of the cover and to create an uneven surface for optimum seedbed conditions.

8.3.9 Erosion Protection Layer: Topsoil

Topsoil (Section 8.2.6) shall be placed in one loose lift to form a uniform layer with a final thickness of 6 inches on the top and side slope surfaces of the disposal cell (shown on the Drawings). The topsoil shall be spread with tracked equipment.

The erosion protection layer will not be amended for organic matter or nutrients to avoid the stimulation of undesirable weedy species.

Following placement of the topsoil layer, the area will be harrowed to reduce any compaction that may have occurred during placement of the cover and to create an uneven surface for optimum seedbed conditions.

8.3.10 Riprap and Filter Material Placement

The side slopes of the reclaimed cover will be protected by rock surfacing. Riprap (Section 8.2.4) and filter material (Section 8.2.5) shall be placed in one or more lifts to the depths outlined in the Drawings and using the methods outlined below. The Drawings show the location of riprap with the size and thickness requirements for the various side slopes and aprons.

Filter material and riprap shall be handled, loaded, transported, stockpiled, and placed in a manner that minimizes segregation. Riprap and filter material shall be placed in or near its final location by dumping, then spread with a small dozer, the bucket of a trackhoe, or other suitable equipment. Riprap and filter material shall be placed and spread in a manner that minimizes displacement of underlying cover soils, natural soils, or filter material. Each layer of riprap and filter material shall be track-walked with a small dozer, tamped with the bucket of a trackhoe, or densified by other approved methods.

Placement of the riprap will avoid accumulation of riprap sizes less than the minimum D_{50} size and nesting of the larger sized rock. The riprap layer will be compacted by at least two passes by a dozer, tamping with the bucket of a trackhoe, or equivalent methods in order to key in the rock particles for stability. The completed layer of filter material shall be well-graded in particle-size distribution and free from pockets of smaller material and free from large voids or loose areas.

8.4 Performance Standard and Testing

8.4.1 Compacted Cover Layer Testing

Each lift of the compacted cover layer shall be compacted to at least 95 percent of the maximum dry density for the material, as determined by the standard Proctor test (ASTM D698). Water contents shall be adjusted, as needed, to meet the density requirements.

Material specifications for the random fill material shall be confirmed by gradation testing conducted by approved personnel. Testing shall consist of No. 200 sieve wash and particle-size distribution testing (ASTM D422) at a frequency of at least one test per 2,000 cubic yards of fill placed, or when material characteristics show a significant variation.

Checking of compaction shall consist of a minimum of one field density test per 500 cubic yards of material compacted. A minimum of two tests shall be taken for each day that more than 150 cubic yards of material is placed. A minimum of one test per lift and at least one test for every full shift of compaction operations will be taken.

Field density tests shall be compared with standard Proctor tests (ASTM D698 Method A or C) on the same material. Standard Proctor tests shall be conducted at a frequency of at least one test per

5,000 cubic yards of material compacted, or when material characteristics show significant variation.

Field density testing may be conducted with the sand cone test (ASTM D1556) or a nuclear density gauge (ASTM D6938, or as modified by the CQA Site Manager). Correlation of nuclear density gauge results shall be by comparison with results from sand cone test(s) and laboratory testing for water content(s) using the oven drying method (ASTM D2216) on similar material.

8.4.2 Growth Medium Layer Testing

Each lift of the growth medium layer shall be compacted to at least 85 percent of the maximum dry density for the material, as determined by the standard Proctor test (ASTM D698). Water contents shall be adjusted, as needed, to meet the density requirements.

Material specifications for the random fill for water storage layer shall be confirmed by gradation testing conducted by approved personnel. Testing shall consist of No. 200 sieve wash and particle-size distribution testing (ASTM D422) at a frequency of at least one test per 2,000 cubic yards of fill placed, or when material characteristics show a significant variation.

The frequency of the field density tests will be not less than one test per 2,000 cubic yards of compacted fill. A minimum of two tests will be taken for each day that more than 150 cubic yards of material is placed. A minimum of one test per lift and at least one test for every full shift of compaction operations will be taken.

Field density tests shall be compared with standard Proctor tests (ASTM D698 Method A or C) on the same material. Standard Proctor tests shall be conducted at a frequency of at least one test per 10,000 cubic yards of material compacted, or when material characteristics show significant variation.

Field density testing may be conducted with the sand cone test (ASTM D1556) or a nuclear density gauge (ASTM D6938, or as modified by the CQA Site Manager). Correlation of nuclear density gauge results shall be by comparison with results from sand cone test(s) and laboratory testing for water content(s) using the oven drying method (ASTM D2216) on similar material.

8.4.3 Topsoil-Gravel Admixture Testing

The gradation specifications for the topsoil-gravel admixture (Section 8.2.3) shall be confirmed by gradation testing, on samples collected from the point of placement (on the top deck). Testing shall consist of particle-size distribution testing (ASTM D422) at a frequency of at least one test per 2,000 cubic yards of mixture placed, or when the characteristics of the mixture show a significant variation. The CQA Site Manager may choose to increase the frequency of testing at the beginning of placement to evaluate the mixing method proposed by the Contractor.

Topsoil-gravel admixture thickness will be controlled through the establishment of grade stakes placed on a 200 x 200 foot grid on the top of the cells and by a 100 x 100 foot grid on the cell slopes. Physical checks of topsoil-gravel admixture depth will be accomplished through the use of hand dug test pits at the center of each grid in addition to monitoring the depth indicated on the grade stakes.

8.4.4 Riprap Testing

Material specifications for the riprap shall be confirmed by gradation testing conducted by the CQA Technician. Testing shall consist of particle-size distribution testing (ASTM D422) at a frequency of at least one test per 2,000 cubic yards of rock delivered to the site, or when rock characteristics show a significant variation.

Rock layer thickness will be controlled through the establishment of grade stakes placed on a 200 x 200 foot grid on the top of the cells and by a 100 x 100 foot grid on the cell slopes. Physical checks of riprap depth will be accomplished through the use of hand dug test pits at the center of each grid in addition to monitoring the depth indicated on the grade stakes.

The durability of the riprap shall be verified by durability tests outlined in Section 8.4.7.

8.4.5 Filter Material Testing

Material specifications for filter material (Section 8.2.5) shall be confirmed by gradation testing conducted by CQA Technician. Testing shall consist of No. 200 sieve wash and maximum particle size testing (ASTM D422) at a frequency of at least one test per 10,000 cubic yards of fill placed, or when material characteristics show a significant variation.

Filter layer thickness will be established during construction with grade stakes placed on a grid or centerline and offset pattern and layer thickness marks on each grade stake. The minimum thickness of the layer will be verified by spot checking of layer thickness by hand excavation in selected locations.

8.4.6 Rock Durability Testing

For riprap materials, each load of material will be visually checked against standard piles for gradation prior to transport to the tailings piles. Prior to delivery of any riprap materials to the site, rock durability tests will be performed for each gradation to be used. Test series for riprap durability will include specific gravity, absorption, sodium soundness and LA abrasion. During construction, additional test series and gradations will be performed for each type of riprap when approximately one-third (1/3) and two-thirds (2/3) of the total volume of each type have been produced or delivered. For any type of riprap where the volume is greater than 30,000 cubic yards, a test series and gradations will be performed for each additional 10,000 cubic yards of riprap produced or delivered.

8.5 Surface Slopes and Grades

The final cover surface shall have maximum side slopes of 5:1 (H:V) and a top surface sloping in the direction and grade shown on the Drawings. The side slopes and top surface shall be free from abrupt changes in grade or areas of runoff concentration. The perimeter apron at the toe of the side slopes shall have the dimensions as shown on the Drawings.

8.6 Grading Tolerances

The completed cover surface shall be constructed to within 1.0 foot (horizontally) of the lines as designed, and within 0.1 foot (vertically) of the elevations as designed. The final surface of the subsoil zone shall be smoothed to avoid abrupt changes in surface grade. The layer thicknesses shall meet the required minimum thicknesses.

The completed riprap shall be placed to within 5.0 foot (horizontally) of the layout as designed, and within 0.5 foot (vertically) of the elevations as designed. The rock layer thicknesses shall meet the minimum requirements.

9.0 REVEGETATION

9.1 General

Following topsoil placement, the cover surface and other areas disturbed during reclamation work will be revegetated. This section outlines the requirements for vegetation establishment where required. This section may be revised as necessary based on field requirements and soil nutrient analyses at the time of revegetation.

9.2 Materials Description

The soil amendments, seed mixture, and erosion control materials for revegetation are outlined below. Submittals for each of the following products shall be provided to the Owner for approval prior to use of such products.

9.2.1 Soil Amendments

The proposed application rate may be adjusted up or down based on soil chemical analysis that is conducted prior to placement of the water storage layer.

Composted biosolids shall be added at a rate of 10 tons/acre and uniformly spread over the surface of the water storage layer and mixed to a depth of 15 cm. This treatment will be applied after the water storage layer is in-place and before placement of the erosion protection layer.

9.2.2 Seed Mix

Species selection for the seed mixture was based on native vegetation found in the area as well as soil and climatic conditions of the Mill site. Changes to the seed mixture will be as approved by the Owner. The seed mixture in Table 9.1 shall be used on all seeded areas.

Table 9.1. Species and seeding rates proposed for Mill site.

Scientific Name	Common Name	Varietal Name	Native/ Introduced	Seeding Rate (lbs PLS/acre)†	Seeding Rate (# seeds/ft^2)
Grasses					
Pascopyrum smithii	Western wheatgrass	Arriba	Native	3.0	7.9
Pseudoroegneria spicata	Bluebunch wheatgrass	Goldar	Native	3.0	9.6
Elymus trachycaulus	Slender wheatgrass	San Luis	Native	2.0	6.2
Elymus lanceolatus	Streambank wheatgrass	Sodar	Native	2.0	7.3
Elymus elymoides	Squirreltail bottlebrush	Toe Jam	Native	2.0	8.8
Thinopyrum intermedium	Pubescent wheatgrass	Luna	Introduced‡	1.0	1.8
Achnatherum hymenoides	Indian ricegrass	Paloma	Native	4.0	14.7
Poa secunda	Sandberg bluegrass	Canbar	Native	0.5	11.4
Festuca ovina	Sheep fescue	Covar	Introduced‡	1.0	11.5
Bouteloua gracilis	Blue grama	Hachita	Native	1.0	16.5
Hilaria jamesii	Galleta	Viva	Native	2.0	7.3
Forbs					
Achillea millefolium, variety *occidentalis*	Common yarrow	VNS*	Native	0.5	32
Artemisia ludoviciana	White sage	VNS	Native	0.5	45
Shrubs					
Atriplex canescens	Fourwing saltbush	Wytana	Native	3.0	3.4
Ericameria nauseosa	Rubber rabbitbrush	VNS	Native	0.5	4.6
Total				26.5	188

†Seeding rate is for broadcast seed and presented as pounds of pure live seed per acre (lbs PLS/acre).
‡Introduced refers to species that have been 'introduced' from another geographic region, typically outside of North America. Also referred to as 'exotic' species.
*VNS=Variety Not Specified and seed source will be from sites that are climatically similar to White Mesa.

Seed shall be purchased as pounds of pure live seed and will be certified by the Utah State Department of Agriculture and Food. Certification will verify that the seed is correctly identified and genetically pure. Once the seed is obtained, seed labels will be checked to determine the percent PLS and the date that the seed was tested for percent purity and percent germination. If the test date is greater than 6 months old, the seed will be tested again before being accepted.

9.2.3 Erosion Control Materials

Wood fiber mulch will consist of specially prepared wood fibers and will not be produced from recycled material such as sawdust, paper, cardboard, or residue from pulp and paper plants. The fibers will be dyed an appropriate color, with non-toxic, water-soluble dye to facilitate visual metering during application. Wood-fiber mulch will be supplied in packages and each package will be marked by the manufacturer to show the air-dry weight.

A tackifier will be used with the wood-fiber mulch to improve adhesion. The tackifier will be a biodegradable organic formulation processed specifically for the adhesive binding of mulch. In addition, the tackifier will uniformly disperse when mixed with water and will not be detrimental to the homogeneous properties of the mulch slurry.

9.3 Work Description

Revegetation efforts shall be directed at all reclaimed and disturbed areas. The goal of the revegetation plan is to ensure that a self-sustaining vegetative community is established.

9.4 Soil Amendment Application

Following final placement and grading of the frost barrier layer, amendments will be applied as discussed in Section 9.2.1. Inorganic sources of nitrogen, phosphorus, and potassium will not be applied to the soil because composted biosolids will provide all the macronutrients required for long-term sustainability.

9.5 Growth Zone Preparation

A favorable seedbed shall be prepared on the topsoil layer or topsoil-rock mixture, prior to seeding operations. The soil shall be loose and friable so as to maximize contact with the seed. The soil will be tilled, following site contours with a disc or harrow (or similar approved equipment) to a maximum depth of 6 inches. The depth of valleys and the height of ridges caused by the final tillage operations are not to exceed 3 inches.

9.6 Seed Application

Seeding will follow the application of soil amendments and seedbed preparation, by broadcast spreading method. This procedure will use a centrifugal type broadcaster (or similar implement), also called an end gate seeder. The broadcasters will have a minimum effective spreading width of 20 feet. Seed will be applied in two separate passes. One-half of the seed will be spread in one direction and the other half of seed will be spread in a perpendicular direction. This will ensure that seed distribution across the site is highly uniform and also provide the opportunity to adjust the seeding rate if the specified rate is not being achieved. Seeding will not occur if wind speeds exceed 10 mph.

Immediately following seeding, the area will be lightly harrowed to provide seed coverage and to maximize seed-soil contact. Broadcast seed shall be harrowed into the soil to a depth of 0.25 to 0.75 inches.

Seeding will take place as soon as practical after the cover system is in place. Successful seeding in southeastern Utah can occur either in late fall (e.g. October) as a dormant seeding, with germination and establishment occurring the following spring or can be conducted in June, prior to the summer monsoon season. Timing for seeding will depend upon the construction schedule for the cover system.

9.7 Erosion Control Material Application

Mulch will be applied immediately following seeding. A weed-free, wood-fiber mulch shall be applied to the seeded area at a minimum rate of 1.5 tons/acre. The wood-fiber mulch will be applied by means of hydraulic equipment that utilizes water as the carrying agent. A continuous agitator action, that keeps the mulching material and approved additives in uniform suspension, will be maintained throughout the distribution cycle.

The pump pressure will be capable of maintaining a continuous non-fluctuating stream of slurry. The slurry distribution lines will be large enough to prevent stoppage and the discharge line will be equipped with a set of hydraulic spray nozzles that will provide even distribution of the mulch slurry to the seedbed. Mulching will not be done in the presence of free surface water resulting from rains, melting snow, or other causes. Tackifier may be added either during the manufacturing of the mulch or incorporated during mulch application.

9.8 Performance Standard and Testing

The following section describes performance-based criteria for successful revegetation.

9.8.1 Seeding Rates

Prior to seeding, a known area will be covered with a tarp and seed will be distributed using the broadcaster and simulating conditions that would exist under actual seeding conditions. Seed will then be collected and weighed to determine actual seeding rate in terms of pounds per acre. This process will be repeated until the specified seeding rate is obtained.

During the seeding process, the seeding rate will be verified at least once by comparing pounds of seed applied to the size of the area seeded.

9.8.2 Erosion Control

The cover shall be inspected two times per year for eroded areas. Any area that has experienced erosion shall be backfilled and reseeded. Erosion control materials shall also be reapplied over reseeded areas.

9.8.3 Weed Control

Weed management will be conducted on the Mill site by identifying the presence of any noxious weeds during annual vegetation surveys and developing a weed control plan that is specific to the species that are present (Table 9.2). Noxious weed control is species-dependent and both method and timing will vary from species to species.

Table 9.2. Noxious weed species.

Scientific Name	Common Name
Utah State—Listed Noxious Weeds	
Acroptilon repens	Russian knapweed
Cardaria spp.	Whitetop (all species)
Carduus nutans	Musk thistle
Centaurea diffusa	Diffuse knapweed
Centaurea solstitialis	Yellow star thistle
Centaurea stoebe ssp. micranthos	Spotted knapweed
Centaurea virgate ssp. Squarrosa	Squarrose knapweed
Cirsium arvense	Canada thistle
Convolvulus spp.	Bindweed (all species)
Cynodon dactylon	Bermuda grass
Elymus repens	Quackgrass
Euphorbia esula	Leafy spurge
Isatis tinctoria	Dyer's woad
Lepidium latifolium	Broadleaf pepperweed
Lythrum salicaria	Purple loosestrife
Onopordum acanthium	Scotch thistle
Sorghum almum	Perennial sorghum (all species)
Taeniatherum caput-medusae	Medusahead
San Juan County—Listed Noxious Weeds	
Aegilops cylindrical	Jointed goatgrass
Alhagi maurorum	Camelthorn
Asclepias subverticillata	Western whorled milkweed
Solanum elaeegnifolium	Silverleaf nightshade
Solanum rostratum	Buffalobur

Each survey will identify noxious weed populations and locate these populations on a map using a set of symbols to identify species, size of the infestation, and density of the population. The effectiveness of control methods will be documented in each annual survey. In addition, immediately adjacent off-site properties will be visually surveyed to a distance of 100 feet. Inspections will be conducted by personnel familiar with the identification of noxious weeds in the area and based on Utah's Noxious Weed List.

The selected control methods will be based on the type, size, and location of the mapped noxious weeds. The treated area(s) will be monitored and re-inspected annually for new weed introductions and to evaluate the success of the control methods. Prevention is the highest priority weed management practice on non-infested lands; therefore protecting weed-free plant communities is the most economical and efficient land management practice. Prevention is best accomplished by ensuring that new weed species seed or vegetative reproductive plant parts of weeds are not introduced into new areas, and by early detection of any new weed species before they begin to spread.

Control methods may include chemical or mechanical approaches. The optimum method or methods for weed management vary depending on a number of site-specific variables such as associated vegetation, weed type, stage of growth, and severity of the weed infestation.

Chemical Control

Chemical control consists mostly of selective and non-selective herbicides. Considerations for chemical controls include: herbicide selection, timing of application, target weed, desirable plant species being grown or that will be planted, number of applications per year and number of years a particular species will need to be treated for desired control. Also important are the health and safety factors involved, and the need to consider undesirable impacts. The use of herbicides will be in compliance with all Federal and State laws on proper use, storage, and disposal. The chemical application will be done by a licensed contractor in accordance with all applicable laws and regulations and all label instructions will be strictly followed. Applications of herbicides will not be permitted when the instructions on the herbicide label indicate conditions that are not optimal.

Mechanical Control

Mechanical control is the physical removal of weeds from the soil and includes tilling, mowing, and pulling undesirable plant species. Tillage is most effective prior to seeding and establishment of desirable vegetation. The tillage method of weed control can be effective in eliminating noxious perennial weeds when repeated at short intervals (every 1-2 weeks) throughout the growing season. Tillage has the drawback of indiscriminately impacting all vegetation interspersed with weeds in established areas and can eliminate competitive, desirable vegetation leaving behind a prime seedbed for weeds to reinvade. Mowing can be an effective method for controlling the spread of an infestation and preventing the formation and dispersal of seeds. Mowing is most effective on weeds which spread solely or primarily by seed. In order to achieve this, mowing must be repeated at least twice during the growing season prior to, or shortly after bloom. Also, even the most intense mowing treatment will not kill hardy perennial weeds. Additional considerations will be made when selecting control treatments when specific situations arise regarding type, size, and location of weed infestations. Examples of this are perennial versus biennial, broadleaf versus grasses, noxious weeds interspersed with desirable vegetation, large monoculture patches, or small patches requiring spot treatment.

Treatment windows schedules, based on the control methods chosen and the noxious weeds present, will be established for each treatment area. The best time to treat perennial noxious weeds is in the spring or fall during their active growth phase. Different species will have different optimum treatment times even with the same type of control. Perennial weeds usually grow vegetative in the spring, flower and seed in late spring and early summer, enter dormancy during the summer and actively grow again in the fall. The treatment windows selected will depend on the species present and control methods selected.

The final preparatory step is to determine the priority for areas to be treated. Prioritization ensures that the most important areas are dealt with at the most effective times. Important areas of concern include areas that may transport weed seeds. These areas include ditches, roadsides, and land equipment storage sites. Large monoculture patches are of concern wherever they occur and will always be high priority. Also, small patches of weeds will be treated to prevent expansion of weed populations.

Once the treatment plan is implemented, detailed records will be kept, and success or failure of treatment will be recorded so as to eliminate unsuccessful treatments.

9.8.4 Vegetation Establishment Performance

The following Revegetation Acceptance Goals/Criteria have been adapted from the Monticello Site and will be used at the Mill site to determine reclamation success.

Revegetation Acceptance Goal/Criteria:

Criterion 1 Species Composition

a. The vegetative cover (the percentage of ground surface covered by live plants) shall be composed of a minimum of five perennial grass species (at least four listed as native), one perennial forb species, and two shrub species listed in Table 9.1.

Criterion 2 Vegetative Cover

a. Attain a minimum vegetative cover percentage of 40 percent.
b. Individual grass and forb species listed in Table 9.1 that are used to achieve the cover criteria shall have a minimum relative cover (the cover of a plant species expressed as a percentage of total vegetative cover) of 4 percent and a maximum relative cover of 40 percent.
c. Individual species not listed in Table 9.1 may be accepted as part of the cover criteria if it is demonstrated that the species is native or adapted to the area and is a desirable component of the reclaimed project site.
d. Species not listed in Table 9.1, including annual weeds or other undesirable species such as those listed in Table 9.2, shall not count toward the minimum vegetative cover requirement. Every attempt shall be made to minimize establishment of all noxious weeds.

e. Reclaimed areas shall be free of state- and county-listed noxious weeds (Table 9.2).

f. The vegetative cover shall be self-regenerating and permanent. Self-regeneration shall be demonstrated by evidence of reproduction, such as tillers and seed production.

Criterion 3 Shrub Density

a. A minimum shrub density of 500 stems per acre.

b. Shrubs shall be healthy and have survived at least two complete growing seasons before being evaluated against success criteria.

Plant cover will be measured annually on the tailing cells for a minimum of ten years or until the revegetation goals stated above are achieved. Cover will be measured by the point method, using a vegetation sighting scope mounted on an adjustable tripod with a level. Cover will be measured for each species encountered, as well as litter, rock, and bareground. Cover measurements will be made along a minimum of ten randomly placed transects on each tailing cell that are 100 feet long. A total of 100 points will be sited at one-foot intervals along each transect to collect cover data in the categories of live vegetation, litter, rock, and bareground. Sample adequacy will be determined for each tailing cell using the following formula that identifies the minimum number of samples that are necessary to estimate the population mean at a 90 percent level of confidence. Total live vegetation cover will be used to calculate sample adequacy.

$$n = \frac{t^2 s^2}{(.10x)^2}$$

Where: n = minimum number of samples required to meet sample adequacy requirements

s^2 = variance

t^2 = 1.64 for 90% confidence

x = sample mean

Shrub density will be measured in belt transects placed on either side of the cover transects. All shrubs will be counted within a three-foot wide strip or belt transect along each side of the transect used for point cover measurements, resulting in a belt transect that is six-feet wide and 100 feet long.

In addition to the above cover sampling, annual observations will be made of overall plant community health and sustainability. Overall health will be based on plant vigor, presence of annual weeds, and signs of plant deficiencies or toxicities. Plant community sustainability will be based on observations of reproduction, including both vegetative reproduction, such as tillering, and seed production.

If revegetated areas are not making satisfactory progress in meeting revegetation goals outlined above, then remedial actions will be implemented as needed. These actions may include fertilization/soil amendments, reseeding, weed control, and/or erosion control depending upon the cause of the problem that may exist and the best remediation approach to ensure plant community success.

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Exhibit A-1:
Daily QA/QC Checks

August 2016

1.0 INTRODUCTION

A background count rate and reliability check using a check source shall be performed daily, prior to use, when the detector/scaler is used for counting. Background count rates and source checks shall be input on a control chart after developing of the mean and standard deviation (sigma) as discussed below.

2.0 QC CONTROL CHARTING

Select a background location such as an office or other location where background gamma radiation gamma values are not expected to vary. Take ten 30-second count readings and record them on Form 1. Using the ten readings, calculate the mean, sigma, and 2 sigma). These results shall also be recorded on Form 1.

Daily, prior to use, and at the end of surveys, perform a 30-second background and source count at the same location and in the same configuration as the acceptable ranges were developed. If the background or source check result exceeds a difference of two standard deviations, (2s or 2 sigma) from the mean, as shown on Figure 2, the Instrument Control Chart, re-count the background or source, log the results, and enter the new data on the Instrument Control Chart. Two successive background or source check counts outside the 2s Instrument Control Chart range indicates possible problems with the detector/electronics.

Values between ± 2s of the mean net counts generally indicate normal operation of the instrument. Values outside the mean ± 2s will occur with a frequency of less than 5 percent. Values greater than 3s from the mean will occur with a frequency of less than one percent and should be investigated. Two consecutive measurements outside 3s indicate problems with equipment and require adjustments and/or repairs as necessary. The scaler shall be removed from service and immediate notification shall be made to the RSO or designee prior to counting any samples.

Calibrations shall be checked whenever a significant change or repair is made to the measurement system, or when changes are detected as a result of check source measurements.

Control charts shall be maintained to indicate instrument operability and/or malfunction problems on a daily basis when instruments are in use. Use the attached control chart. Control charts should be kept for both background counts and counts with a check source, such as a 5 µCi Cs-137 source.

FORM 1: CALCULATION OF INSTRUMENT STANDARD DEVIATION							
Date of 1st Instrument Use	Count 1	Count 2	Count 3	Count 4	Count 5	Count 6	Count 7
	Count 8	Count 9	Count 10	Sample Mean (λ)	Sample Standard Deviation (σ)	Lower Control Limit (λ-2s)	Upper Control Limit (λ+2s)

$$\lambda = \frac{1}{10}\sum_{i=1}^{10} n_i$$

Where λ is the mean of the counts, and n is the 30 second count rate

$$s = \sqrt{\frac{\sum_{i=1}^{m}(n_i - \lambda)}{9}}$$

Where σ is the standard deviation, λ is the mean of the counts, and n is the 30 second count rate

FORM 2: INSTRUMENT CONTROL CHART							
Initials	Date	Count	Sample Mean (λ)	Sample Standard Deviation (s)	Lower Control Limit (λ-2s)	Upper Control Limit (λ+2s)	Pass?
							Y or N
							Y or N
							Y or N
							Y or N
							Y or N
							Y or N
							Y or N
							Y or N
							Y or N
							Y or N
							Y or N
							Y or N
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							Y or N
							Y or N
							Y or N
							Y or N

ATTACHMENT B

CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL PLAN

FOR RECLAMATION OF WHITE MESA MILL FACILITY

BLANDING, UTAH

TABLE OF CONTENTS

1 INTRODUCTION

This Construction Quality Assurance/Quality Control Plan (CQA/QC Plan) has been prepared for construction activities related to the reclamation of the Energy Fuels Resources (USA) Inc. (”EFRI”) White Mesa Mill Facility located in Blanding, Utah and is submitted as an attachment to the Reclamation Plan.

1.1 Purpose and Scope

The purpose of this CQA/QC Plan is to address the Construction Quality Assurance (CQA) and Construction Quality Control (CQC) procedures and requirements to be used during reclamation activities at the site to assure that the project is constructed in conformance with the Technical Specifications, Drawings, and applicable regulatory requirements and permit conditions. The CQA/QC Plan is intended to: 1) define individuals and organizations who will be involved in reclamation activities and their respective responsibilities and qualifications; 2) establish guidelines for the flow of information and project communication; 3) establish protocols for project documentation; and 4) establish specific CQA/CQC procedures for the major components of the project.

This CQA/QC Plan addresses reclamation of the following facilities:

- Cell 1 (evaporation)
- Cells 2, 3, and 4A (tailings)
- Cell 4B (This cell is currently used for evaporation of process solutions. The CQA/QC Plan was written assuming this cell will be used for tailings storage in the future.)
- Mill buildings and equipment
- On-site contaminated areas
- Off-site contaminated areas (i.e., potential areas affected by windblown tailings)

The CQA/QC Plan has been written assuming tailings management Cells 2, 3, 4A, and 4B will receive tailings to the maximum permitted tailings elevations. Cell 2 is full and partially reclaimed. Cell 3 was used for tailings storage, but is currently only receiving mill waste. Cell 3 is partially full and partially reclaimed. Cell 4A is the only cell currently receiving tailings and is partially full. Cell 4B is used for evaporation of process solutions and has not yet been used for storage of tailings.

Reclamation of the above facilities will include the following:

- Placement of contaminated soils, crystals, and synthetic liner material and any contaminated underlying soils from Cell 1 into the last active tailings cell
- Placement of a compacted clay liner on a portion of the Cell 1 impoundment areas to be used for disposal of contaminated materials and debris from the Mill site
- Decommissioning the Cell 1 (evaporation) area
- Reclamation of the Mill and ancillary areas
- Placement of materials and debris from Mill decommissioning into the Cell 1 Disposal Area or the last active tailings cell
- Placement of an Evapotranspiration (ET) cover over the entire area of Cells 2, 3, 4A, 4B and the Cell 1 Disposal Area
- Construction of runoff control and diversion channels as necessary
- Reclamation of borrow sources

1.2 Definition of Terms

In the context of this CQA/QC Plan, the following definitions apply:

Construction Quality Assurance (CQA) – A planned and systematic pattern of means and actions designed to assure adequate confidence that the materials or services meet contractual and regulatory requirements and will perform satisfactorily in service. CQA refers to means and actions employed by the involved parties to assure conformity of the project work with this CQA/QC Plan, the Drawings, and the Technical Specifications.

Construction Quality Control (CQC) – Actions that provide a means to measure and regulate the characteristics of an item or service in relation to contractual and regulatory requirements. CQC refers to those actions taken by the Contractor, technicians, or other involved parties to verify that the materials and the workmanship meet the requirements of this CQA/QC Plan, the Drawings, and the Technical Specifications.

Technical Specifications – The document that prescribes requirements and standards for specific elements of the reclamation. This document is included as Attachment A to the Reclamation Plan. Technical Specifications will be prepared in final form prior to commencement of reclamation activities.

Drawings – Detailed project drawings to be used in conjunction with the Technical Specifications. These drawings will be prepared in final form as construction drawings prior to reclamation.

Construction Project – The total authorized/approved reclamation project that requires several construction segments to complete.

Construction Segment – A portion of the total construction project involving a specific area or type of work. Several construction segments will likely take place simultaneously during reclamation.

Construction Task – A basic construction feature of a construction segment involving a specific construction activity.

ASTM Standards – The latest versions of the American Society for Testing and Materials specifications, procedures and methods.

2 INVOLVED PARTIES AND PERSONNEL

Each construction task within each segment of the overall project will consist of both a QC and QA component. Compliance reporting will be completed for each segment. Upon completion of all project segments, a final construction report will be prepared for the project. Following is a listing of the parties (organizations and individuals) that will be involved in the implementation of the CQA/QC Plan during the reclamation at the site, including a discussion of each party's responsibility, authority and qualifications.

2.1 Owner

The Owner of this project is EFRI.

2.2 Construction Manager

Responsibility & Authority: The on-site Construction Manager is responsible for the conduct, direction and supervision of all reclamation activities as detailed in the Drawings and Technical Specifications. The Construction Manager will be selected/appointed by the Owner. The Construction Manager is responsible for maintaining a detailed schedule for the various Construction Segments so that each is performed according to the schedule for the overall Reclamation Project. The Construction Manager will interact as required with all other parties involved in implementing the reclamation including the Contractor, the CQA/QC personnel, and the DWMRC Project Manager. In the temporary absence of the Construction Manager, a designated representative will assume the duties of the Construction Manager. The Owner may appoint separate Construction Managers to oversee the various Construction Segments within the overall Reclamation Project. The Construction Manager(s) will report directly to the Owner.

Qualifications: The Construction Manager(s) shall have the mine and mill reclamation and construction experience necessary to manage a large-scale reclamation project.

2.3 Design Engineer

Responsibility & Authority: The Design Engineer is responsible for the design of the various elements of the reclamation project and for preparing the Drawings and Technical Specifications. Throughout the project, the Design Engineer will interact as necessary with the Owner, Construction Manager, CQA/QC staff, and the DWMRC Project Manager. The Design Engineer will approve all design changes that arise during the course of the Reclamation Project.

Qualifications: The Design Engineer shall be a qualified Professional Engineer registered in the State of Utah. The Design Engineer shall have expertise which demonstrates significant familiarity with the design and construction of the various elements of mine and Mill site reclamation including earthwork, cover design, mill demolition and disposal.

2.4 Contractor

Responsibility & Authority: The Contractor refers to an independent party or parties, contracted by the Owner, performing the work in accordance with this CQA/QC Plan, the Drawings, and the Technical Specifications. It is anticipated that various Contractors will be employed to perform the various Construction Segments within the overall Reclamation Project. The Contractor will work under the direction of and report directly to the Construction Manager.

Qualifications: Qualifications of the Contractor are specific to the construction contract and the specific Construction Segment. The Contractor shall have a demonstrated history of successful construction experience as appropriate for the Construction Segment. The Contractor shall maintain current state and federal licenses as appropriate.

2.5 Surveyor

Responsibility & Authority: The Surveyor is a party, independent from the Owner or Contractor, who is responsible for surveying, documenting, and verifying the location of all significant components of the work. The Surveyor is responsible for issuing Record Drawings of the completed elements of the Construction Project. The Surveyor's work is coordinated with the Contractor and CQA Consultant. The Surveyor will report directly to the Construction Manager.

Qualifications: The Surveyor will be a well-established surveying company with at least 3 years of surveying experience in the State of Utah. All survey activities shall be performed under the direction of a Professional Land Surveyor, licensed as required by State of Utah regulations. The Surveyor shall be fully equipped and experienced in the use of total stations and AutoCAD.

2.6 CQA/QC Consultant

Responsibility & Authority: The CQA/QC Consultant is a party, independent from the Owner or Contractor, who is responsible for observing, testing, and documenting the various activities comprising the Reclamation Project in accordance with this CQA/QC Plan, the Technical Specifications and the Drawings. The CQA/QC Consultant will be responsible for issuing a CQA report at the completion of the Reclamation Project which will document construction and associated CQA/QC activities. The CQA/QC Consultant will work in coordination with the Contractor, Surveyor and other parties and will report directly to the Construction Manager.

Qualifications: The CQA Consultant shall be a well-established firm specializing in geotechnical and reclamation engineering that possesses the equipment, personnel, and licenses necessary to conduct the observation and testing required. The CQA/QC Consultant will be experienced with earthwork, mill decommissioning, and other reclamation activities. The CQA/QC Consultant will be experienced in preparation of CQA documentation including field documentation, field testing procedures, laboratory testing procedures, and CQA reports.

The CQA Consultant will provide qualified staff for the project which will include the following individuals.

1) CQA Officer
2) CQA Site Manager
3) QC Technicians

2.7 CQA Officer

Responsibility & Authority: The CQA Officer will be responsible for overall implementation and management of the CQA/QC Plan for the reclamation project. The CQA Officer works from the office of the CQA Consultant and conducts periodic visits to the site as required. The CQA Officer will supervise the CQA Site Manager and all QC Technicians and will coordinate with the Surveyor, the Contractor and other staff. The CQA Officer will report directly to the Construction Manager.

The CQA Officer will be expected to maintain a thorough understanding of the existing White Mesa facilities and the reclamation project design documents including the Drawings, Technical

Specifications, and this CQA/QC Plan. He/she will have the authority to reject work or material, to require removal or placement, to specify and require appropriate corrective actions if it is determined that the Quality Control/Quality Assurance, personnel, instructions, controls, tests, or records are not conforming to the CQA/QC Plan, the Construction Plans, or the Technical Specifications. The approval of the CQA Officer is required on all Compliance Reports required in this CQA/QC Plan. Specific responsibilities of the CQA Officer will include the following:

1. Administer the CQA program (i.e., provide supervision of and manage all CQA personnel and activities)
2. Provide and document all necessary training and certifications for CQA personnel
3. Review and approve the Contractor's QC Plan(s), if applicable
4. Attend Project Kickoff and Pre-Construction Meetings, and make site visits as needed
5. Perform ongoing, timely review of all CQA documentation and provide signature on all CQA documentation

Qualifications: The CQA Officer will be a Professional Engineer registered in the State of Utah and will be experienced in providing CQA oversight for large construction projects.

2.8 CQA Site Manager

Responsibility & Authority: The CQA Site Manager will be appointed by the CQA Consultant to provide day-to-day, on-site oversight of the CQA/CQC activities. The CQA Site Manager will report directly to the CQA Officer and will interact with the Construction Manager, Contractor and others on a daily basis, as project activities take place. The CQA Site Manager will maintain a thorough understanding of the Drawings, Technical Specifications, and this CQA/QC Plan. Specific responsibilities of the CQA Site Manager will include the following:

1. Attend all CQA-related meetings including Project Kickoff and Pre-Construction Meetings
2. Provide direct oversight of QC Technicians
3. Assign locations for testing and sampling
4. Oversee the collection and shipping of laboratory test samples

5. Review results of field and laboratory testing and any test results provided by the Contractor and make appropriate recommendations
6. Review the calibration and condition of onsite testing equipment, and maintain necessary equipment documentation
7. Report any deviations from the CQA/QC Plan, Drawings, or Technical Specifications to the Construction Manager and CQA Officer and arrange consultation with other parties as necessary to find solutions to unsolved problems
8. Prepare a daily field report for submittal to the CQA Officer and Construction Manager

Qualifications: The CQA Site Manager will be an engineer experienced in providing field CQA/CQC oversight for construction projects.

2.9 QC Technicians

Responsibility & Authority: The CQA Consultant will utilize various QC Technicians to assist the on-site CQA Site Manager to perform specific tasks through the project to verify the adequacy of construction materials and procedures. The QC Technicians will work under the direct supervision of the CQA Site Manger and will work in close coordination with the Contractor. The number of technicians will depend on the project needs as the work progresses.

Qualifications: The CQA Consultant will identify areas of competency and select technicians as necessary. The QC Technicians will receive on-the-job training or off-site training as required under the direction of the CQA Consultant. The CQA Officer will determine the areas of expertise of the respective technician and maintain a file on each technician's training and certifications.

2.10 Document Control Officer

Responsibility & Authority: The Document Control Officer will be appointed by the Construction Manager to assist with managing the various documents that will be produced throughout the project. The Document Control Officer will maintain permanent files for the Construction Project. All tests, surveys, monitoring and report originals will be maintained in the project files. The Document Control Officer will oversee document reproduction and distribution. A distribution list will be prepared in coordination with the Owner, Construction Manager, and CQA Officer.

Qualifications: The Document Control Officer will have the organizational and computer skills necessary to manage and distribute the various project documents.

2.11 CQA Laboratory

Responsibility & Authority: The CQA Laboratory is a party, independent from the Owner and Contractor, responsible for conducting tests of soils and other project materials in accordance with ASTM and other applicable standards in either an on-site or off-site laboratory. It is likely that more than one CQA Laboratory will be used to perform testing during reclamation activities, depending upon the material being tested. The CQA Laboratory will work in coordination with other personnel and will report directly to the CQA Consultant.

Qualifications: The CQA Laboratory will be an AASHTO AMRL accredited laboratory in testing soils using the ASTM standards outlined in the Technical Specifications. The CQA Laboratory will be capable of providing test results within a maximum of seven days of receipt of samples and will maintain that capability throughout the duration of the project.

2.12 DWMRC Project Manager

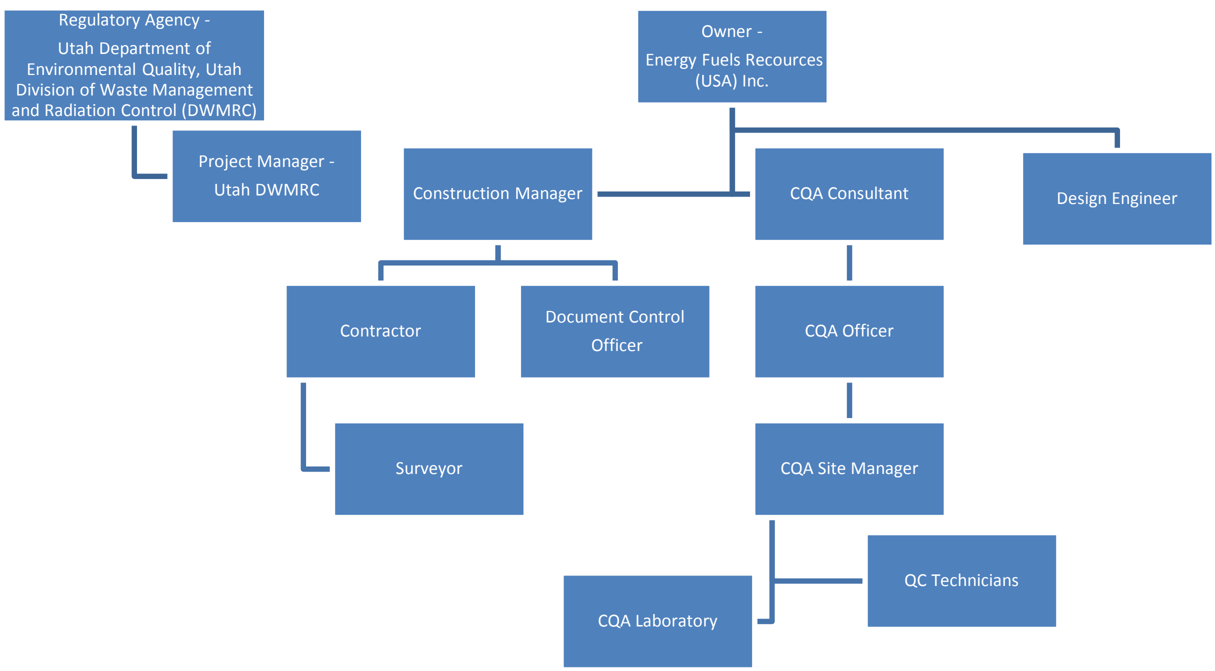
The DWMRC Project Manager will represent the DWMRC's interests in the Reclamation Project. The DWMRC Project Manager may choose to review selected procedures, personnel qualifications, equipment, calculations, and documentation. DWMRC personnel will be granted full access to the project files upon request.

3 PROJECT COMMUNICATION

3.1 Flow of Information

Effective communication is necessary to ensure a high degree of quality during the Reclamation Project. Specific meetings of key project personnel will take place including a Project Kickoff Meeting, Pre-Construction Meetings, weekly Progress Meetings, and Problem or Work Deficiency Meetings. In addition, informal communication and cooperation will take place between the various parties listed in Section 2 above. The organizational chart showing the proposed lines of communication between the various parties is shown in Figure 1. The planned project meetings are described in the following sections.

Figure 1 – Project Organization



3.2 Project Kickoff Meeting

At the beginning of major reclamation activities, a Project Kickoff Meeting will take place at the site. At a minimum, this meeting will be attended by the Owner, the Construction Manager, the Contractors, the CQA Consultant, the Engineer, and the DWMRC Project Manager. The Construction Manager will conduct a site tour to observe the current site conditions and to identify various areas of the site including equipment storage areas, soil stockpiling areas, and staging areas. The Construction Manager will appoint an individual to record the discussions and decisions of the meeting and distribute meeting minutes to all attendees. Specific items for discussion will include:

1. The Drawings, Technical Specifications, and CQA/QC Plan and any modifications or clarifications to these documents
2. Lines of communication and authority
3. The responsibilities of each party
4. The overall schedule for the Reclamation Project and the anticipated sequencing and schedule of the various Construction Segments
5. Documentation requirements

3.3 Pre-Construction Meetings

The overall Reclamation Project will be comprised of several individual Construction Segments. At the beginning of each Construction Segment, a Pre-Construction meeting will take place at the site and will be attended by the Construction Manager, the Contractor, the CQA Consultant, and the DWMRC Project Manager. The Construction Manager will conduct a tour of the work area to observe the current site conditions and to identify various areas of the site including equipment storage areas, soil stockpiling areas, staging areas, and other details related to the Construction Segment. The Construction Manager will appoint an individual to record the discussions and decisions of the meeting and distribute meeting minutes to all attendees. Specific items for discussion at the Pre-Construction Meetings include the following:

1. The Drawings, Technical Specifications, and CQA/QC Plan and any modifications or clarifications to these documents

2. Safety procedures
3. Lines of communication and authority
4. The responsibilities of each party
5. The overall schedule for the Construction Segment
6. Acceptance and rejection criteria
7. Protocols for handling deficiencies, repairs, and re-testing
8. Documentation requirements

3.4 Progress Meetings

Progress meetings will be held weekly between the CQA Site Manager, the Contractor, the Construction Manager, and other concerned parties participating in the construction of the project. This meeting will include discussions of the progress of the project, planned activities for the next week, and revisions to the work plan or schedule. The Construction Manager will appoint an individual to document the meeting and send meeting minutes to all attendees for review and comment.

3.5 Problem or Work Deficiency Meetings

It is anticipated that most work deficiencies will be minor and can be resolved in the field by the QC Technicians, the CQA Site Manager, and the Contractor. The deficiency and resolution will be recorded in daily field reports and weekly summary reports prepared by the CQA Site Manager.

A special meeting will be held when a problem or deficiency is present, or likely to occur, that cannot be easily resolved in the field. The meeting will be attended by the Contractor, the Construction Manager, the CQA Site Manager, and other parties as appropriate. If the problem requires a design modification, the Engineer should either be present at, consulted prior to, or notified immediately upon conclusion of this meeting. The Construction Manager will appoint an individual to record the meeting and send meeting minutes to all attendees for review and approval. The purpose of the work deficiency meeting is to define and resolve the problem or work deficiency as follows:

1. Define and discuss the problem or deficiency
2. Review alternative solutions
3. Select a suitable solution agreeable to all parties
4. Implement an action plan to resolve the problem or deficiency

4 DOCUMENTATION

4.1 Overview

The CQA Consultant will be responsible to prepare documentation that demonstrates that CQA/CQC requirements have been addressed and satisfied. Documentation will include monitoring logs, testing data sheets, photo logs, equipment calibration forms, daily field reports, weekly summary reports, reports of design or specification changes, and a final CQA Report. Documentation will be maintained in the White Mesa Project files and will be available to the Owner, Engineer, CQA Officer, and the DWMRC Project Manager at all times.

The CQA Officer and Site Manager will be responsible for preparing forms required throughout the Reclamation Project. These forms will be used by QC Technicians and other parties to document QC activities.

4.2 Daily Field Reports

The CQA Site Manager will prepare daily field reports that will document each day's activities. These daily reports will include the following, as applicable:

1. Basic information including date, project name, weather conditions, and the applicable Construction Segment
2. A summary of construction locations, activities, and observations an QC activities performed
3. Equipment and personnel on the project and a summary of meetings and attendees
4. Monitoring logs, testing data sheets, photo logs, and equipment calibration forms
5. A description of materials used and result of testing and documentation
6. Laboratory test reports
7. Reports of construction problems and resolution data sheets
8. Identification of deficient work or materials, and results of re-testing of deficient work
9. The signature of the CQA Site Manager

4.3 Weekly Summary Reports

At the end of each work week, a weekly summary report will be prepared and submitted to the Construction Manager and the CQA Officer. Weekly summary reports will include a brief description of the week's activities and all of the week's daily field reports. The CQA Officer will be responsible to review and sign each weekly summary report.

4.4 Field Change Reports

Changes that do not alter the intent of the Construction Plans or Technical Specifications may be made during construction to fit field conditions. Field changes require the approval of the Construction Manager and the CQA Site Manager. Field changes are to be reported on Form No. F-25 (Included in Section 6.0).

4.5 Construction Problems and Resolution Data Sheets

If significant recurring nonconformance occurs, or if special construction situations arise, the Construction Manager and CQA Officer will be made aware of the situation. The cause of the nonconformance will be determined and appropriate changes in procedures or specifications may be recommended. A Construction Problems and Resolution Data Sheet will be prepared to describe the situation and the resolution. Supporting documentation, such as photos or testing data sheets, will be attached to the data sheet. Data sheets will be included in the daily field reports and weekly summary reports.

4.6 Design or Specification Changes

During construction, design or specification changes may be required. Design changes will require the written approval of the Engineer and will take the form of technical memorandum and/or an addendum to the Drawings or Technical Specifications. Design changes are to be reported on Form No. F-26 (Included in Section 6.0).

4.7 CQA Compliance Reports

At the completion of each Construction Segment, the CQA Consultant will prepare a CQA Compliance Report signed and sealed by a Professional Engineer licensed in the State of Utah. The CQA Report will acknowledge that the work has been performed in conformance with the

Drawings and Technical Specifications. The CQA Report will incorporate supporting documentation including:

1. All daily field reports and weekly summary reports
2. Laboratory test reports
3. Field change reports
4. Construction problems and resolution data sheets
5. Documentation of design or specification changes

Any subsequent Construction Segment that is dependent upon successful completion of a specific Construction Segment cannot be initiated until a Compliance Report is prepared and approved for the previous dependent Construction Segment. Compliance Reports are to be completed on Form No. F-23 (Included in Section 6.0).

4.8 Final Construction Report

At the conclusion of the Reclamation Project, the Construction Manager or a designated representative will prepare a Final Construction Report. This report will be submitted to the DWMRC for review and approval within 180 calendar days after completion of construction. This report will be prepared under the direct supervision of and stamped by a Professional Engineer registered in the state of Utah. This report will include, at a minimum:

1. All of the individual CQA Compliance Reports which will summarize all CQA/CQC operations, construction equipment and processes, results, and observations of conformance/verification testing
2. A summary of any actions taken to resolve construction problems encountered
3. Field notes and photographs
4. As-built drawings and details

5 CQA/CQC PROCEDURES

This section describes the CQA/CQC monitoring and testing procedures to be used during the Reclamation Project to ensure that construction takes place in accordance with the Drawings and Technical Specifications. Specific requirements for construction procedures and materials are presented in the Drawings and Technical Specifications, along with criteria for site cleanup activities. If there is a conflict between CQA/QC procedures presented herein and those presented in the Technical Specifications, those presented in the Technical Specifications shall take precedence unless otherwise indicated by the Design Engineer.

5.1 Contractor Evaluation

Prior to construction, each Contractor will submit a summary of proposed construction methods, equipment and testing protocols. The Construction Manager, CQA Officer, and Engineer will review the submittal and provide approval, in writing, of the Contractor's plans. The Contractor may be required to modify proposed methods, equipment, or testing protocols prior to approval.

5.2 Testing Methods

Throughout the Reclamation Project, various field and laboratory testing will be conducted to ensure that materials meet the Technical Specifications. Where applicable, testing will be conducted in accordance with the current versions of the corresponding ASTM test procedures. Any revisions to the testing methods will be reviewed and approved by the Engineer and the CQA Officer prior to usage. Testing methods to be used are summarized in Table 1. The required frequency of testing is described in the applicable Sections that follow.

Table 1 - Summary of Testing Methods

TEST METHOD	TEST STANDARD
Particle Size Analysis (Gradation)	ASTM D422
Atterberg Limits	ASTM D4318
Standard Proctor	ASTM D698
Rock Correction of Unit Weight & Water Content	ASTM D4718
Nuclear Moisture/Density Gauge	ASTM D6938

TEST METHOD	TEST STANDARD
Sand-Cone Test	ASTM D1556
Moisture Content	ASTM D2216
LA Abrasion – Coarse	ASTM C535
LA Abrasion – Fine	ASTM C131
Specific Gravity – Aggregate	ASTM C127
Absorption – Aggregate	ASTM C127
Sodium Soundness – Aggregate	ASTM C88

During earthwork operations and fill placement, testing will be conducted to verify that the materials meet the gradation and classification specifications. Testing will include gradation testing (ASTM D422) and Atterberg Limit testing (ASTM D4318).

Moisture-density curves will be developed using the standard Proctor test (ASTM D698). Rock corrections (ASTM D4718) for the Proctor tests may be required depending on the material being tested. Field density testing may be conducted with the sand cone test (ASTM D1556) or a nuclear density gauge (ASTM D6938, or as modified by the QA Manager). Correlation of nuclear density gauge results shall be by comparison with results from sand cone test(s) and laboratory testing for water content(s) using the oven drying method (ASTM D2216) on similar material. A sufficient number of sand cone tests and moisture content tests will be performed to provide a correlation between the sand cone and nuclear density tests.

Rock protection aggregate will be tested using the LA Abrasion test for coarse or fine material (ASTM C535 or C131), the sodium soundness test (ASTM C88), and the specific gravity and absorption test (ASTM C127).

Other field or laboratory testing may be required throughout the Reclamation Project. Any testing shall be performed in accordance with the applicable ASTM or other industry standard.

5.3 Cell 1 Reclamation

Reclamation of Cell 1 will include the removal of contaminated materials including raffinate crystals, PVC liner, and contaminated site soils and the construction of a clay-lined area for permanent disposal of contaminated site materials. This disposal area (the Cell 1 Disposal Area) will be constructed adjacent to and parallel with the existing Cell 1 dike. A sedimentation basin will then be constructed and a drainage channel provided.

5.3.1 Removal of Contaminated Materials

QC staff will monitor of the removal of raffinate crystals, liner, and contaminated soils from Cell 1 and placement in the designated area. QC procedures for the placement of these materials are described in Section 5.4.

5.3.2 Subgrade Preparation

Subgrade for the clay liner may be leveled and filled as needed to provide a stable base for the placement of the clay liner. The QC staff will monitor placement and compaction of any subgrade fill.

5.3.3 Clay-Lined Cell 1 Disposal Area

A clay lined area will be constructed adjacent to and parallel with the existing Cell 1 dike for permanent disposal of contaminated material and debris. Tailings will not be placed in the Cell 1 Disposal Area. The area will be lined with a 12-inch thick clay layer prior to placement of contaminated materials and installation of the final reclamation cap. Placement of clay liner materials will be based on a schedule determined by the availability of contaminated materials removed from the Mill decommissioning area in order to maintain optimum moisture content of the clay liner prior to placing of contaminated materials.

5.3.4 Clay Liner Material Conformance Monitoring and Testing

The CQA Contractor will perform monitoring and frequent verification testing to verify that the clay liner material meets the gradation and classification specifications. The CQA Contractor will monitor earthmoving operations to ensure that fill material is taken from the proper borrow sources.

Clay liner material shall have a D_{100} particle size of less than 1-inch (100 percent passing the 1-inch sieve), and shall be free from roots, branches, rubbish, and process area debris. Liner material shall have a minimum of 40 percent passing the No. 200 sieve and a minimum plasticity index (PI) of 15. Suitable soils will classify as CL, CH, or SC materials under the Unified Soil Classification System.

Gradation and Atterberg limits testing will be performed at a minimum of one test per 2,000 cubic yards of clay liner material placed or when the material shows significant variation. Samples should be randomly selected for testing.

Laboratory test results for the clay liner shall be verified for compliance and approved by the CQA site manager prior to placement of disposed materials in the cell.

5.3.5 Clay Liner and Subgrade Material Placement

QC Technicians will observe the surface condition prior to fill placement. If the compacted surface of any layer of fill is too dry or smooth to bond properly with the layer of material to be placed thereon, it will be moistened and/or reworked with a harrow, scarifier, or other suitable equipment to a sufficient depth to provide relatively uniform moisture content and a satisfactory bonding surface before the next succeeding layer of fill is placed. If the compacted surface of any layer of fill is too wet (due to precipitation) for proper compaction, it will be reworked with harrow, scarifier or other suitable equipment to dry out the layer and reduce the moisture content to within the required limits. It will then be recompacted to the specified requirements.

QC Technicians will monitor the weather and temperature conditions. No material will be placed when fill material or the underlying material is frozen or when ambient temperatures do not permit the placement or compaction of the materials to the specified density without developing frost lenses in the fill.

The QC Technicians will monitor lift thicknesses frequently to verify the Technical Specifications are being met. The required layer and lift thicknesses for the clay liner and subgrade fill are listed in Table 2.

Table 2 - Summary of Liner Component Layers and Lift Thicknesses

Liner Component	Material Type (USCS)	Layer Thickness	Lift Thickness
Subgrade Fill	CL, ML, SC, SP, or SM	Variable	8 in. loose (max.)
Clay Liner	CL, SC, or CH	12 in. (min.)	6 in. loose (max.)

5.3.6 Moisture and Density Control

The QC Technicians will monitor placement, moisture conditioning, and compaction of the fill as it is placed. Prior to the start of field compaction operations, appropriate laboratory compaction curves will be obtained for the range of materials to be placed. Laboratory compaction curves based on complete Proctor tests will be obtained at the frequencies outlined in Table 3, depending on the variability of materials being placed.

Each layer of the fill will be conditioned so that the moisture content is uniform throughout the layer prior to and during compaction. As far as practicable, materials will be brought to the proper moisture content before placement. If necessary, water will be added after lift placement to the material by sprinkling on the layer. Each lift will be compacted by a sufficient number of roller passes or other compaction equipment to achieve the required dry density. Material that is too dry or too wet or does not meet the required dry density will be rejected and reworked until the moisture content and dry density are within the specified limits. Reworking may include removal, re-harrowing, reconditioning, rerolling, or combinations of these procedures.

The required density testing frequencies are included in Table 3. For all materials, a minimum of two tests will be taken for each day that more than 150 cubic yards of material is placed. A minimum of one test per lift and at least one test for every full shift of compaction operations will be taken.

Field density testing may be conducted with the sand cone test (ASTM D1556) or a nuclear density gauge (ASTM D6938, or as modified by the QA Manager). Correlation of nuclear density gauge results shall be by comparison with results from sand cone test(s) and laboratory testing for water content(s) using the oven drying method (ASTM D2216) on similar material. A sufficient number of sand cone tests and moisture content tests will be performed to provide a correlation between the sand cone and nuclear density tests. Field density tests shall be compared with standard Proctor tests (ASTM D698 Method A or C) on the same material.

Testing frequency may be increased by the CQA Site Manager if variability of materials is noted at the site, during adverse conditions, or to isolate failing areas of the construction.

Field density testing should not jeopardize the integrity of the clay liner. Holes in the clay material resulting from testing should be repaired by hand by filling with clay fill, or by filling with bentonite powder which is hydrated to fully seal the hole.

Table 3 - Summary of Liner Component Moisture-Density Testing Frequencies and Requirements

Liner Component	Test Frequency	Density Requirement*	Moisture Requirement*	Proctor Frequency
Subgrade Fill	1/1,000 cubic yards placed	90% (min.)	+/- 3%	1/10,000cubic yards placed
Clay Liner	1/500 cubic yards placed	95% (min.)	+/- 2%	1/5,000 cubic yards placed

* Based on maximum dry density and optimum water contents as determined by standard Proctor tests (ASTM D698 Method A or C) on the same material.

5.3.7 Sedimentation Basin and Discharge Channel

After contaminated material is removed from Cell 1 and the Cell 1 Disposal Area clay liner has been constructed, Cell 1 will be breached and constructed as a sedimentation basin. A discharge channel out of the sedimentation basin will be constructed. Details of these features are provided in the Drawings and Technical Specifications. The QC staff will monitor the excavation and construction of these features to ensure conformance with the Technical Specifications.

The channel excavation will be located within competent bedrock. The CQA team must document and verify the competency of the sedimentary bedrock along the channel for the Engineer and the Owner’s approval.

5.3.8 Riprap Conformance Monitoring and Testing

A rock apron will be constructed at the transition from soil to bedrock within the sedimentation basin. Rock apron riprap material of the specified size shall have a minimum rock quality designation or durability score of 70 or higher. If actual rock quality designation is between 65 and 69, oversizing will be required. Rock quality designations below 65 will not be acceptable.

The rock size specifications for the riprap shall be confirmed by particle-size distribution testing prior to placement, using ASTM D422, ASTM D5519, or an approved equivalent method for large-sized material. Testing shall be at a frequency of at least one test per 10,000 cubic yards of riprap placed, per select size, or when riprap characteristics show significant variation.

Test series for rock durability will include specific gravity, absorption, sodium soundness and LA abrasion. During construction additional test series and gradations will be performed for each type of riprap when approximately one-third (1/3) and two-thirds (2/3) of the total volume of each type have been produced or delivered. For any type of rock where the volume is greater than 30,000 cubic yards, a test series and gradations will be performed for each additional 10,000 cubic yards of rock produced or delivered.

5.3.9 Riprap and Filter Material Placement

In subgrade areas requiring fill placement to achieve final grades, after liner removal, the upper 12 inches shall be scarified, moisture conditioned and compacted prior to fill placement.

Filter material and riprap shall be placed in one or more lifts to form a continuous, uniform layer on top with a minimum thickness as identified in the Drawings. The top surface of the riprap shall be track-rolled or tamped with the bucket of a track-hoe to provide a uniform riprap surface and minimize void spaces within the riprap.

5.3.10 Tolerances

Completed grading for the sedimentation basin, in soil, shall be within 1.0 foot (horizontally) of the lines as designed, and within 0.1 foot (vertically) of the elevations as designed. Final surfaces shall be smoothed to avoid abrupt changes in surface grade or areas of runoff concentration.

The completed grading for the discharge channel (and portions of the sedimentation basin) in rock shall be within 2.0 foot (horizontally) of the lines as designed, and within 0.5 foot (vertically) of the elevations as designed. The final rock surfaces will be rough and shall not be filled to make grade. The bedrock channel shall be constructed at or below the design grades in order to meet the intent of the design.

5.3.11 Nonconformance, Corrective Action and Stop Work

The CQA staff, including the CQA Site Manager and QC Technicians, will have the authority to reject material brought to the site or material that has been placed. For a failed field moisture/density test, the QC Technician will determine the extent and depth of the affected area and require the Contractor to re-work the material as described above. If persistent failed tests occur (indicating inadequate compaction methods), the CQA Site Manager will have the authority to stop the work until the underlying cause is determined and the Contractor can demonstrate that moisture/density specifications can be met.

Laboratory test results for the clay liner shall be verified for compliance and approved by the CQA site manager prior to placement of disposed materials in the cell.

5.3.12 Documentation

Field and laboratory test results, observations of fill placement, and field compaction test results will be recorded using the appropriate field forms and reports, as described in Section 4. Table 4 includes a summary of the required materials testing and frequencies.

Table 4 - Summary of Testing Frequency and Criteria for Clay Liner and Sedimentation Basin Riprap

Component	Test	ASTM Standard	Frequency	Criteria
Clay Liner	Gradation (200 Wash)	D422	1/2,000cubic yards	40% min. passing the 200 sieve
	Atterberg Limits	D4318	1/2,000 cubic yards	Min. PI = 15
Riprap*	Gradation with 200 Wash	D422	1/10,000 cubic yards	D_{50}, Durability

*Rock durability testing per section 5.3.8

5.4 Mill Decommissioning

Decommissioning of the Mill will include:

- Disposal of the Mill processing equipment and structures and contaminated soils in the Mill area
- Cleanup of contaminated areas of the Mill Site including ore storage area and roadways
- Cleanup of windblown contamination

These areas are shown on the Drawings. The Technical Specifications describe methods and cleanup criteria, including radiological equipment that will be used and the development of cleanup criteria. Contaminated materials will be disposed of in the designated areas of the tailings impoundment.

The CQA Contractor will provide specialized QC Technicians qualified to monitor the dismantling of the Mill equipment and structures and the cleanup of contaminated soils. These Technicians will be trained in the proper use and calibration of radiological monitoring equipment and will monitor the work to ensure the cleanup criteria are met.

5.4.1 Characterization Surveys

Following scanning, classification and cleanup (as required), the areas will be scanned again to verify compliance with activity criteria. QC Technicians will use calibrated beta/gamma instruments capable of detecting activity levels of less than or equal to 25 percent of the guideline values.

After removal of contamination, the technicians will make final surveys over the remediated areas. The QC Technicians will document within the specific ten meter by ten meter grids, the sample point locations, as detailed in the Technical Specifications. Soil samples from 10 percent of the surveyed grids will be chemically analyzed to confirm the initial correlation factors utilized and confirm the success of cleanup effort for radium, thorium and uranium. Ten percent of the samples chemically analyzed will be split and duplicates will be sent to an off-site laboratory. Spikes and blanks, equal to 10 percent of the samples that are chemically analyzed, will be processed with the samples.

5.4.2 Contaminated Material Disposal

Contaminated materials including mill debris, site soils, liner material, and raffinate crystals will be disposed of in the designated portion of the Cell 1 Disposal Area. Material specifications and placement methods are described in the Construction Plans and Technical Specifications. The CQA Contractor will provide monitoring and testing during material placement.

5.4.3 Material Conformance Monitoring

For scrap and debris, the QC Technicians will monitor the volume and size of the material to ensure compliance with the maximum dimensions provided in the Technical Specifications (a maximum dimension of 20 feet and a maximum volume of 30 cubic ft) and to ensure that containers are properly pierced. If the size limits are exceeded, the QC staff will require the Contractor cut the material down to size.

5.4.4 Material Placement

QC Technicians will monitor material placement to verify the debris is spread out and placed according to the Technical Specifications and that voids are filled with stockpiled soils, contaminated soils, tailings and/or other approved materials. The approval of the Construction Manager and CQA Officer will be required for the use of other materials to fill voids.

A minimum of one foot of compacted soil will be required above the clay liner prior to placing any scrap or debris.

When liner or other lightweight material is placed, the QC staff will ensure that at least one foot of soil, crystals or other materials is placed above for protection against wind.

To the extent practicable, the various materials will not be concentrated in thick deposits on top of the tailings, but will be spread over the working surface as much as possible to provide relatively uniform settlement and consolidation characteristics of the cleanup materials.

It is anticipated that raffinate crystals will have a consistency similar to a granular material when brought to the cells, with large crystal masses being broken down for transport. Placement of the crystals will be performed as a granular fill, with care being taken to avoid nesting of large sized material. Actual placement procedures will be evaluated by the QC staff during construction as crystal materials are brought and placed in the cells.

Soil or soil-like material shall be placed and compacted over each lift of debris or other materials in lifts not to exceed two feet in loose thickness and compacted prior to placement of additional lifts.

5.4.5 Material Compaction

CQA staff will monitor material compaction to verify compliance with the Technical Specifications. The first lift (bridging lift) will be compacted by the tracking of heavy equipment, such as a Caterpillar D6 Dozer (or equivalent), using at least 4 passes, prior to the placement of a subsequent lift. Contaminated soils and other cleanup materials after the bridging lift will be compacted to the density requirement provided in the Technical Specifications. During construction, compaction requirements for the raffinate crystals will be re-evaluated based on field conditions and modified by the Construction Manager and CQA Officer, with the agreement of the DWMRC personnel.

Soil or similar material shall be compacted with a minimum of six passes with self-propelled, towed, or hand-held vibratory compaction equipment. The number of passes shall be confirmed with actual compaction equipment on site with a field test section of soil to establish a correlation between the field compaction method and 80 percent of maximum dry density for the soil, as determined by the standard Proctor test (ASTM D698).

The upper 12 inches of the final disposed material surface shall be compacted to 90 percent of the maximum dry density for the material, as determined by the standard Proctor test.

Field density tests shall be compared with standard Proctor tests (ASTM D698 Method A or C) on the same material. Standard Proctor tests shall be conducted at a frequency of at least one test

per 5,000 cubic yards of material compacted, or when material characteristics show significant variation.

Field density testing may be conducted with the sand cone test (ASTM D1556) or a nuclear density gauge (ASTM D6938, or as modified by the QA Manager). Correlation of nuclear density gauge results shall be by comparison with results from sand cone test(s) and laboratory testing for water content(s) using the oven drying method (ASTM D2216) on similar material. A sufficient number of sand cone tests and moisture content tests will be performed to provide a correlation between the sand cone and nuclear density tests.

The frequency of the field density and moisture tests will be not less than one test per 1,000 cubic yards of compacted fill. A minimum of two tests will be taken for each day that more than 150 cubic yards of material is placed. A minimum of one test per lift and at least one test for every full shift of compaction operations will be taken. Tables 5 and 6 summarize the placement and testing criteria for the disposed materials.

Table 5 - Summary of Disposed Materials and Lift Thicknesses

Disposed Materials	Material Type (USCS)	Layer Thickness	Lift Thickness
Debris Lift	Variable	48 in. (max.)	As needed to fill voids
Fill Above Debris Lift	Variable	36 in. (min.)	12 in. compacted (max.)

Table 6 - Summary of Disposed Materials Moisture-Density Testing Frequencies and Requirements

Disposed Materials	Test Frequency	Density Requirement *	Proctor Frequency
Fill around debris	1/1,000 cubic yards placed	80% (min.)	1/5,000 cubic yards placed
Upper Debris Fill	1/1,000 cubic yards placed	90% (min.)	1/5,000 cubic yards placed

* Based on maximum dry density and optimum water contents as determined by standard Proctor tests (ASTM D698 Method A or C) on the same material.

5.4.6 Final Slope and Grades

The final disposed material surface shall have maximum side slopes of 5:1 and a top surface sloping in the directions and grades shown on the Drawings. The side slopes and top surface shall be free from abrupt changes in grade or areas of runoff concentration. The final disposed material surface shall be compacted with approved construction equipment to form a smooth surface with uniform density for subsequent cover placement.

5.4.7 Tolerances

The final surface of the disposed material shall be smoothed to avoid abrupt changes in surface grade. The layer thicknesses shall meet the required minimum thicknesses.

5.4.8 Nonconformance, Corrective Action and Stop Work

The CQA Site Manager and QC Technicians will have the authority to reject scrap and debris that is not properly prepared for placement. The Contractor may be required to reduce the size of large pieces of material or pierce drums or other containers. CQ staff may also require site soils to be re-worked if a failed test indicates the compaction requirements were not met. If persistent inadequacies occur during the placement of contaminated materials, the CQA Site Manager will have the authority to stop the work until the underlying cause is determined and the Contractor can demonstrate that the Technical Specifications can be met.

5.4.9 Documentation

All observations and monitoring of contaminated material placement and all field compaction test results will be recorded using the appropriate field forms and reports, as described in Section 4.

5.5 Settlement Plates

The CQA team will need to verify proper construction and placement of the settlement points. The Surveyor will conduct the settlement plate measurements based on the DWMRC approved monitoring plan.

5.6 Cover System

A multi-layered earthen cover will be placed over tailings Cells 2, 3, 4A, and 4B and the portion of Cell 1 used for disposal of contaminated materials (the Cell 1 Disposal Area). The cover layers, from bottom to top, will include: 1) interim fill layer, 2) compacted cover layer 3) growth medium layer, and 4) erosion protection layer. Layers 1 through 3 will consist of “random fill.”

The material specifications, layer configurations, layer thicknesses, borrow sources, placement methods, and compaction requirements are described in the Technical Specifications. The CQA Contractor will provide monitoring and testing during material placement.

5.6.1 Material Conformance Monitoring and Testing

The CQA Contractor will perform monitoring and frequent verification testing to ensure that the fill materials meet the gradation and classifications specifications. The CQA Consultant will monitor earthmoving operations to ensure that the fill material is taken from the proper borrow sources.

Prior to the placement of the next layer of the cover, the CQA Site Manager or the QC Technicians under the supervision of the CQA Site Manager shall inspect the completed layer and document any of the following:

- Erosion of the layer surface
- Cracking or desiccation of the surface
- Fill areas that may contain excessive organics or other debris
- Depressions, or settlement of the layer
- Irregularities in the layer surface (e.g. grading errors)

Any documented items that constitute non-conformance with the Drawings and Technical Specifications should be corrected prior to placement of the subsequent layer of the cover.

5.6.1.1 Random Fill

Random fill will be used for each of the lower three layers of the cover system. The fill will consist of mixtures of sands and silts with varying amounts of clay and random amounts of gravel and rock-size material. Random fill, except for the interim fill layer, shall have a maximum particle size of 6 inches, and at least 10 percent of the material shall be finer than the No. 200 sieve. Oversized material will be controlled through selective excavation at the stockpiles and through the utilization of a grader, bulldozer or backhoe to cull oversize materials from the fill. The source of these materials will be site stockpiles from previous cell construction activities.

Testing for all layers except the interim fill shall consist of No. 200 sieve wash and particle-size distribution testing (ASTM D422) at a frequency of at least one test per 2,000 cubic yards of fill placed, or when material characteristics show a significant variation.

5.6.1.2 Topsoil-Gravel Admixture

Topsoil-gravel admixture material shall be free from roots, branches, rubbish, and debris. The gravel portion of the topsoil-gravel admixture material will consist of granular materials from approved off-site sources.

The mixture will be 25 percent gravel by weight. The gravel will be purchased from nearby commercial sources of alluvial gravel and cobbles. The gravel portion of the topsoil-gravel admixture material shall be a screened product and have a maximum particle size of less than 1-inch. The topsoil portion of the topsoil-gravel admixture material will consist of select material from the on-site topsoil borrow area.

Gradation specifications for the gravel used for topsoil-gravel admixture material shall be confirmed by gradation testing prior to mixing with the topsoil, to determine the maximum particle size. Testing shall consist of particle-size distribution testing (ASTM D422) at a frequency of at least one test per 2,000 cubic yards of rock delivered to the site, or when rock characteristics show a significant variation.

Gradation specifications for topsoil-gravel admixture material shall be confirmed by gradation testing, on samples collected from the point of placement (on the topdeck). Testing shall consist of particle-size distribution testing (ASTM D422) at a frequency of at least one test per 2,000 cubic yards of mixture placed, or when the characteristics of the mixture show a significant variation.

Layer thickness of the topsoil-gravel admixture will be controlled through establishment of grade stakes placed on a 200 x 200 foot grid on the top of the cells and by a 100 x 100 foot grid on the cell slopes. Physical checks of topsoil-gravel admixture depth will be accomplished through the use of hand dug test pits at the center of each grid in addition to monitoring the depth indicated on the grade stakes.

5.6.2 Material Placement

QC Technicians will observe the surface condition prior to fill placement. If the compacted surface of any layer of fill is too dry or smooth to bond properly with the layer of material to be placed thereon, it will be moistened and/or reworked with a harrow, scarifier, or other suitable equipment to a sufficient depth to provide relatively uniform moisture content and a satisfactory bonding surface before the next successive layer of fill is placed. If the compacted surface of any layer of fill is too wet (due to precipitation) for proper compaction of the fill material to be placed thereon, it will be reworked with harrow, scarifier or other suitable equipment to reduce the moisture content to the required level. It will then be recompacted to the specified requirements.

Nesting of oversized material will be controlled through selective excavation of stockpiled material, observation of placement by QC Technicians with authority to stop work and reject material being placed and by culling oversized material from the fill utilizing a grader. Successive loads of material will be placed on the fill so as to produce the best practical distribution of material.

QC Technicians will monitor the weather and temperature conditions. No material will be placed when the fill material or the underlying material is frozen or when ambient temperatures do not permit the placement or compaction of the materials to the specified density without developing frost lenses in the fill.

QC Technicians will monitor and document lift thicknesses frequently to ensure the Technical Specifications are being met. The required layer and lift thicknesses are listed in Table 7.

Table 7 - Summary of Cover Component Layer and Lift Thicknesses

Cover Component	Layer Thickness	Lift Thickness
Interim Fill	30 in. (min.)	12 in. loose (max.)
Compacted Cover Layer	36 to 48 in. (min.)	12 in. loose (max.)
Growth Medium Layer	42 in. (min.)	18 in. loose (max.)
Erosion Protection Layer	6 in. (min.)	6 in. (max.)

5.6.3 Density Control

The QC Technicians will monitor placement, moisture conditioning, and compaction of the fill as it is placed. Prior to the start of field compaction operations, appropriate laboratory compaction curves will be obtained for the range of materials to be placed. Laboratory compaction curves based on complete Proctor tests will be conducted at the frequencies outlined in Table 8, depending on the variability of materials being placed.

Each layer of the fill will be conditioned so that the moisture content is uniform throughout the layer prior to and during compaction. Each lift will be compacted by a sufficient number of roller passes or other compaction equipment to achieve the required dry density. Material that does not meet the required dry density will be rejected and will be reworked until the dry density is within the specified limits. Reworking may include removal, re-harrowing, reconditioning, re-rolling, or combinations of these procedures.

The required testing frequencies are included in Table 8. For all layers requiring compaction testing, a minimum of two tests will be taken for each day that an applicable amount of fill is placed in excess of 150 cubic yards. A minimum of one test per lift and at least one test for every full shift of compaction operations will be taken.

Table 8 - Summary of Cover Component Density Testing Frequencies and Requirements

Cover Component	Compaction Test Frequency	Relative Compaction Requirement*	Proctor Frequency
Compacted Cover Layer	1/500 cubic yards placed	95% (min.)	1/5,000 cubic yards placed
Growth Medium Layer	1/2,000 cubic yards placed	85% (min.)	1/10,000 cubic yards placed

* Based on maximum dry density and optimum water contents as determined by standard Proctor tests (ASTM D698 Method A or C) on the same material.

Field density testing may be conducted with the sand cone test (ASTM D1556) or a nuclear density gauge (ASTM D6938, or as modified by the QA Manager). Correlation of nuclear density gauge results shall be by comparison with results from sand cone test(s) and laboratory testing for water content(s) using the oven drying method (ASTM D2216) on similar material. A sufficient number of sand cone tests and moisture content tests will be performed to provide a correlation between the sand cone and nuclear density tests. Field density tests shall be compared with standard Proctor tests (ASTM D698 Method A or C) on the same material. Rock corrections (ASTM D4718) for oversize particles may be required for the topsoil-gravel admixture material (or other materials) depending on the gradation of the gravel material selected.

The actual frequency of testing may be increased by the CQA Site Manager if variability of materials is noted at the site, during adverse conditions, or to isolate failing areas of the construction.

5.6.4 Surface Slopes and Grades

The final cover surface shall have maximum side slopes of 5:1 and a top surface sloping in the direction and grade shown on the Drawings. The side slopes and top surface shall be free from abrupt changes in grade or areas of runoff concentration. The perimeter apron at the toe of the side slopes shall have a minimum width of 20 feet from the toe of the side slopes and slope away from the toe of the side slopes (as shown on the Drawings).

5.6.5 Tolerances

The completed cover surface shall be constructed to within 1.0 foot (horizontally) of the lines as designed, and within 0.1 foot (vertically) of the elevations as designed. The final surface of the cover shall be smoothed to avoid abrupt changes in surface grade. The layer thicknesses shall meet the required minimum thicknesses identified in the Technical Specifications and Drawings.

5.6.6 Nonconformance, Corrective Action and Stop Work

The CQA Site Manager and QC Technicians will have the authority to reject material that is brought to the site or material that has been placed. For a failed field density test, the QC Technician will determine the extent and depth of the affected area and require the Contractor to re-work the material as described above. If persistent failed tests occur (indicating inadequate compaction methods), the CQA Site Manager will have the authority to stop the work until the underlying cause is determined and the Contractor can demonstrate that the moisture/density specifications can be met.

5.6.7 Documentation

All field and laboratory test results, observations of fill placement, and field compaction test results will be recorded using the appropriate field forms and reports, as described in Section 4. Table 9 includes a summary of the required materials testing and frequencies for the cover components.

Table 9 - Summary of Testing Frequency and Criteria for Cover Components

Component	Test	ASTM Standard	Frequency	Criteria
Random Fill (compacted cover & growth medium layers)	Gradation with 200 Wash	D422	1/2,000 cubic yards	Max. Particle = 6 inches, Min. 10% passing the No. 200 sieve
Rock Mulch	Gradation	D422	1/2,000 cubic yards	$D_{100} \leq 1$ inch

5.7 Riprap and Filter Material

The side slopes of the reclaimed cover will be protected by riprap surfacing. The size, thickness and gradation requirements for the riprap are provided in the Drawings and Technical Specifications.

5.7.1 Material Conformance Monitoring and Testing

Riprap will be a screened product transported from aggregate sources north of the project site. The CQA Contractor will perform monitoring and frequent verification testing to confirm that the riprap meets the gradation and durability specifications.

During active riprap placement, each load of material will be visually checked against standard piles for gradation prior to transport to the tailings cells.

5.7.1.1 Riprap

Material for the perimeter aprons and side slopes will consist of granular materials from approved off-site areas. Riprap shall meet NRC long-term durability requirements (rock quality designation of 65 or more; Johnson, 2002).

Riprap shall be a screened product, free from roots, branches, rubbish, and debris. The specifications as given below are for rock quality designations of 70 or higher. If actual rock quality designation is between 65 and 69, additional oversizing will be required. Rock quality designations below 65 will not be acceptable.

Designated gradations for the riprap will be specified on the final drawings for construction. Riprap will be imported from off-site.

- Side slope riprap shall have a minimum D_{50} as listed below and a minimum layer thickness of 1.5 times the D_{50} or the D_{100} of the riprap, whichever is greater:
    - 1.7 in. for non-accumulating flow side slopes
    - 5.3 in. for Cell 4A and Cell 4B southern side slopes
    - 4.5 in. for Cell 1 Disposal Area side slope

- Riprap used in the rock aprons shall have a minimum D_{50} as listed below and a minimum layer thickness of 1.5 times the D_{50} or the D_{100} of the riprap, whichever is greater:
    - 3.4 in. for Rock Apron A
    - 10.5 in. for Rock Apron B
    - 9.0 in. for Rock Apron C

Material specifications for the riprap shall be confirmed by gradation testing conducted by the CQA Laboratory. Testing shall consist of particle-size distribution testing (ASTM D422) at a frequency of at least one test per 10,000 cubic yards of rock delivered to the site, or when rock characteristics show a significant variation.

Riprap layer thickness will be controlled through establishment of grade stakes placed on a 200 x 200 foot grid on the top of the cells and by a 100 x 100 foot grid on the cell slopes. Physical checks of riprap depth will be accomplished through the use of hand dug test pits at the center of each grid in addition to monitoring the depth indicated on the grade stakes.

Test series for rock durability will include specific gravity, absorption, sodium soundness and LA abrasion. During construction additional test series and gradations will be performed for each type of riprap when approximately one-third (1/3) and two-thirds (2/3) of the total volume of each type have been produced or delivered. For any type of rock where the volume is greater than 30,000 cubic yards, a test series and gradations will be performed for each additional 10,000 cubic yards of rock produced or delivered. Gradation tests will also be performed at the direction of the QC Technician for any locations considered inadequate based on visual inspection by the QC Technician, or if difficulties are experienced by the Contractor during rock placement.

5.7.1.2 Filter Material

Filter material shall be free from roots, branches, rubbish, and debris. Filter material will generally be classified as sand containing gravel and fines and shall meet the following gradation specifications.

Table 10 – Filter Material Gradation

Sieve Size	Percent Passing, by Weight
3-inch	100
No. 4	70-100
No. 20	40-60
No. 200	0-5

Material specifications for the filter material shall be confirmed by gradation testing conducted by the CQA Laboratory. Testing shall consist of particle-size distribution testing (ASTM D422) at a frequency of at least one test per 10,000 cubic yards of filter material delivered to the site, or when material characteristics show a significant variation.

Filter layer thickness will be established during construction with grade stakes placed on a grid or centerline and offset pattern and layer thickness marks on each grade stake. The minimum thickness of the layer will be verified by spot checking of layer thickness by hand excavation in selected locations.

5.7.2 Material Placement

QC Technicians will monitor riprap placement. An initial section of each type of riprap constructed shall be visually examined and used to evaluate future placement. The initial section will be constructed with material meeting gradation and riprap thickness requirements. Initial testing should be conducted to determine the gradation and the rock weight/unit volume that will be achieved in future rock placement activities. Riprap material will be hauled to the reclaimed surfaces and placed on the surfaces using belly dump highway trucks and road graders. Riprap will be dumped in windrows and the grader will spread the riprap in a manner to minimize segregation of the material. Depth of placement will be controlled through the establishment of grade stakes. Minimum required thicknesses for riprap and filter material layers are provided in the Technical Specifications and Drawings. Physical checks of riprap depth will be accomplished through the use of hand dug test pits at the center of each grid in addition to monitoring the depth indicated on the grade stakes. The Contractor will excavate the test pits, and QC Technicians will observe and document the excavation. Placement of riprap will avoid accumulation of riprap sizes less than the minimum D_{50} size and nesting of the larger sized rock. Additional riprap placement requirements include:

- Individual stones shall not be greater than 90 percent of the riprap layer thickness.
- Dumped riprap shall be placed to its full course thickness in one operation and in such a manner as to avoid displacing bedding material.
- Hand placement or rearrangement of individual stones will be required only to the extent necessary to secure the results specified above. Larger stones may require individual placement by equipment.
- Any stones that are not firmly wedged shall be adjusted and additional selected stones inserted or existing stones replaced, so as to achieve a solid interlock.

5.7.3 Compaction

QC staff will monitor riprap placement. The riprap layer will be compacted by at least two passes by a D7 Dozer, tamping with the bucket of a trackhoe, or equivalent methods in order to key the rock for stability.

5.7.4 Tolerances

The completed riprap shall be placed to within 5.0 foot (horizontally) of the layout as designed, and within 0.5 foot (vertically) of the elevations as designed. The rock layer thicknesses shall meet the minimum requirements. Minimum required thicknesses for riprap and filter material layers are provided in the Technical Specifications and Drawings. Riprap layer thickness will be directly measured as outlined in Section 5.7.2. A measurement device (i.e. tape measure) may be used to determine the distance from the top of the bedding or filter layer to the top of the riprap layer.

5.7.5 Nonconformance, Corrective Action and Stop Work

The CQA Site Manager and QC Technicians will have the authority to reject riprap that is brought to the site or riprap that has been placed. For rejected riprap, QC Technicians will identify the extent of inadequate riprap and will require the Contractor to excavate the material and place additional riprap. If persistent failed tests occur (indicating inadequate placement methods), the CQA Site Manager will have the authority to stop the work until the underlying cause is determined and the Contractor can demonstrate that the riprap can be placed according to the Technical Specifications.

5.7.6 Documentation

All field and laboratory test results, observations of riprap placement, and field compaction test results will be recorded using the appropriate field forms and reports, as described in Section 4. Table 11 includes a summary of the required materials testing and frequencies for the erosion protection materials.

Table 11 - Summary of Testing Frequency and Criteria for Riprap and Filter Material

Component	Test	ASTM Standard	Frequency	Criteria
Riprap*	Gradation with 200 Wash	D422	1/10,000 cubic yards	D_{50} and Durability*
Filter Material	Gradation with 200 Wash	D422	1/10,000 cubic yards	See Table 10

*Rock durability testing per section 5.7.1.1

5.8 Protection of Soil Stockpiles

The Contractor shall maintain proper erosion control measures for stockpiles and may be required to cover piles in situations where precipitation is anticipated. The CQA Site Manager should document improper stockpile management in situations where the integrity of the material is affected. The Construction Manager and/or the CQA Officer should determine corrective measures.

6 FIELD REPORT FORMS

Form No. F-23

COMPLIANCE REPORT

Project No.________________________________ Date:______________________________

Construction Segment:____

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Drawing No.:_______________________

Specification No.:___________________

Description of Completed Construction Segment:

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By: CQA Officer ____

Approvals:

CQA Site Manager ____

DWMRC Project Manager ______________________________________

Form No. F-25

FIELD CHANGE ORDER

Project No.________________________________ Date:______________________________

Drawing No.:_______________________

Specification No.:___________________

Design Feature:

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Modifications:

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Reason:

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Initiated by:____

Approved by:____
CQA Site Manager

Form No. F-26

DESIGN CHANGE ORDER

Project No.______________________________ Date:____________________________

Drawing No.:______________________

Specification No.:__________________

Design Feature:

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Change in Design:

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Reason:

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Initiated by:____

Approvals:

CQA Site Manager:____

DWMRC Project Manager:_____________________________________

Design Engineer:____

ATTACHMENT C

COST ESTIMATES FOR RECLAMATION OF WHITE MESA FACILITY IN BLANDING, UTAH

Cost Summary

WHITE MESA MILL RECLAMATION COST ESTIMATE
June 2016
Revision 5.1

Mobilization		$553,834
Office Facilities		$106,224
Mill Decommissioning		$2,296,874
Cell 1		$1,009,743
Cell 2		$1,092,353
Cell 3		$2,067,154
Cell 4A		$1,372,956
Cell 4B		$1,499,557
Management/Legal Support		$2,422,560
Miscellaneous		$2,055,680
Subtotal Direct Costs		$14,476,933
Profit Allowance	10.00%	$1,332,260
Contingency	25.00%	$3,325,170
Licensing & Bonding	2.00%	$289,539
UDEQ Contract Administration	4.00%	$579,077
Engineering Design Review	2.25%	$325,731
Contractors Equipment Floater		$82,250
Automobile and General Liability Insurance		$177,500
Long Term Care Fund		$876,425
Total Reclamation		$21,464,885
Revised Bond Amount		$21,464,885

Mill Decommissioning

MILL DECOMMISSIONING

Mill Building Demolition

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Mechanics	hrs	$15.87	640	$10,155
Laborers	hrs	$17.16	320	$5,490
Small Tools	hrs	$1.35	960	$1,296
Cat 770 Haul Truck	hrs	$102.19	640	$65,404
Truck Drivers	hrs	$21.30	640	$13,632
Cat 988 Loader	hrs	$144.84	160	$23,175
Cat 988 Loader Operator	hrs	$26.00	160	$4,160
Cat 365 Excavator	hrs	$139.69	160	$22,351
Cat 365 Excavator Operator	hrs	$28.78	160	$4,604
PC 300 w/metal Shears	hrs	$170.14	160	$27,222
PC 300 Operator	hrs	$28.78	160	$4,604
60 Ton Crane	hrs	$91.90	160	$14,704
60 Ton Crane Operator	hrs	$31.03	160	$4,964
30 Ton Crane	hrs	$58.29	80	$4,664
30 Ton Crane Operator	hrs	$31.03	80	$2,482
Equipment Maintenance (Butler)	hrs	$22.45	1,360	$30,539
Concrete Removal	sf	$3.30	37,500	$123,750

Total Mill Building Demolition **$363,196**

Ore Feed Demolition

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Mechanics	hrs	$15.87	64	$1,015
Laborers	hrs	$17.16	32	$549
Small Tools	hrs	$1.35	96	$130
Cat 770 Haul Truck	hrs	$102.19	64	$6,540
Truck Drivers	hrs	$21.30	64	$1,363
Cat 988 Loader	hrs	$144.84	16	$2,317
Cat 988 Loader Operator	hrs	$26.00	16	$416
Cat 365 Excavator	hrs	$139.69	16	$2,235
Cat 365 Excavator Operator	hrs	$28.78	16	$460
PC 300 w/metal Shears	hrs	$170.14	16	$2,722
PC 300 Operator	hrs	$28.78	16	$460
30 Ton Crane	hrs	$58.29	0	$0
30 Ton Crane Operator	hrs	$31.03	0	$0
Equipment Maintenance (Butler)	hrs	$22.45	112	$2,515

Total Ore Feed Demolition **$20,724**

SX Building Demolition

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Mechanics	hrs	$15.87	320	$5,077
Laborers	hrs	$17.16	160	$2,745
Small Tools	hrs	$1.35	480	$648
Cat 770 Haul Truck	hrs	$102.19	320	$32,702
Truck Drivers	hrs	$23.25	320	$7,440
Cat 988 Loader	hrs	$144.84	80	$11,587
Cat 988 Loader Operator	hrs	$26.00	80	$2,080
Cat 365 Excavator	hrs	$139.69	80	$11,175
Cat 365 Excavator Operator	hrs	$28.78	80	$2,302
PC 300 w/metal Shears	hrs	$170.14	80	$13,611
PC 300 Operator	hrs	$28.78	80	$2,302
60 Ton Crane	hrs	$91.90	0	$0
60 Ton Crane Operator	hrs	$31.03	0	$0
30 Ton Crane	hrs	$58.29	0	$0
30 Ton Crane Operator	hrs	$31.03	0	$0
Equipment Maintenance (Butler)	hrs	$22.45	560	$12,575
Asbestos Removal	sf			
Concrete Removal	sf	$3.30	55,970	$184,701

Total SX Building Demolition **$288,947**

MILL DECOMMISSIONING

CCD Circuit Removal

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Mechanics	hrs	$15.87	120	$1,904
Laborers	hrs	$17.16	60	$1,029
Small Tools	hrs	$1.35	180	$243
Cat 770 Haul Truck	hrs	$102.19	120	$12,263
Truck Drivers	hrs	$23.25	120	$2,790
Cat 988 Loader	hrs	$144.84	30	$4,345
Cat 988 Loader Operator	hrs	$26.00	30	$780
Cat 365 Excavator	hrs	$139.69	30	$4,191
Cat 365 Excavator Operator	hrs	$28.78	30	$863
PC 300 w/metal Shears	hrs	$170.14	30	$5,104
PC 300 Operator	hrs	$28.78	30	$863
60 Ton Crane	hrs	$91.90	30	$2,757
60 Ton Crane Operator	hrs	$31.03	30	$931
30 Ton Crane	hrs	$58.29	15	$874
30 Ton Crane Operator	hrs	$31.03	15	$465
Equipment Maintenance (Butler)	hrs	$22.45	255	$5,726
Concrete Removal	sf	$3.30	15,000	$49,500

Total CCD Circuit Removal **$94,630**

Sample Plant Removal

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Mechanics	hrs	$15.87	32	$508
Laborers	hrs	$17.16	16	$275
Small Tools	hrs	$1.35	48	$65
Cat 770 Haul Truck	hrs	$102.19	32	$3,270
Truck Drivers	hrs	$21.30	32	$682
Cat 988 Loader	hrs	$144.84	8	$1,159
Cat 988 Loader Operator	hrs	$26.00	8	$208
Cat 365 Excavator	hrs	$139.69	8	$1,118
Cat 365 Excavator Operator	hrs	$28.78	8	$230
PC 300 w/metal Shears	hrs	$170.14	8	$1,361
PC 300 Operator	hrs	$28.78	8	$230
30 Ton Crane	hrs	$58.29	0	$0
30 Ton Crane Operator	hrs	$31.03	0	$0
Equipment Maintenance (Butler)	hrs	$22.45	56	$1,257
Concrete Removal	sf	$2.15	4,200	$9,030

Total Sample Plant Removal **$19,392**

Temporary Storage Building Removal

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Laborers	hrs	$17.16	8	$137
Small Tools	hrs	$1.35	8	$11
Cat 770 Haul Truck	hrs	$102.19	2	$204
Truck Drivers	hrs	$21.30	2	$43
Cat 988 Loader	hrs	$144.84	2	$290
Cat 988 Loader Operator	hrs	$26.00	2	$52
Equipment Maintenance (Butler)	hrs	$22.45	4	$90
Concrete Removal	sf	$2.15	600	$1,290

Total Temporary Storage Building Removal **$2,117**

MILL DECOMMISSIONING

Truck Shop Removal

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Mechanics	hrs	$15.87	32	$508
Laborers	hrs	$17.16	16	$275
Small Tools	hrs	$1.35	48	$65
Cat 770 Haul Truck	hrs	$102.19	24	$2,453
Truck Drivers	hrs	$21.30	24	$511
Cat 988 Loader	hrs	$144.84	8	$1,159
Cat 988 Loader Operator	hrs	$26.00	8	$208
Cat 365 Excavator	hrs	$139.69	8	$1,118
Cat 365 Excavator Operator	hrs	$28.78	8	$230
PC 300 w/metal Shears	hrs	$170.14	8	$1,361
PC 300 Operator	hrs	$28.78	8	$230
30 Ton Crane	hrs	$58.29	0	$0
30 Ton Crane Operator	hrs	$31.03	0	$0
Equipment Maintenance (Butler)	hrs	$22.45	48	$1,078
Concrete Removal	sf	$2.15	4,200	$9,030

Total Truck Shop Removal **$18,225**

Boiler Demolition

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Mechanics	hrs	$15.87	160	$2,539
Laborers	hrs	$17.16	80	$1,373
Small Tools	hrs	$1.35	240	$324
Cat 770 Haul Truck	hrs	$102.19	160	$16,351
Truck Drivers	hrs	$21.30	160	$3,408
Cat 988 Loader	hrs	$144.84	40	$5,794
Cat 988 Loader Operator	hrs	$26.00	40	$1,040
Cat 365 Excavator	hrs	$139.69	40	$5,588
Cat 365 Excavator Operator	hrs	$28.78	40	$1,151
PC 300 w/metal Shears	hrs	$170.14	40	$6,805
PC 300 Operator	hrs	$28.78	40	$1,151
60 Ton Crane	hrs	$91.90	0	$0
60 Ton Crane Operator	hrs	$31.03	0	$0
30 Ton Crane	hrs	$58.29	0	$0
30 Ton Crane Operator	hrs	$31.03	0	$0
Equipment Maintenance (Butler)	hrs	$22.45	280	$6,287
Concrete Removal	sf	$3.30	2,900	$9,570

Total Boiler Demolition **$61,381**

Vanadium Oxidation Circuit Removal

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Mechanics	hrs	$15.87	64	$1,015
Laborers	hrs	$17.16	32	$549
Small Tools	hrs	$1.35	96	$130
Cat 770 Haul Truck	hrs	$102.19	64	$6,540
Truck Drivers	hrs	$21.30	64	$1,363
Cat 988 Loader	hrs	$144.84	16	$2,317
Cat 988 Loader Operator	hrs	$26.00	16	$416
Cat 365 Excavator	hrs	$139.69	16	$2,235
Cat 365 Excavator Operator	hrs	$28.78	16	$460
PC 300 w/metal Shears	hrs	$170.14	16	$2,722
PC 300 Operator	hrs	$28.78	16	$460
60 Ton Crane	hrs	$91.90	0	$0
60 Ton Crane Operator	hrs	$31.03	0	$0
30 Ton Crane	hrs	$58.29	0	$0
30 Ton Crane Operator	hrs	$31.03	0	$0
Equipment Maintenance (Butler)	hrs	$22.45	112	$2,515
Concrete Removal	sf	$3.30	1,200	$3,960

Total Vanadium Oxidation Circuit Removal **$24,684**

Main Shop/Warehouse Demolition

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Mechanics	hrs	$15.87	128	$2,031
Laborers	hrs	$17.16	64	$1,098
Small Tools	hrs	$1.35	192	$259
Cat 770 Haul Truck	hrs	$102.19	128	$13,081
Truck Drivers	hrs	$21.30	128	$2,726
Cat 988 Loader	hrs	$144.84	32	$4,635
Cat 988 Loader Operator	hrs	$26.00	32	$832
Cat 365 Excavator	hrs	$139.69	32	$4,470
Cat 365 Excavator Operator	hrs	$28.78	32	$921
PC 300 w/metal Shears	hrs	$170.14	32	$5,444
PC 300 Operator	hrs	$28.78	32	$921
Equipment Maintenance (Butler)	hrs	$22.45	224	$5,030
Asbestos Removal	sf			
Concrete Removal	sf	$2.15	19,300	$41,495

Total Main Shop/Warehouse Demolition **$82,944**

Decon Pads (2) Demolition

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Mechanics	hrs	$15.87	64	$1,015
Laborers	hrs	$17.16	32	$549
Small Tools	hrs	$1.35	96	$130
Cat 770 Haul Truck	hrs	$102.19	64	$6,540
Truck Drivers	hrs	$21.30	64	$1,363
Cat 988 Loader	hrs	$144.84	16	$2,317
Cat 988 Loader Operator	hrs	$26.00	16	$416
Cat 365 Excavator	hrs	$139.69	16	$2,235
Cat 365 Excavator Operator	hrs	$28.78	16	$460
PC 300 w/metal Shears	hrs	$170.14	16	$2,722
PC 300 Operator	hrs	$28.78	16	$460
Equipment Maintenance (Butler)	hrs	$22.45	112	$2,515
Concrete Removal	sf	$3.30	1,350	$4,455

Total Decon Pads (2) Demolition **$25,179**

Office Building Demolition

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Mechanics	hrs	$15.87	96	$1,523
Laborers	hrs	$17.16	48	$824
Small Tools	hrs	$1.35	144	$194
Cat 770 Haul Truck	hrs	$102.19	96	$9,811
Truck Drivers	hrs	$21.30	96	$2,045
Cat 988 Loader	hrs	$144.84	24	$3,476
Cat 988 Loader Operator	hrs	$26.00	24	$624
Cat 365 Excavator	hrs	$139.69	24	$3,353
Cat 365 Excavator Operator	hrs	$28.78	24	$691
PC 300 w/metal Shears	hrs	$170.14	24	$4,083
PC 300 Operator	hrs	$28.78	24	$691
Equipment Maintenance (Butler)	hrs	$22.45	168	$3,772
Asbestos Removal	sf			
Concrete Removal	sf	$1.25	12,100	$15,125

Total Office Building Demolition **$46,211**

Septic Tanks and Drain Fields

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Mechanics	hrs	$15.87	0	$0
Laborers	hrs	$17.16	16	$275
Small Tools	hrs	$1.35	32	$43
Cat 770 Haul Truck	hrs	$102.19	16	$1,635
Truck Drivers	hrs	$21.30	16	$341
Cat 988 Loader	hrs	$144.84	8	$1,159
Cat 988 Loader Operator	hrs	$26.00	8	$208
Cat 365 Excavator	hrs	$139.69	8	$1,118
Cat 365 Excavator Operator	hrs	$28.78	8	$230
PC 300 w/metal Shears	hrs	$170.14	0	$0
PC 300 Operator	hrs	$28.78	0	$0
Equipment Maintenance (Butler)	hrs	$22.45	32	$719

Total Septic Tanks and Drain Fields **$5,727**

Misc. Tankage & Spare Parts Removal

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Mechanics	hrs	$15.87	48	$762
Laborers	hrs	$17.16	24	$412
Small Tools	hrs	$1.35	72	$97
Cat 770 Haul Truck	hrs	$102.19	48	$4,905
Truck Drivers	hrs	$21.30	48	$1,022
Cat 988 Loader	hrs	$144.84	12	$1,738
Cat 988 Loader Operator	hrs	$26.00	12	$312
Cat 365 Excavator	hrs	$139.69	12	$1,676
Cat 365 Excavator Operator	hrs	$28.78	12	$345
PC 300 w/metal Shears	hrs	$170.14	12	$2,042
PC 300 Operator	hrs	$28.78	12	$345
Equipment Maintenance (Butler)	hrs	$22.45	84	$1,886

Total Misc. Tankage & Spare Parts Removal **$15,543**

Alternate Feed Circuit and Reagent Storage Building

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Mechanics	hrs	$15.87	50	$793
Laborers	hrs	$17.16	50	$858
Small Tools	hrs	$1.35	96	$130
Cat 770 Haul Truck	hrs	$102.19	50	$5,110
Truck Drivers	hrs	$23.25	50	$1,163
Cat 988 Loader	hrs	$144.84	34	$4,925
Cat 988 Loader Operator	hrs	$26.00	34	$884
Cat 365 Excavator	hrs	$139.69	34	$4,750
Cat 365 Excavator Operator	hrs	$28.78	34	$978
PC 300 w/metal Shears	hrs	$170.14	52	$8,847
PC 300 Operator	hrs	$28.78	52	$1,496
Equipment Maintenance (Butler)	hrs	$22.45	170	$3,817
Concrete Removal	sf	$2.15	25,500	$54,825

Total Alternate Feed Circuit and Reagent Storage Building **$88,575**

MILL DECOMMISSIONING

Mill Yard Decontamination

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 637 Scraper	hrs	$221.91	257	$57,032
Cat 637 Scraper Operator	hrs	$28.78	257	$7,396
Cat D8N Dozer With Ripper	hrs	$103.84	65	$6,749
Cat D8N Dozer Operator	hrs	$26.00	65	$1,690
Cat D7 Dozer	hrs	$88.08	65	$5,725
Cat D7 Dozer Operator	hrs	$26.00	65	$1,690
Cat 651 Waterwagon	hrs	$115.90	65	$7,534
Cat 651 Waterwagon Operator	hrs	$23.25	65	$1,511
Cat 14H Motorgrader	hrs	$77.15	65	$5,015
Cat 14H Motorgrader Operator	hrs	$28.78	65	$1,871
Equipment Maintenance (Butler)	hrs	$22.45	517	$11,609

Total Mill Yard Decontamination **$107,822**

Ore Storage Pad Decontamination

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 637 Scraper	hrs	$221.91	189	$41,942
Cat 637 Scraper Operator	hrs	$28.78	189	$5,439
Cat D8N Dozer With Ripper	hrs	$103.84	48	$4,984
Cat D8N Dozer Operator	hrs	$26.00	48	$1,248
Cat D7 Dozer	hrs	$88.08	48	$4,228
Cat D7 Dozer Operator	hrs	$26.00	48	$1,248
Cat 651 Waterwagon	hrs	$115.90	48	$5,563
Cat 651 Waterwagon Operator	hrs	$23.25	48	$1,116
Cat 14H Motorgrader	hrs	$77.15	48	$3,703
Cat 14H Motorgrader Operator	hrs	$28.78	48	$1,381
Equipment Maintenance (Butler)	hrs	$22.45	381	$8,555

Total Ore Storage Pad Decontamination **$79,408**

Equipment Storage Area Cleanup

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 637 Scraper	hrs	$221.91	68	$15,090
Cat 637 Scraper Operator	hrs	$28.78	68	$1,957
Cat D8N Dozer With Ripper	hrs	$103.84	17	$1,765
Cat D8N Dozer Operator	hrs	$26.00	17	$442
Cat D7 Dozer	hrs	$88.08	17	$1,497
Cat D7 Dozer Operator	hrs	$26.00	17	$442
Cat 651 Waterwagon	hrs	$115.90	17	$1,970
Cat 651 Waterwagon Operator	hrs	$23.25	17	$395
Cat 14H Motorgrader	hrs	$77.15	17	$1,312
Cat 14H Motorgrader Operator	hrs	$28.78	17	$489
Equipment Maintenance (Butler)	hrs	$22.45	136	$3,054

Total Equipment Storage Area Cleanup **$28,414**

Revegetate Mill Yard & Ore Pad

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 637 Scraper	hrs	$221.91	174	$38,613
Cat 637 Scraper Operator	hrs	$28.78	174	$5,007
Cat D8N Dozer With Ripper	hrs	$103.84	33	$3,427
Cat D8N Dozer Operator	hrs	$26.00	33	$858
Cat D7 Dozer	hrs	$88.08	33	$2,907
Cat D7 Dozer Operator	hrs	$26.00	33	$858
Cat 14H Motorgrader	hrs	$77.15	33	$2,546
Cat 14H Motorgrader Operator	hrs	$28.78	33	$950
Seed Mix	Acre	$25.50	2,178	$55,539
Equipment Maintenance (Butler)	hrs	$22.45	273	$6,130

Total Revegetate Mill Yard & Ore Pad **$116,834**

Total Demolition and Decontamination **$1,489,953**

CLEANUP OF WINDBLOWN CONTAMINATION

Scoping Survey

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Soil Samples	each	$50.00	100	$5,000
Survey Crew	hrs	$15.27	752	$11,483
Sample Crew	hrs	$15.27	1,312	$20,035

Total Scoping Survey **$36,518**

Characterization Survey

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Soil Samples	each	$50.00	472	$23,600
Sample Crew	hrs	$15.27	1,136	$17,347

Total Characterization Survey **$40,947**

Final Status Survey

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Soil Samples	each	$50.00	300	$15,000
Sample Crew	hrs	$15.27	3,552	$54,241

Total Final Status Survey **$69,241**

Windblown Cleanup

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 637 Scraper	hrs	$221.91	680	$150,902
Cat 637 Scraper Operator	hrs	$28.78	680	$19,569
Cat D8N Dozer With Ripper	hrs	$103.84	170	$17,652
Cat D8N Dozer Operator	hrs	$26.00	170	$4,420
Cat D7 Dozer	hrs	$88.08	170	$14,973
Cat D7 Dozer Operator	hrs	$26.00	170	$4,420
Cat 14H Motorgrader	hrs	$77.15	170	$13,116
Cat 14H Motorgrader Operator	hrs	$28.78	170	$4,892
Soil Samples	each	$50.00	500	$25,000
Survey Crew	hrs	$15.27	163	$2,489
Sample Crew	hrs	$15.27	83	$1,267
Equipment Maintenance (Butler)	hrs	$22.45	1,190	$26,721

Total Windblown Cleanup **$285,421**

Quality Control

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Quality Control Contractor	hrs	$62.00	2,080	**$128,960**

Total Quality Control **$128,960**

Total Cleanup Windblown Contamination **$561,088**

<u>Conventional Ore Disposal</u>

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 770 Haul Truck (3)	hrs	$102.19	130	$13,322
Truck Drivers (3)	hrs	$21.30	130	$2,777
Cat 988 Loader	hrs	$144.84	43	$6,294
Cat 988 Loader Operator	hrs	$26.00	43	$1,130
Cat 651 Water wagon	hrs	$115.90	43	$5,036
Cat 651 Water wagon Operator	hrs	$23.25	43	$1,010
Cat 14H Motorgrader	hrs	$77.15	25	$1,929
Cat 14H Motorgrader Operator	hrs	$28.78	25	$719
Equipment Maintenance (Butler)	hrs	$22.45	242	$5,440

Total Conventional Ore Disposal **$37,658**

Total Quantity	25,551	Cubic Yards*
	196	Cubic Yards per Truck per hour
	130	Truck Hours

34,494 * tons as of 1/25/16
Loose (in-truck) material unit weight assumed as 100 lb/cubic foot

Claricone Contaminated Soil Disposal

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 770 Haul Truck (3)	hrs	$102.19	20	$2,086
Truck Drivers (3)	hrs	$21.30	20	$435
Cat 988 Loader	hrs	$144.84	7	$985
Cat 988 Loader Operator	hrs	$26.00	7	$177
Cat 651 Waterwagon	hrs	$115.90	7	$788
Cat 651 Waterwagon Operator	hrs	$23.25	7	$158
Cat 14H Motorgrader	hrs	$77.15	15	$1,157
Cat 14H Motorgrader Operator	hrs	$28.78	15	$432
Equipment Maintenance (Butler)	hrs	$22.45	49	$1,101

Total Claricone Contaminated Soil Disposal **$7,319**

Total Quantity 4,000 Cubic Yards*
196 Cubic Yards per Truck per hour
20 Truck Hours

13.96 *Use 4 times estimated volume
Loose (in-truck) material unit weight assumed as 100 lb/cubic foot

Nitrate Contaminated Soil Disposal

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 770 Haul Truck (3)	hrs	$97.66	335	$32,723
Truck Drivers (3)	hrs	$21.30	335	$7,137
Cat 988 Loader	hrs	$144.84	112	$16,178
Cat 988 Loader Operator	hrs	$26.00	112	$2,904
Cat D8N Dozer With Ripper	hrs	$50.00	251	$12,545
Cat D8N Dozer Operator	hrs	$15.27	251	$3,831
Cat 651 Waterwagon	hrs	$115.79	112	$12,933
Cat 651 Waterwagon Operator	hrs	$21.30	112	$2,379
Cat 14H Motorgrader	hrs	$67.43	112	$7,532
Cat 14H Motorgrader Operator	hrs	$26.32	112	$2,940
Equipment Maintenance (Butler)	hrs	$22.45	921	$20,682
Concrete Removal	sf	$2.15	27,500	$59,125

Total Nitrate Contaminated Soil Disposal **$180,908**

Total Quantity 95,352 Cubic Yards*
285 Cubic Yards per Truck per hour
335 Truck Hours

*Use 2 times estimated volume

MILL DECOMMISSIONING

Bulk Alternate Feed Material

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 770 Haul Truck (3)	hrs	$102.19	46	$4,653
Truck Drivers (3)	hrs	$21.30	46	$970
Cat 988 Loader	hrs	$144.84	15	$2,198
Cat 988 Loader Operator	hrs	$26.00	15	$395
Cat 651 Waterwagon	hrs	$115.90	15	$1,759
Cat 651 Waterwagon Operator	hrs	$23.25	15	$353
Cat 14H Motorgrader	hrs	$77.15	6	$463
Cat 14H Motorgrader Operator	hrs	$28.78	6	$173
Equipment Maintenance (Butler)	hrs	$22.45	82	$1,839

Bulk Alternate Feed Material **$12,801**

Total Quantity 8,924 Cubic Yards* (current as of 01/25/2016)
196 Cubic Yards per Truck per hour
46 Truck Hours

* Includes FMRI, GAM and Dawn Mining

Alternate Feed Barrels

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Equipment Operators	hrs	$21.30	53	$1,130
Flat Bed Trailer and Tractor*	hrs	$55.00	53	$2,917
Fork Lift (2)	hrs	$18.00	106	$1,909
Equipment Maintenance (Butler)	hrs	$22.45	53	$1,191

Total Alternate Feed Barrels **$7,147**

* includes operator

5,242 Barrels (current as of 01/25/2016)
31 Totes
40 Barrels per load
20 Totes Per Load
0.4 Hours per load
53 Truck Hours

	lbs. per barrel	No. Drums
CaF2	727	161
Calcined	320	2,200
Regen	406	57
KF		2,704
Cotter Resin		31
UF4	547	120
		5,242

Sub-Total Alternate Feed Disposal **$19,949**

TOTAL MILL DECOMMISSIONING **$2,296,874**

Reviewed 2/25/16

1) Removal of contaminated material from Mill Yard

Assume:

-- 18 inches (1.5 feet) will have to be removed
-- Area (from CAD takeoff) = 1,643,453 sq. feet
37.7 acres

Therefore: Volume moved = [1,643,453 x 1.5] / 27 = 91,303 cubic yards
(use 91,300)

91,300 / 355 cubic yards per hour = 257 machine hours

Haul route H

2) Removal of contaminated material from Ore Pad

Assume:

-- 18 inches (1.5 feet) will have to be removed
-- Area (from CAD takeoff) = 976,780 sq. feet
22.4 acres

Therefore: Volume moved = [976,780 x 1.5] / 27 = 54,266 cubic yards
(use 54,300)

54,300 / 287 cubic yards per hour = 189 machine hours

Haul route H

3) Demolition Equipment

- Kamatsu PL400 (or Cat equivalent) with LaBounty Sheers (hydraulic)
- Cat 365 Trackhoe with Grapples
- Cat 770 Rock Trucks (4 each)
- Cat 988 Loader (1 each)

4) Demolition Crew

- Heavy Equipment Operators - PC400, Cat 365, Cat 988
- Dust Control - 2 Laborers
- Mechanics - Cut debris to reduce/avoid oversize and voids - 4 each
- Truck Drivers - 4 each

5) Tool and Expendable Allowance, covering the following items:

- -- Safety gear and supplies
- -- Hand tools
- -- Bottled Gases and Torches
- -- Allow $1.30 per man-hour for all but Heavy Equipment Operators and Truck Drivers

6) Demolition Time Estimates

-- Mill Building	20 Days
-- Ore Bin	2 Days
-- CCD, Pre-Leach, Claricone	5 Days
-- Sample Plant	1 Day
-- Boiler House	5 Days
-- Vanadium EMF/Ox	2 Days
-- Shop/Warehouse	4 Days
-- Office/Lab Building	3 Days
-- Misc. & Bone Yard	4 Days
-- Decon Pads (2)	2 Days

7) Foundation Demolition

-- Assume area of structure times $3.30 per square foot

	Area, sq ft	$ Cost
Mill Building	37,500	$ 123,750
SX Building	55,970	$ 184,701
CCD, Pre-Leach, Claricone	15,000	$ 49,500
Shop/Warehouse	19,300	$ 63,690
Office*	12,100	$ 15,125
Sample Plant	4,200	$ 13,860
Vanadium EMF/Ox	1,200	$ 3,960
Boiler house	2,900	$ 9,570
Decon Pads	1,350	$ 4,455

-- Labor at $2.75, Equipment at $0.55

-- * Labor at $0.70, Equipment at $0.55

8) Revegetation

Assume:

-- Mill Yard Area	1,643,453	sq. feet
-- Ore Pad Area	976,780	sq. feet

-- Place 6 inches of Topsoil

[1,643,453 976,780] sq.feet x 0.5 feet] / [27 cubic feet / cubic Yard] 48,523 cu yds

Use 48,600 Cubic Yards

48,600 / 279 cu yds per hour = 174 Scraper hours

Seeding

RS Means Referance 32 92 19 14 0500	=	$25.50 / 1 thousand sq.ft.
50 acres	=	2178 thousand sq.ft.

9) Removal of Nitrate and Ammonium Sulfate Contaminated Soil
and Concrete Cover Required by Phase 1 of the Nitrate CAP

Assume:

-- 222 inches (18.5 feet) will have to be removed over the entire excavated area as delineated by the proposed excavation contours in Attachment 4-1 to the December 2013 White Mesa Uranium Mill Proposal for Remediation, 2012 Phase 1 of Final Nitrate Corrective Action Plan, May 7, and Stipulation and Consent Order of December 12, 2012 Docket No. UGW-12-04
-- This depth corresponds to 20 feet minus the 18 inches associated with the Mill Yard and Ore Pad reclamation.
-- The nitrate and ammonium sulfate contamination is located within the Mill Yard and Ore Pad which will both have the top 18 inches removed during reclamation as addressed in above in item 1 and 2.
-- Production is limited by the trucking fleet and not the loader.
-- The dozer will assist the loader during the soil removal.
-- The dozer will backfill and grade the excavation area after the contaminated soil has been removed.
--Volumes and areas are taken from CAD and shown on Attachment 4-1.
--RS Means reference 02 41 13 17 5300 was used to estimate the costs. $2.15 per square foot.

--Excavation Area (from CAD takeoff) =	83,641	sq. feet
-- Concrete Cover Area (from CAD takeoff)	27,500	sq. feet

-- Volume (from CAD takeoff) =	47,676	Cubic Yards
-- Volume including a 200% Conservatism Factor	95,352	Cubic Yards

95,352	/ 285 cubic yards per hour =	335	Trucking Hours
95,352	/ 685 cubic yards per hour =	139	Backfilling Hours
	Haul route H		

10) Asbestos Removal

See the attached Executive Summaries from the Asbestos Inspection Reports.

Admin Building	$ 35,650
Maint/Warehouse	$ 8,601
SX Building	$ 100

Cell 1

Cell 1 Reclamation

Dewatering of Cell 1

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Dewatering of Cell 1 (2 yrs)	hrs	$0.48	17,520	**$8,423**

Total Dewatering of Cell 1 **$8,423**

Crystal Removal

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 770 Truck	hrs	$102.19	1,119	$114,387
Truck Drivers	hrs	$21.30	1,119	$23,842
Cat 988 Loader	hrs	$144.84	373	$54,041
Cat 988 Loader Operator	hrs	$26.00	373	$9,701
Cat D8N Dozer With Ripper	hrs	$103.84	373	$38,741
Cat D8N Dozer Operator	hrs	$26.00	373	$9,701
Cat 365 Excavator	hrs	$139.69	373	$52,120
Cat 365 Excavator Operator	hrs	$28.78	373	$10,737
Liner Cutting (Laborer)	hrs	$18.69	373	$6,974
Cat 651 Waterwagon	hrs	$115.90	373	$43,244
Cat 651 Waterwagon Operator	hrs	$23.25	373	$8,675
Cat 14H Motorgrader	hrs	$77.15	373	$28,786
Cat 14H Motorgrader Operator	hrs	$28.78	373	$10,737
Equipment Maintenance (Butler)	hrs	$22.45	2,985	$67,024

Total Crystal Removal **$478,710**

Contaminated Materials Removal

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 637 Scraper	hrs	$221.91	308	$68,350
Cat 637 Scraper Operator	hrs	$28.78	308	$8,863
Cat D8N Dozer With Ripper	hrs	$103.84	77	$7,995
Cat D8N Dozer Operator	hrs	$26.00	77	$2,002
Cat 651 Waterwagon	hrs	$115.90	77	$8,924
Cat 651 Waterwagon Operator	hrs	$23.25	77	$1,790
Cat 14H Motorgrader	hrs	$77.15	77	$5,941
Cat 14H Motorgrader Operator	hrs	$28.78	77	$2,216
Equipment Maintenance (Butler)	hrs	$22.45	539	$12,103

Total Contaminated Materials Removal **$118,185**

Topsoil Application

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 637 Scraper	hrs	$221.91	61	$13,537
Cat 637 Scraper Operator	hrs	$28.78	61	$1,755
Cat D8N Dozer With Ripper	hrs	$103.84	40	$4,153
Cat D8N Dozer Operator	hrs	$26.00	40	$1,040
Cat 651 Waterwagon	hrs	$115.90	40	$4,636
Cat 651 Waterwagon Operator	hrs	$23.25	40	$930
Cat 14H Motorgrader	hrs	$77.15	40	$3,086
Cat 14H Motorgrader Operator	hrs	$28.78	40	$1,151
Equipment Maintenance (Butler)	hrs	$22.45	181	$4,064

Total Topsoil Application **$34,353**

Cell 1 Reclamation

Construct Channel

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 770 Truck	hrs	$102.19	324	$33,061
Truck Drivers	hrs	$21.30	324	$6,891
Cat 365 Excavator	hrs	$139.69	81	$11,298
Cat 365 Excavator Operator	hrs	$28.78	81	$2,327
Drilling & Blasting Contractor	BCY	$2.44	67,000	$163,717
Drilling & Blasting Contractor, Fuel	Gal.	$1.81	1,011	$1,834
Cat 14H Motorgrader	hrs	$77.15	81	$6,240
Cat 14H Motorgrader Operator	hrs	$28.78	81	$2,327
Cat D8N Dozer With Ripper	hrs	$103.84	81	$8,398
Cat D8N Dozer Operator	hrs	$26.00	81	$2,103
Equipment Maintenance (Butler)	hrs	$22.45	566	$12,713

Total Construct Channel **$250,910**

Rock Armor and Rip Rap Filter

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat D7 Dozer	hrs	$88.08	30	$2,642
Cat D7 Dozer Operator	hrs	$26.00	30	$780
Cat 651 Waterwagon	hrs	$115.90	30	$3,477
Cat 651 Waterwagon Operator	hrs	$23.25	30	$698
Cat 14H Motorgrader	hrs	$77.15	30	$2,315
Cat 14H Motorgrader Operator	hrs	$28.78	30	$863
Rock Cost Delivered	CY	$6.60	8,607	$56,766
Equipment Maintenance (Butler)	hrs	$22.45	90	$2,021

Total Place Rock Armor and Rip Rap Filter **$69,561**

Quality Control

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Quality Control Contractor	hrs	$62.00	800	**$49,600**

Total Quality Control **$49,600**

TOTAL RECLAMATION OF CELL 1 **$1,009,743**

Volume Calculation - Cell 1

Reviewed 2/25/16

1) Area of Cell 1 - 2,575,703 sq ft = 59.13 acres

2) Crystal and Liner Cover Removal
- Dewatering estimated at 2 years based on the last time Cell 1 was dry and approximate duration.
- Crystal thickness assumed as 1.5 feet.
- Soil Cover over the PVC Liner is based on design and as-built - 1.5 feet.
- Crystal and soil cover will be excavated at the same time and placed in Cell 4A.
- Crystal and soil cover will be windrowed with a dozer, and loaded into 3 trucks with a loader.
- The PVC Liner will cut into manageable pieces and loaded into a truck with a hydraulic excavator.
- Road maintenance will be accomplished with a motorgrader and water wagon.

$$\text{Volume to be removed} = \frac{2{,}575{,}703 \times (1.5\text{ ft} + 1.5\text{ ft})}{27\text{ ft}^3/\text{cy}} \quad \boxed{286{,}189 \text{ CY}}$$

3) Removal of Contaminated Material Under Liner
- Estimated depth of contaminated soil required to be removed - 1 foot.
- Contaminated material will be removed to Cell 4A.
- Contaminated soil will be windrowed with a dozer, and loaded into 3 trucks with a loader.
- Road maintenance will be accomplished with a motorgrader and water wagon.

$$\text{Volume to be removed} = \frac{2{,}575{,}703 \times (1\text{ ft})}{27\text{ ft}^3/\text{cy}} \quad \boxed{95{,}396 \text{ CY}}$$

4) Construct Channel
- The channel will be constructed in the southwest corner of Cell 1 and will daylight to an existing natural channel.
- The channel requires blasting of the bedrock to achieve the design grade.
- Approximate dimensions of the channel are 1,200 feet long by 150 feet wide by 10 feet deep.

$$\text{Volume to be removed} = \frac{1{,}200\text{ ft} \times 150\text{ ft} \times 10\text{ ft}}{27\text{ ft}^3/\text{cy}} \quad \boxed{66{,}667 \text{ CY}}$$

- The broken rock material will be loaded into 3 trucks with a hydraulic excavator.
- 23,188 CY of this material will be used in Cell 1 to grade the side slopes from 3H:1V to 5H:1V.
- The remainder of the excavated material will be hauled to Cell 4A South Slope and used as Random Fill - 43,479 CY.

5) Grade Side slopes
- Material needed to grade the side slopes of Cell 1 will be produced during the construction of the Cell 1 Drainage Channel
- The costs for staging the grading material at the base of the slopes is accounted for thin the Channel Construction Task.
- The slopes will be graded and shaped with a dozer.
- Cell 1 has 6,020 feet of slopes. The slopes are 8 feet high and currently at a 3H:1V slope.

$$\text{Volume needed for Grading} = \frac{6{,}020\text{ ft} \times 8\text{ ft} \times 26\text{ ft} \times (1/2)}{27\text{ ft}^3/\text{cy}} \quad \boxed{23{,}188 \text{ CY}}$$

6) Topsoil Application

- 29 acres of Cell 1 requires placement of 6 inches of topsoil.
- The remainder of Cell 1 will be covered with exposed Dakota Sandstone or Rip Rap.
- The topsoil will hauled from Topsoil pile W4.
- A scraper fleet will haul the topsoil and a dozer will assist with loading and final spreading.
- Road maintenance will be accomplished with a motorgrader and water wagon.

$$\text{Volume needed for be placed} = \frac{29 \text{ acres x } 43{,}560 \text{ ft2 /acre x } 0.5 \text{ ft}}{27 \text{ ft}^3\text{/cy}} \quad \boxed{23{,}393 \quad \text{CY}}$$

7) Rock Armor and Rip Rap Filter Placement

- Rock for side armor, top armor and toe aprons will come from an off-site gravel source one (1) mile north of Blanding. Rock will be produced through screening, stockpiled and trucked to the site at the time of use. Belly dump trucks will dump gravel in windrows on the top and sides of the Cell.
- A dozer will spread the delivered rock.
- Road maintenance will be accomplished with a motorgrader and water wagon.
- 8,607 CY of rock will be placed.

Cell 2

RECLAMATION OF CELL 2

Dewatering of Cell 2

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Dewatering of Cell 2 (12 yrs)	hrs	$0.48	105,120	**$50,539**

Total Dewatering of Cell 2 **$50,539**

RECLAMATION OF CELL 2

Upper Random Fill (2')

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 365 Excavator	hrs	$139.69	264	$36,864
Cat 365 Excavator Operator	hrs	$28.78	264	$7,594
Cat 980 Loader	hrs	$100.39	264	$26,493
Cat 980 Loader Operator	hrs	$26.00	264	$6,861
Cat 770 Truck (4 trucks in Fleet)	hrs	$102.19	1,056	$107,872
Truck Drivers	hrs	$21.30	1,056	$22,484
Cat 825 Compactor	hrs	$101.99	264	$26,915
Cat 825 Compactor Operator	hrs	$23.25	264	$6,136
Cat D7 Dozer	hrs	$88.08	264	$23,243
Cat D7 Dozer Operator	hrs	$26.00	264	$6,861
Cat 651 Waterwagon	hrs	$115.90	264	$30,585
Cat 651 Waterwagon Operator	hrs	$23.25	264	$6,136
Cat 14H Motorgrader	hrs	$77.15	264	$20,360
Cat 14H Motorgrader Operator	hrs	$28.78	264	$7,594
5000 Gallon Water Truck	hrs	$67.74	264	$17,877
5000 Gallon Water Truck Operator	hrs	$23.25	264	$6,136
Equipment Maintenance (Butler)	hrs	$22.45	1,583	$35,554

* assumes 4 trucks and the trucks are limiting production.

Total Place Upper Random Fill **$395,563**

Rock Armor and Rip Rap Filter

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat D7 Dozer	hrs	$88.08	300	$26,423
Cat D7 Dozer Operator	hrs	$26.00	300	$7,800
Cat 651 Waterwagon	hrs	$115.90	300	$34,771
Cat 651 Waterwagon Operator	hrs	$23.25	300	$6,975
Cat 14H Motorgrader	hrs	$77.15	300	$23,146
Cat 14H Motorgrader Operator	hrs	$28.78	300	$8,633
Rock Cost Delivered	CY	$6.60	72,945	$481,093
Equipment Maintenance (Butler)	hrs	$22.45	900	$20,209

Total Place Rock Armor and Rip Rap Filter **$609,051**

Quality Control

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Quality Control Contractor	hrs	$62.00	600	$37,200

Total Quality Control **$37,200**

TOTAL RECLAMATION OF CELL 2 **$1,092,353**

Volume Calculation - Cell 2

Reviewed 02/25/16

1) Area of Cell 2 - 2,986,660 sq ft = 68.56 acres

2) The bridging layer of the cover has already been placed over the entire Cell 2 surface.

3) Assumptions

- Cell will be graded to Design elevation utilizing finer materials in random fill stockpiles and from "clay" stockpiles.
-Dewatering Estimated at 12 years based on the Cell 2 2013 drawdown(1 foot/ year) and remaing solution depth (12 feet).

"- Radon Barrier has been placed over the entire Cell"

- The upper 1 foot of random fill will be placed utilizing the fine random fill and clay stockpiles

- Rock for side armor, top armor and toe aprons will come from an off-site gravel source one (1) mile north of Blanding. Rock will be produced through screening, stockpiled and trucked to the site at the time of use. Belly dump trucks will dump gravel in windrows on the top and sides of the Cell.

5) Bring Platform Fill up to Design elevation (Lower Random) **COMPLETE**
Assume full area of Cell X one (1) foot thick

2,986,660 sq ft X 1 ft. / 27 cubic feet per cubic yard = cubic yards

Use cubic yards

6) Placement of Clay Layer (One (1) foot thick on top of Cell only) **DELETED**
Assume full area of Cell X one (1) foot thick

2,986,660 sq ft X 1 ft. / 27 cubic feet per cubic yard = cubic yards

Use cubic yards

7) Upper Random Fill Volume - Top of Cell area
Assume full area of Cell X two (2) foot thick
- An excavator and loader will load 4 trucks.
- The dozer will place the material, water truck will moisture condition and the compactor will compact the material.
- The water wagon and grader will maintain the haul road.

2,986,660 sq ft X 2 ft. / 27 cubic feet per cubic yard = 221,234 cubic yards

Use **221,300 cubic yards**

8) Armor Protection - Top of Cell
Assume full area of Cell X one-half (0.5) foot thick

2,986,660 sq ft X 0.5 ft. / 27 cubic feet per cubic yard = 55,309 cubic yards

Use **55,400 cubic yards**

9) Cell 2 North Slope (Slope #1) common with Cell 1-I

Average height	12	feet
Length	2600	feet

a) Random fill to reduce slope from 3:1 to 5:1

First Wedge [12 X 12 X 5)/2 - (12 X 12 X 3)/2] X 2600

= 374,400 cubic feet/ 27 = 13,867 cubic yards

Use **13,900 cubic yards**

Remaining Random Fill

[15 X 15 X 5)/2 - (12 X 12 X 5)/2] X 2600

= 526,500 cubic feet/ 27 = 19,500 cubic yards

Use **19,500 cubic yards**

Total Random Fill North Slope **33,400 cubic yards**

b) Rock Armor 8" thick - 0.67 feet

[15.67 X 15.67 X 5)/2 - (15 X 15 X 5)/2] X 2600

= 133,568 cubic feet/ 27 = 4,947 cubic yards

Use **5,000 cubic yards**

c) Rip Rap Filter 6" thick - 0.5 feet

[15.5 X 15.5 X 5)/2 - (15 X 15 X 5)/2] X 2600

= 99,125 cubic feet/ 27 = 3,671 cubic yards

Use **3,700 cubic yards**

d) Toe Apron — 2 X 7 X 2600 / 27 = 1,348 cubic yards

Use **1,400 cubic yards**

Total Rock Armor Cell 2 north Slope — **6,400 cubic yards**

10) North Slope common with Mill yard (Slope #2)

Average height	1	feet
Length	900	feet

a) Random fill to reduce slope from 3:1 to 5:1

First Wedge [1 X 1 X 5)/2 - (1 X 1 X 3)/2] X 900

= 900 cubic feet/ 27 = 33 cubic yards

Use **100 cubic yards**

Remaining Random Fill

[4 X 4 X 5)/2 - (1 X 1 X 5)/2] X 900

= 33,750 cubic feet/ 27 = 1,250 cubic yards

Use **1,300 cubic yards**

Total Random Fill North Slope — **1,400 cubic yards**

b) Rock Armor 8" thick - 0.67 feet

[4.67 X 4.67 X 5)/2 - (4 X 4 X 5)/2] X 900

= 13,070 cubic feet/ 27 = 484 cubic yards

Use **500 cubic yards**

c) Rip Rap Filter 6" thick - 0.5 feet

[4.5 X 4.5 X 5)/2 - (4 X 4 X 5)/2] X 900

= 9,563 cubic feet/ 27 = 354 cubic yards

Use **350 cubic yards**

d) No Toe Apron on fill common with Mill Yard

Total Rock Armor on slope common to Mill Yard — **500 cubic yards**

11) Cell 2 West Dike (Slope #3)

Average height 2 feet
Length 500 feet

a) Random fill to reduce slope from 3:1 to 5:1

First Wedge [2 X 2 X 5)/2 - (2 X 2 X 3)/2] X 500

= 2,000 cubic feet/ 27 = 74 cubic yards
Use 100 cubic yards

Remaining Random Fill

[2 X 2 X 5)/2 - (2 X 2 X 3)/2] X 500

= 2,000 cubic feet/ 27 = 74 cubic yards
Use 100 cubic yards

Total Random Fill North Slope 200 cubic yards

b) Rock Armor 8" thick - 0.67 feet

[5.67 X 5.67 X 5)/2 - (5 X 5 X 5)/2] X 500

= 8,936 cubic feet/ 27 = 331 cubic yards
Use 400 cubic yards

c) Rip Rap Filter 6" thick - 0.5 feet

[5.5 X 5.5 X 5)/2 - (5 X 5 X 5)/2] X 500

= 6,563 cubic feet/ 27 = 243 cubic yards
Use 250 cubic yards

d) Toe Apron Not required for slope 10 feet long - Drainage from Cell goes south to Cell 3 and then off of south slope of Cell 3

Total Rock Armor Cell 2 north Slope 400 cubic yards

12) Cell 2 East Dike (Slope #4)

Average height 1 feet
Length 1250 feet

a) Random Fill Wedge from #10 1 cubic foot per linear foot X 1250 46 cubic yards
Use 100 cubic yards

b) Remaining Random Fill from #10

37.5 cubic foot per linear foot X 1250 / 27 — 1,736 cubic yards

Use **1,800 cubic yards**

Total Random Slope #4 — **1,900 cubic yards**

c) Rock Armor 8" thick - 0.67 feet from #10 14.52 cubic feet per linear foot of dike

14.52 cubic foot per linear foot X 1250 / 27

= 18,150 cubic feet/ 27 = 672 cubic yards

Use **675 cubic yards**

d) Rip Rap Filter 6" thick - 0.5 feet

9.075 cubic foot per linear foot X 1250 / 27

= 420 cubic feet/ 27 = 420 cubic yards

Use **420 cubic yards**

e) Toe Apron Not required

Total Rock Armor Cell 2 north Slope — **675 cubic yards**

13) South Slope Cell 2 common with Cell 3 (Slope #5)

Average height 3 feet
Length 3500 feet

a) Random fill to reduce slope from 3:1 to 5:1

Random Fill [3 X 3 X 5)/2 - (3 X 3 X 3)/2] X 3500

= 31,500 cubic feet/ 27 = 1,167 cubic yards

Use **1,200 cubic yards**

Random Fill Upper

[6 X 6 X 5)/2 - (4 X 4 X 5)/2] X 3500

= 175,000 cubic feet/ 27 = 6,481 cubic yards

Use **6,500 cubic yards**

b) Clay Layer

[4 X 4 X 5)/2 - (3 X 3 X 5)/2] X 3500

= 61,250 cubic feet/ 27 =		2,269	cubic yards
	Use	2,300	cubic yards

c) Rock Armor 8" thick - 0.67 feet

[6.67 X 6.67 X 5)/2 - (6 X 6 X 5)/2] X 3500

= 74,278 cubic feet/ 27 =		2,751	cubic yards
	Use	2,800	cubic yards

c) Rip Rap Filter 6" thick - 0.5 feet

[6.5 X 6.5 X 5)/2 - (6 X 6 X 5)/2] X 3500

= 54,688 cubic feet/ 27 =		2,025	cubic yards
	Use	2,050	cubic yards

No Toe Apron

Total Rock Armor on slope Cell 2 Slope common to Cell 3 — 2,800 cubic yards

Volume Summary - Cell 2

	Bridging Layer	Random	Clay	Random	Rock Armor	**Filter**
Top of Cell	-	-	-	221,300	55,400	0
North (Slope #1)		13,900		19,500	6,400	3,700
North (Slope #2)		100		1,300	500	350
West (Slope #3)		100		100	400	250
East (Slope #4)		100		1,800	675	420
South (Slope #5)		1,200	2,300	6,500	2,800	2,050
Totals	-	15,400	2,300	250,500	66,175	6,770

Cell 2 Reclamation

Cat 637 Resource Requirements

	Volume	Route	Yds/hr	%	Equip. Hr.
Cell 2 Lower Random Fill					
Tailings Surface	-	E	263	100%	0.0
Slope 1	13,900	E	263	100%	52.8
Slope 2	100	E	263	100%	0.4
Slope 3	100	E	263	100%	0.4
Slope 4	100	E	263	100%	0.4
Slope 5	1,200	E	263	100%	4.6
Total	15,400				58.5

Trucking Fleet Requirements

Cell 2 Upper Random Fill	Volume	Route	Yds/hr per Truck	%	Equip. Hr.
Tailings Surface	221,300	E	237	100%	932.5
Slope 1	19,500	E	237	100%	82.2
Slope 2	1,300	E	237	100%	5.5
Slope 3	100	E	237	100%	0.4
Slope 4	1,800	E	237	100%	7.6
Slope 5	6,500	E	237	100%	27.4
Total	250,500				1055.6

Cell 2 Rock Armor and Rip Rap Filter -- use Highway Trucks

Clay Production Cell 2 **DELETED**

(use same assumptions as Cell 3)

Clay Volume =	2,300	Bank Cubic Yards (BCY)
	0.8	Swell Factor
=	2,875	Loose Cubic Yards (LCY)

Trucking 475 LCY/hr 8 trucks plus one (1) Loader

150,000 LCY / 475 LCY/hr = 6 hours

use 300 hours

300 X 8 Trucks = 2400 hours

	Hours
980 Loader	300
D8N w/ ripper	300
Cat 651 WW	300
Cat 825 Comp.	325
14G Patrol	325
5000 gal WW	175

Rock Armor and Rip Rap Filter Production Cell 2

72,945 cubic yards (cy)

38 cy per hour times 8 trucks

304 cy per hour delivered

Assume 25% extra time for spreading, loading and screen wait

304 / 1.25 243.2 cy per hour 300 Hours

Cell 3

RECLAMATION OF CELL 3

Dewatering of Cell 3

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Dewatering of Cell 3 (12 yrs)	hrs	$0.48	105,120	**$50,539**

Total Dewatering of Cell 3 **$50,539**

Place Remainder of Bridging (Platform) Lift

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 637 Scraper	hrs	$221.91	415	$92,094
Cat 637 Scraper Operators	hrs	$28.78	415	$11,943
Cat 825 Compactor	hrs	$101.99	104	$10,582
Cat 825 Compactor Operator	hrs	$23.25	104	$2,412
Cat D8N Dozer With Ripper	hrs	$103.84	104	$10,773
Cat D8N Dozer Operator	hrs	$26.00	104	$2,697
Cat D7 Dozer	hrs	$88.08	104	$9,138
Cat D7 Dozer Operator	hrs	$26.00	104	$2,697
5000 Gallon Water Truck	hrs	$67.74	104	$7,028
5000 Gallon Water Truck Operator	hrs	$23.25	104	$2,412
Cat 14H Motorgrader	hrs	$77.15	104	$8,005
Cat 14H Motorgrader Operator	hrs	$28.78	104	$2,986
Equipment Maintenance (Butler)	hrs	$22.45	934	$20,967

Total Place Remainder of Bridging (Platform) Lift **$183,735**

Place Lower Random Fill (12")

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 637 Scraper	hrs	$221.91	485	$107,628
Cat 637 Scraper Operators	hrs	$28.78	485	$13,957
Cat 825 Compactor	hrs	$101.99	194	$19,787
Cat 825 Compactor Operator	hrs	$23.25	194	$4,511
Cat D8N Dozer With Ripper	hrs	$88.08	194	$17,087
Cat D8N Dozer Operator	hrs	$26.00	194	$5,044
Cat D7 Dozer	hrs	$77.15	194	$14,968
Cat D7 Dozer Operator	hrs	$26.00	194	$5,044
5000 Gallon Water Truck	hrs	$67.74	194	$13,142
5000 Gallon Water Truck Operator	hrs	$23.25	194	$4,511
Cat 14H Motorgrader	hrs	$77.15	194	$14,968
Cat 14H Motorgrader Operator	hrs	$28.78	194	$5,583
Equipment Maintenance (Butler)	hrs	$22.45	1,455	$32,672

Total Place Lower Random Fill (12") **$258,900**

RECLAMATION OF CELL 3

Clay Layer

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 825 Compactor	hrs	$101.99	350	$35,697
Cat 825 Compactor Operator	hrs	$23.25	350	$8,138
Cat D8N Dozer With Ripper	hrs	$103.84	320	$33,227
Cat D8N Dozer Operator	hrs	$26.00	320	$8,320
Cat 651 Waterwagon	hrs	$115.90	320	$37,089
Cat 651 Waterwagon Operator	hrs	$23.25	320	$7,440
Cat 14H Motorgrader	hrs	$77.15	350	$27,004
Cat 14H Motorgrader Operator	hrs	$28.78	350	$10,072
Cat 980 Loader	hrs	$100.39	320	$32,125
Cat 980 Loader Operator	hrs	$26.00	320	$8,320
5000 Gallon Water Truck	hrs	$67.74	175	$11,855
5000 Gallon Water Truck Operator	hrs	$23.25	175	$4,069
Highway Trucks	hrs	$79.20	2,560	$202,750
Truck Drivers	hrs	$21.30	2,560	$54,530
Equipment Maintenance (Butler)	hrs	$22.45	1,835	$41,205

Total Place Clay Layer **$521,840**

RECLAMATION OF CELL 3

Upper Random Fill

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 365 Excavator	hrs	$139.69	235	$32,852
Cat 365 Excavator Operator	hrs	$28.78	235	$6,768
Cat 770 Truck (4 trucks in Fleet)	hrs	$102.19	941	$96,134
Truck Drivers	hrs	$21.30	941	$20,038
Cat 825 Compactor	hrs	$101.99	235	$23,986
Cat 825 Compactor Operator	hrs	$23.25	235	$5,468
Cat 988 Loader	hrs	$144.84	235	$34,063
Cat 988 Loader Operator	hrs	$26.00	235	$6,115
Cat D7 Dozer	hrs	$88.08	235	$20,714
Cat D7 Dozer Operator	hrs	$26.00	235	$6,115
Cat 651 Waterwagon	hrs	$115.90	235	$27,257
Cat 651 Waterwagon Operator	hrs	$23.25	235	$5,468
Cat 14H Motorgrader	hrs	$77.15	235	$18,144
Cat 14H Motorgrader Operator	hrs	$28.78	235	$6,768
5000 Gallon Water Truck	hrs	$67.74	235	$15,931
5000 Gallon Water Truck Operator	hrs	$23.25	235	$5,468
Equipment Maintenance (Butler)	hrs	$22.45	2,587	$58,089

Total Upper Random Fill **$389,377**

Rock Armor and Rip Rap Filter

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat D7 Dozer	hrs	$88.08	290	$25,543
Cat D7 Dozer Operator	hrs	$26.00	290	$7,540
Cat 651 Waterwagon	hrs	$115.90	290	$33,612
Cat 651 Waterwagon Operator	hrs	$23.25	290	$6,743
Cat 14H Motorgrader	hrs	$77.15	290	$22,374
Cat 14H Motorgrader Operator	hrs	$28.78	290	$8,345
Rock Cost Delivered	CY	$6.60	70,455	$464,671
Equipment Maintenance (Butler)	hrs	$22.45	870	$19,536

Total Place Rock Armor and Rip Rap Filter **$588,363**

Quality Control

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Quality Control Contractor	hrs	$62.00	1,200	**$74,400**

Total Quality Control **$74,400**

TOTAL RECLAMATION OF CELL 3 **$2,067,154**

Volume Calculation - Cell 3

Reviewed 02/25/16

1) Area of Cell 3 - 3,234,252 sq ft = 74.25 acres

2) Area of Cell 3 still open as of January 2015

3.0 acres Use 131,328 sq ft

3) Assumptions

- Bridging layer is placed using random fill from piles east and west of Cell 3
-Dewatering estimated at 12 years.
- Cell will be graded to Design elevation utilizing finer materials in random fill stockpiles and from "clay" stockpiles.

- Clay will be mined, blended, and hauled from borrow site location in Section 16 - four miles south of the mill area, using belly dump trucks, clay layer on top of Cell only

- The upper 1 foot of random fill will be placed utilizing the fine random fill and clay stockpiles

- Rock for side armor, top armor and toe aprons will come from an off-site gravel source one (1) mile north of Blanding. Rock will be produced through screening, stockpiled and trucked to the site at the time of use. Belly dump trucks will dump gravel in windrows on the top and sides of the Cell.

4) Bridging Layer (Platform Fill) Remaining to be placed

131,328 sq ft X 3 ft. / 27 cubic feet per cubic yard = **14,592 cubic yards**

- The cost to Blast Load and Haul the material from the Cell 1 channel is accounted for in the channel construction.

5) Bring Platform Fill up to Design elevation (Lower Random)
Assume full area of Cell X one (1) foot thick

3,234,252 sq ft X 1 ft. / 27 cubic feet per cubic yard = 119,787 cubic yards

6) Placement of Clay Layer (One (1) foot thick on top of Cell only)
Assume full area of Cell X one (1) foot thick

3,234,252 sq ft X 1 ft. / 27 cubic feet per cubic yard = 119,787 cubic yards

Use **120,000 cubic yards**

7) Upper Random Fill Volume - Top of Cell area
Assume full area of Cell X one (2) foot thick
- 4 trucks, 1 loader and 1 excavator used to load and haul the random fill.
- A dozer will spread the material, a water truck will moisture condition prior to being compacted with the compactor.
- A road grader and water wagon will maintain the haul roads.

3,234,252 sq ft X 2 ft. / 27 cubic feet per cubic yard = 239,574 cubic yards

Use **240,000 cubic yards**

8) Armor Protection - Top of Cell
Assume full area of Cell X one-half (0.5) foot thick

3,234,252 sq ft X 0.5 ft. / 27 cubic feet per cubic yard = 59,894 cubic yards

Use **60,000 cubic yards**

9) Cell 3 North Slope (Slope #6) common with Cell 2

No clay on slopes. Toe apron only at base of long slope or where drainage is directed.

Average height 2 feet
Length 1100 feet

a) Random fill to reduce slope from 3:1 to 5:1
First Wedge [2 X 2 X 5)/2] X 1100

= 11,000 cubic feet/ 27 = 407 cubic yards
Use **410 cubic yards**

Remaining Random Fill

[5 X 5 X 5)/2 - (2 X 2 X 5)/2] X 1100

= 57,750 cubic feet/ 27 = 2,139 cubic yards
Use **2,200 cubic yards**

Total Random Fill North Slope **2,610 cubic yards**

b) Rock Armor 8" thick - 0.67 feet

[5.67 X 5.67 X 5)/2 - (5 X 5 X 5)/2] X 1100

= 19,659 cubic feet/ 27 = 728 cubic yards
Use **730 cubic yards**

c) Rip Rap Filter 6" thick - 0.5 feet

[5.5 X 5.5 X 5)/2 - (5 X 5 X 5)/2] X 1100

= 14,438 cubic feet/ 27 = 535 cubic yards
Use 550 cubic yards

d) Toe Apron No rock required

Total Rock Armor Cell 3 north Slope **730 cubic yards**

10) Cell 3 South Dike, west end (Slope #7)

Average height	16 feet
Length	1750 feet

a) Random fill to reduce slope from 3:1 to 5:1

First Wedge [16 X 16 X 5)/2 - (16 X 16 X 3)/2] X 1750

= 448,000 cubic feet/ 27 = 16,593 cubic yards

Use 16,600 cubic yards

Remaining Random Fill

[19 X 19 X 5)/2 - (16 X 16 X 5)/2] X 1750

= 459,375 cubic feet/ 27 = 17,014 cubic yards

Use 17,100 cubic yards

Total Random Fill North Slope 33,700 cubic yards

b) Rock Armor 8" thick - 0.67 feet

[19.67 X 19.67 X 5)/2 - (19 X 19 X 5)/2] X 1750

= 113,351 cubic feet/ 27 = 4,198 cubic yards

Use 4,200 cubic yards

c) Rip Rap Filter 6" thick - 0.5 feet

[19.5 X 19.5 X 5)/2 - (519 X 19 X 5)/2] X 1750

= 84,219 cubic feet/ 27 = 3,119 cubic yards

Use 3,200 cubic yards

d) Rock Apron at toe of slope [2ft X 7ft wide X 1750 long] / 27 = 907

Use 1,000 cubic yards

Total Rock Armor Slope #7 5,200 cubic yards

11) Cell 3 South Dike (Slope #8) **VOLUME DELETED. AREA FILLED WITH CELL 4A TAILINGS**

a) Random Fill No existing Dike [(4 X 4 X 5) / 2] X 800 /27 = 1185 cubic yards

Use 1,200 cubic yards

Total Random Slope #4 1,200 cubic yards

b) Rock Armor 8" thick - 0.67 feet 14.52 cubic feet per linear foot of dike

14.52 cubic foot per linear foot X 800 / 27

= 430 cubic feet/ 27 = 430 cubic yards

Use 450 cubic yards

c) Rip Rap Filter 6" thick - 0.5 feet

10.84 cubic foot per linear foot X 800 / 27

= 321 cubic feet/ 27 = 321 cubic yards

Use 325 cubic yards

d) Toe Apron Not required

Total Rock Armor Cell 3 East Slope 450 cubic yards

Volume Summary - Cell 3

	Bridging Layer	Lower Random	Clay	Upper Random	Rock Armor	Rip Rap Filter
Top of Cell	14,592	119,787	120,000	240,000	60,000	0
West (Slope #6)		410		2,200	730	550
South (Slope #7)		16,600		17,100	5,200	3,200
East (Slope #9)				1,200	450	325
Totals	14,592	136,797	120,000	260,500	66,380	4,075

Cell 3 Reclamation

Cat 637 Resource Requirements

	Volume	Route	Yds/hr	%	Equip. Hr.
Cell 3 Bridging Lift					
Tailings Surface	14,592	C	285	100%	51.3
Cell 3 Lower Random Fill					
Tailings Surface	119,787	C	285	100%	420.8
Slope 6	410	C	285	100%	1.4
Slope 7	16,600	C	285	100%	58.3
Slope 9	-	C	285	100%	0.0
Total					480.5

Trucking Fleet Requirements

Cell 3 Upper Random Fill	Volume	Route	Yds/hr per Truck	%	Equip. Hr.
Tailings Surface	154,990	C	258	100%	601.2
Tailings Surface	85,010	D	311	100%	273.5
Slope 6	2,200	D	311	100%	7.1
Slope 7	17,100	D	311	100%	55.0
Slope 9	1,200	D	311	100%	3.9
Total	260,500				940.7

Cell 3 Rock Armor -- use Highway Trucks

Clay Production Cell 3

(use same assumptions as Cell 2)

Clay Volume =	120,000	Bank Cubic Yards (BCY)
	0.8	Swell Factor
=	150,000	Loose Cubic Yards (LCY)

Trucking 475 LCY/hr 8 trucks plus one (1) Loader

150,000 LCY / 475 LCY/hr = 316 hours

use	320 hours

320 X 8 Trucks = 2560 hours

	Hours
980 Loader	320
D8N w/ ripper	320
Cat 651 WW	320
Cat 825 Comp	350
14G Patrol	350
5000 gal WW	175

Rock Armor and Rip Rap Filter Production Cell 3

70,455 cubic yards (cy)

38 cy per hour times 8 trucks

304 cy per hour delivered

Assume 25% extra time for spreading, loading and screen wait

304 / 1.25 243.2 cy per hour 290 Hours

Cell 4A

RECLAMATION OF CELL 4A

Dewatering of Cell 4A

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Dewatering of Cell 4A (6 yrs)	hrs	$0.48	52,560	**$25,269**

Total Dewatering of Cell 4A **$25,269**

Place Bridging (Platform) Lift

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 637 Scraper	hrs	$221.91	554	$123,045
Cat 637 Scraper Operators	hrs	$28.78	554	$15,956
Cat 825 Compactor	hrs	$101.99	139	$14,138
Cat 825 Compactor Operator	hrs	$23.25	139	$3,223
Cat D8N Dozer With Ripper	hrs	$103.84	139	$14,393
Cat D8N Dozer Operator	hrs	$26.00	139	$3,604
Cat D7 Dozer	hrs	$88.08	139	$12,209
Cat D7 Dozer Operator	hrs	$26.00	139	$3,604
Cat 651 Waterwagon	hrs	$115.90	139	$16,066
Cat 651 Waterwagon Operator	hrs	$23.25	139	$3,223
Cat 14H Motorgrader	hrs	$77.15	139	$10,695
Cat 14H Motorgrader Operator	hrs	$28.78	139	$3,989
Equipment Maintenance (Butler)	hrs	$22.45	1,248	$28,014

Total Place Bridging (Platform) Lift **$252,158**

Place Lower Random Fill

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 637 Scraper	hrs	$221.91	461	$102,404
Cat 637 Scraper Operators	hrs	$28.78	461	$13,280
Cat 825 Compactor	hrs	$101.99	115	$11,766
Cat 825 Compactor Operator	hrs	$23.25	115	$2,682
Cat D8N Dozer With Ripper	hrs	$88.08	115	$10,161
Cat D8N Dozer Operator	hrs	$26.00	115	$2,999
Cat D7 Dozer	hrs	$77.15	115	$8,901
Cat D7 Dozer Operator	hrs	$26.00	115	$2,999
Cat 651 Waterwagon	hrs	$115.90	115	$13,371
Cat 651 Waterwagon Operator	hrs	$23.25	115	$2,682
Cat 14H Motorgrader	hrs	$77.15	115	$8,901
Cat 14H Motorgrader Operator	hrs	$28.78	115	$3,320
Equipment Maintenance (Butler)	hrs	$22.45	1,038	$23,314

Total Place Lower Random Fill **$206,781**

RECLAMATION OF CELL 4A

Clay Layer

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 825 Compactor	hrs	$101.99	200	$20,398
Cat 825 Compactor Operator	hrs	$23.25	200	$4,650
Cat D8N Dozer With Ripper	hrs	$103.84	180	$18,690
Cat D8N Dozer Operator	hrs	$26.00	180	$4,680
Cat 651 Waterwagon	hrs	$115.90	180	$20,862
Cat 651 Waterwagon Operator	hrs	$23.25	180	$4,185
Cat 14H Motorgrader	hrs	$77.15	200	$15,431
Cat 14H Motorgrader Operator	hrs	$28.78	200	$5,755
Cat 980 Loader	hrs	$100.39	150	$15,059
Cat 980 Loader Operator	hrs	$26.00	150	$3,900
5000 Gallon Water Truck	hrs	$67.74	150	$10,161
5000 Gallon Water Truck Operator	hrs	$23.25	150	$3,488
Highway Trucks	hrs	$33.70	1,440	$48,527
Truck Drivers	hrs	$21.30	1,440	$30,673
Equipment Maintenance (Butler)	hrs	$22.45	1,060	$23,802

Total Place Clay Layer **$230,262**

Upper Random Fill

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 365 Excavator	hrs	$139.69	219	$30,575
Cat 365 Excavator Operator	hrs	$28.78	219	$6,299
Cat 770 Truck (3 trucks in Fleet)	hrs	$102.19	657	$67,103
Truck Drivers	hrs	$21.30	657	$13,986
Cat 825 Compactor	hrs	$101.99	219	$22,323
Cat 825 Compactor Operator	hrs	$23.25	219	$5,089
Cat D7 Dozer	hrs	$88.08	219	$19,278
Cat D7 Dozer Operator	hrs	$26.00	219	$5,691
Cat 651 Waterwagon	hrs	$115.90	219	$25,368
Cat 651 Waterwagon Operator	hrs	$23.25	219	$5,089
Cat 14H Motorgrader	hrs	$77.15	219	$16,887
Cat 14H Motorgrader Operator	hrs	$28.78	219	$6,299
5000 Gallon Water Truck	hrs	$67.74	219	$14,827
5000 Gallon Water Truck Operator	hrs	$23.25	219	$5,089
Equipment Maintenance (Butler)	hrs	$22.45	1,970	$44,233

Total Place Upper Random Fill **$170,172**

RECLAMATION OF CELL 4A

Rock Armor and Filter Layer

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat D7 Dozer	hrs	$88.08	240	$21,139
Cat D7 Dozer Operator	hrs	$26.00	240	$6,240
Cat 651 Waterwagon	hrs	$115.90	240	$27,816
Cat 651 Waterwagon Operator	hrs	$23.25	240	$5,580
Cat 14H Motorgrader	hrs	$77.15	240	$18,517
Cat 14H Motorgrader Operator	hrs	$28.78	240	$6,907
Rock Cost Delivered	CY	$6.60	48,695	$321,157
Equipment Maintenance (Butler)	hrs	$22.45	720	$16,167

Total Place Rock Armor and Filter Layer **$423,523**

Quality Control

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Quality Control Contractor	hrs	$62.00	1,045	**$64,790**

Total Quality Control **$64,790**

TOTAL RECLAMATION OF CELL 4A **$1,372,956**

Volume Calculation - Cell 4A

Reviewed 2/25/16

1) Area of Cell 1,785,960 sq ft = 41.00 acres

2) Assumptions

- Bridging layer is placed using random fill from piles east of Cell 4A
- Dewatering estimated at 6 years.
- Cell will be graded to Design elevation utilizing finer materials in random fill stockpiles and from "clay" stockpiles.

- Clay will be mined, blended, and hauled from borrow site location in Section 16 - four miles south of the mill area, using belly dump trucks, clay layer on top of Cell only.

- The upper 1 foot of random fill will be placed utilizing the fine random fill and clay stockpiles

- Rock for side armor, top armor and toe aprons will come from an off-site gravel source one (1) mile north of Blanding. Rock will be produced through screening, stockpiled and trucked to the site at the time of use. Belly dump trucks will dump gravel in windrows on the top and sides of the Cell.

3) Bridging Layer (Platform Fill) Remaining to be placed

1,785,960 sq ft X 3 ft. / 27 cubic feet per cubic yard = 198,440 cubic yards

Use 198,500 cubic yards

4) Bring Platform Fill up to Design elevation (Lower Random)
Assume full area of Cell X one (1) foot thick

1,785,960 sq ft X 1 ft. / 27 cubic feet per cubic yard = 66,147 cubic yards

Use 66,000 cubic yards

5) Placement of Clay Layer (One (1) foot thick on top of Cell only)
Assume full area of Cell X one (1) foot thick

1,785,960 sq ft X 1 ft. / 27 cubic feet per cubic yard = 66,147 cubic yards

Use 66,000 cubic yards

6) Upper Random Fill Volume - Top of Cell area
Assume full area of Cell X one (2) foot thick
- 3 trucks, 1 excavator used to load and haul the random fill.
- A dozer will spread the material, a water truck will moisture condition prior to being compacted.
- A road grader and water wagon will maintain the haul roads.

1,785,960 sq ft X 2 ft. / 27 cubic feet per cubic yard = 132,293 cubic yards

Use **132,500 cubic yards**

7) Armor Protection - Top of Cell
Assume full area of Cell X one-half (0.5) foot thick

1,785,960 sq ft X 0.5 ft. / 27 cubic feet per cubic yard = 33,073 cubic yards

Use **33,000 cubic yards**

8) Cell 4A South Dike, (Slope #1)

Average heigl	36	feet
Length	1600	feet

a) Random fill to reduce slope from 3:1 to 5:1

First Wedge [36 X 36 X 5)/2 - (36 X 36 X 3)/2] X 1600

= 2,073,600 cubic feet/ 27 = 76,800 cubic yards
- 43,479 CY of material will come from the excavated channel within Cell 1. (43,479) cubic yards
- The cost to load, haul and stage the material is included in Cell 1 channel construction.

Use **33,321 cubic yards**

Remaining Random Fill

[39 X 39 X 5)/2 - (36 X 36 X 5)/2] X 1600

= 900,000 cubic feet/ 27 = 33,333 cubic yards

Use **34,000 cubic yards**

Total Random Fill South Slope **110,800 cubic yards**

b) Rock Armor 8" thick - 0.67 feet

[39.67 X 39.67 X 5)/2 - (39 X 39 X 5)/2] X 1600

= 210,836 cubic feet/ 27 = 7,809 cubic yards

Use **7,800 cubic yards**

c) Rip Rap Filter 6" thick - 0.5 feet

[39.5 X 39.5 X 5)/2 - (39 X 39 X 5)/2] X 1600

= 157,000 cubic feet/ 27 = **5,815 cubic yards**

Use **6,000 cubic yards**

d) Rock Apron at toe of slope [2ft X 7ft wide X 1600 long] / 27 = 830

Use 850 cubic yards

Total Rock Armor South Slope 8,650 cubic yards

9) Cell 4A East Slope (Slope #2)

Average heigl	8	feet
Length	1200	feet

a) Random fill to reduce slope from 3:1 to 5:1

First Wedge [8 X 8 X 5)/2 - (8 X 8 X 3)/2] X 1200

= 76,800 cubic feet/ 27 = 1185 cubic yards

Use 1,200 cubic yards

Remaining Random Fill

[11 X 11 X 5)/2 - (8 X 8 X 5)/2] X 1200

= 171,000 cubic feet/ 27 = 6,333 cubic yards

Use 6,500 cubic yards

Total Random Slope #3 7,700 cubic yards

b) Rock Armor 8" thick - 0.67 feet 14.52 cubic feet per linear foot of dike

14.52 cubic foot per linear foot X 1200 / 27

= 645 cubic feet/ 27 = 24 cubic yards

Use 25 cubic yards

c) Rip Rap Filter 6" thick - 0.5 feet

10.84 cubic foot per linear foot X 1200 / 27

= 482 cubic feet/ 27 = **18 cubic yards**

Use **20 cubic yards**

c) Toe Apron Not required

Total Rock Armor Cell 4A East Slope | 25 cubic yards

Volume Summary - Cell 4A

	Bridging Layer	Lower Random	Clay	Upper Random	Rock Armor	Rip Rap Filter
Top of Cell	198,500	66,000	66,000	132,500	33,000	0
South (Slope #1)		33,321		34,000	8,650	6,000
East (Slope #2)		1,200		6,500	25	20
Totals	198,500	100,521	66,000	173,000	41,675	6,020

Cell 4A Reclamation

Cat 637 Resource Requirements

	Volume	Route	Yds/hr	%	Equip. Hr.
Cell 4A Bridging Lift					
Tailings Surface	198,500	A	358	100%	554.9
Cell 4A Lower Random Fill					
Tailings Surface	37,500	B	303	100%	123.7
Tailings Surface	28,500	A	358	100%	79.7
Slope 1	33,321	B	303	100%	109.9
Slope 2	1,200	B	303	100%	4.0
Total					317.2

Trucking Fleet Requirements

Cell 4A Upper Random Fill	Volume	Route	Yds/hr per truck	%	Equip. Hr.
Tailings Surface	132,500	B	263	100%	502.9
Slope 1	34,000	B	263	100%	129.0
Slope 2	6,500	B	263	100%	24.7
Total					656.6

Cell 4A Rock Armor -- use Highway Trucks

Clay Production Cell 4A

(use same assumptions as Cell 2)

Clay Volume = 66,000 Bank Cubic Yards (BCY)

0.8 Swell Factor

= 82,500 Loose Cubic Yards (LCY)

Trucking 475 LCY/hr 8 trucks plus one (1) Loader

85,000 LCY / 475 LCY/hr = 174 hours

use 180 hours

180 X 8 Trucks = 1,440 hours

Machine	Hours
980 Loader	180
D8N w/ ripper	180
Cat 651 WW	180
Cat 825 Comp	200
14G Patrol	200
5000 gal WW	150

Rock Armor and Filter Layer Production Cell 4A

47,695 cubic yards (cy)

38 cy per hour times 8 trucks

304 cy per hour delivered

Assume 25% extra time for spreading, loading and screen wait

304 / 1.25	243.2 cy per hour	196 Hours

Cell 4A Capacity 2014

		1,190,000	tons
		991,667	cy
Source	Cell 1 Crystals	286,189	cy
	Cell 1 Cont Mat	95,396	cy
	Demo Mat	663	hr
	Demo Mat Vol	265,250	cy
	Mill Cont Mat	240,921	cy
	Cell 4B Cont Mat	66,147	cy
	Total	953,902	cy

Cell 4B

RECLAMATION OF CELL 4B

Dewatering of Cell 4B

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Dewatering of Cell 4B (1 Yr)	hrs	$0.48	8,760	**$4,212**

Total Dewatering of Cell 4B **$4,212**

Place Bridging (Platform) Lift

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 637 Scraper	hrs	$221.91	660	$146,463
Cat 637 Scraper Operators	hrs	$28.78	660	$18,993
Cat 825 Compactor	hrs	$101.99	165	$16,829
Cat 825 Compactor Operator	hrs	$23.25	165	$3,836
Cat D8N Dozer With Ripper	hrs	$103.84	165	$17,133
Cat D8N Dozer Operator	hrs	$26.00	165	$4,290
Cat D7 Dozer	hrs	$88.08	165	$14,533
Cat D7 Dozer Operator	hrs	$26.00	165	$4,290
Cat 651 Waterwagon	hrs	$115.90	165	$19,124
Cat 651 Waterwagon Operator	hrs	$23.25	165	$3,836
Cat 14H Motorgrader	hrs	$77.15	165	$12,730
Cat 14H Motorgrader Operator	hrs	$28.78	165	$4,748
Equipment Maintenance (Butler)	hrs	$22.45	1,485	$33,345

Total Place Bridging (Platform) Lift **$300,151**

Place Lower Random Fill

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 637 Scraper	hrs	$221.91	480	$106,519
Cat 637 Scraper Operators	hrs	$28.78	480	$13,813
Cat 825 Compactor	hrs	$101.99	120	$12,239
Cat 825 Compactor Operator	hrs	$23.25	120	$2,790
Cat D8N Dozer With Ripper	hrs	$103.84	120	$12,460
Cat D8N Dozer Operator	hrs	$26.00	120	$3,120
Cat D7 Dozer	hrs	$88.08	120	$10,569
Cat D7 Dozer Operator	hrs	$26.00	120	$3,120
Cat 651 Waterwagon	hrs	$115.90	120	$13,908
Cat 651 Waterwagon Operator	hrs	$23.25	120	$2,790
Cat 14H Motorgrader	hrs	$77.15	120	$9,258
Cat 14H Motorgrader Operator	hrs	$28.78	120	$3,453
Equipment Maintenance (Butler)	hrs	$22.45	1,080	$24,251

Total Place Lower Random Fill **$218,292**

Clay Layer

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 637 Scraper	hrs	$221.91	0	$0
Cat 637 Scraper Operators	hrs	$28.78	0	$0
Cat 825 Compactor	hrs	$101.99	200	$20,398
Cat 825 Compactor Operator	hrs	$23.25	200	$4,650
Cat D8N Dozer With Ripper	hrs	$103.84	180	$18,690
Cat D8N Dozer Operator	hrs	$26.00	180	$4,680
Cat D7 Dozer	hrs	$88.08	0	$0
Cat D7 Dozer Operator	hrs	$26.00	0	$0
Cat 651 Waterwagon	hrs	$115.90	180	$20,862
Cat 651 Waterwagon Operator	hrs	$23.25	180	$4,185
Cat 14H Motorgrader	hrs	$77.15	200	$15,431
Cat 14H Motorgrader Operator	hrs	$28.78	200	$5,755
Cat 980 Loader	hrs	$100.39	150	$15,059
Cat 980 Loader Operator	hrs	$26.00	150	$3,900
5000 Gallon Water Truck	hrs	$67.74	150	$10,161
5000 Gallon Water Truck Operator	hrs	$23.25	150	$3,488
Highway Trucks	hrs	$31.75	1,440	$45,719
Truck Drivers	hrs	$23.25	1,440	$33,481
Equipment Maintenance (Butler)	hrs	$22.45	1,060	$23,802

Total Place Clay Layer **$230,262**

Upper Random Fill

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat 637 Scraper	hrs	$221.91	570	$126,491
Cat 637 Scraper Operators	hrs	$28.78	570	$16,403
Cat 825 Compactor	hrs	$101.99	143	$14,534
Cat 825 Compactor Operator	hrs	$23.25	143	$3,313
Cat D8N Dozer With Ripper	hrs	$103.84	143	$14,796
Cat D8N Dozer Operator	hrs	$26.00	143	$3,705
Cat D7 Dozer	hrs	$88.08	143	$12,551
Cat D7 Dozer Operator	hrs	$26.00	143	$3,705
Cat 651 Waterwagon	hrs	$115.90	143	$16,516
Cat 651 Waterwagon Operator	hrs	$23.25	143	$3,313
Cat 14H Motorgrader	hrs	$77.15	143	$10,994
Cat 14H Motorgrader Operator	hrs	$28.78	143	$4,101
5000 Gallon Water Truck	hrs	$67.74	143	$9,653
5000 Gallon Water Truck Operator	hrs	$23.25	143	$3,313
Equipment Maintenance (Butler)	hrs	$22.45	1,425	$31,998

Total Place Upper Random Fill **$275,388**

Rock Armor and Filter Layer

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Cat D7 Dozer	hrs	$88.08	200	$17,616
Cat D7 Dozer Operator	hrs	$26.00	200	$5,200
Cat 651 Waterwagon	hrs	$115.90	200	$23,180
Cat 651 Waterwagon Operator	hrs	$23.25	200	$4,650
Cat 14H Motorgrader	hrs	$77.15	200	$15,431
Cat 14H Motorgrader Operator	hrs	$28.78	200	$5,755
Rock Cost Delivered	CY	$6.60	48,695	$321,157
Equipment Maintenance (Butler)	hrs	$22.45	600	$13,473

Total Place Rock Armor and Filter Layer **$406,462**

Quality Control

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Quality Control Contractor	hrs	$62.00	1,045	**$64,790**

Total Quality Control **$64,790**

TOTAL RECLAMATION OF CELL 4B **$1,499,557**

	Volume	Route	Yds/ Hr		Equip Hours
Cell 4B Bridging Lift					
Tailings Surface	198,500	2	303	100%	655.1
Cell 4B Lower Random Fill					
Tailings Surface	66,000	2	303	100%	217.8
South Slope	77,000	2	303	100%	254.1
West Slope	1,200	2	303	100%	4.0
					475.9
Cell 4B Upper Random Fill					
Tailings Surface	132,000	2	303	100%	435.6
South Slope	34,000	2	303	100%	112.2
West Slope	6,500	2	303	100%	21.5
					569.3
Rock Armor					
Rip Rap	42,675			100%	
Filter	6,020			100%	

Volume Calculation - Cell 4B

Reviewed 2/25/16

1) Area of Cell 4I 1,785,960 sq ft = 41 acres

2) Assumptions

- Bridging layer is placed using random fill from piles west of Cell 4B

- Cell will be graded to Design elevation utilizing finer materials in random fill stockpiles and from "clay" stockpiles.

- Clay will be mined, blended, and hauled from borrow site location in Section 16 - four miles south of the mill area, using belly dump trucks, clay layer on top of Cell only.

- The upper 1 foot of random fill will be placed utilizing the fine random fill and clay stockpiles

- Rock for side armor, top armor and toe aprons will come from an off-site gravel source one (1) mile north of Blanding. Rock will be produced through screening, stockpiled and trucked to the site at the time of use. Belly dump trucks will dump gravel in windrows on the top and sides of the Cell.

3) Bridging Layer (Platform Fill) Remaining to be placed

1,785,960 sq ft X 3 ft. / 27 cubic feet per cubic yard = 198,440 cubic yards

Use 198,500 cubic yards

4) Bring Platform Fill up to Design elevation (Lower Random)
Assume full area of Cell X one (1) foot thick

1,785,960 sq ft X 1 ft. / 27 cubic feet per cubic yard = 66,147 cubic yards

Use 66,000 cubic yards

5) Placement of Clay Layer (One (1) foot thick on top of Cell only)
Assume full area of Cell X one (1) foot thick

1,785,960 sq ft X 1 ft. / 27 cubic feet per cubic yard = 66,147 cubic yards

Use 66,000 cubic yards

6) Upper Random Fill Volume - Top of Cell area

Assume full area of Cell X one (2) foot thick

1,785,960 sq ft X 2 ft. / 27 cubic feet per cubic yard = 132,293 cubic yards

Use **132,000 cubic yards**

7) Armor Protection - Top of Cell

Assume full area of Cell X one-half (0.5) foot thick

1,785,960 sq ft X 0.5 ft. / 27 cubic feet per cubic yard = 33,073 cubic yards

Use **33,000 cubic yards**

8) Cell 4B South Dike, (Slope #1)

Average height	36	feet
Length	1600	feet

a) Random fill to reduce slope from 3:1 to 5:1

First Wedge [36 X 36 X 5)/2 - (36 X 36 X 3)/2] X 1600

= 2,073,600 cubic feet/ 27 = 76,800 cubic yards

Use **77,000 cubic yards**

Remaining Random Fill

[39 X 39 X 5)/2 - (36 X 36 X 5)/2] X 1600

= 900,000 cubic feet/ 27 = 33,333 cubic yards

Use **34,000 cubic yards**

Total Random Fill South Slope **111,000 cubic yards**

b) Rock Armor 8" thick - 0.67 feet

[39.67 X 39.67 X 5)/2 - (39 X 39 X 5)/2] X 1600

= 210,836 cubic feet/ 27 = 7,809 cubic yards

Use **7,800 cubic yards**

c) Rip Rap Filter 6" thick - 0.5 feet

[39.5 X 39.5 X 5)/2 - (39 X 39 X 5)/2] X 1600

= 157,000 cubic feet/ 27 = **5,815 cubic yards**

Use **6,000 cubic yards**

d) Rock Apron at toe of slope [2ft X 7ft wide X 1600 long] / 27 = 830

Use 850 cubic yards

Total Rock Armor South Slope 8,650 cubic yards

9) Cell 4B West Slope (Slope #2)

Average height	8 feet
Length	1200 feet

a) Random fill to reduce slope from 3:1 to 5:1

First Wedge [8 X 8 X 5)/2 - (8 X 8 X 3)/2] X 1200

= 76,800 cubic feet/ 27 = 1185 cubic yards

Use 1,200 cubic yards

Remaining Random Fill

[11 X 11 X 5)/2 - (8 X 8 X 5)/2] X 1200

= 171,000 cubic feet/ 27 = 6,333 cubic yards

Use 6,500 cubic yards

Total Random Slope #3 7,700 cubic yards

b) Rock Armor 8" thick - 0.67 feet 14.52 cubic feet per linear foot of dike

14.52 cubic foot per linear foot X 1200 / 27

= 645 cubic feet/ 27 = 24 cubic yards

Use 25 cubic yards

c) Rip Rap Filter 6" thick - 0.5 feet

10.84 cubic foot per linear foot X 1200 / 27

= 482 cubic feet/ 27 = **18 cubic yards**

Use **20 cubic yards**

c) Toe Apron Not required

Total Rock Armor Cell 4B West Slope 25 cubic yards

Volume Summary - Cell 4B

	Bridging Layer	Lower Random	Clay	Upper Random	Rock Armor	Rip[Rap Filter
Top of Cell	198,500	66,000	66,000	132,000	33,000	0
South (Slope #1)		77,000		34,000	8,650	6,000
West (Slope #3)		1,200		6,500	25	20
Totals	198,500	144,200	66,000	172,500	41,675	6,020

Cell 4B Reclamation

Cat 637 Resource Requirements

	Volume	Route	Yds/hr	%	Equip. Hr.
Cell 4B Bridging Lift					
Tailings Surface	198,500	B	303	100%	654.6
Cell 4B Lower Random Fill					
Tailings Surface	66,000	B	303	100%	217.6
Slope 1	77,000	B	303	100%	253.9
Slope 2	1,200	B	303	100%	4.0
Total					475.5
Cell 4B Upper Random Fill					
Tailings Surface	132,000	B	303	100%	435.3
Slope 1	34,000	B	303	100%	112.1
Slope 2	6,500	B	303	100%	21.4
Total					568.8

Cell 4B Rock Armor -- use Highway Trucks

Clay Production Cell 4B

(use same assumptions as Cell 2)

Clay Volume = 66,000 Bank Cubic Yards (BCY)

0.8 Swell Factor

= 82,500 Loose Cubic Yards (LCY)

Trucking 475 LCY/hr 8 trucks plus one (1) Loader

85,000 LCY / 475 LCY/hr = 174 hours

use 180 hours

180 X 8 Trucks = 1,440 hours

Machine	Hours
980 Loader	180
D8N w/ ripper	180
Cat 651 WW	180
Cat 825 Comp.	200
14G Patrol	200
5000 gal WW	150

Rock Armor and Filter Layer Production Cell 4B

47,695 cubic yards (cy)

38 cy per hour times 8 trucks

304 cy per hour delivered

Assume 25% extra time for spreading, loading and screen wait

304 / 1.25 243.2 cy per hour 196 Hours

Miscellaneous

MISCELLANEOUS ITEMS

Decontamination Pad

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Laborers	hrs	$17.16	8,320	**$142,747**
Construct Wheel Wash Facility	LS	$180,000	1	**$180,000**
	Facilities constructed in 2000 & 2008			($180,000)
Total Decontamination Facilities				**$142,747**

Chloroform System Operation and Reclamation

Task 1: Operation for a 10 year period.	$	185,252
Task 2: Maintenance for a 10 year period.	$	104,382
Task 3: Monitoring for a 10 year period.	$	763,045
Task 4: Reporting for a 10 year period.	$	101,653
Task 5: Chloroform System Abandonment	$	21,920
Sub Total	**$**	**1,176,252**

Nitrate System Operation and Reclamation

Task 1: Operation for a 5 year period.	$	-
Task 2: Maintenance for a 5 year period.	$	4,349
Task 3: Monitoring for a 5 year period.	$	6,864
Task 4: Reporting for a 5 year period.	$	8,242
Task 5: Nitrate System Abandonment	$	3,555
Sub Total	**$**	**23,010**

Notes: The Nitrate Pumping System Operation is included in the Chloroform Pumping System Operation Costs.
There is only 1 Nitrate pumping well that is not already included in the 13 wells associated with the Chloroform Pumping System.

Maintenance is scaled from the Chloroform estimate based on the ratio of pumping wells (1 Nitrate Pumping well / 13 Chloroform Pumping Wells and 5 years instead of 10 years)

Monitoring is based on an analytical cost of $345 per quarter for 5 years.

Reporting is scaled from the Chloroform estimate based on the ratio of total wells (6 Nitrate wells / 37 Chloroform Wells and 5 years instead of 10 years)

Abandonment is scaled from the Chloroform estimate based on the ratio of total wells (6 Nitrate wells / 37 Chloroform Wells)

Slimes Drain Evaporation Pond

Resource Description	Units	Cost/Unit	Task Units	Task Cost
60 mil HDPE Liner, installed	sq. ft.	$0.70	960,000	$672,000
Cat 637 Scraper	hrs	$221.91	100	$22,191
Cat 637 Scraper Operator	hrs	$28.78	100	$2,878
Cat 825 Compactor	hrs	$101.99	25	$2,550
Cat 825 Compactor Operator	hrs	$23.25	25	$581
Cat D7 Dozer	hrs	$88.08	25	$2,202
Cat D7 Dozer Operator	hrs	$26.00	25	$650
Cat 651 Waterwagon	hrs	$115.90	25	$2,898
Cat 651 Waterwagon Operator	hrs	$23.25	25	$581
Cat 14H Motorgrader	hrs	$77.15	25	$1,929
Cat 14H Motorgrader Operator	hrs	$28.78	25	$719
Equipment Maintenance (Butler)	hrs	$22.45	200	$4,491

Total Slimes Drain Evaporation Pond **$713,670**

TOTAL MISCELLANEOUS ITEMS **$2,055,680**

Chloroform Pumping System

Chloroform Pumping System - Required Surety Estimate

Task 1: Operation for a 10 year period.

Assumptions

The full Chloroform pumping and monitoring system has already been installed.
Operation will be performed by the Environmental Technician at $30.890 per hour
Environmental Technician will be local labor hired by a DWMRC Contractor. A 15% markup has been applied to the actual labor rate
Daily operation checks take 1.0 hours for 1 Environmental Technician.
Weekly operation checks take 3.0 hours for 1 Environmental Technician.
Measure Depth to Water Monthly 6 hours for 1 Environmental Technician.
Water from the chloroform pumping sysytem will be pumped to the evaporation or tailings ponds or used in the Mill process. After reclamation, the water will pumped to the Cell 2 Slimes evaporation pond. The costs associated with the Cell 2 slimes evaporation pond are included in the Miscellaneous items.
Power $0.07/KWH
Average power of each pump motor = 0.75 hp.
Average pumping time per day = 1.1 hr.

Item	Quantity	Units	Quantity	Units	Cost
Daily Operation Checks - Labor	1	Hrs/Day	365	hrs/Yr	$ 11,274
Weekly Operation Checks - Labor	3	Hrs/Wk	156	hrs/Yr	$ 4,819
Measure Depth to Water Monthly	6	Hrs/Month	72	hrs/Yr	$ 2,224
Pumping hours per well per quarter	1.1	Hrs/Day	401.5	hrs/Yr	$ 16.00
				Total per year	**$ 18,525**
				Total 10 years	**$ 185,252**

Task 2: Maintenance for a 10 year period.

Assumptions

Maintenance will be performed by the Environmental Technician at $30.890 per hour
Environmental Technician will be local labor hired by a DWMRC Contractor. A 15% markup has been applied to the actual labor rate
Pump Replacement takes 4 hours for 2 Environmental Technicians.
Average of 3 pump replacements per year. Each replacement pump costs $2,200
Flow Meter Replacement takes 2 hours for 2 Environmental Technicians.
Average of 4 flow meter replacements per year. Each replacement flow meter costs $245
Heat lamp bulb replacement labor is included in daily operational checks.
Average of 14 heat lamp bulb replacements per year. Each bulb cost $10
Average of 3 pipeline freezing per year.
Clearing of a pipeline freeze takes 8 hours for 2 Environmental Technicians. No material costs.

Item	Quantity	Units	Labor Hours / Year	Material Cost per year	Cost
Pump Replacement	3	Replaced / year	24	6600	$ 7,341
Flow Meter Replacement	4	Replaced / year	16	980	$ 1,474
Heat Lamp Replacement	14	Replaced / year	0	140	$ 140
Frozen Pipeline Clearing	3	Clearing / year	48	0	$ 1,483
				Total	**$ 10,438**
				Total 10 years	**$ 104,382**

Task 3: Monitoring for a 10 year period.

Assumptions

Analytical cost per sample = $169
45 samples per quarter
Sample collection will be performed by an Environmental Technician and a Contractor Field Geologist
Environmental Technician = $31.89 per hour. Field Geologist = $90.00 per hour
Environmental Technician will be local labor hired by a DWMRC Contractor. A 15% markup has been applied to the actual labor rate
Sample collection requires 80 hours for 2 Environmental Technicians per quarter.

Item	Quantity	Units	Quantity	Unit	Cost
Analytical Costs	180	Samples/year	$ 169	$/Sample	$ 30,420
Sampling Labor - Environmental Technician	320	Hrs/year	$ 30.89	$/hr	$ 9,884
Sampling Labor - Field Geologist	320	Hrs/year	$ 90.00	$/hr	$ 28,800
Field Geologist - Travel Costs	40	Days/year	$ 180.00	$/day	$ 7,200
				Total	**$ 76,304**
				Total 10 years	**$ 763,044.67**

Task 4: Reporting for a 10 year period.

Assumptions

Reporting will be performed by the Environmental Technician at $30.890 per hour
Environmental Technician will be local labor hired by a DWMRC Contractor. A 15% markup has been applied to the actual labor rate
Report preparation is expected to take 40 hours for the Environmental Technician to complete each quarter.
Quarterly analysis of contamination extent is estimated to cost $3,000.

Item	Quantity	Units	Quantity	Unit	Cost
Report Preparation	160	Hrs/year	$ 30.89	$/hr	$ 4,942
Contamination Analyisis	4	per year	$ 3,000.00	$/Quarter	$ 12,000
				Total 10 years	**$ 101,653**

Task 5: Chloroform System Abandonment

Assumptions

Pumps and well head enclosures will be loaded on a flat bed truck by hand.
Abandonment will be performed by the Environmental Technician at $30.890 per hour
Wells will be abandoned in accordance with State of Utah Administrative Code R655-4 subsection 14.9
Flatbed truck with operator costs $55/hr.
Assumed 1 hour of labor to remove each pump and enclosure.
The materials will be discarded in the active trash area of the tailing cells if available or in an off-site landfill.
Well casing will be cut off 2 feet below the ground level.
The well will be abandoned by filling will Hole Plug.
Hole Plug Material cost estimated at $2 per foot of well.
Average well depth of 120 feet.
There is 2,600 feet of underground electrical line and 3,850' of pipeline
The HDPE pipeline and power line will be uncovered with a 365 Excavator
The 365 Excavator is estimated to excavate or backfill 412 feet per hour.
The 365 Excavator costs $155/hr without the operator.
The Excavator will also backfill the trench after the pipe has been removed.
Assumed 8 hours to place the pipeline and powerlines in the tailing cell.

Item	Quantity	Units	Labor Hrs	Equipment Hours	Total Cost
Pull pumps and remove enclosures	13	Pumping Wells	13	13	$ 1,116.56
Abandon All Wells - Labor	38	Wells	38	0	$ 1,173.78
Abandon All Wells - Materials	38	Wells	0	0	$ 9,120.00
Landfil Charges	1	Surcharge	0	0	$ 5,000.00
Excavate and Backfill Pipeline Trench	12900	Linear Feet	39.34	31.34	$ 5,510.09
				Total	**$ 21,920.43**

Labor Costs

LABOR COSTS

Specified Wages

Energy Fuels and WMI Rates **2014 Estimated Labor Rates****

Labor Rates increased by 3% and 2.5% in 2015 and 2016 respectivly.

	2015	2016
	103%	102.5%

Labor Classification	Base Rate ***	Mandated Fringe	Labor Burden (FICA, SUI, FUI, etc.)	Company Benefits (medical, life insure, etc)	Fringe Costs	Labor Cost/HR	Fringe Costs - on Overtime hours	Labor Cost/HR - Overtime	**Labor Cost/HR - 50 hour week**
			15.65%	7.00%			15.05%		
Boiler Makers	$26.63	$18.76	$4.17	no added cost	$22.93	$49.55	$22.33	$73.43	**$54.33**
Millwrights	$21.98	$4.28	$3.44	no added cost	$7.72	$29.70	$7.12	$43.65	**$32.49**
Ironworkers	$23.06	$9.92	$3.61	no added cost	$13.53	$36.59	$12.93	$53.98	**$40.06**
Carpenters	$15.57	$3.03	$2.44	no added cost	$5.47	$21.04	$4.87	$30.66	**$22.96**
Cement Masons	$14.78	$0.56	$2.31	$0.47	$3.35	$18.13	$2.75	$26.29	**$19.76**
Electricians	$15.33	$2.71	$2.40	no added cost	$5.11	$20.44	$4.51	$29.76	**$22.30**
Ironworkers - Reinforcing	$21.76		$3.41	$1.52	$4.93	$26.69	$4.33	$39.13	**$29.18**
Laborers (including pipe layers)	$13.99	$0.00	$2.19	$0.98	$3.17	$17.16	$2.57	$24.84	**$18.69**
Pipefitters	$21.47		$3.36	$1.50	$4.86	$26.34	$4.26	$38.61	**$28.79**
POWER EQUIPMENT OPERATORS									
Backhoes	$17.37		$2.72	$1.22	$3.93	$21.30	$3.33	$31.05	**$23.25**
Cranes	$23.13		$3.62	$1.62	$5.24	$28.37	$4.64	$41.66	**$31.03**
Dozers	$19.40		$3.04	$1.36	$4.40	$23.80	$3.80	$34.80	**$26.00**
Graders	$21.46		$3.36	$1.50	$4.86	$26.32	$4.26	$38.59	**$28.78**
Loaders	$19.40		$3.04	$1.36	$4.40	$23.80	$3.80	$34.80	**$26.00**
Scrapers	$21.46		$3.36	$1.50	$4.86	$26.32	$4.26	$38.59	**$28.78**
Trackhoes	$21.46		$3.36	$1.50	$4.86	$26.32	$4.26	$38.59	**$28.78**
Tractors	$17.37		$2.72	$1.22	$3.93	$21.30	$3.33	$31.05	**$23.25**
Truck Drivers	$17.37		$2.72	$1.22	$3.93	$21.30	$3.33	$31.05	**$23.25**

	% of employee pay
Payroll Taxes	7.65
WC	7.4
UI	0.60
	15.65

Note: base rates do not include FICA, worker comp, unemployment, or company benefits which increase the cost per hour

State of Utah - General Decision - Current Update UT130043, attached, 5 pages, 02/27/2014. **(For comparison only, not used)**

LABOR COSTS

Nonspecified Wages	Base Rate***	Mandated Fringe	Labor Burden (FICA, SUI, FUI, etc.	Company Benefits (medical, life insure, etc)	Fringe Costs	Labor Cost/HR	Fringe Costs - on Overtime hours	Labor Cost/HR - Overtime	**Labor Cost/HR - 50 hour week**
Survey Crew Member	$12.45	$0.00	$1.95	$0.87	$2.82	$15.27	$2.22	$22.01	**$16.62**
Sample Crew Member	$12.45	$0.00	$1.95	$0.87	$2.82	$15.27	$2.22	$22.01	**$16.62**
Mechanic (Demolition)	$12.94	$0.00	$2.02	$0.91	$2.93	$15.87	$2.33	$22.90	**$17.27**
Manager/Engineer	$45.55	$0.00	$7.13	$3.19	$10.32	$55.87	$9.72	$82.90	**$61.27**
Radiation Safety Officer	$35.59	$0.00	$5.57	$2.49	$8.06	$43.65	$7.46	$64.58	**$47.84**
Secretary	$14.39	$0.00	$2.25	$1.01	$3.26	$17.65	$2.66	$25.58	**$19.24**
Clerk	$11.84	$0.00	$1.85	$0.83	$2.68	$14.53	$2.08	$20.89	**$15.80**
Engineer	$35.59	$0.00	$5.57	$2.49	$8.06	$43.65	$7.46	$64.58	**$47.84**
Environmental Technician	$20.04	$0.00	$3.14	$1.40	$4.54	$24.58	$3.94	$35.97	**$26.86**
Safety Engineer	$20.04	$0.00	$3.14	$1.40	$4.54	$24.58	$3.94	$35.97	**$26.86**
Maintenance Foreman	$26.12	$0.00	$4.09	$1.83	$5.92	$32.03	$5.32	$47.15	**$35.05**
Security Personnel	$7.71	$0.00	$1.21	$0.54	$1.75	$9.46	$1.15	$13.29	**$10.23**
Chemist	$20.95	$0.00	$3.28	$1.47	$4.75	$25.70	$4.15	$37.65	**$28.09**

** Labor rates based on the 2014 White Mesa Mill Operating Budget.
*** Reflects 0.0% cost of living raise for 2014

Equipment Costs

EQUIPMENT COSTS

WHITE MESA MILL RECLAMATION COST
HOURLY EQUIPMENT COSTS 2016 DOLLARS

Actual equipment rates quoted from North Central Rental & Leasing, LLC, 12 month rental period
January 19, 2016

		RATE				MTCE	FUEL	FUEL @	Tires and GET	TOTAL	Mob/Demob	Mob/Demob	Operating Hrs	Replacement Cost
	Units	MONTHLY	HOURLY	Excess Hours	50 Hour Weeks	EXPENDABLES	USAGE	$1.81		COST	per machine	Totals	per Month	
637G Scraper	4	31,700	180.11	91.00	162.29	11.75	23.5	42.62	5.25	$221.91	$35,900	$143,600	880	$ 1,940,000
D8T Dozer	1	15,800	89.77	46.00	81.02	6.35	8.5	15.42	1.05	$103.84	$23,850	$23,850	220	$ 650,000
D7E Dozer	1	13,350	75.85	39.00	68.48	5.85	7.0	12.70	1.05	$88.08	$21,100	$21,100	220	$ 550,000
825H Compactor	1	14,050	79.83	41.00	72.06	5.85	13.0	23.58	0.50	$101.99	$22,050	$22,050	220	$ 250,000
980 H/K Loader	1	14,150	80.40	41.00	72.52	6.30	9.0	16.32	5.25	$100.39	$21,700	$21,700	220	$ 300,000
988 H Loader	1	21,800	123.86	62.00	111.49	8.15	11.0	19.95	5.25	$144.84	$26,200	$26,200	220	$ 345,000
770 Haul Truck	4	14,350	81.53	41.00	73.43	9.25	8.5	15.42	4.10	$102.19	$22,500	$90,000	880	$ 2,000,000
365CL Excavator	1	20,650	117.33	59.00	105.66	9.40	13.0	23.58	1.05	$139.69	$40,500	$40,500	220	$ 425,000
651 Water Wagon	1	14,700	83.52	42.00	75.22	7.75	17.0	30.83	2.10	$115.90	$24,800	$24,800	220	$ 250,000
5000 gal Water Truck	1	8,350	47.44	25.00	42.95	4.55	10.0	18.14	2.10	$67.74	$10,950	$10,950	220	$ 175,000
14H/Ripper Motor Grader	1	11,050	62.78	32.00	56.63	5.30	5.5	9.98	5.25	$77.15	$17,200	$17,200	220	$ 265,000
												$441,950	3,740	

Equipment Rental Rate Quoted by WorldWide Rental Services (02/26/2013) for PC 300 Excavator with Shear
Rental Rates increased by 2013, 2014 and 2015 CPI-u Rate of 1.50%, 0.80% and 0.50% respectively

	MONTHLY	HOURLY	Excess Hours	50 Hour Weeks	MTCE EXPENDABLES	FUEL USAGE	FUEL @ $1.81	Tires and GET	TOTAL COST	Mob/Demob	Replacement Cost
PC 300 w/ Shear	25,705.89	146.06	59.00	128.64	18.82	12.5	22.67		$170.14	$4,884	$ 450,000

Small tools allocation - Demolition - $1.35/mechanic labor hour for oxygen/acetylene, expendables: $1.35

	Monthly Maintenance Flat Rate	Butler Maintained Equipment Planned Operating Hours/month	Planned Operating hours/month (other equipment	Total Operating hours per month	Fuel Usage per day, gal,	Fuel Cost per month, 21 days	Maintenance Cost per Operating Hour	Mob/Demob
Butler Equipment Maintenance Cost	$83,600	3,740	570	4,310	10	$ 380.89	$22.45	$ 100,200

Crane Rental Rates	RATE MONTHLY	RATE HOURLY	MTCE EXPENDABLES	FUEL USAGE	FUEL @ $1.81		TOTAL COST	Mob/Demob	Replacement Cost
60 ton Hydraulic Crane	11,002	62.51	2.18	15.0	27.21		$91.90	$ 2,500	$ 250,000
30 ton Hydraulic Crane	6,684	37.97	2.18	10.0	18.14		$58.29	$ 900	$ 175,000

Rental Rates updated from Honnen Equipment, 02/26/2013
Rental Rates increased by 2013, 2014 and 2015 CPI-u Rate of 1.50%, 0.80% and 0.5% respectively

2013 Crane Monthly Rental Rates

60 ton	$10,700
30 ton	$6,500

Power Motive - Screen deck and conveyors, Replacement Cost: $ 200,000

$ 8,225,000

$ 82,250

Fuel

Producer Price Index-Commodities
Original Data Value

Series Id: WPU057303
Not Seasonally Adjusted
Group: Fuels and related products and power
Item: No. 2 diesel fuel
Base Date: 198200
Years: 2005 to 2015

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	141.1	149.5	173.3	175.4	170.8	187.2	189.8	200.6	212.6	264.1	206.2	198.5
2006	197.1	196.2	206.5	230.4	239.6	246.9	237.5	250.2	201.3	197.5	197.2	203.0
2007	180.9	193.5	220.2	238.0	226.5	227.6	243.5	231.2	246.2	249.6	296.7	271.9
2008	278.2	287.5	353.7	365.1	398.2	421.0	431.9	346.7	342.3	281.8	224.1	168.0
2009	161.6	147.2	139.2	167.4	166.4	191.1	172.8	204.1	193.2	202.8	215.7	205.1
2010	229.4	206.9	225.5	240.0	235.8	221.8	218.5	231.1	227.7	243.7	255.3	259.2
2011	270.0	289.3	321.8	339.8	328.4	333.7	327.8	307.3	317.8	310.6	337.1	311.0
2012	322.0	329.2	344.3	339.4	325.8	295.4	298.7	324.1	342.4	351.0	323.8	317.4
2013	318.9	342.4	321.0	318.3	307.7	304.8	311.6	319.3	328.0	318.4	307.0	314.7
2014	308.5	322.0	318.1	318.7	316.5	308.8	307.8	306.9	302.3	283.4	272.3	229.9
2015	182.6	191.5	193.1	183.8	202.6	198.7	194.0	189.2	168.6	174.4	168.3	129.7

12 month Average 181.4

Equipment Productivity

Equipment Productivity

Dozer (D-8) Productivity Determination - 100' Push Distance			
Work Efficiency, %:		0.83	Assumes 50 minutes/hour
Average Dozing Distance, FT:		100	
Ideal Dozer Productivity	LCY/HR	825	*CAT Handbook*
Adjusted Dozer Productivity	LCY/HR	**685**	
Wheel Loader (988) Productivity Determination loading 3 @ 30 C.Y. Trucks			
Work Efficiency, %:		0.83	Assumes 50 minutes/hour
Bucket Capacity (C.Y)		10.0	
Load Time, 3 loads / truck (min)		1.65	
Ideal Loader Productivity	LCY/HR	1091	
Adjusted Loader Productivity	LCY/HR	**905**	
Haul Truck (770) Productivity Determination - 3,310' haul (Haul Route M)			
Work Efficiency, %:		0.83	Assumes 50 minutes/hour
Average Distance, FT:		3,310	Haul Route M
Average Travel Speed		20	Miles per Hour
Truck Capacity (C.Y)		30.00	
Load Time (min)		1.65	
Haul Time (min)		3.76	
Dump Time (min)		1.00	
Cycle Time (min)		5.25	
Ideal Truck Productivity	LCY/HR	343	
Adjusted Truck Productivity	LCY/HR	**285**	

Hydraulic Excavator (365) Productivity Determination loading 3 @ 30 C.Y. Trucks			
Work Efficiency, %:		0.83	Assumes 50 minutes/hour
Bucket Capacity (C.Y)		6.0	Mass Excavation Boom, pg. 18
Time per Pass (min)		0.35	Cat Handbook, V 42 pg. 4-204
Load Time, 5 passes / truck (min)		1.75	
Truck Capacity (CY)		30.0	
Ideal Loading Productivity	LCY/HR	1029	
Adjusted Loading Productivity	LCY/HR	**854**	

Hydraulic Excavator (365) Productivity Determination Digging a Trench			
Work Efficiency, %:		0.83	Assumes 50 minutes/hour
Bucket Capacity (C.Y)		6.0	Mass Excavation Boom, pg. 18
Time per Pass (min)		0.35	Cat Handbook, V 42 pg. 4-204
CY per Linear Foot of Trench		1	7 ft wide 4 ft deep
Ideal Excavating Productivity	CY/HR	1029	
Efficency in uncovering pipe		50%	
Linear feet per hour		**412**	

Haul Truck (770) Productivity Determination - 3120' haul (Haul Route E)			
Work Efficiency, %:		0.83	Assumes 50 minutes/hour
Average Distance, FT:		3,120	Haul Route E
Average Travel Speed		20	Miles per Hour
Truck Capacity (C.Y)		30.00	
Load Time (min)		1.75	
Haul Time (min)		3.55	
Dump Time (min)		1.00	
Cycle Time (min)		6.30	
Ideal Truck Productivity	LCY/HR	286	
Adjusted Truck Productivity	LCY/HR	**237**	

Haul Truck (770) Productivity Determination - 2680' haul (Haul Route C)			
Work Efficiency, %:		0.83	Assumes 50 minutes/hour
Average Distance, FT:		2,680	Haul Route C
Average Travel Speed		20	Miles per Hour
Truck Capacity (C.Y)		30.00	
Load Time (min)		1.75	
Haul Time (min)		3.05	
Dump Time (min)		1.00	
Cycle Time (min)		5.80	
Ideal Truck Productivity	LCY/HR	311	
Adjusted Truck Productivity	LCY/HR	**258**	

Haul Truck (770) Productivity Determination - 2,470' haul (Haul Route D)			
Work Efficiency, %:		0.83	Assumes 50 minutes/hour
Average Distance, FT:		2,470	Haul Route D
Average Travel Speed		20	Miles per Hour
Truck Capacity (C.Y)		30.00	
Load Time (min)		1.00	
Haul Time (min)		2.81	
Dump Time (min)		1.00	
Cycle Time (min)		4.81	
Ideal Truck Productivity	LCY/HR	374	
Adjusted Truck Productivity	LCY/HR	**311**	

Haul Truck (770) Productivity Determination - 2,810' haul (Haul Route L)			
Work Efficiency, %:		0.83	Assumes 50 minutes/hour
Average Distance, FT:		2,810	Haul Route L
Average Travel Speed		20	Miles per Hour
Truck Capacity (C.Y)		30.00	
Load Time (min)		1.65	
Haul Time (min)		3.19	
Dump Time (min)		1.00	
Cycle Time (min)		5.84	
Ideal Truck Productivity	LCY/HR	308	
Adjusted Truck Productivity	LCY/HR	**256**	

Haul Truck (770) Productivity Determination - 3960' haul (Haul Route K)			
Work Efficiency, %:		0.83	Assumes 50 minutes/hour
Average Distance, FT:		3,960	Haul Route K
Average Travel Speed		20	Miles per Hour
Truck Capacity (C.Y)		30.00	
Load Time (min)		1.75	
Haul Time (min)		4.50	
Dump Time (min)		1.00	
Cycle Time (min)		7.25	
Ideal Truck Productivity	LCY/HR	248	
Adjusted Truck Productivity	LCY/HR	**206**	

Haul Truck (770) Productivity Determination - 2010' haul (Haul Route A)			
Work Efficiency, %:		0.83	Assumes 50 minutes/hour
Average Distance, FT:		2,010	Haul Route A
Average Travel Speed		20	Miles per Hour
Truck Capacity (C.Y)		30.00	
Load Time (min)		1.75	
Haul Time (min)		2.28	
Dump Time (min)		1.00	
Cycle Time (min)		5.03	
Ideal Truck Productivity	LCY/HR	358	
Adjusted Truck Productivity	LCY/HR	**297**	

Haul Truck (770) Productivity Determination - 2,570' haul (Haul Route B)			
Work Efficiency, %:		0.83	Assumes 50 minutes/hour
Average Distance, FT:		2,570	Haul Route B
Average Travel Speed		20	Miles per Hour
Truck Capacity (C.Y)		30.00	
Load Time (min)		1.75	
Haul Time (min)		2.92	
Dump Time (min)		1.00	
Cycle Time (min)		5.67	
Ideal Truck Productivity	LCY/HR	317	
Adjusted Truck Productivity	LCY/HR	**263**	

Haul Truck (770) Productivity Determination - 1,150' haul (Haul Route N)			
Work Efficiency, %:		0.83	Assumes 50 minutes/hour
Average Distance, FT:		1,150	Haul Route B
Average Travel Speed		20	Miles per Hour
Truck Capacity (C.Y)		30.00	
Load Time (min)		1.75	
Haul Time (min)		1.31	
Dump Time (min)		1.00	
Cycle Time (min)		4.06	
Ideal Truck Productivity	LCY/HR	444	
Adjusted Truck Productivity	LCY/HR	**368**	

Haul Truck (770) Productivity Determination - 2,030' haul (Haul Route O)			
Work Efficiency, %:		0.83	Assumes 50 minutes/hour
Average Distance, FT:		2,030	Haul Route B
Average Travel Speed		20	Miles per Hour
Truck Capacity (C.Y)		30.00	
Load Time (min)		1.65	
Haul Time (min)		2.31	
Dump Time (min)		1.00	
Cycle Time (min)		4.96	
Ideal Truck Productivity	LCY/HR	363	
Adjusted Truck Productivity	LCY/HR	**301**	

Rock Production

ROCK PRODUCTION COST

Assumptions:
Rock is obtained from gravel source north of Blanding, Utah. BLM Public Pit
Rip Rap Rock is processed by screening only, no crushing is required, 1.25 CY of feed for 1 CY of product
Filter material is produced from Rip Rap reject
Rock is produced and stockpiled at the site
Site is 7 road miles from the mill; 6 miles of which is paved public highway
Rock will be hauled in 22 CY bellydump trucks, contract haulers ($100.00/hr)
Rock will be dumped in windrows on Tailings Cells by trucks, spread by grader, and spread by D7 Dozer
Trucks can average 30 MPH (1.75 rounds/hr)

	Product Required (CY)	Reject Factor	Material Feed to Plant (CY)	Plant Throughput (CY/hr)	Plant Operating Hours
Rip Rap material fed to plant	189,000	25.0%	236,250	122	1,900
Filter material fed to plant	25,500	10.0%	28,050	122	200
	214,500				2,100

PRODUCTION OF RIPRAP

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Laborer	hrs	$17.16	2,100	$36,030
Cat D8N Dozer With Ripper	hrs	$103.84	375	$38,938
Cat D8N Dozer Operator	hrs	$26.00	375	$9,750
Cat 980 Loader	hrs	$100.39	2,100	$210,823
Cat 980 Loader Operator	hrs	$26.00	2,100	$54,600
Screening Plant w/conveyors*	hrs	$72.46	2,100	$152,164
BLM Usage Fee	CY	$0.60	214,500	$128,700
Contract Highway Trucks - Bellydumps**	hrs	$100.50	5,571	$559,929
Equipment Maintenance (Butler)	hrs	$22.45	2,475	$55,576
Total Production of RipRap				**$1,246,509**
RIPRAP COST PER CUBIC YARD DELIVERED				**$6.60**

* Cost Quoted from Power Motive Corporation, Denver, Colorado updated February 14, 2012
$12,800 (less 10%) for screen and conveyors, 176 hours per month for one month, plus screen set up at $2,500.
Mob and Demob - $ 5,500.00
Rental costs for screening equipment increased by CPI-U 2012, 2013, 2014 and 2015 of 1.74%, 1.50%, 0.80% and 0.50% respectively.

** Cost quoted from Dennis Cosby, Cosby Trucking, Inc., Blanding, Utah, Updated 3/3/14. Escalated by 2015 CPI of 0.5%.
(includes ownership expense, fuel, maintenance and operator)

Long Term Care

LONG TERM CARE CALCULATION
March 2016

Base Amount (Starting in Dec. 1978)	$250,000
CPI-U December, 1978	67.7
CPI-U November 2015	237.336

Adjusted Long Term Care = $250,000 x (CPI-U most recent / CPI-U Dec., 1978)

Adjusted Long Term Care	$876,425

General Liability & Auto Insurance

General Liability and Auto Insurance

Project Life 7 years

GL Insurance per full year $ 15,000

Auto $ 1,250

	Vehicles	Vehicle Ins.	GL Insurance
Year 1	5	$ 6,250	$ 15,000
Year 2	10	$ 12,500	$ 15,000
Year 3	10	$ 12,500	$ 15,000
Year 4	10	$ 12,500	$ 15,000
Year 5	10	$ 12,500	$ 15,000
Year 6	10	$ 12,500	$ 15,000
Year 7	3	$ 3,750	$ 15,000
		$ 72,500	$ 105,000

Project Cost $ 177,500

Mobilization and Management Support

Mobilization and Management Support

Office Facilities

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Install New Powerline	LS	$15,225	1	**$15,225**
Utilities for Offices	months	$1,028	36	**$37,016**
Temporary Office Trailer	months	$1,542	33	**$50,898**
Temporary Office Trailer, mob, demob & setup	LS	$3,085	1	**$3,085**

* All Office Facilities costs were estimated in 2012 and escalated by CPI 1.5%, 0.8% and 0.5% in 2013,2014 and 2015 respectively.

Total Office Facilities **$106,224**

Equipment Mobilization

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Butler Machinery Mobilization	LS	$542,150	1	**$542,150**
Other Equipment Mobilization	LS	$4,884	1	**$4,884**
Cranes	LS	$3,400	2	**$6,800**

Total Equipment Mobilization **$553,834**

MANAGEMENT/SUPPORT

Resource Description	Units	Cost/Unit	Task Units	Task Cost
Manager/Engineer	hrs	$55.87	6,240	**$348,614**
Legal	hrs	$450.00	100	**$45,000**
Radiation Safety Officer	hrs	$43.65	6,240	**$272,384**
Secretary	hrs	$17.65	6,240	**$110,162**
Clerk	hrs	$14.53	4,866	**$70,682**
Environmental Technician (3/4 time, 4.5 years)	hrs	$24.58	7,300	**$179,447**
Maintenance Foreman	hrs	$32.03	6,240	**$199,872**
Chemist	hrs	$25.70	2,080	**$53,454**
Security	hrs	$9.46	18,720	**$177,096**
Safety Engineer	hrs	$24.58	4,160	**$102,260**
Misc. Materials & Supplies	hrs	$36.45	6,240	**$227,448**
Health Physics Costs	hrs	$64.81	2,080	**$134,800**
Environmental Monitoring Costs, Laboratory	years	$71,620.00	7.0	**$501,340**

Total Management/Support **$2,422,560**

Total Mobilization and Manaagement Support **$3,082,617**

ATTACHMENT D

RADIATION PROTECTION MANUAL FOR RECLAMATION ACTIVITIES

Responsible Authority

Radiation Safety Officer

The Radiation Safety Officer (RSO) shall meet the requirements as specified in section 2.4, Technical Qualifications of Health Physics Staff in NRC Regulatory Guide 8.31. Along with meeting the requirements outline in Regulatory Guide 8.31, the RSO must also be submitted and approved by the State of Utah as an acceptable responsible authority for reclamation activities.

The RSO will be responsible for following and complying with all rules and specifications that are outlined in the Reclamation Plan along with all standards pertaining to the health and safety of the employees and environment. The RSO must also maintain accurate documentation of all decontamination and disposal activities. The RSO will have the responsibility of overseeing all aspects of this procedure and all total releases of any materials from the facility. These records will be maintained on site for review.

1.0 RADIATION MONITORING – PERSONNEL

This section contains the following procedures for personnel radiation monitoring including: (1) airborne particulates (2) alpha surveys (3) beta/gamma surveys and (4) urinalysis surveys.

1.1 AIRBORNE PARTICULATES

Sampling for personnel exposure to airborne particulate radionuclides, other than for radon progeny, will be done utilizing two distinct sampling protocols: (1) personnel breathing zone samplers, and (2) ambient air high volume samplers. Specific standard operating procedures for these two collection methods are described in Section 1.1.2 and 1.1.3 below.

1.1.1 Frequency

For work where there is the potential to cause airborne radiation doses to site personnel, the frequency and type of air sampling to be conducted is determined from measured air concentrations:

0.01 DAC – 0.1 DAC	Quarterly or monthly area air sampling and/or bioassay measurements
> 0.1 DAC	Continuous sampling is appropriate if concentrations are likely to exceed 0.10 DAC averaged over 40 hours or longer.

The RSO will determine the exact frequency of area air sampling, breathing zone sampling and/or bioassay measurements and determine how many workers in a group of workers performing similar jobs are to be equipped with breathing zone air samplers. Higher airborne concentrations warrant more frequent use of area air samplers, bioassay measurements, and breathing zone air samplers. Area air samplers may be used where documentation exists showing the sample is equivalent to a breathing zone sample. Breathing zone samples taken within one foot of the worker's head are considered representative without further documentation. Breathing zone air samplers are preferred under work conditions of higher airborne concentrations. Table 1.1.1-1 below, from Regulatory Guide 8.25, provides additional guidance for the RSO in designing and implementing air sampling programs for specific jobs.

Table 1.1.1-1
Air Sampling Recommendations Based on Estimated Intakes and Airborne Concentrations

Worker's Estimated Annual Intake as a Fraction of ALI	Estimated Airborne Concentrations as a Fraction of DAC	Air Sampling Recommendations
< 0.1	< 0.01	Air sampling is generally not necessary. However, monthly or quarterly grab samples or some other measurement may be appropriate to confirm that airborne levels are indeed low.
	> 0.01	Some air sampling is appropriate. Intermittent or grab samples are appropriate near the lower end of the range. Continuous sampling is appropriate if concentrations are likely to exceed 0.1 DAC averaged over 40 hours or longer.
> 0.1	< 0.3	Monitoring of intake by air sampling or bioassay is required by 10 CFR 20.1502(b).
	> 0.3	A demonstration that the air samples are representative of the breathing zone is appropriate if (1) intakes of record will be based on air sampling and (2) concentrations are likely to exceed 0.3 DAC averaged over 40 hours (i.e., intake more than 12 DAC-hours in a week).
Any annual intake	> 1	Air samples should be analyzed before work resumes the next day when potential intakes may exceed 40 DAC-hours in 1 week. When work is done in shifts, results should be available before the next shift ends. (Credit may be taken for protection factors if a respiratory protection program is in place.)
	> 5	Continuous air monitoring should be provided if there is a potential for intakes to exceed 40 DAC-hours in 1 day. (Credit may be taken for protection factors if a respiratory protection program is in place.)

1.1.2 Breathing Zone Sampling

1.1.2.1 General

Breathing zone samplers (SKC pumps and accessory kits, or equivalent) are used to determine airborne exposure to uranium while individuals are performing specific jobs. The units consist of a portable low volume pump that attaches to the individuals belt, tygon tubing and filter holder that is attached to the individual's lapel or shirt collar. The unit monitors airborne uranium in a person's breathing zone. Pumps must be recharged after 6 to 8 hours of use.

1.1.2.2 Applicability

Breathing zone samples are required:

- for all calciner activities,
- at least quarterly during routine tasks on representative individuals performing these tasks,
- when radiation work permits are issued in which airborne concentrations may exceed 25% of 10 CFR Part 20 limits, or
- at the discretion of the RSO.

1.1.2.3 Procedure

The procedure for collecting a breathing zone sample is as follows:

1. Secure the breathing zone sampler, which has been charged and loaded with a filter paper from the radiation department.

2. Secure the pump to the worker's belt and the filter holder to the shirt collar or lapel. Try to secure pump tubing to minimize restriction of motion.

3. Turn pump on (record the time pump was turned on) and continue monitoring until the work being monitored is completed and the worker no longer is in the exposure area. Record the time at which the job is complete.

4. Return the pump and accessories to the RSO, who will remove the filter paper for analysis. Be sure to indicate accurately the total time taken by the work being monitored.

5. Analysis of filter samples will be performed using a sensitive alpha detector. The procedure is as follows: (a) count a background sample for ten minutes; (b) divide the background count by ten to obtain the background count rate in cpm; (c) Place the breathing zone sample in the instrument and count the sample again for ten minutes;

(d) divide the sample count by ten to obtain the count rate in cpm; (e) subtract the background count rate from the sample count rate; and, (f) record all data on the Breathing Zone sampling analysis form (a copy of which is attached).

6. Record the total hours of exposure that are being assigned to the employee on the Employee Exposure form, which is maintained in personnel folders. Be sure to consider protection factors permitted by respirator use if the employee was also wearing respiratory protection during the job.

7. The number of DAC hours assigned is calculated using the following formula:

$$\text{DAC hours of exposure} = \frac{\text{Measured air concentration}}{(\text{DAC})(\text{PF})} \times \text{Total hours of exposure}$$

where: DAC = Derived Air Concentration (for uranium; 10 CFR Part 20, Appendix B)

PF = protection factor for respirator use. If no respiratory protection was used PF =1.

The measured air concentration must be in μCi/cc.

1.1.2.4 Calibration

Prior to use, calibration of the breathing zone samplers will be done using a calibration method as described in Section 3.2.

1.1.2.5 Equipment – Breathing Zone Sampler

The equipment used for breathing zone samples consists of:

1. Personal sampling pumps
2. Gelman 37 mm Delrin filter holders, or equivalent
3. Gelman 37 mm type A/E glass fiber filters, or equivalent
4. Kurz Model 543 air mass flow meter, or equivalent

1.1.2.6 Data Record

Data maintained on file includes:

1. Time on and off for each sample pump.
2. Sampling location(s).
3. Individual's name, identification number, etc.
4. Date and sample number.

5. Sample count rate.

1.1.2.7 Calculations

The airborne concentration in μCi/cc is equal to the sample count rate minus the background count rate in cpm divided by the instrument alpha efficiency, the sample flow rate in cc/minute, the sample time in minutes and a conversion factor converting dpm to μCi.

The calculation is:

Equation Number 1:

$$\text{Airborne concentration} = \frac{\text{(Count Rate)}}{\text{(Time)(eff)(Conversion factor)(Flow Rate)}}$$

$$\text{i.e. } \frac{\text{uCi}}{\text{cc}} = \frac{\text{(cpm-Bkg) 1 uCi} \quad (1) \quad (1)}{(\text{eff})(2.22\text{x}10^6\text{dpm})(\text{cc/min})(\text{min})}$$

where: eff = cpm/dpm for counting instruments
cpm = counts/min
dpm = disintegrations/min
Conversion factor 1 μCi = $2.22\text{x}10^6$ dpm
Flow Rate = cc/min
Collection time = min

Once the airborne concentration has been calculated it is possible to calculate personnel exposure in microcuries (μCi). Personnel exposure is determined for an individual who is working in an area at a known air concentration (μCi /cc) for a given amount of time (hours) breathing the area air at an assumed rate. The breathing rate for a standard person (Handbook of Radiological Health) is 1.20 cubic meters per hour (m^3/hr).

The calculation for personnel exposure is:

Equation Number 2:

Exposure μCi = (μCi /cc)(1.20m^3/hr)(hours of exposure)(conversion rate)

Where: μCi /cc = air concentration from Equation 1

1.20 m^3/hr = breathing rate for standard man (ICRP)
hours of exposure = hours
conversion factor = 10^6cc/m^3

It is also possible to determine the percent or fraction of the Derived Air Concentration (DAC) for a particular radionuclide using the information obtained from the exposure calculation and dividing this value by the regulatory limit DAC listed in 10 CFR Part 20.

% DAC = Exposure in μCi / μCi limit 10 CFR Part 20

For the natural uranium (U-Nat) the DAC limits from 10 CFR Part 20 for insoluble Class Y compounds are as follows:

- Weekly 1.0 x 10^{-3} μCi /week
- Quarterly 1.25 x 10^{-2} μCi /Qt
- Yearly 5.0 x 10^{-2} μCi /yr

1.1.2.8 ALARA/Quality Control

The RSO reviews each monitored result and initiates action if levels exceed 25% of 10 CFR 20 limits. At a minimum, ten percent (10%) of the air samples collected in a given quarter will be recounted using the same instrument or using a different instrument and these results will be compared to the original sample results. Deviations exceeding 30% of the original sample results will be reviewed by the RSO and the samples will be recounted again until the sample results are determined to be consistent. Additional QA samples consisting of spiked air samples, duplicate samples and blank samples will be submitted to the radiation department for counting. This will be based on ten percent (10%) of the number of samples collected during a quarter. The sample results will be compared to the spiked values, duplicate values, or blank (background) values of the prepared sample. Deviations exceeding 30% of the determined spiked, duplicate or blank value will be recounted. If no resolution of the deviation exceeding 30% is made the QA samples preparation will be repeated. Periodic reviews by the RSO and the ALARA audit committee will be made and documented to ensure quality maintenance and ALARA control.

1.1.3 Airborne High Volume Sampling

Grab air sampling involves passing a representative sample of air through a filter paper disc via an air pump for the purpose of determining the concentration of uranium in breathing air at that location. Although the process is only measuring airborne concentrations at a specific place and at a specific time, the results can often be used to represent average concentration in a general area. A high volume sample pump will be used for this purpose. Samples will be analyzed as per standard gross alpha analysis procedures using a sensitive alpha detector.

1.1.3.1 Frequency and Locations

The following principles used for the collection of area grab samples must be considered when collecting a sample in order to obtain a representative air concentration that workers may be exposed to during their assigned work tasks.

1. The locations selected for sampling should be representative of exposures to employees working in the area.
2. For special air sampling, the sampling period should represent the conditions during the entire period of exposure. This may involve sampling during the entire exposure period.
3. For routine sampling, the sampling period must be sufficient to ensure a minimum flow rate of 40 liters per minute (lpm) for at least 60 minutes.
4. Sample filters will be analyzed for gross alpha using a sensitive alpha detector.
5. Grab sampling procedures may be supplemented by use of Breathing Zone Samples for special jobs or non-routine situations.

1.1.3.2 Sampling Equipment

Monitoring equipment will be capable of obtaining an air sample flow rate of at least 40 liters per minute for one hour or longer. Equipment utilized will be and Eberline RAS-1, or a Scientific Industries Model H25004, or equivalent. Filter media will be of appropriate micron pore diameter. Equipment is calibrated prior to each usage as per Section 3.3 of this manual.

1.1.3.3 Sampling Procedure

Steps for collection of area airborne grab samples are as follows:

1. A high volume pump will be used for sample collection.
2. Check sample pump calibration.
3. Locate sampler at designated site. Insert a clean filter, using tweezers, into the filter holder on the sampler. Do not contaminate the filter. Log start time and conditions at the site.
4. Collect a sample for a minimum of 60 minutes at a flow rate of 40 lpm.
5. After sampling is completed, carefully remove the filter, using tweezers, from the filter holder and place it in a clean envelope, or in the plastic casing furnished with the filter.

6. Log all sample data on the log sheet.
   A. Sample location and number (also on the envelope).
   B. Time on, time off and date.
   C. Mill operating conditions at the site.
   D. Sampler's initials.

7. Analyze for gross alpha

1.1.3.4 Calculations

Perform calculations as described in Section 1.1.2.7.

1.1.3.5 Records

Logs of all samples taken are filed in the RSO's files. Data are used to calculate radiation exposures as described in Section 4.0.

Whenever grab sampling results indicate that concentrations in work locations exceed 25% of the applicable value in 10 CFR Part 20, Appendix B, time weighted exposures of employees who have worked at these locations shall be computed. Calculations will reveal an individual's exposure in DAC hours. This value shall be assigned to the worker and logged onto the worker's "Employee Exposure to Airborne Radionuclides" form. This form is in Section 4. Whenever special air sampling programs (as required for cleanup, maintenance, decontamination incidents, etc.) reveal that an employee has been exposed to airborne radioactive material, the calculated value shall also be entered on the individual's exposure form.

1.1.3.6 Quality Assurance

Calibration checks on each air sampler, prior to field use, ensure accurate airflow volumes. Use of tweezers and new filter storage containers minimizes contamination potential. Field logging of data during sampling and logging of identifying data on sampled filter containers minimizes sample transposition. Quality control samples will be analyzed as described in Section 1.1.2.8

Review of data by the RSO and by the ALARA Audit committee further assures quality maintenance.

1.2 ALPHA SURVEYS

1.2.1 Restricted Area

The Restricted Area is defined as:

1. The property area within the chain link fence surrounding the mill property and the area enclosed to the north and east of the facility by the posted Restricted Area fence.

2. The active tailings and liquid waste disposal areas.

All personnel who enter the Restricted Area will monitor themselves each time they leave the Restricted Area and at the end of their shift. The Radiation Safety Department will review the monitoring information. All personnel exiting the Restricted Area must initial a record of their monitoring activity.

1.2.2 Instrumentation

The instrumentation utilized for personnel alpha scanning is listed in Appendix 1 at the end of this manual. Personnel alpha survey instruments are located at the exits from the Restricted Area.

1.2.3 Monitoring Procedures

The monitoring procedure includes the following steps:

1. The alarm rate meter is adjusted within the range of 750 to 1,000 dpm/100 cm^2 to ensure a margin of 250 dpm/100 cm^2 due to the low efficiency of this instrumentation.

2. An individual monitors himself by slowly passing the detector over their hands, clothing and shoes, including the shoe bottoms, at a distance from the surface of approximately ¼ inch. An area that is suspected of possessing any contamination (i.e. hands, boots, visible spotting/stain on clothing etc.) should be carefully monitored by placing the detector directly on the surface and note the measurement.

3. Should an alarm be set off indicating the presence of contamination, the individual should:
    a. Resurvey themselves to verify the contamination.
    b. If contamination is present the individual must wash the affected area and again resurvey themselves to ensure the contamination has been removed.

4. If the decontamination efforts by the individual are not successful, then the Radiation Safety personnel will be contacted to assess the situation. Further decontamination may be required.

5. If an individual's clothing cannot be successfully decontaminated, they must obtain clothing from the warehouse to use and must launder the personal clothing in the laundry room.

6. Individual surveys are to be logged and initialed.

7. Access to and from the Mill's Restricted Area by all Mill workers, contractors and delivery personnel, other than Radiation, Safety and Environmental Staff, Senior Laboratory personnel, Mill Management and Mill Supervisory personnel and others as may be designated by the RSO, will be limited to one or more access points as may be designated by the RSO from time to time.

8. A Radiation Technician will be positioned at each access point designated by the RSO under paragraph 7 above during peak transition times, such as during breaks and at the ends of shifts, to observe that each worker, contractor or delivery person is performing a proper scan.

1.2.4 Training

All employees will be trained on the proper scanning procedures and techniques.

1.2.5 Records

Log sheets will be collected daily and filed by the Radiation staff. Records will be retained at the Mill. Contamination incidents will result in a written record, which is maintained on file.

1.2.6 Limits/ALARA

Contamination limits for personnel scans are set at 1,000 dpm/100 cm^2. Records will be reviewed by the RSO to maintain levels noted as low as reasonable achievable.

1.2.7 Quality Assurance

A random check of an individual's scanning technique provides quality assurance of the monitoring procedures. Daily function checks using calibrated sources assures instrumentation performance. Periodic review by the RSO and the ALARA audit committee document and ensure quality control and ALARA maintenance.

1.3 PERSONNEL BETA-GAMMA MONITORING

Site employees working within the Restricted Area will be required to wear a personal monitoring device (such as a TLD, LUXEL badge or other NVLAP approved device which has been approved by the RSO and the SERP) during their work period. The personal monitoring devices are normally issued to each employee quarterly; however, during pregnancy or if the radiological potential for exposure to an individual is anticipated to be elevated and requires quick assessment the badges may be issued monthly.

1.3.1 Monitoring Procedures

The monitoring procedures consist of:

1. Personnel issued personal monitoring devices will wear the device on the trunk (torso) of the body. The personal monitoring device records beta/gamma radiation as well as other forms of penetrating radiation such as x-rays. A personal monitoring device is an exposure record of an individual's personal exposure to radiation while on the job. Therefore, personal monitoring devices are to remain at the Mill and stored on the assigned dosimeter storage boards. All exposure records obtained by a personal monitoring device which are not consistent with the exposure rates of work tasks or work location measurements made throughout the Mill will be evaluated by the RSO. This evaluation will result in an investigation by the RSO and a written explanation of the findings. These written records will be maintained at the Mill.

2. Personal monitoring devices will be issued at a minimum quarterly and will be exchanged by the Radiation Safety Department. Missing or lost badges will be reported to management.

3. Female employees that become pregnant and continue to work during the course of their pregnancy will be placed on a monthly personal monitoring device exchange during this period. NRC Regulation Guide 8.13 provides guidelines to be followed during pregnancy and is made part of this procedure.

1.3.2 Records

The Radiation Safety Department will maintain all occupational exposure records in the departmental files:

1. Occupational exposure records are a part of an individual's health record and, as such, will be considered private information.

2. An individual may examine his/her exposure record upon request.

3. An employee terminating his/her employment with the Company may request a copy of his/her occupational exposure records.

4. The Radiation Safety Department on the signature of the employee will request prior occupational exposure records.

5. Occupational exposure records will be made available to authorized company or regulatory personnel.

1.3.3 Quality Assurance

Periodic reviews by the RSO and the ALARA audit committee document and ensure quality control and maintenance of conditions ALARA.

1.4 URINALYSIS SURVEYS

1.4.1 Frequency

Urinalyses will be performed on those employees that are a) exposed to potential airborne yellowcake or involved in maintenance tasks during which yellowcake dust may be produced, or b) routinely exposed to airborne uranium dust. Baseline urinalyses will be performed prior to initial work assignments.

Urine samples are collected on a routine basis from employees as required in Regulatory Guide 8.22. Samples will be collected from all employees monthly. Bi-weekly samples will be collected if individual exposures are expected to exceed 25% of the DAC value. Non-routine urinalyses will usually be performed on employees who have been working on assignments that require a Radiation Work Permit, and always on any individual that may have been exposed to airborne uranium or ore dust concentrations that exceed the 25% of the DAC level.

1.4.2 Specimen Collection

Clean, disposable sample cups with lids will be provided to each employee that will be required to submit a urine specimen. The containers will be picked up at the administration building before the individual enters the Restricted Area.

The container, filled with specimen, will be returned to the bioassay laboratory prior to reporting to work. The name of the employee and the date of collection will be indicated on the specimen cup.

A valid sample must be collected at least 40 hours, but not more than 96 hours, after the most recent occupancy of the employee's work area (after two days, but not more than four days off).

The specimen should be collected prior to reporting to the individual's work location. To prevent contamination, the hands should be carefully washed prior to voiding.

Under unusual circumstances where specimens cannot be collected in this manner, the worker will shower immediately prior to voiding.

1.4.3 Sample Preparation

Equipment required:

- 15 ml disposable centrifuge tubes with lids
- 10 ml pipette
- 1 mL pipette
- 200 µL pipette
- 5 µl pipette
- 10 µl pipette
- Disposable tips for the above pipettes
- 1,000 ppm uranium solution
- Spiking solution – 0.03 or 0.02 g/l of uranium in de-ionized water

After the specimens are received, they will be stored in a refrigerator until they are prepared for analysis.

Sample preparation will be done in an area decontaminated to less than 25 dpm alpha (removable) per 100 cm^2 prior to preparation of samples. All of the equipment that is used in sample preparation will be clean and maintained in such condition.

A log will be prepared and the following information will be kept for each urinalysis performed:

Sample identification number
Name of employee submitting the specimen
Date of sample collection
Date the sample was sent to the laboratory
Date the results were received
Results of the urinalysis in µg/1
Indication of any spike used in µg/1

The centrifuge tubes will be marked with a sample identification number. 10 milliliters of urine will then be pipetted into the centrifuge tube using the pipette device. Or 1 milliliters of urine will then be pipette into the centrifuge tube using the pipette device (To prevent contamination, a new tip must be used for each specimen.) After each step of the procedure, the proper entry must be made in the logbook.

The samples that are to be spiked for quality assurance purposes will then be prepared. The spikes will be introduced into the sample with 5 µl or 10 µl pipettes. A new tip must be used with each spike. With the standard spike solution (0.03 g/l of U), a 5 µl spike will result in a 15 µg/l concentration for the 10 ml sample; the 10 µl spike will give 30 µg/l). The proper entry must be made in the logbook for each sample spiked.

After preparation has been completed, the QA samples are securely packaged as soon as practicable and sent to the contract laboratory for analysis.

The samples that are to be analyzed in-house will be placed in the chemistry laboratory's refrigerator until the analysis can be completed. A copy of the in-house analytical procedure is described in Section 1.4.7.6. Once the on-site laboratory is no longer functional, all samples will be submitted to a certified laboratory.

1.4.4 Quality Assurance

To assure reliability and reproducibility of results, at least 25% of the samples that are submitted for analysis will be used for quality assurance purposes. These samples will consist of spikes, duplicates, and blanks (samples collected from individuals known to have no lung or systemic uranium burden).

Spiked samples will be prepared as stated under sample preparation of this procedure.

Duplicates will be identical samples of the same specimen and/or spikes of identical concentrations.

To assure reliability of the in-house analytical procedure, 10% of the samples will be sent to a contractor laboratory for analysis. These samples will contain quality assurance items designed to provide intra-laboratory comparisons.

1.4.5 Analysis

After the samples are collected as outlined in Guide 8.22, they are identified to the lab by collection date and number. Urinalysis results must be completed and reported to the Radiation Safety Department within seven days of the sample collection.

1.4.5.1 Equipment List

1. Specimen collection cups with disposable lids (VWR No. 15708-711 or equivalent)
2. Screw cap, disposable, graduated 15 ml centrifuge tubes (Corning No. 25310 or equivalent)
3. Micro-pipettes 1 each 5, 5 each 10 µL (Oxford Model 7000 or equivalent)
4. Adjustable Finnpipette each 1,000 µL, 200 µL and 5 mL
5. Disposable micro-pipette tips for micro-pipettes (Oxford No. 910A or equivalent)
6. Fume Hood
7. Ultrasonic Cleaner
8. PE-SCIEX ELAN DRC II AXIAL FIELD TECHNOLOGY ICP-MS (or equivalent)
9. Polyscience Water Circulator (or equivalent)
10. Perkin-Elmer AS-10 Auto Sampler (or equivalent)

11. Thermo Scientific Vortex mixtures (or equivalent)

1.4.5.2 Reagent List

1. 1% to 2% Nitric Acid
2. Concentrated Nitric Acid
3. 1,000 µg/ml Uranium Stock Solution, certified vendor prepared
4. Dilutions of the above stock solution, replaced bi-annually. Used for QA/QC.
5. Appropriate Cleaning Solution for Ultrasonic Cleaner
6. 1,000 µg/ml Uranium Stock Solution, purchased from certified vendor to use as calibration standard at different dilutions

Ensure that all reagents used are within their expiration dates listed on each reagent package, if applicable.

1.4.5.3 Premise

A portion of urine is diluted with 2% Nitric acid solution, mixed thoroughly and analyzed.

1.4.5.4 Safety Precautions

1 Follow laboratory guidelines when working with acids.

2. Utilize all appropriate PPE.

1.4.5.5 Sample Preparation Procedure

1. Compare sample numbering with bioassay result sheet to insure order and eliminate discrepancies.

2. To 15 ml centrifuge tube add 1 mL urine sample, 200 µL internal standard of 1,000 ppb and 2% Nitric acid to make up volume to 10 mL.

3. Maintaining sample order of left to right, front to back, lowest sample number to highest sample number in the set.

4. Use vortex to mix it thoroughly.

5. Analyze using procedure on the ICP-MS described in section 1.4.5.6.

1.4.5.6 ICP-MS Procedures

Special considerations: Because of the high salt content of the samples, it is necessary to clean the skimmer and sampler cones after each use.

1. Turn the argon on at the tank and set the delivery pressure at 80 pounds per square inch (psi).

2. Turn on the exhaust fan and the water supply to the ICP-MS. The water supply has to have a delivery pressure of 70 psi. It may be necessary to change the filters on the water supply in order to achieve sufficient water supply pressure. The ICP-MS will not operate below this pressure.

3. Turn on the computer, monitor and printer.

4. On the windows desktop, double-click the ELAN icon.

5. Check the condition of the sample introduction system.

6. Check that the sample tubing and drain tubing leading from the peristaltic pump to the spray chamber are properly set up and in good working condition. It is recommended to use new tubes every day.

7. Place the capillary tubing into a container of 2% Nitric acid solution.

8. Open the instrument window, and then click the Front Panel Tab.

9. On the front panel tab click vacuum start.

10. When the instrument is ready, click Plasma Start.

11. After the plasma ignites, allow the instrument to warm up for 45 minutes.

12. To begin sample analysis, click the sample tab, build the sample analysis list and click on analyze sample.

13. After the last sample, aspirate the blank long enough to clean the lines.

14. Allow the pump to run long enough without aqueous uptake to void all lines.

15. Turn the flame off and relax lines off of pump.

16. After 5 to 10 minutes, turn off the water supply, exhaust fan and argon.

All bioassay samples need to be analyzed three (3) working days from receipt in the laboratory. Samples are extremely susceptible to contamination. Precautions should be taken to minimize traffic and fugitive dust while samples are digesting.

1.4.6 Reporting and Corrective Actions

As soon as the analytical results are received, they are entered in the logbook and the entries are checked for correctness and completeness.

The lab report is returned to the Radiation Safety Department with results reported as micrograms/liter of uranium. The information must be placed in the individual employee's exposure file and maintained as directed by the DRC.

The Radiation Safety Department is notified immediately of any sample with a concentration greater than 35 micrograms/liter of uranium. Corrective actions will be taken when the urinary uranium concentration falls within the limits listed in Table 1 (attached).

The Radiation Safety Department should compute the error on the control spiked samples and advise the lab if the results are more than ± 30% of the known values. If any of the results obtained for the quality assurance control samples are in error by a ± 30%, the analysis must be repeated.

1.5 IN-VIVO MONITORING

In-vivo body counting for lung burdens of U-natural and U-235 will not be routinely conducted. Monitoring will be conducted at the discretion of the RSO, samples may be sent for a follow-up analysis for specific radionuclides in consultation with DUSA management should potential exposure to an individual warrant.

2.0 RADIATION MONITORING – AREA

2.1 HIGH VOLUME AIRBORNE AREA AIR SAMPLING

Area air sampling involves passing a representative sample of air through a filter paper disc via an air pump for the purpose of determining the concentration of uranium in breathing air at that location. Although the process is only measuring airborne concentrations at a specific place and at a specific time, the results can often be used to represent average concentration in a general area. A high volume sampler or similar high volume pump will be used for this purpose. Samples will be analyzed as per standard gross alpha analysis procedures using a sensitive alpha detector.

2.1.1 Equipment

Monitoring equipment will be capable of obtaining an air sample flow rate of 40 lpm or greater for one hour or longer. A variety of equipment may be used for area air sampling, however normally the equipment used is an Eberline RAS-1, Scientific Industries Model H25004, or equivalent. Equipment is calibrated prior to each usage as per Section 3.6 of this manual.

2.1.2 Frequency/Locations

Area dust monitoring frequency is monthly for the locations shown in Table 2.1.2-1.

Table 2.1.2-1
Airborne Radiation Sample Locations

Code	Location/Description
BA1	Ore Scalehouse
BA2	Ore Storage
BA6	Sample Plant
BA7	SAG Mill Area
BA7A	SAG Mill Control Room
BA8	Leach Tank Area
BA9	Washing Circuit CCD Thickness
BA10	Solvent Extraction Building/Stripping Section
BA11	Solvent Extraction Building/Control Room
BA12	Yellowcake Precipitation & West Storage Area
BA12A	North Yellowcake Dryer Enclosure
BA12B	South Yellowcake Dryer Enclosure
BA13	Yellowcake Drying & Packaging Area
BA13A	Yellowcake Packaging Enclosure
BA14	Packaged Yellowcake Storage Room
BA15	Metallurgical Laboratory Sample Preparation Room

Code	Location/Description
BA16	Lunch Room Area (New Training Room)
BA17	Change Room
BA18	Administrative Building
BA19	Warehouse
BA20	Maintenance Shop
BA21	Boiler
BA22	Vanadium Panel
BA22A	Vanadium Dryer
BA23	Filter Belt/Rotary Dryer
BA24	Tails
BA25	Central Control Room
BA26	Shifter's Office
BA27	Operator's Lunch Room
BA29	Filter Press
BA30	Truck Shop
BA31	Women's Locker Room
BA32	Oxidation
BA33A	AF South Pad
BA33B	AF North Pad

Areas BA-10 and BA-12 were soluble uranium exposure areas. These areas were areas where the uranium compounds that were produced are soluble in lung fluids and are comparatively quickly eliminated from the body. All the other areas are insoluble exposure areas. Insoluble uranium areas were areas where the uranium compounds are not readily soluble in lung fluids and are retained by the body to a higher degree. Temperature of drying operations has a significant impact on solubility of uranium compounds. High drying temperatures produce insoluble uranium compounds. Area uranium dust monitoring, during production periods, is weekly in the designated yellowcake production areas. Monitoring increases to weekly in other monitored areas with the observance of levels exceeding 25% of 10 CFR 20 limits and reverts to monthly upon a continued observance of levels below 25% of 10 CFR 20 limits as determined by the RSO. The RSO may also perform any additional samplings at his or her discretion.

As areas are decommission and the ability to sample those areas is removed, the RSO will document this in the files and those areas will be removed from further monitoring.

2.1.3 Sampling Procedures

1. A RAS-1 or similar high volume pump shall be used for area grab sampling. Insure the pump has been recently calibrated within the past month.

2. The locations selected for area air samples should be representative of exposures to employees working in the area.

3. For routine sampling, the sampling period should be for a minimum collection duration of 60 minutes at a flow of 40 lpm or greater.

4. Insert a clean filter into the filter holder on the sampler. Note start time of pump and record unusual mill operating conditions if they exist.

   A. Stop sample collection and note time. Normally, an automatic timer is connected to the sampler and a 1 hour sample collection time is used.

6. Remove the filter from the sampler and place in a clean glassine envelope or the package supplied by the manufacturer for delivery to the Radiation Department.

7. Count the sample by gross alpha counting techniques and enter the result and sampling information into the record.

2.1.4 Calculations

Perform calculations as specified in Section 4.0.

2.1.5 Records

Logs of all samples taken are filed in the Radiation Safety Officer's files. Data is utilized to calculate radiation exposures as specified in Section 4.0.

2.1.6 Quality Assurance

Calibration checks on each air sampler are made at least monthly to ensure accurate airflow volumes are being collected. Usage of tweezers and new filter storage containers minimizes contamination potential. Field logging of data during sampling and logging of identifying data on sampled filter containers minimizes sample transposition. Samples may periodically be submitted for chemical analysis and a comparison of these results to the radiometric measurements will be made.

Review of data by the RSO and by the ALARA audit committee further assures quality maintenance.

2.2 RADON PROGENY

2.2.1 Definitions

Working Level:

A. The exposure to 1.3E + 05 MEV of alpha energy or the potential alpha energy in one liter of standard air containing 100 pCi each of RaA (Polonium-218), RaB (Lead-214), RaC (Bismuth-214), and RaC prime (Polonium-214). (Exposure level, not a dose rate)

Kusnetz Method: Method of radon progeny measurement and calculation based upon a 10 liter sample and at least 40 minutes decay time before counting.

2.2.2 Equipment

The equipment utilized consists of the following, or appropriate equivalents:

- Portable personal sampler
- Gelman 25 mm filter holder with end cap, or equivalent
- Gelman Type A/E 25 mm diameter glass fiber filters, or equivalent
- Counter-Scaler – Eberline MS-3 with SPA-1 probe, or equivalent

2.2.3 Frequency/Location

Radon progeny samples are obtained monthly for only those locations occupied by personnel where exposures may have the potential of exceeding 25% of 10 CFR 20 limits.

2.2.4 Procedures

The procedures to be utilized are as follows:

1. Assemble filter trains.

2. Ensure pump batteries are fully charged.

3. Calibrate pump (see Section 3.5).

4. Attached filter trains at sample locations; disconnect end plug.

5. Collect sample in the breathing zone of the employee.

6. Collect sample for five minutes at 4.0 lpm.

7. Log sample site, time started, time stopped, and filter pump number prior to leaving each site on the field log notebook.

8. Samples are counted between 40 minutes and 90 minutes after collection using sensitive alpha detector.

9. Check the calibration and function check information to ensure the detector is calibrated and operating.

10. If the calibration check correlates, proceed with sample analysis.

11. Radon progeny samples are normally counted for three minutes; however any sample count time may be selected for counting.

12. Run background detector count prior to running sampled filters.

13. After counting, calculate working levels.

Equation:

$$\frac{(\text{CPM - Bkg})}{(\alpha \text{ eff})\ (20 \text{ liters})\ (\text{Time Factor})} = \text{WL}$$

Where:

CPM - sample count per minute
Bkg - counter-detector background count per minute
α Efficiency - The efficiency of the counting system (See Section 3.2.3.3)
Time Factor - Values determined from Kusnetz method (See attached Table 2.2.4-1)
WL - Working Levels

TABLE 2.2.4-1
Time Factors

Min.	Factor	Min.	Factor
40	150	71	89
41	148	72	87
42	146	73	85
43	144	74	84
44	142	75	83
45	140	76	82
46	138	77	81
47	136	78	78
48	134	79	76
49	132	80	75
50	130	81	74
51	128	82	73
52	126	83	71
53	124	84	69
54	122	85	68
55	120	86	66
56	118	87	65
57	116	88	63
58	114	89	61
59	112	90	60
60	110		
61	108		
62	106		
63	104		
64	102		
65	100		
66	98		
67	96		
68	94		
69	92		
70	90		

2.2.5 Exposure Calculations

The personnel exposure calculations are a job-weighted average of those areas and concentrations that an individual is exposed to. The procedure is:

1. Determine areas and durations (hrs.) each individual worked during the period (month and quarter).

2. Determine monitored concentrations (WL) for each area so noted.

3. The multiplication of the hours worked in each area by the area concentration (WL) noted is added to the result for each area involved in the period.

4. The result is the Working Level Hours exposed (WLH) for the period.

5. The working level hours (WLH) divided by 173 (30 CFR 57.5-40 note); or hours per month gives the working level months (WLM) exposure. (The limit is 4 working level months exposure per year.)

6. If calculated per quarter, the working level hours summed for the quarter are divided by 519 (173 X 3) to obtain the working level quarter exposure.

See Section 4.0 for details on how to perform exposure calculations and maintain the exposure records.

2.2.6 Records

Data records, which are filed in the Radiation Safety files, include:

1. Sample location
2. Date and time of sample
3. Time on and off of sample pump
4. Counts per minute of sample
5. Elapsed time after sampling
6. Background detector count
7. Appropriate Kusnetz time factor
8. Working level
9. Sampler identification

Employee exposure records include:

1. Month monitored
2. Areas and duration worked
3. Employee identification
4. Concentrations (WL) observed
5. Calculated WLMs

2.2.7 Quality Assurance

Calibration checks each month assure proper calibration of the counting equipment. Documented semi-annual calibrations of the counting equipment using certified alpha calibration and pulse meter sources ensure proper calibration of the equipment over the anticipated ranges. The air sampling system has documented calibration prior to each use, ensuring sampling the appropriate air volumes. Duplicate counts of select data may be counted to assure instrument precision. Field documentation is maintained for each sample during monitoring. This methodology provides assurance in data quality.

Review of data by the RSO and the ALARA audit committee further assures quality maintenance.

2.3 ALPHA SURVEYS

2.3.1 Equipment

Equipment to be utilized in area alpha surveys is shown in Appendix 1. Pre-use function checks will be performed on all radiation survey equipment as specified in Section 3.1.2.3.2.

2.3.2 Frequency/Locations

Fixed and removable alpha surveys are made at those general locations on the Table 2.3.2-1, "Alpha Area Survey Locations." Surveys are completed weekly in those areas designated by the RSO as authorized lunchroom/break areas are monitored. Designated eating areas are listed in Table 2.3.2-2.

As areas are decommission and the ability to sample those areas is removed, the RSO will document this in the files and those areas will be removed from further monitoring.

Table 2.3.2-1
White Mesa Mill
Alpha Area Survey Locations

Scale House Table
Warehouse Office Desks
Maintenance Office Desks
Change Room Lunch Tables
Maintenance Lunchroom Tables
Mill Office Lunchroom Tables
Metallurgical Laboratory Desks
Chemical Laboratory Desks
Administrative Break Room Counter
Administrative Office Desks

Table 2.3.2-2
White Mesa Mill
Designated Eating Area Locations

Maintenance Supervisor Break Room
Main Lunch/Training Room
Administrative Break/Conference Rooms
Administrative Office Desks

2.3.3 Procedures

2.3.3.1 *Respirators*

Respirators are monitored utilizing a removable alpha smear that is read using alpha scaler meter such as a Ludlum Model 2200 or other equivalent radiological instruments. Readings exceeding 100 dpm/100 cm^2 result in re-cleaning or discarding of the respirator. Respirator cleaning and monitoring is a function of the Radiation Safety staff assigned to this duty. The meter's performance is checked prior to each use period.

2.3.3.2 *Fixed Alpha Surveys*

Alpha surveys for fixed alpha contamination are performed using a variety of alpha detecting instruments, as listed in Appendix 1. Each instrument is checked using a calibrated alpha source for proper function and operation prior to use, as described in Section 3.1.2.3.2.

Adjustments to the surface area being measured must be made to convert from the particular detector's surface area to the commonly used surface area of 100 cm^2. Therefore when converting a measurement to the commonly used unit of dpm/100 cm^2, a multiplying area factor must be applied to the measurement. For the Ludlum instrument with a 43-1 detector of 75 cm^2 surface, multiply the value by 1.33 (i.e. 100 cm^2 divided by 75 cm^2).

The procedures are:

1. Turn the meter on and check the meter battery condition.
2. Check alpha detector mylar surface for pinholes, etc. Replace if necessary and repeat calibration.
3. As specified in Section 3.1.2.3.2, perform a function calibration check using calibrated alpha source.
4. If check is acceptable, proceed with monitoring.

5. At each designated site, monitor designated surfaces, table tops, etc., holding within ¼ inch of the surface.

6. Record data, location, cpm/cm^2 monitored on data sheet.

7. At the conclusion of the survey, transpose results to the file log, correcting to dpm/100 cm^2, using correction for detector's surface area and cpm/dpm conversion factor.

2.3.3.3 *Removable Alpha Surveys*

The Ludlum Model 2200 scaler with 43-17 detector, or a variety of other sensitive alpha detection instruments such as Model 2929 or equivalent, counts wipe samples collected during removable alpha surveys. Glass fiber filters, sized to fit the detector sample slot, are utilized as the wipe medium. A template having a 100 cm^2 surface area maybe used to standardize the surface area wiped.

The procedure is:

1. Perform function check calibration of the scaler/detector. Ensure that this measurement is within ± 10% of the value obtained from the calibration laboratory.

2. If so proceed with the survey and counting.

3. Obtain clean filters and clean envelopes for filter storage.

4. At a location to be surveyed, remove the filter from the envelope and wipe the surface covering approximately 100 cm^2. This is easily accomplished by making an "S" shaped smear for approximately 10 inches using normal swipes (approximately 2.5 cm diameter).

5. Record on envelope the date and location of the sample.

6. Upon returning to counting lab, place an unused filter in the counting unit for at least 1 minute and obtain a background count rate.

7. Repeat procedure for each used filter, extracting filter from envelope, immediately prior to counting, using tweezers and placing in the detector slot with the wiped surface facing the detector, and count for at least 1 minute.

8. Convert results from cpm/filter to dpm/filter (100 cm^2 wiped) after subtracting the blank background count.

9. Record on the alpha survey form the following information:

    A. Sample location and conditions
    B. Sample date
    C. Sampler identification
    D. Wipe count dpm/100 cm^2

10. Discard the filters and envelopes

2.3.4 Action Limits

2.3.4.1 *Respirators*

Levels greater than 100 dpm/100 cm^2 squared require re-cleaning or discarding of a respirator.

2.3.4.2 *Fixed Alpha Surveys*

Levels greater than 1,000 dpm/100 cm^2 squared require remedial action by management. ALARA criterion ensures that the RSO takes action where necessary to maintain levels as low as reasonably achievable.

2.3.4.3 2.3.4.3 *Removable Alpha Surveys*

Levels greater than 1,000 dpm/100 cm^2 squared require remedial action and decontamination. ALARA criteria ensure that the RSO takes action where necessary to maintain levels as low as reasonably achievable.

2.3.5 Records

Records of fixed and removable alpha surveys are maintained in the Radiation Safety office files. Records include:

1. Sample location/conditions
2. Sample date
3. Sampler identification
4. Fixed alpha determination – dpm/100 cm^2
5. Removable alpha determination – dpm/100 cm^2
6. Remedial action taken, where necessary

2.3.6 Quality Assurance

Calibration function checks of detector performance and visual observation of detector surfaces prior to each survey ensures counting reliability and consistency. Usage of clean containers and tweezers minimizes contamination of wipe samples. A Field log of sample I.D.'s on sample containers minimizes transposition of samples. Data review by the RSO and by the Audit Committee further assures quality maintenance.

2.4 BETA-GAMMA SURVEYS

2.4.1 Equipment

Beta/Gamma surveying instruments used for beta-gamma surveys are listed in Appendix 1 and the sources used are listed in Appendix 2.

Some instruments read directly in mrem/hour while others read in cpm (with a conversion to mrem/hour). The model 44-6 detector has a removable beta shield allowing discrimination between beta and gamma contributions. Each instrument has a manufactures user's manual which describes the function, use and capability of each instrument. These manuals must be understood before surveying proceeds. Calibration of Beta/Gamma and functional checks are performed using calibrated Cs-137 or SrY 90 sources

2.4.2 Frequency/Locations

The sites noted on Table 2.4.2-1 may be monitored on a monthly basis by of the Radiation Safety staff. During reclamation periods, only areas routinely occupied by personnel are monitored as designated by the RSO. As areas are decommission and the ability to sample those areas is removed, the RSO will document this in the files and those areas will be removed from further monitoring.

Table 2.4.2-1
Beta-gamma Survey Locations

Identification Number	Description of Possible Source of Area of Exposure	Distance from Source in cm
WM-1	Mill Feed Hopper & Transfer Chute	1
WM-2	SAG Mill Intake-Feed Chute	1
WM-3	Screens-Area Floor Between Screen	1
WM-4	Leach Operator's Desk	1
WM-5	Leach Tank Vent #3	1
WM-6	Leach Tank #3 – Wall	1
WM-7	CCD Thickeners	1
WM-8	Pumphouse Tailings Discharge	1
WM-9	Oxidant Makeup Room-Sump Pump	1
WM-10	Shift Foreman's Office-Work Desk	1
WM-11	SX Operator's Area	1
WM-12	Precipitation Tanks #1 Tank; Wall	1
WM-13	Precipitation Section "Lab Bench"	1

Identification Number	Description of Possible Source of Area of Exposure	Distance from Source in cm
WM-14	Precipitation Vent	1
WM-15	Yellowcake Thickener #1; Wall	1
WM-16	Centrifuge Discharge-Chute Wall	1
WM-17	Yellowcake Thickener #2; Wall	1
WM-18	Yellowcake Packaging Room	1
WM-19	Yellowcake Dryer	1
WM-20	Yellowcake Dust Collector	1
WM-21	SX Uranium Mixer #1 Extractor	1
WM-22	SX Uranium Mixer #1 Stripping	1
WM-23	SX Vanadium Mixer #1 Stripping	1
WM-24	Vanadium Dryer	1
WM-25	Mill Laboratory Fume Hood	1
WM-26	Chemical Laboratory Work Area	1
WM-27	Metallurgical Laboratory Work Area	1
WM-28	Lunchroom Eating Area	1
WM-29	Lunchroom Wash Area	1
WM-30	Maintenance Shop – Work Area	1
WM-31	Maintenance Shop – Rubber Coating	1
WM-32	Tailings Impoundment Discharge	1
WM-33	Tailings Impoundment Dike 1	1
WM-34	Tailings Impoundment Dike 2	1
WM-35	Tailings Impoundment Dike 3	1
WM-36	Scalehouse	1
WM-37	Tailings Impoundment Dike 4	1

2.4.3 Procedures

The monitoring procedures are:

1. Check meter battery condition.

2. Check detector using a check source.

3. If the calibration function check indicates that the instrument is operating within calibration specifications, proceed with monitoring.

4. Survey each designated location on Table 2.4.2-1 and record in the field log:

   A. Site location/condition
   B. Date
   C. Instrument used
   D. Sampler's initials
   E. Meter reading (beta + gamma)
   F. Meter reading (gamma)

5. Upon returning to the office, record the mrem/hr reading into a permanent file which is maintained for beta-gamma exposure evaluation.

2.4.4 Action Levels

The ALARA concept is utilized in action levels. Responses include operative cleaning of the area or isolation of the source. The Radiation Safety Department will ensure levels ALARA.

2.4.5 Records

Records maintained in the Radiation Safety office files include:

1. Date monitored
2. Site location/condition
3. Instrument used
4. Sampler's initials
5. Beta/Gamma level, mrem/hr
6. Remedial action taken, if necessary

2.4.6 Quality Assurance

Quality of data is maintained with routine calibration and individual function checks of meter performance. Personnel utilizing equipment are trained in its usage. Records of the operational checks and calibrations are maintained in the files. The RSO routinely reviews the data and the ALARA audit committee periodically analyzes the performance of the management of the monitoring and administrative programs.

2.5 EXTERNAL GAMMA MONITORING

External gamma area monitoring is conducted at various locations around the Mill site in order to provide Radiation Safety Staff with area-specific gamma measurements. The procedures applicable to such monitoring are set out in Section 4.3 of the Mill's Environmental Protection Manual.

2.5.1 Locations and Frequency of Monitoring

External gamma measurements are taken over a quarterly interval for the twelve months of the year at all BHV locations and selected areas around the mill site (see Attachment #1 for those locations).

2.5.2 Quality Assurance

Quality assurance for external gamma measurements consists of:

2.5.2.1.1 Monitoring the container locations to ensure the TLDs have not been lost;

2.5.2.1.2 Ensuring that all containers are present when receiving or shipping to Landauer; and

2.5.2.1.3 Reviewing Landauer data for consistency and data transportation.

2.5.3 Analytical Requirements

Values reported are in millirems per week average for the monitor period (supplied by Landauer) along with a counting error term. The counting error term is calculated by:

[(sample 2 sigma) – (control mrem/week)] / (#weeks)

2.5.4 STANDARD OPERATING PROCEDURES

2.5.4.1 Equipment

External gamma is monitored at the ambient air sampling sites and other selected areas around the mill site, using the OSL badges from Landauer, Inc., or the equivalent.

2.5.4.2 Monitoring Methodology

2.5.4.2.1 The containers, each containing five TLD chips, are mounted approximately one meter above ground plane at each site with one container per site.

2.5.4.2.2 The containers loaded with TLDs are received the first of each quarter from Landauer and exchanged with those in the field.

2.5.4.2.3 A background TLD is stored in the Administration Vault as a transportation control.

2.5.4.2.4 The TLDs are returned to Landauer for processing.

2.5.4.3 Record Keeping

Data maintained in record form for external gamma is:

2.5.4.3.1 Sample period;

2.5.4.3.2 Sample location; and

External gamma levels for total radiation.

2.6 EQUIPMENT RELEASE SURVEYS

2.6.1 Policy

Materials leaving a Restricted Area going to unrestricted areas for usage must meet requirements of NRC guidance for "Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use" (dated April 1993).

All material originating within the restricted area will be considered contaminated until checked by the Radiation Safety Department. All managers who desire to ship or release material from the facility will inform the RSO of their desires. The RSO has the authority to deny release of materials exceeding NRC guidance for "Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use" (dated April 1993). No equipment or materials will be released without documented release by the RSO or his designee.

2.6.2 Limits

The release limits for unrestricted use of equipment and materials is contained in the NRC guidance listed above in Section 2.6.1 and are summarized as follows:

Limits for Alpha emissions for U-Nat and its daughter products are:

Average	5,000 dpm/100 cm^2
Maximum	15,000 dpm/100 cm^2
Removable	1,000 dpm/100 cm^2

Limits for Beta-gamma emissions (measured at a distance of one centimeter) for Beta/Gamma emitting radioisotopes are:

Average	0.2 mrem/hr or 5,000 dpm/100 cm^2
Maximum	1.0 mrem/hr or 15,000 dpm/100 cm^2

2.6.3 Equipment

Radiological survey instruments are listed in Appendix 1.

2.6.4 Procedures

Upon notification that materials are requested for release, the Radiation Safety Department shall inspect and survey the material. Surveys include fixed and removable alpha surveys and beta-gamma surveys. See sections 2.3 Alpha Surveys and 2.4 Beta-Gamma Surveys for a detailed breakdown on the surveying aspects and equipment used for each survey. An equipment inspection and release form, see attached, is to be prepared and signed by the RSO or his designee. Any material released from the mill will be accompanied with the appropriate release form. If contamination exceeds levels found in NRC guidance "Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use", (dated April 1993), then decontamination must proceed at the direction of the RSO. If the material cannot be decontaminated, then it will not be released.

2.6.5 Records

Documented records for each released item are filed in the Radiation Safety Department files. These files shall include a completed Release Form, see attached, and a photograph of the material that is being released.

2.6.6 Quality Assurance

The RSO and the ALARA Audit Committee periodically review the policy and documented release forms to ensure policy and regulatory compliance.

2.7 Field Gamma Surveys

The field gamma surveys will be conducted in accordance with the currently approved Reclamation Plan, Section 6 of the Technical Specifications.

3.0 EQUIPMENT/CALIBRATION

All radiation detection instruments used at the Mill are sent to a qualified independent laboratory for calibration every six months. If necessary, Radiation Safety Staff can use the procedures outlined below to verify calibration.

3.1 Counters/Detectors

3.1.1 General

All radiation detectors require determination of detector optimal voltage performance or plateau operating point. The graph of voltage applied to a detector versus detector response is referred to as a plateau curve. The plateau curve typically has two rapidly sloping sections and a stable, flat region. The optimal operating point is typically located at the beginning of the flat, or flatter, section of the graph. The plateau curve is specific for a particular detector and its accompanying readout, or measuring meter, and may vary over time depending upon electronic component condition.

The equipment used to determine detector plateau curves includes:

1. Appropriate radiation sources
2. Electrostatic voltmeter
3. Radiation detecting instrument
4. Graph paper
5. Manufacturer's technical manual

The procedure is:

1. Ensure instrument batteries are fresh or fully charged, if applicable.

2. Turn the instrument on.

3. Adjust the instrument voltage control starting at voltage of 600 using electrostatic voltmeter to monitor voltage setting.

4. Expose detector to a radiation source applicable to the type of detector and in the appropriate setting.

5. Record voltage and instrument response for each adjustment of voltage applied; increments of 50 volts are adequate.

6. Repeat steps 4 and 5 until instrument response rapidly increases versus voltage level. At this point, the detector is approaching potential differentials across the electrode that may damage the detector.

7. Graph instrument response versus voltage applied.

8. Set equipment high voltage control to the optimum operating point. Record on graph voltage selected.

9. Retain graph with calibration records.

3.1.2 Function Checks

Calibration function checks are required prior to use of radiation detection instruments used at the Mill for the purpose of verifying that the instruments are operating at the same efficiency as when they were calibrated by the calibration laboratory (i.e., within +/-10%). Function checks are also used for verifying repeatability, reliability, and comparability of an instrument's measurements from one period to another. By performing function checks for extended time periods, or on a larger sample size, these goals are met.

Function checks involve two basic elements:

(1) The calibration laboratory efficiency is compared to the instrument's efficiency on the date of the function check; and
(2) The function check is verified with a check source having similar isotopic composition as the one that was used by the calibration laboratory to calibrate the instrument.

Function checks are made for all types of radiation survey instruments. The basic principle in performing a function check is measuring the radiation field using a survey instrument against a known amount of radiation from a calibrated source. These measurements are made for the specific type of radiation occurring. For example, when performing a beta/gamma survey, the instrument function check is performed using a beta/gamma check source, such as a (SrY)-90. When performing an alpha survey, use an alpha check source, such as Th-230 or Pu-239 for performing the function check.

Function checks are documented on the Calibration Check Forms (see Attachment A for copies of forms to be used) for each specific instrument. They will be maintained in the instrument's' calibration and maintenance file.

A number of radiation detection instruments are used at the Mill. An Instrument Users Manual for each instrument is maintained in the calibration files, together with calibration documentation. The Users Manuals are to be considered the primary reference for operating a particular instrument. This Standard Operating Procedure (SOP) is not intended to replace the Users Manual, but rather to supplement the Manual by providing steps to be performed for function checks. Before operating an instrument, personnel should read the Users Manual and become familiar with the instrument's operation, capabilities, and special features. Personnel will also receive on the job training on each instrument.

3.1.3 Alpha Monitors

Alpha particles travel very short distances in the air due to their high ionization ability – typically ¼ to ½ inch. Due to this limitation, alpha monitoring must be done at a distance of ¼ inch or less between the detector face and the source. Alpha monitoring, to be consistent, requires ensuring a consistent distance be utilized between the detector face and the source. Alpha detectors read out in counts per minute (cpm). A correlation relationship, known as the efficiency factor, between the meter response and the actual disintegration rate of the source is used to determine actual calibration of the meter.

Radioactivity is measured in curies (Ci), which, by definition, is 3.7×10^{10} disintegrations per second (dps), or $2.2 \text{ X } 10^{12}$ disintegrations per minute (dpm). Another measurement unit is the Becquerel, or one dps. Alpha radiation is usually monitored as dpm, per surface area measured.

Radiation survey equipment used at the Mill for alpha surveys is listed in Appendices 1 and 2.

3.1.3.1 *Calibration and Function Check Frequency*

The frequency of calibration is specified in individual instrument user manuals and manufacturer's specifications.

The following frequencies are observed for calibration and function checks of radiation detection instruments:

	Type	Calibration Frequency	Function Checks
1.	Employee scans	6 months	7 days/week
2.	Radon progeny	6 months	each use
3.	Respirator checks	6 months	each use
4.	Area fixed scans	6 months	Daily or each use
5.	Area wipe scans	6 months	Daily or each use

3.1.3.2 *Function Check Procedures – Alpha Counters and Scaler Instruments*

The following steps will be used for function checks for alpha counters and alpha scaler instruments.

1. Turn the instrument on and place a calibrated alpha check source in the detector holder on or the face of the detector.

2. Count the source for 1 minute and record this value in cpm.

3. Repeat step 2 four more times.

4. Average the five readings and divide the average in cpm by the known activity on the alpha source. This is the efficiency of the instrument and detector.

5. Compare this efficiency with the efficiency obtained from the calibration lab. If the efficiency comparison is within ±10% deviation the instrument needs is calibrated if not the instrument needs to be recalibrated.

6. If this efficiency comparison is within ±10% deviation the instrument is in calibration.

7. Proceed with monitoring activities.

3.1.3.4 *Calibration Procedures*

All radiation detection instruments used at the Mill are sent to a qualified offsite laboratory every six months for calibration. However, if additional onsite calibration is required the calibration procedures are:

1. Set the detector high voltage at the prior determined operating point using an electrostatic voltmeter.

2. For counter/scalers (radon progeny/wipes), close the detector, without source present, obtain a reading for a set time. This is a background reading.

3. Place a calibrated source for the type of radiation being measured in the source holder and obtain reading.

4. Observe the cpm for both the background and the source.

5. Subtract the cpm value of background from the cpm value of the source to obtain the net cpm.

6. Divide the net cpm value by the known dpm of the source. This is the percentage efficiency of the instrument system for this energy source.

7. By dividing 100 by this efficiency, an efficiency factor is obtained.

8. Dpm equals the cpm divided by the efficiency of the instrument detector system:

Note: *1 curie = 2.22 E + 12 dpm*
1 microcurie = 2.22 E + 6 dpm
1 picocurie = 2.22 dpm

3.1.4 Beta-gamma Monitors

Equipment utilized for beta-gamma monitoring is listed in Appendices 1 and 2.

3.1.4.1 *Function Check Procedure*

The following steps will be used for function checks on beta/gamma instruments:

1. Turn the instrument on and place the calibrated beta/gamma (SrY-90) check source on the face of the detector.

2. Let the reading stabilize to a constant value.

3. Record this value in cpm.

4. Divide this value by the known activity on the check source. This is the efficiency of the instrument and detector.

5. Compare this efficiency to the efficiency obtained from the calibration laboratory. If the efficiency comparison is within ±10% deviation the instrument needs is calibrated if not the instrument needs to be recalibrated.

6. If this efficiency comparison is within ±10% deviation the instrument is in calibration.

7. Proceed with monitoring activities.

3.1.4.2 *Calibration*

All beta-gamma survey instruments are sent out every six months for calibration. Additional calibration, if necessary, may be performed on site using techniques described in Reg. Guide 8.30, Appendix C – Beta Calibration of Survey Instruments for calibration performed by a qualified calibration laboratory using the indicated source as listed in Appendix 2.

3.1.5 Gamma Monitors

Instruments for gamma measurements are listed in Appendix 1.

3.1.5.1 *Calibration*

Independent calibration service laboratories shall perform calibrations every six months. Meters are calibrated to Cs-137 or other radioisotopes as suggested by the calibration laboratory or manufacturer. Most calibration service laboratories calibrate Beta/Gamma instruments electronically in accordance with their standard calibration procedures. However, electronic calibration basically consists of the steps described below:

1. Connect survey instrument to be calibrated to the Model 500.

2. Turn both instruments on.

3. Record high voltage reading on Model 500.

4. Set cpm and the range multiplier on the Model 500 to the desired meter deflection. The model 500 frequency controls consist of the three-digit readout, range selector, coarse tuning knob, and the fine tuning knob. The three-digit readout is in cpm times the frequency multiplier.

5. Calibrating survey instruments in cpm:

    A. Set Model 500 frequency to value that will provide a ¾ meter deflection on the survey instrument's highest count scale. Set pulse height/amplitude to twice instrument input sensitivity.

    B. Adjust the range calibration potentiometer on the survey meter to provide correct reading record.

    C. De-code Model 500 frequency to next lower value; then do the same for the survey instrument.

    D. Adjust the range calibration potentiometer for correct reading on survey instrument. Record readings.

    E. Repeat process until all ranges have been calibrated at ¾ meter deflection. Record readings.

    F. Return to highest count scale on survey meter.

    G. Set Model 500 for ¼ scale deflection readings.

    H. Survey instrument should read within ± 10% of Model 500 frequency. Record readings.

1) If readings are outside of the tolerance, re-calibrate for ¾ meter deflection.

2) Tap instrument meter lightly to check for sticky meter. Meter tolerance is ± 3% from the initial readings to the final reading.

I. Decode Model 500 to next lower scale. Check survey instruments for ¼ scale reading. Record.

6. Record input sensitivity.

A. Select the most sensitive amplitude range 0-5 mv on the Model 500.

B. Observe meter on survey instrument.

C. Increase pulse amplitude, switching to next higher range, if necessary, until the rate meter indicates a stable reading (i.e., further increase of pulse amplitude does not cause an increase in meter reading). Now, decrease pulse height until the survey instrument meter reading drops 15 ± 5%. Record this pulse height as the instrument sensitivity.

D. If your instrument has a gain or threshold control to set instrument sensitivity, set pulse height on the Model 500 to desired sensitivity level. Now adjust your instrument threshold or gain control until the rate meter reading is within 85 ± 5% of its stable reading value (see step C). Record the pulse height as instrument sensitivity.

7. Calibrating survey instrument to cps.

A. Set frequency in Model 500. Divide the Model 500 readings by 60 to convert to counts per second.

B. Repeat calibration steps as in item 5 above.

3.1.5.2 *Frequency of Calibration*

If electronic calibration is performed using the above method by the Radiation Safety Department, the Model 500 pulse generator will be sent out for calibration on an annual basis.

3.2 PERSONNEL AIR SAMPLERS

The calibration procedure for personnel air samplers involves one of three calibration procedures. Samplers will be calibrated prior to each use by one of the three methodologies: bubble tube, electronic or mass flow determinations. Air samplers may be calibrated to standard air conditions.

3.2.1 Bubble Tube Calibration Method

The Bubble Tube Calibration Method is a calibration method and does not require corrections to or from standard conditions for temperature and pressure. Personal air samplers are calibrated for the flow rate for the sampling being performed, typically 2-4 lpm.

The equipment utilized is as follows:

1. Burette – 1,000 ml capacity, 10 ml divisions
2. Support, iron, rectangular base, with rod
3. Burette clamps – 2
4. Soap solution, dish
5. Tubing, Gelman filter holder, filter media (0.8 micron glass fiber Gelman type A/E)
6. Stopwatch
7. Small screwdriver
8. Sample pump

The procedures utilized are:

1. Assemble a filter train – place a filter in an in-line filter. Attach two lengths of tubing to each connector of the in-line filter holder.

2. Make sure the Burette is clean. Clamp the 1,000 ml Burette upside down on the ring stand with the Burette clamps.

3. Attach the pump to be calibrated to one end of the filter train, connect the other end of the filter train to the small end of the 1,000 ml Burette, as per Figure 1.

4. Check all tubing connections for air tightness.

5. Pour approximately ½ inch (12 mm) of soap solution into the dish.

6. Start the pump.

7. Raise the dish up under the Burette opening, and then immediately lower the dish. This should cause a film of soap to form over the Burette opening (i.e., a bubble). Repeat this procedure until the film (bubble) will travel up the inverted Burette the length of the graduation marks on the Burette without breaking.

8. When the film (bubble) has wetted the Burette inside and will travel the entire length of the graduated area of the Burette, proceed with the actual calibration run.

9. Quickly form three bubbles and start the stopwatch when the middle bubble is at the bottom graduation line (actually the 1,000 ml mark, but for purposes here, it will be called the "zero" line).

10. Time the travel of the bubble from the zero line to the top line of the graduated distance (0 ml). Since the capacity of the Burette is 1,000 ml (1.0 liter), then the volume of air that is displaced above the bubble (i.e., needed to raise the bubble) is 1.0 liter. Stopping the stopwatch at the top mark is the time elapsed for the pump to accomplish this. The rate of rise of the bubble through the apparatus is the flow rate of air being pulled by the pump.

11. Increase or decrease the pump collection rate by adjusting the appropriate screw or knob designed for this purpose.

12. Set the pump flow collection rate to the desired valued usually between 2 and 4 liters per minute for low volume collection pumps and between 30 and 80 liters per minute for high volume collection pumps.

3.2.2 Mass Flow Method

Mass flow meters are manufactured equipment designed to measure air collection flow rates for a variety of purposes. Mass flow meters may be subject to temperature and pressure corrections of air movement depending on whether they are calibrated/manufactured for standard conditions.

Utilizing an air mass flow meter, traceable to NBS, the airflow rate of pumps can be quickly adjusted to correct standard flow rate conditions. However, the mass flow meter must be calibrated annually using a primary calibration method.

The equipment consists of the following:

1. Kurz air mass flow model 543 or equivalent
2. Suitable filter head adapter connections
3. Filter heads with filter media
4. Pump to be calibrated

Note: The meter is calibrated directly in standard air conditions – 25º C., 29.82" Hg.

The procedures utilized are:

1. Ensure pump batteries are fully charged.

2. Ensure flow meter batteries are fully charged.

3. Assemble filter train.

4. Connect (with a suitable adapter) the Kurz probe onto the filter train. Ensure an airtight seal with tape, if necessary.

5. Set the meter function switch to the highest range: 40 std liters per minute.

6. Turn the pump on.

7. Select appropriate range on the meter. (Do not allow meter needle to be forcibly pegged.)

8. Adjust the pump flow rate as necessary to desired flow rate. Allow the meter to stabilize before adjustment of the pump.

9. Meter reads directly in standard air conditions, correcting for temperature and barometric pressure.

Pump is now calibrated. Low volume pumps are set 4 lpm.

3.2.3 Electronic Calibration Method

The electronic calibration is the calibration method and does not require corrections to or from standards conditions for temperature and pressure. Personal air samplers are calibrated for the flow rate for the sampling being performed typically 2 – 4 lpm. Area Airborne high volume air samplers should be calibrated to a minimum of 40 lpm.

The equipment utilized is as follows:

1. UltraFlo Primary Gas Flow Calibrator, or equivalent
2. Soap solution
3. Tubing
4. Small screwdriver
5. Sample pump

The procedure proceeds as follows:

1. Remove the two nipples on the back of the UltraFlo Primary Gas Flow Calibrator.
2. Attach the connection tubing from the top nipple to the sample pump.
3. Turn calibrator on.
4. Turn sample pump on.

5. Press the plunger style button on top of the soap dispensing portion of the device.
6. Write down the digital reading from the calibrator device.
7. Repeat steps 5 and 6 three times.
8. Take an average of the three readings.
9. If the sample pump requires adjustment, take the screwdriver and adjust the set screw on the face of the sample pump and then repeat steps 5 through 7.
10. After the sample pump is calibrated, document the calibration on the Breathing Zone/Radon or the High Volume Calibration Sheet depending on which device is being calibrated, in the Radiation department.
11. Replace nipple caps on the back of the calibrator.

3.3 AREA AIR SAMPLERS

The calibration procedure for area air samplers involves one of the following procedures; Kurz Mass Flow, Wet Test Gas Meter, Electronic or Bubble Tube Method.

3.3.1 Kurz Mass Flow Method

Repeat procedures discussed in 3.2.2 – except – airflow rate is adjusted to 40 slpm and samplers utilized are:

1. Eberline RAS-1
2. Scientific Industries Model H25004
3. Equivalent

3.3.2 Wet Test Gas Meter Method

The wet test gas meter method utilizes a Precision Scientific wet test meter rated at one cubic foot per revolution of the main dial. This method is used to calibrate the Kurz air mass flow meter in addition to direct calibration of the area air samplers.

The procedures are:

1. Attached coupling to sampler filter assembly; secure it with tape.

2. Connect wet test meter hose to coupling.

3. Check water level of wet test meter. The needle should be on slightly above the water level.

4. Check the thermometer temperature of the wet test meter. Record this on the calibration sheet. Assume that the wet and dry bulb temperatures are the same.

5. Turn on the sampler. Check the west test meter's manometer reading. This reading is obtained by adding the left and right column values. (A typical reading might be .3). Log these values for each ball height on the "Static pressure … H_2O" column.

6. For the following sampler approximate settings, pull one cubic foot of air through the wet test meter and record the time (in seconds) for each: 20, 30, 40, and 50 lpm.

Sampler Calibration Procedures – Calculations and Equations

1. To convert the static pressure (of the manometer attached to the wet test meter) from inches of water to inches of mercury, divide the number of inches to water by 13.6. Example: 0.4/13.6-0.02941176" Hg

2. To compute the actual flow rate ("Q rate act. lpm"), first divide the number of cubic feet by the number of seconds. Example: 1 ft.^{3}/90 sec = .01111 ft.^{3}/awx. Convert the cubic feet to liters. The conversion factor is 28.317. Example: .01111 ft.^{3}/sec x 28.317 L ft.^{3} = .3146 L/sec. Multiply this by 60 to convert from seconds to minutes. Example: .3146 L/sec x 60 sec = 1888 L/m or 18.88 lpm.

3. Using the "Vapor Pressures of Water" chart, find the vapor pressure inside the wet test meter by matching the wet bulb temperature with the corresponding vapor pressure. This number is the vapor pressure at the standard wet bulb (Pvpstw).

4. Find the vapor pressure at dewpoint using this formula: Pv dewpoint = Pvpstw = 0.0003613 (td-tw) Bp (Where +d = dry bulb temp; tw = wet bulb temp; bp = barometric pressure in inches of mercury.) Assume that the dry bulb temperature and the wet bulb temperature are the same, so the difference between them will always be zero. Thus, Pv dewpoint will equal Pvpstw.

5. Determine the actual air density (D act) with this formula:

$$D\ act = \frac{1.327}{td + 459.67\ \ [(Pg-Sp) - 0.378\ (Pv\ dewpoint)]}$$

(Where td - dry bulb temp in degrees F.; Bp = barometric pressure in inches of mercury; Sp = static pressure of wet test meter in inches of mercury.)

Example:

D act = 1.327

70.5 + 459.67 [(24,8031 - 0.02941176) - 0.378 (.875)]

= 1.327

530.17 (24,773688 - 0.33075)

= (0.00250297) (24.442938)

D act = 0.06117996

Log this in "Air Density lbs/ft^3" column of log sheet.

6. Find the flow rate of the sampler at standard conditions (Q std) using this formula:

$$Q\ std = Q\ act \ \frac{D\ act}{D\ std}$$

(Where D std = .075 lbs/ft^3)

$$\text{(i.e., } Q\ std = 18.88 \ \frac{(0.06117996)}{0.075}$$

= 18.88 (0.8157328)

= 15.40

Q std = 15.40 (write this down for each position in the Q 0.075 column)

3.3.3 Bubble Tube Method

Refer to Section 3.2.1 to perform this method.

3.3.4 Electronic Calibration

Refer to Section 3.2.3 to perform this method.

4. EXPOSURE CALCULATIONS AND RECORD MAINTENANCE

4.1 PERSONNEL EXPOSURE CALCULATIONS

4.1.1 DACs for Conventional Ores

4.1.1.1 *Solubility Classes*

The solubility class, chemical form and abundance of conventional ores at the Mill, and the resulting DACs to be used are as set out in the following table:

Table 4.1.1.1-1
Solubility Class, Chemical Form and Abundance of Conventional Ores

Location	DAC	U nat	Th-230	Ra-226	Pb-210
Ore-Grind	6.00E-11	DAC is specified in 10 CFR Part 20			
Leach	2.8E-10	½ Ore, ½ Precipitation	½ Ore, ½ Precipitation	½ Ore, ½ Precipitation	½ Ore, ½ Precipitation
CCD	1.2E-11	Class D Sulfate 25%	Class W [1] Sulfate 25%	Class W [1] Sulfate 25%	Class D [1] Sulfate 25%
SX	1.2E-11	Class D Sulfate 25%	Class W [1] Sulfate 25%	Class W [1] Sulfate 25%	Class D [1] Sulfate 25%
Precipitation	5.00E-10	Class D [2] Diuranate 100%	NA	NA	NA
Yellowcake Packaging	2.20E-11	Class Y: 90 % and Class W: 10 % Oxide 100%	NA	NA	NA
Tailings	1.70E-11	Class Y Oxide 4%	Class Y [2] Oxide 32%	Class W [1] Oxide 32%	Class W [1] Oxide 32%

[1] 10 CFR Part 20, Appendix B
[2] NUREG/CR-0530, PNL-2870, D.R. Kalkwarf, 1979, "Solubility Classifications of Airborne Products from Uranium Ores and Tailings Piles"

4.1.1.2 *Application of Conventional Ore DACs to Workplace Locations*

The Conventional Ore DACs will be applied as follows to the various locations in the Mill site:

Table 4.1.1.2-1
Application of Conventional Ore DACs to Workplace Locations

Type of DAC	DAC (μCi/ml)	Individual Location
Ore/Grind	6.00E-11	Ore Scalehouse Ore Storage Maintenance Shop Warehouse Lunch Room Change Room Administration Bldg
Ore/Grind	6.00E-11	Dump Station
Ore/Grind	6.00E-11	SAG Mill SAG Mill Control Shifter's Office Operations Lunch Room Filter Press
Leach	2.80E-10	Leach Tank Area
CCD	1.20E-11	CCD Circuit Thickeners
SX	1.20E-11	SX Building South Boiler
Ore/Grind	6.00E-11	Control Room
Yellowcake Precipitation	5.00E-10	YC Precipitation &Wet Storage
Yellowcake Packaging	2.20E-11	North YC Dryer Encl. South YC Dryer Encl. YC Pkg Enclosure YC Drying & Packaging Area Packaged YC Staging Area
Tailings	1.70E-11	Truck Shop Tailings
Yellowcake Precipitation	5.00E-10	Vanadium Circuit

4.1.2 Sampling Time

Calculate the sampling time required to detect 10% of the DAC by solving for sampling time in the following equation:

$$\frac{\text{LLD}}{(\text{Sampling Time})\ (\text{Flow Rate of Sampler})} = 0.1\ \text{DAC}$$

For example:

To detect 10% of the DAC for U-Nat, a 40 lpm air sampler would have to operate 57 minutes, assuming the sample counter has a lower level of detection of 10 dpm above background, i.e.:

$$\frac{(10\ \text{DPM})\left(\frac{\text{pCi}}{2.22\ \text{DPM}}\right)\left(\frac{\text{E-6}\ \mu\text{Ci}}{\text{pCi}}\right)}{(\text{X min.})\left(\frac{40\ \text{lit}}{\text{min.}}\right)\left(\frac{10^3\text{ml}}{\text{lit}}\right)} = \frac{2\text{E-12}\ \mu\text{Ci}}{\text{ml}}$$

X = 56.8 minutes

4.1.3 Dose Calculations (10 CFR 20.1201-20.1202)

1. Analytical results of airborne particulate samples may be obtained in several different units that need to be converted into mg soluble natural uranium to determine the weekly exposures and into uCi-hr/ml or WL-hr to determine annual exposures. The following table presents a summary of the conversions that may be necessary. The first row of the table presents the operations to be performed in the conversions. Enter the measured weight or activity, the sampler flow rate, the sampling time, and the exposure time into the first four columns. Divide the values in column 1 by the values in column 2 and column 3, and then multiply by the values in columns 4 and 5 to obtain the units in column 6, or:

$$\frac{(\text{Column 1})\ (\text{Column 4})\ (\text{Column 5})}{(\text{Column 2})\ (\text{Column 3})} = \text{Column 6}$$

UNIT CONVERSION TABLE

1	2	3	4	5	6
OPERATION	DIVIDE	DIVIDE	MULTIPLY	MULTIPLY	ANSWER
MEASURED VALUE	SAMPLER FLOW RATE	SAMPLING TIME	EXPOSURE TIME	CONSTANT	ANSWER
μg soluble U-Nat	L/min	min	hrs	1.2	mg soluble U-Nat
pCi soluble U-Nat	L/min	min	hrs	1.77	mg soluble U-Nat
pCi gross alpha	L/min	min	hrs	E-9	μCi-hrs / ML
μg U-Nat	L/min	min	hrs	6.77E-10	μCi-hrs / ML
μCi mL Radon	---	---	hrs	E7	WL-hrs

For example:

$$\frac{(10\ \mu g\ \text{Soluble U-Nat})\ (10\ \text{hrs})\ (1.2)}{(2\ \text{L/min})\ (30\ \text{min})} = 2\ \text{mg Soluble U-Nat}$$

See notes for a description of the unit conversions.

2. The table on the following page is divided into four quadrants. Different quadrants are for soluble uranium, insoluble uranium, tailings dust, and radon. Select the proper quadrant for the type of airborne particulate being sampled. Enter the area, particulate concentration, and hours of exposure in the labeled columns of the selected quadrant.

3. The protection factors are whole numbers, e.g., 10, 50, 1,000. Divide 1 by the protection factor and enter the quotient in the fourth column of each quadrant, e.g., for a protection factor of 1,000, enter 1/1,000 or 0.001 in the column. The 1/PF values are unit-less.

4. Enter the product of the airborne concentration, the hours of exposure, the time, and 1/PF in the fifth column of each quadrant. Add these values and enter the total at the bottom of the column.

5. On the dose calculations form which follows, enter the total for Soluble Uranium in the equation and calculate the corresponding mg. If a value exceeds 10 mg, an over-exposure may have occurred. If verified by a high uranium in urine results, an over-exposure has probably occurred and needs to be reported to the NRC.

6. Enter the totals for Soluble Uranium, Insoluble Uranium, Tailings Dust, and Radon in their respective equations. Perform the indicated calculations, add the fractions

together, and record as the subtotal. (Use the DAC for Th-230 or the DAC for tailings dust to determine the contribution of tailings dust to the subtotal.) If a subtotal exceeds 1, an over-exposure may have occurred. If verified by a high uranium in urine result, an over-exposure has probably occurred and needs to be reported to the NRC.

7. Enter the TLD determinations of whole body dose as the Deep Dose Equivalent on the form. If the Deep Dose Equivalent exceeds 5 rems, an over-exposure may have occurred and needs to be reported to the NRC.

8. If the Deep Dose Equivalent exceeds 0.5 rem and the subtotal exceeds 0.1, calculate the Total Effective Dose Equivalent by adding the Deep Dose Equivalent to the product of 5 rems times the subtotal and enter on the form. If the total effective dose equivalent exceeds 5 rems, an over-exposure may have occurred and may have to be reported to the NRC.

DOSE CALCULATIONS (10 CFR 20.1201 + 20.1202)

Name ____________ Soc. Sec. No. ____________ Co. I.D. No. ____________ Week ______ Year ______

AREA	SOL. U µCi/ML	HR	1/PF	µCi-HR/ML	AREA	INSOL. U µCi/ML	HR	1/PF	µCi-HR/ML
TOTAL	---	---	---		TOTAL	---	---	---	---
AREA	TAILINGS DUST µCi/ML	HR	1/PF	µCi-HR/ML	AREA	RADON WL	HR	1/PF	WL-HR

TOTAL	---	---	---		**TOTAL**	---	---	---	

DOSE CALCULATIONS (10 CFR 20.1201 + 20.1202)

________	________	________	________	________
Name	Soc. Sec. No.	Co. I.D. No.	Week	Year

Weekly Soluble Uranium   (µCi-hr) (1.77E9) / (mL)   = ____________ mg

Limit   10 mg

Annual Soluble Uranium   (µCi-hr / mL) / (2000 hr) (5E-10)   = ____________

Annual Insoluble Uranium   (µCi-hr / mL) / (2000 hr) (2E-11)   = ____________

Annual Tailings Dust   (µCi-hr / mL) / (2000 hr) (*)   = ____________

* = DAC for Th-230 = 6E-12;
or = DAC for tailings dust.

Annual Radon with Daughters Present   (WL-hr) / (2000 hr) (0.33 WL)   = ____________

Subtotal   ____________

Limit   1

Deep Dose Equivalent = TLD Whole Body Dose in rem =   ____________ rem

Limit   5 rem

If the Deep Dose Equivalent is > 0.5 rem
and
the Subtotal is > 0.1, then

Total Effective Dose Equivalent = Deep Dose Equivalent + Committed Effective Dose Equivalent

= (rem) + (5 rem) (Subtotal) = ____________ rem

Limit   5 rem

DOSE CALCULATIONS (10 CFR 20.1201 + 20.1202)

Notes:µ

1. PF = Respiratory Protection Factor.

2. The 10 mg soluble uranium per week limit in 10 CFR Part 20.1201 is more restrictive than the (40 hour) (DAC) limit for natural uranium, thus compliance is based on 10 mg per week.

3. The conversion of uCi-hr/mL to mg natural uranium is the product of:

   (air concentration) (hours of exposure) (breathing rate for light work) (conversion of minutes to hours) (specific activity of natural uranium) (conversion of ug to mg) which is:

$$\left(\frac{\mu Ci\text{-}hr}{mL}\right)\left(\frac{2E4\ mL}{min}\right)\left(\frac{60\ min}{hr}\right)\left(\frac{\mu g}{6.77E\text{-}7\ \mu Ci}\right)\left(\frac{E\text{-}3\ mg}{\mu g}\right) =$$

$$\left(\frac{\mu Ci\text{-}hr}{mL}\right)(1.77E9) = mg\ U\text{-}Nat$$

   Thus to obtain mg natural uranium, multiply the µCi-hr/mL by 1.77E9.

4. Soluble Uranium DAC (Class D) = 5E-10 µCi/mL
   Insoluble Uranium DAC (Class Y) = 2E-11 µCi/mL
   Thorium-230 DAC (Class Y) = 6E-12 µCi/mL
   Radon with Daughters DAC = 3E-8 µCi/mL = 0.33 WL
   Tailings Dust DAC is a Site Specific Value = µ5. Description of unit conversions:

   a. ug soluble U-Nat → mg soluble U-Nat

$$\left(\frac{\mu g}{(L/min)\ (min\ sampler)\ (E3\ mL/L)}\right)\left(\frac{E\text{-}3\ mg}{\mu g}\right)\left(\frac{60\ min}{hr}\right)(hr\ exposure) =$$

$$\left(\frac{\mu g}{(L/min)\ (min\ sampler)}\right)(hr\ exposure)\ (1.2) = mg\ soluble\ U\text{-}Nat$$

   b. pCi soluble U-Nat → mg soluble U-Nat

$$\left(\frac{\text{pCi}}{(\text{L/min})\ (\text{min sampler})\ \left(\frac{\text{E3 mL}}{\text{L}}\right)}\right)\left(\frac{\text{E-9 mCi}}{\text{pCi}}\right)\left(\frac{\text{mg}}{\text{6.77E-7 mCi}}\right)\left(\frac{\text{2E4 mL}}{\text{min}}\right)\rightarrow$$

$$\left(\frac{\text{60 min}}{\text{hr}}\right)(\text{hr exposure}) =$$

$$\left(\frac{\text{pCi}}{(\text{L/min})\ (\text{min sampler})}\right)(\text{hr exposure})\ (1.77) = \text{mg soluble U-Nat}$$

c. pCi gross alpha $\rightarrow$ µCi-hr

$$\left(\frac{\text{pCi}}{\left(\frac{\text{L}}{\text{min}}\right)(\text{min sampler})\left(\frac{\text{E-3 mL}}{\text{L}}\right)}\right)\left(\frac{\text{E-6 }\mu\text{Ci}}{\text{pCi}}\right)(\text{hr exposure}) =$$

$$\left(\frac{\text{pCi}}{\left(\frac{\text{L}}{\text{min}}\right)(\text{min sampler})}\right)(\text{hr exposure})\ (\text{E-9}) = \frac{\mu\text{Ci-hr}}{\text{mL}}$$

d. µg U-Nat $\rightarrow \frac{\mu\text{Ci- hr}}{\text{mL}}$

$$\left(\frac{\mu\text{g}}{\left(\frac{\text{L}}{\text{min}}\right)(\text{min sampler})\left(\frac{\text{E3 mL}}{\text{L}}\right)}\right)\left(\frac{\text{6.77E-7 }\mu\text{Ci}}{\mu\text{g}}\right)(\text{hr exposure}) =$$

$$\left(\frac{\mu\text{Ci}}{\left(\frac{\text{L}}{\text{min}}\right)(\text{min sampler})}\right)(\text{hr exposure})\ (\text{6.77E-10}) = \frac{\mu\text{Ci-hr}}{\text{mL}}$$

e. $\frac{\mu\text{Ci}}{\text{mL}}$ of Radon-222 $\rightarrow$ WL

$$\left(\frac{\mu\text{Ci}}{\text{mL}}\right)\left(\frac{\text{E6 pCi}}{\mu\text{Ci}}\right)\left(\frac{\text{E3 mL}}{\text{L}}\right)\left(\frac{\text{L-WL}}{\text{E2 pCi}}\right) =$$

$$\left(\frac{\mu\text{Ci}}{\text{mL}}\right)(\text{E7}) = \text{WL}$$

4.2 Personnel Exposure Files

The Company will generate and maintain individual exposure records for each employee that works at the White Mesa Mill. The record system will be designed to meet the specifications of the Federal Code of Regulations 10 CFR Part 20.

When an employee is hired, a file will be generated specifically for that individual. All records that are to be in the radiation exposure file will be maintained during the term of employment. When the employee terminates, all records will be preserved until the NRC authorizes their disposition.

Personnel exposure records will be maintained at the mill site and will be accessible only to the employee and the Radiation Safety staff. No copy of the exposure history will be furnished to anyone outside of the Radiation Safety Department without a signed consent form from the employee.

Contents of the exposure file:

Each personnel exposure file will contain the following records:

1. Information Sheet – Each information sheet will include the following information:

    A. Employee's full name
    B. Birth date
    C. Social Security number
    D. Date of hire
    E. Date of termination

2. Record of Urinalyses – A multiple entry log of all urinalyses conducted at this work site will include the following information:

    A. Employee's full name
    B. Sample dates
    C. Sample identification number
    D. Concentration of uranium in μg/l
    E. An entry for any quality assurance "spikes" entered in μg/l

3. Internal personnel Exposure Records – These will be calculated and prepared using the forms above or by the computer and the printout will be used as the permanent record in the exposure file. The internal exposure records will contain the following information:

    A. Employee's full name
    B. Social Security number

C. Birth date
D. Exposure to airborne uranium expressed in both µCi and percent MPC
E. Any breathing zone samples collected for airborne uranium to be expressed in µCi
F. Radon daughters expressed in working levels (WL) and period of exposure (date)

4. External Exposure Record (OSL, Dosimeter) – The date received from the Dosimeter contractor will be posted to the Dosimeter record in the exposure file. The following information will be included on the Dosimeter record:

   A. Employee's full name
   B. Birth date
   C. Social Security number
   D. Period of exposure (dates)
   E. Exposure in millirems (mrem) for a given period
   F. Total accumulated exposure while at the White Mesa Mill
   G. Identification number of the Dosimeter badge

5. Record of Exposure from Previous Employment (NRC form 4 or similar) – A record of occupational exposures that occurred prior to employment at the mill must be obtained for each employee. If no such exposure record is available, the employee must sign a statement to that affect. If previous exposure records were kept, a copy must be secured and placed in the individual's file.

6. Reports of Over-exposure – If an individual has been found to be over-exposed, the RSO will draft a letter of explanation. The report will explain the circumstances and/or reasons for the over-exposure. It will also state any actions taken to correct the problem or to prevent future over-exposures. The report must be placed in the individual's exposure file.

5. RADIATION WORK PERMITS

5.1 General

A Radiation Work Permit ("RWP") system has been established for non-routine activities where there is a potential for a significant radiation exposure, or for certain routine activities where there is a potential to spread radioactive materials.

Specifically, an RWP is required for:

a) All non-routine maintenance work, or work for which there is no effective procedure, which may, by the determination of the RSO, exceed 25% of the R313-15 limits;

b) All routine work, not covered by an procedure, that could involve the spread of radioactive materials; and

c) The receipt, handling or processing of any alternate feed material or other radioactive material, which has been determined by the RSO, not to fall within an existing operating procedure.

An RWP may also be used on a temporary basis for routine activities in lieu of an procedure, while a procedure is being developed for the activity.

5.2 All Non-Routine Activities Require RSO Review

All non-routine activities require review by the RSO. The RSO will advise the Mill Manager on a regular basis of any activities that require an RWP.

5.3 Radiation Work Permit

The RWP is a form that describes the work to be performed, the location, duration and personnel involved, and the radiological controls needed, such as respirator, urine samples, breathing zone monitoring, time limitations for the activity, etc. The form must also have an area for the RSO, or his designee's, signature. A copy of a form of RWP is attached.

5.4 Procedure for Obtaining a Radiation Work Permit

The procedure for obtaining an RWP is:

a) When RWP-type work is to be performed, the Shift Foreman, Maintenance Superintendent or other supervisory personnel shall complete the top portion of the RWP, which will provide information on the specific work locations, estimated work duration, type of work to be performed, and personnel utilized, and present it to the RSO;

b) The RSO will indicate the radiological controls needed based on the information given and the safety of personnel. The RSO or his designee will provide the necessary surveillance and respiratory protection equipment;

c) No work can be performed until the RSO or his designee has approved the RWP;

d) Any maintenance or RWP jobs done in the yellowcake dryer or packaging enclosures will require a member of the Radiation Staff to be present for the duration of the job;

e) All supervisors will be given training in and copies of the requirements for using RWPs, with the permits remaining on file for five years; and

f) Any supervisor found to be knowingly and willfully violating these procedures will be issued a written warning, and the situation will be reviewed by appropriate management for remedial action.

EMPLOYEE SPOT ALPHA CONTAMINATION SURVEY

DATE	NAME	BOOTS	CLOTHES	HANDS	COMMENTS

Alpha Instrument Information:

Instrument Model: ______________________________

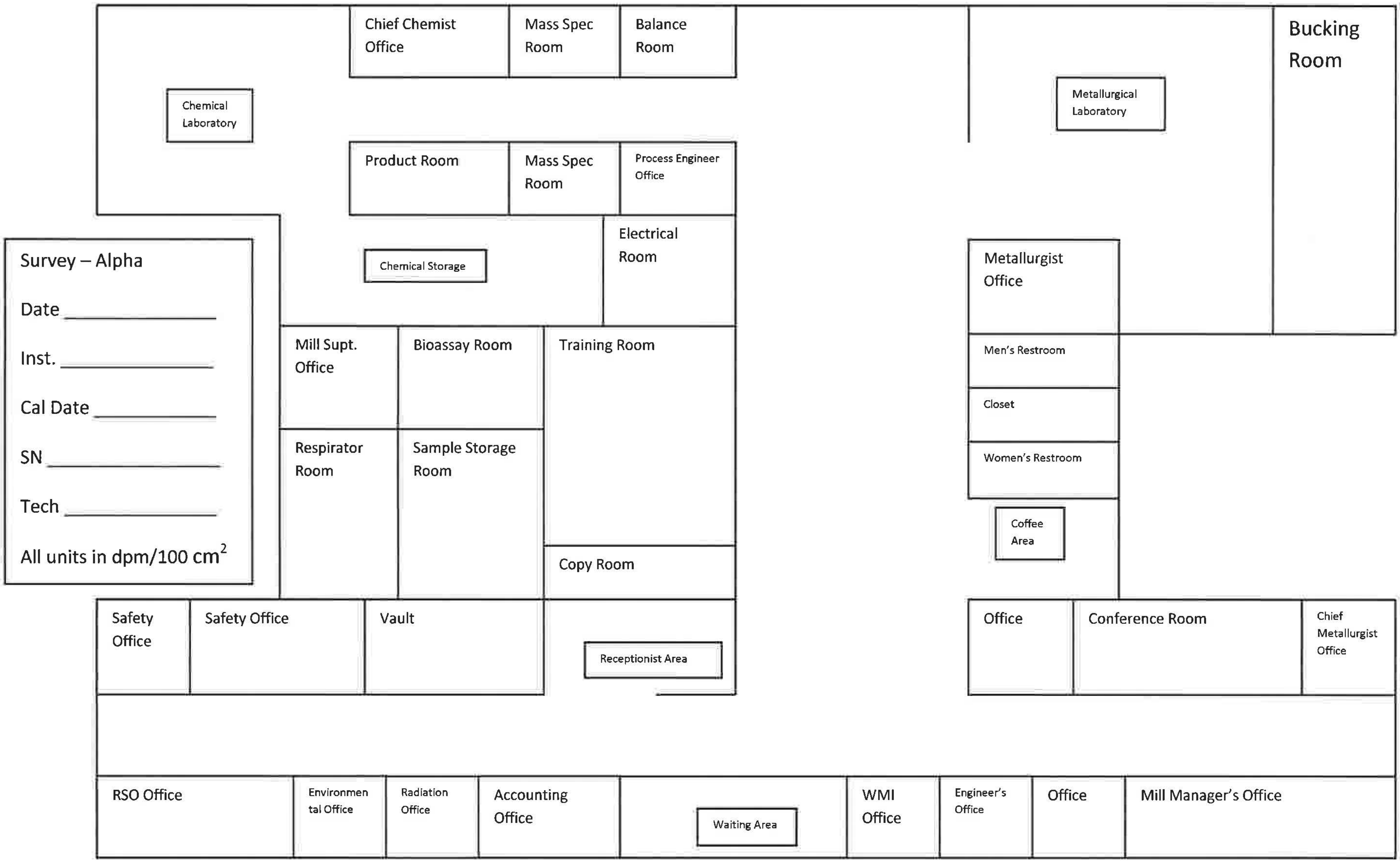
Instrument SN: ________________________________

Th_{230} Source SN: _____________________________

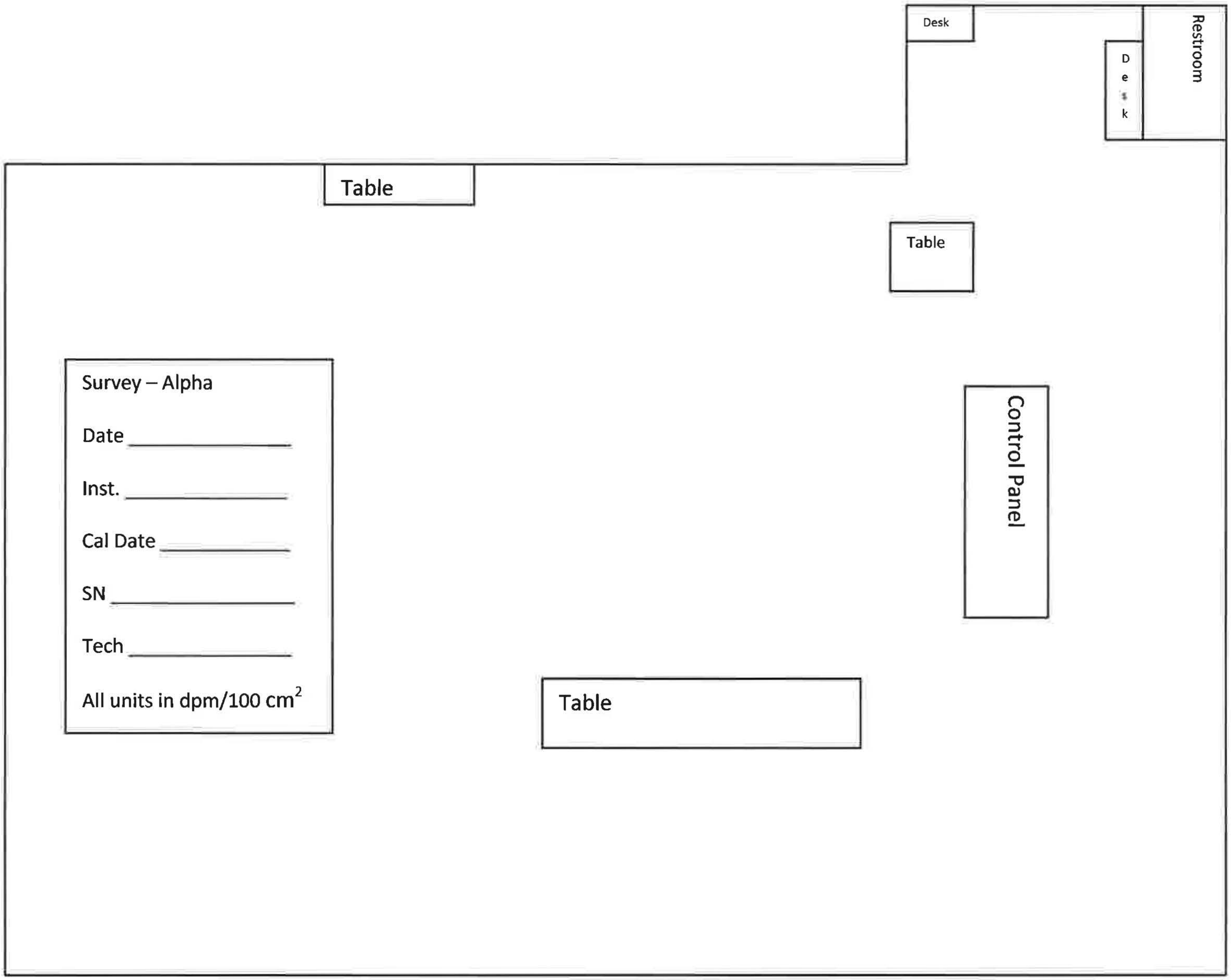
DPM: ________________ CPM: __________________

Efficiency: ____________ Efficiency Factor: __________

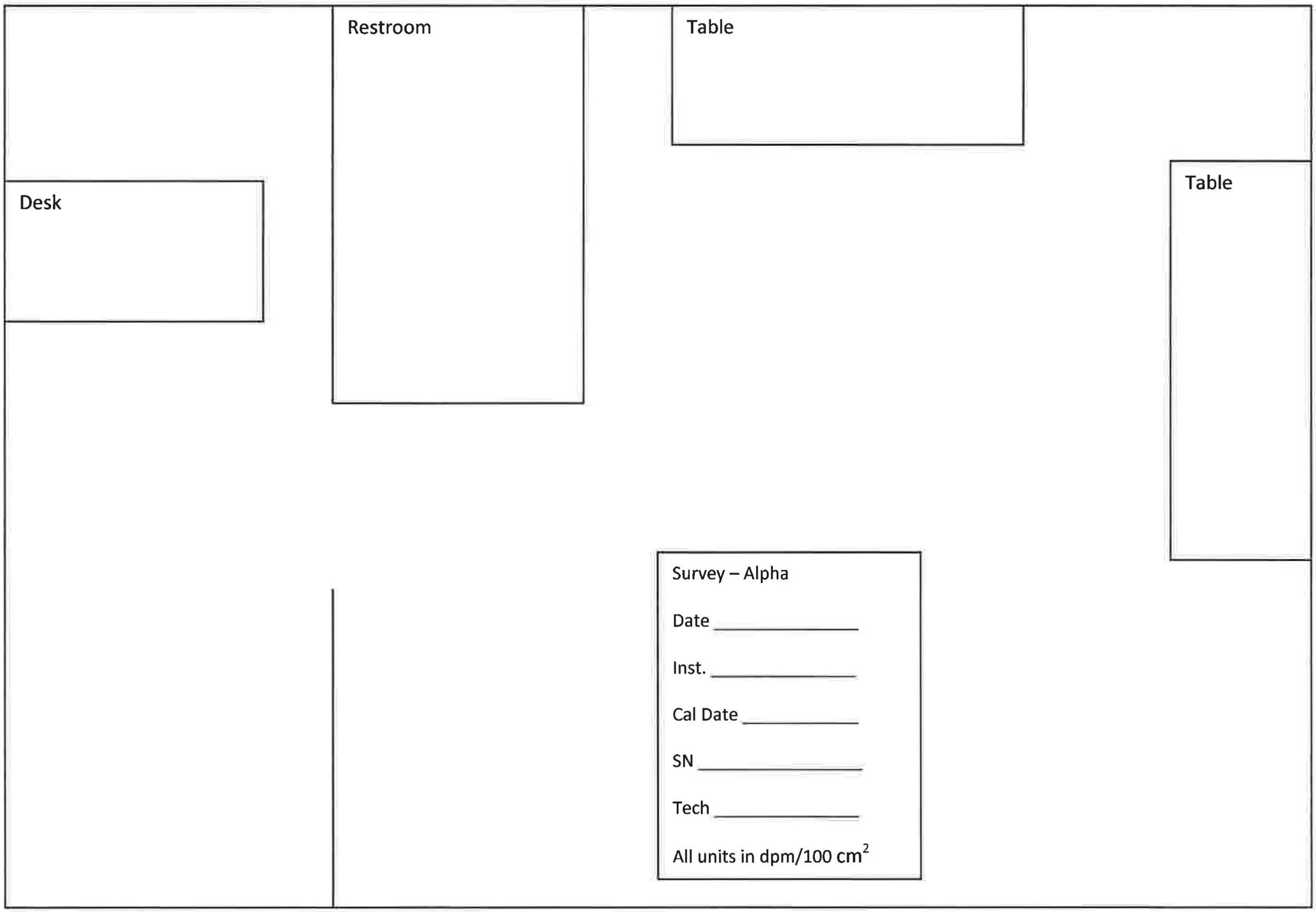
Administration Building



Central Control Room

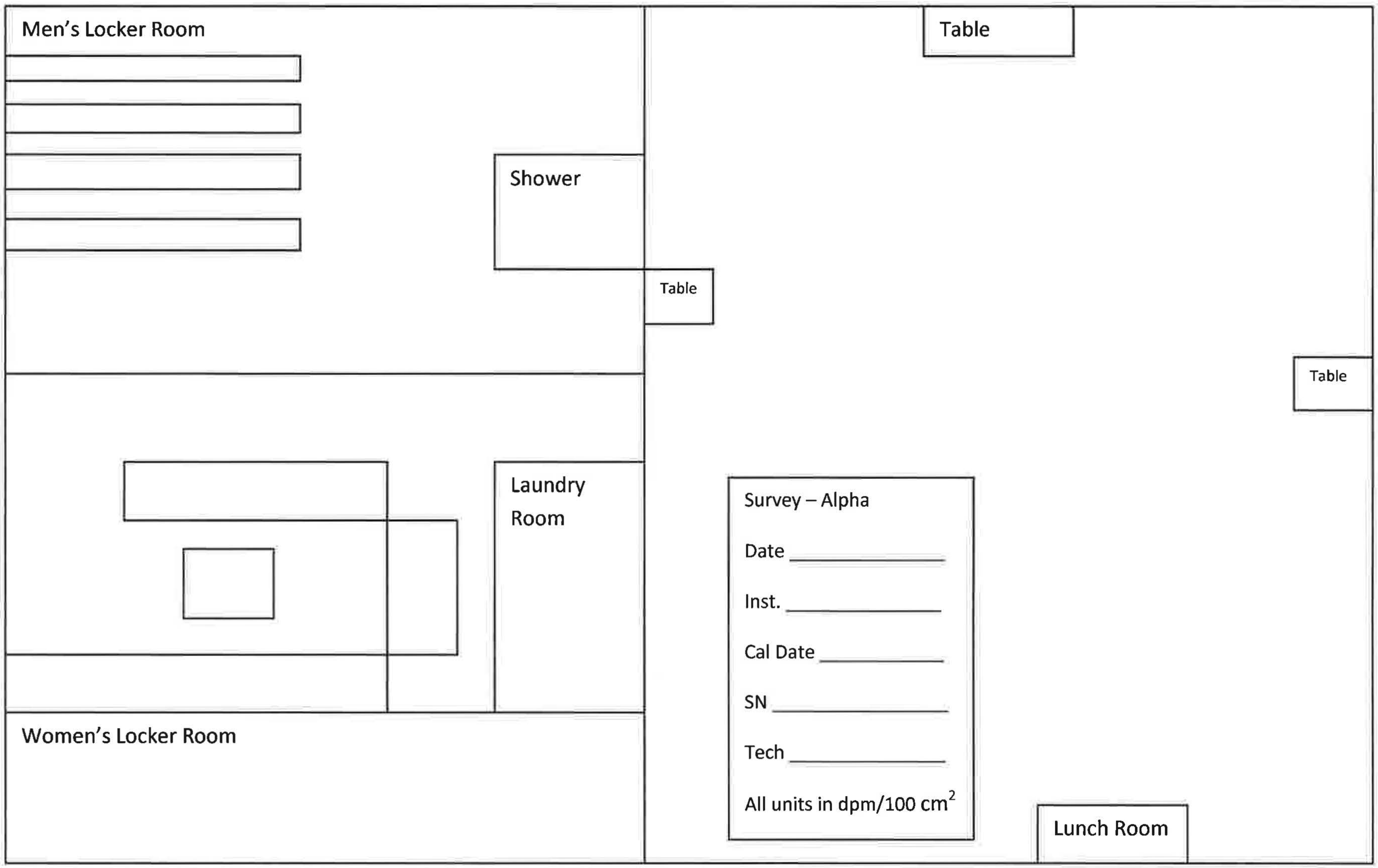


Scalehouse

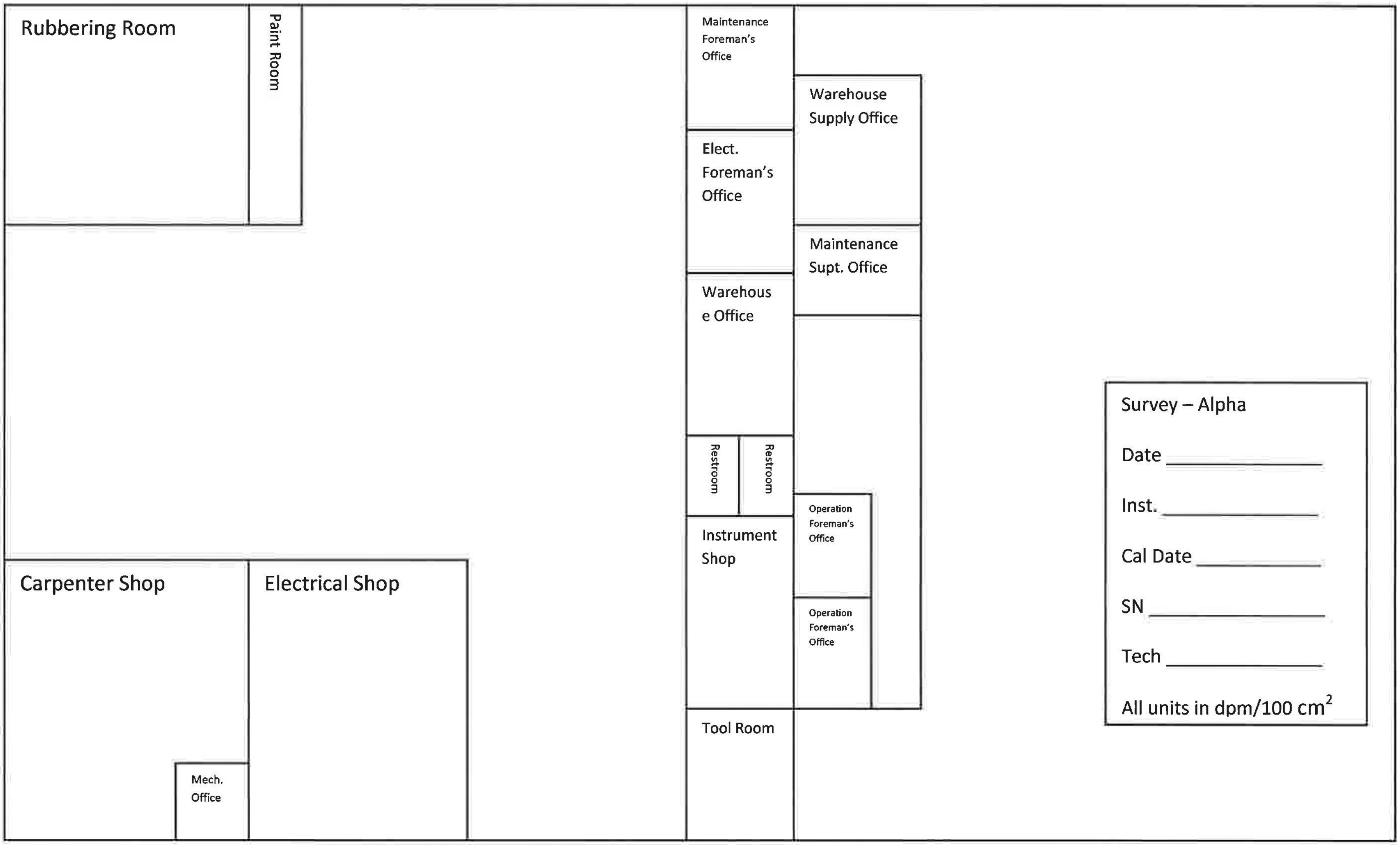


Restroom
Table
Desk
Table
Survey – Alpha
Date ______________
Inst. ______________
Cal Date ___________
SN ________________
Tech ______________
All units in dpm/100 cm2

Change/Lunch Room



Maintenance and Warehouse Areas



SX Building

Survey – Beta/Gamma

Date ________________

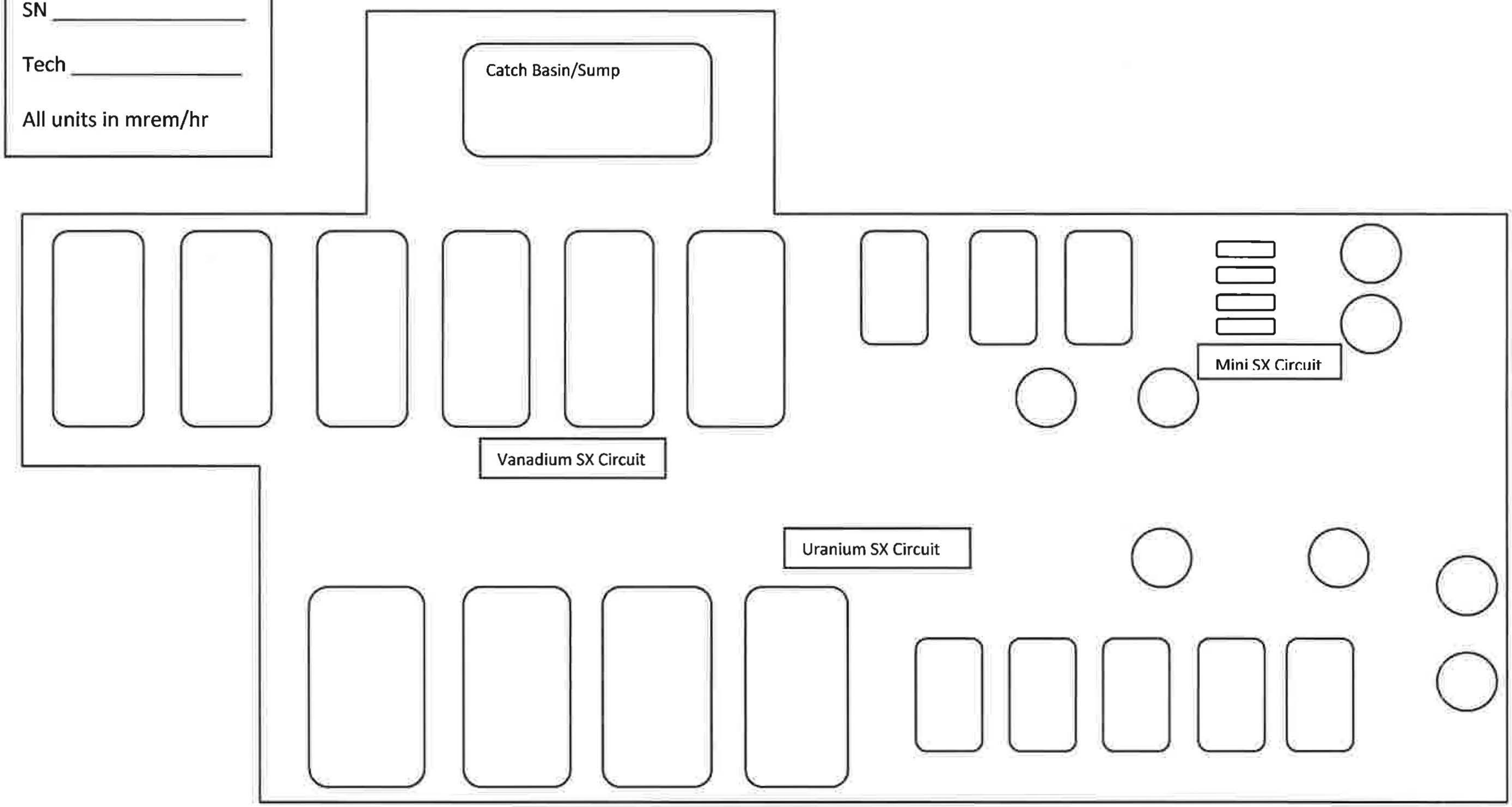
Inst. ________________

Cal Date _____________

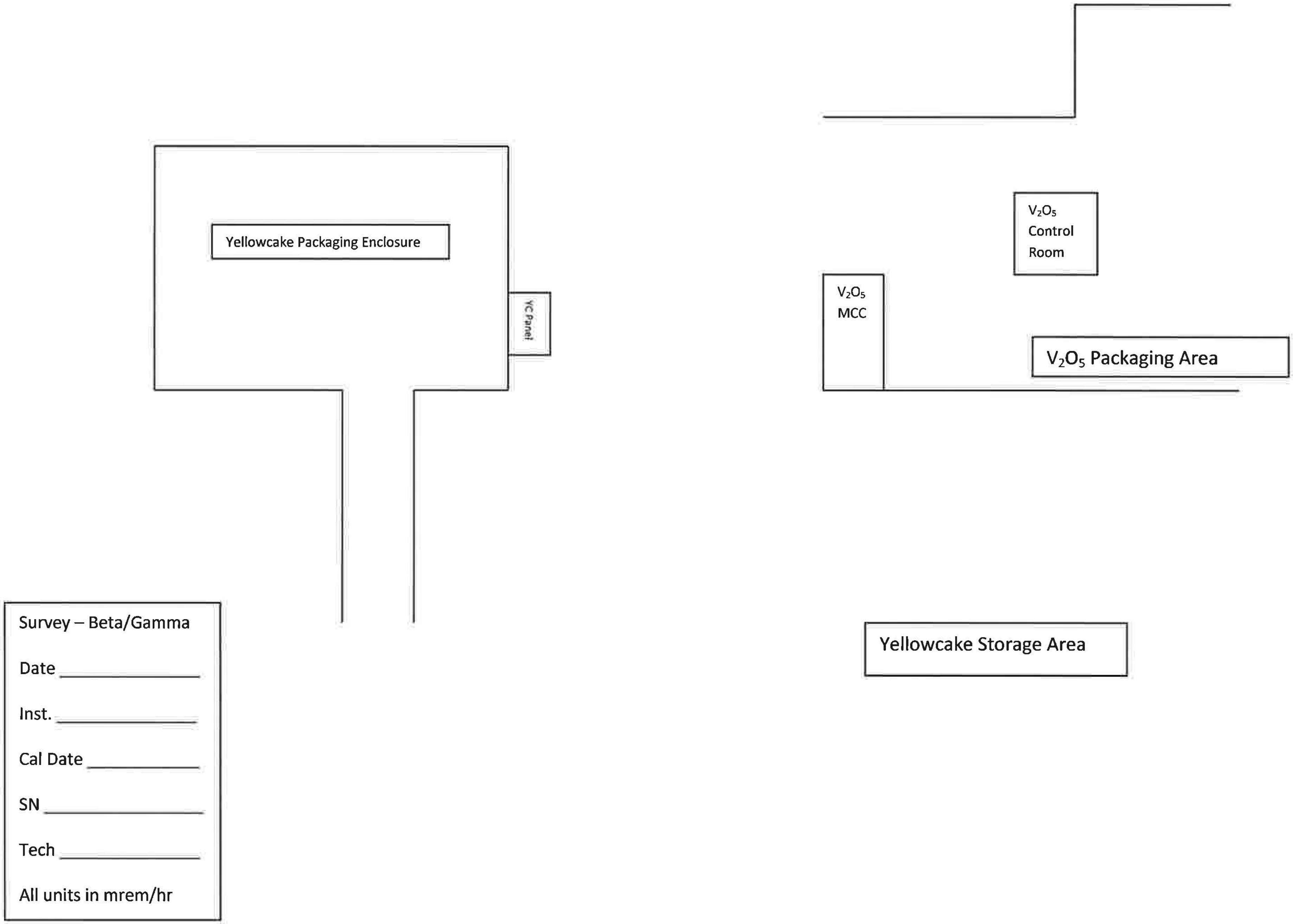
SN __________________

Tech ________________

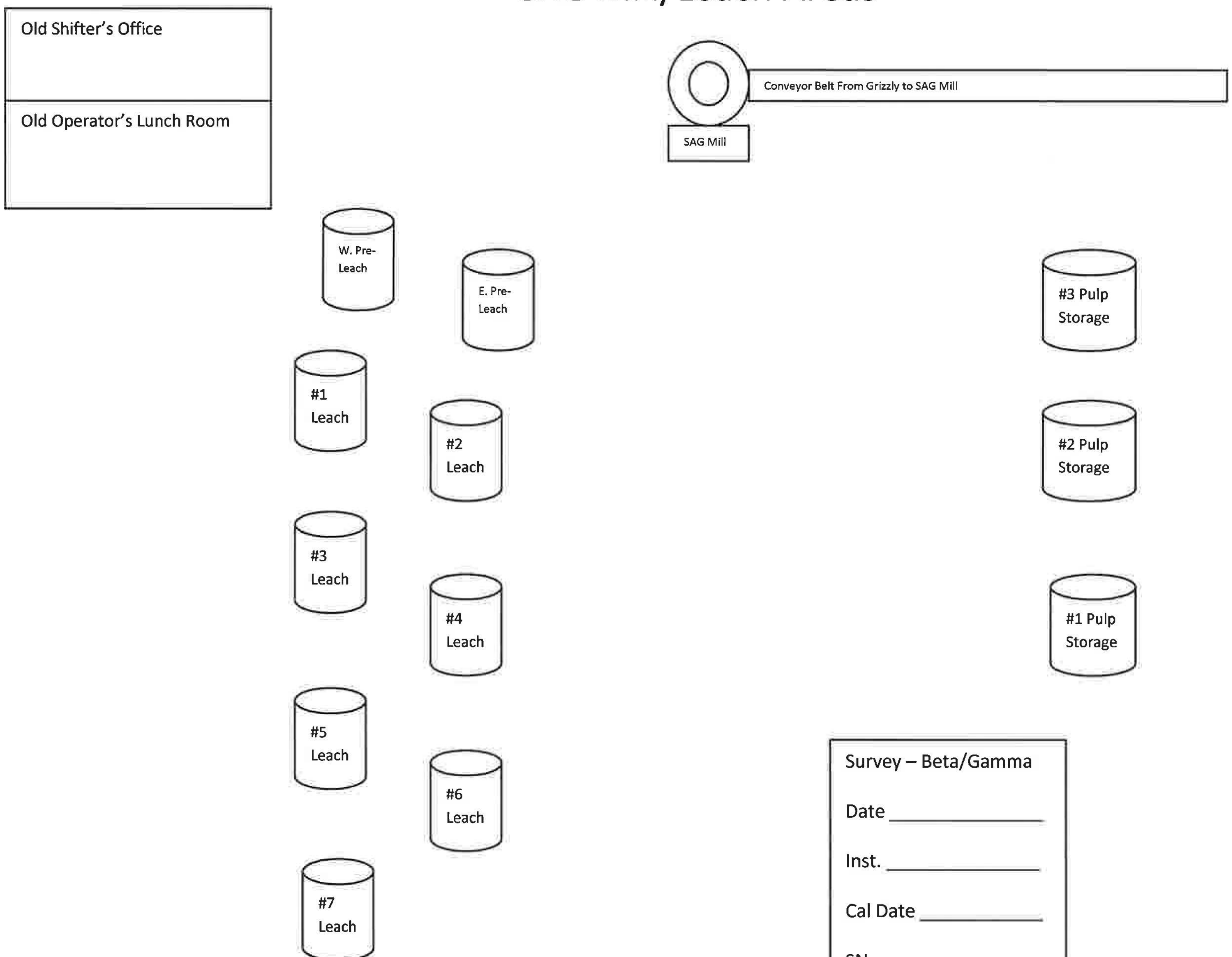
All units in mrem/hr



Product Packaging Areas



SAG Mill/Leach Areas



Survey – Beta/Gamma

Date ________________

Inst. ________________

Cal Date _____________

SN __________________

Tech ________________

All units in mrem/hr

Emergency Generator Building

Survey – Beta/Gamma

Date ______________

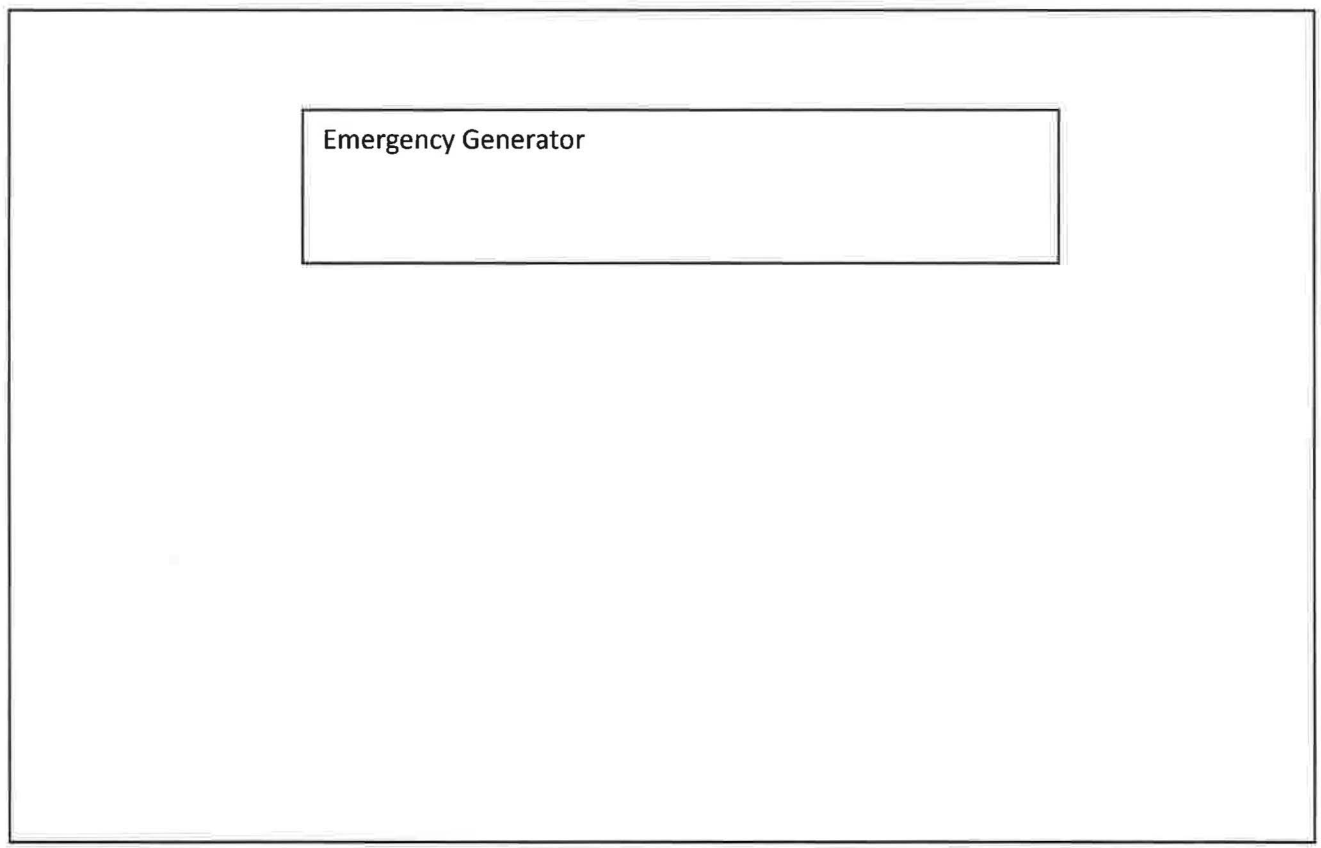
Inst. ______________

Cal Date ___________

SN ________________

Tech ______________

All units in mrem/hr



CCD/Precipitation Circuits

Survey – Beta/Gamma

Date ________________

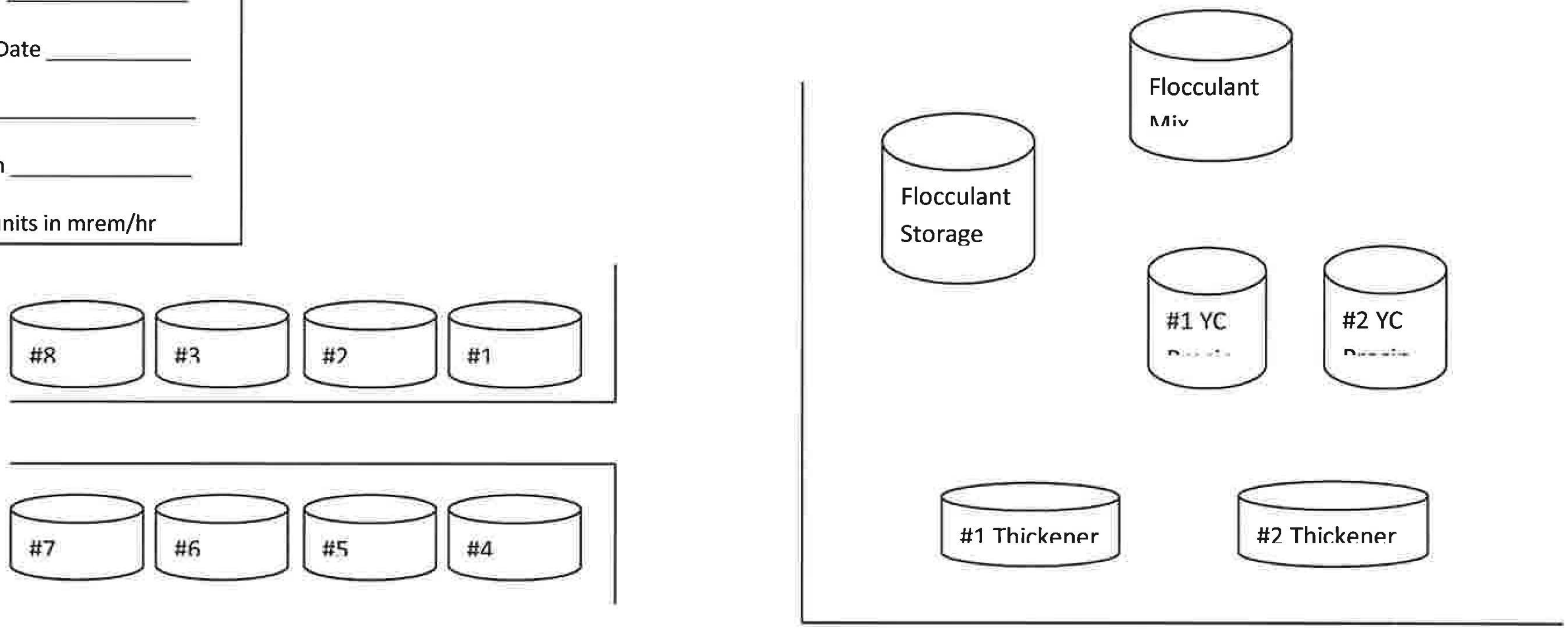
Inst. ________________

Cal Date _____________

SN __________________

Tech ________________

All units in mrem/hr



Uranium Packaging Circuit Upper Levels

Survey – Beta/Gamma

Date ______________

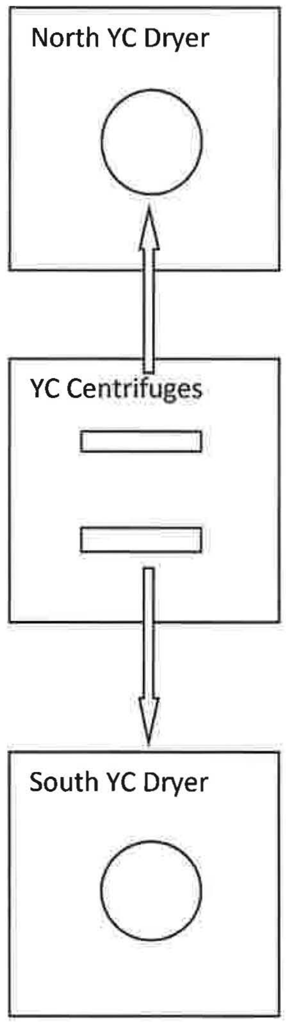
Inst. ______________

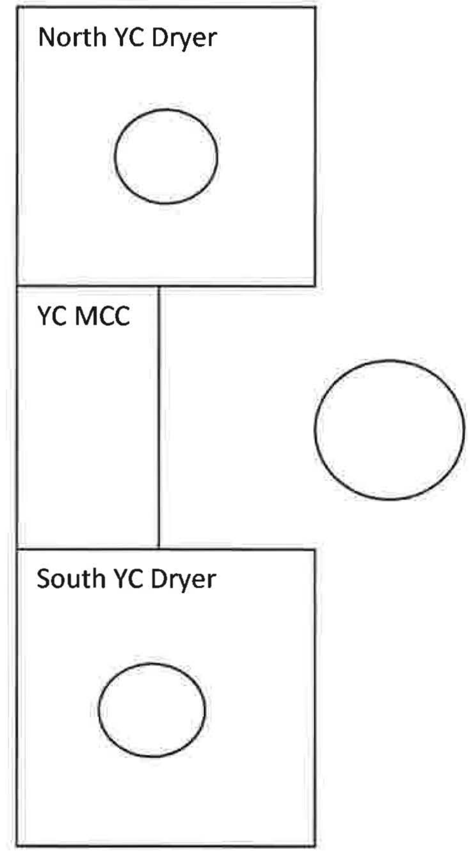
Cal Date ___________

SN ________________

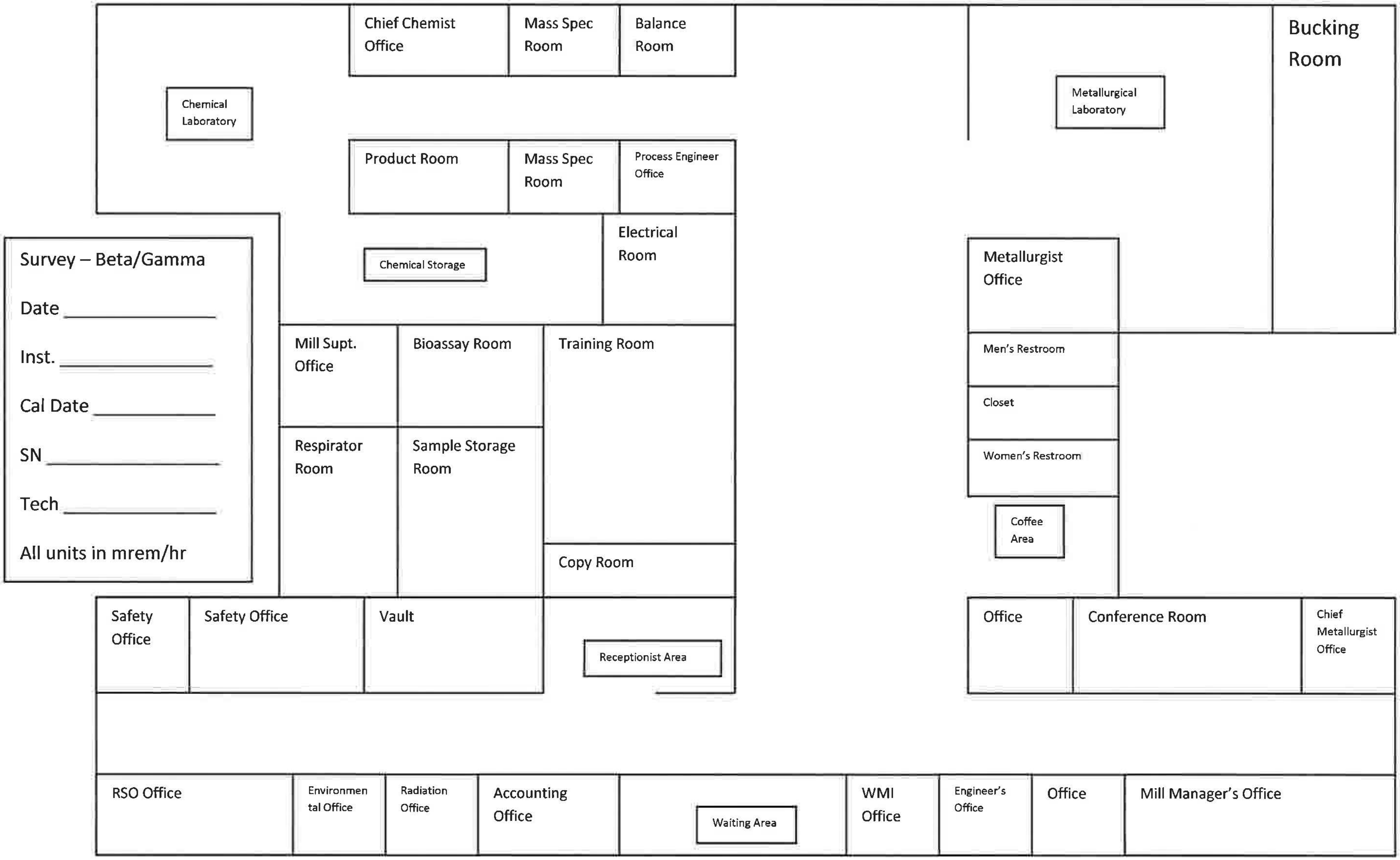
Tech ______________

All units in mrem/hr

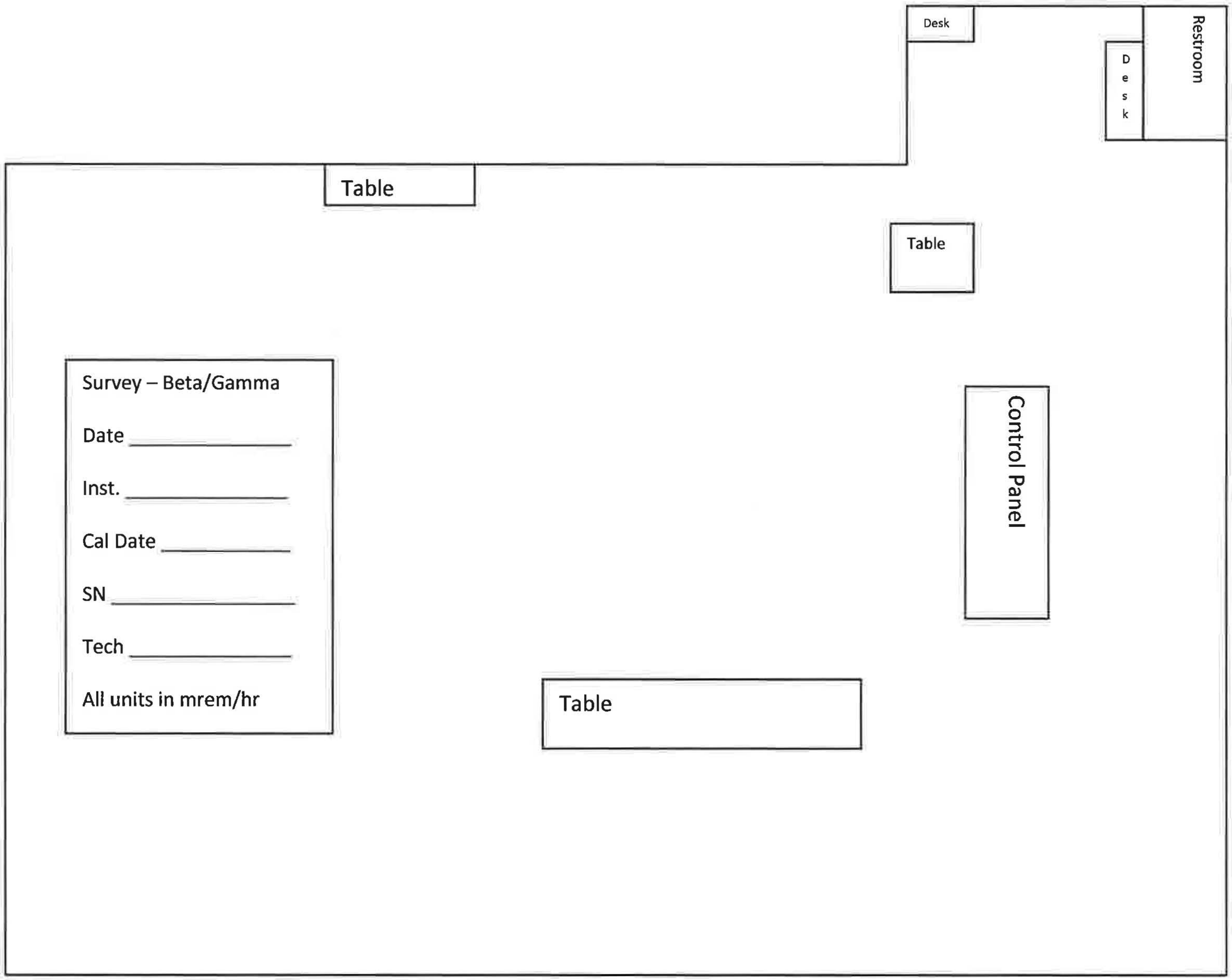




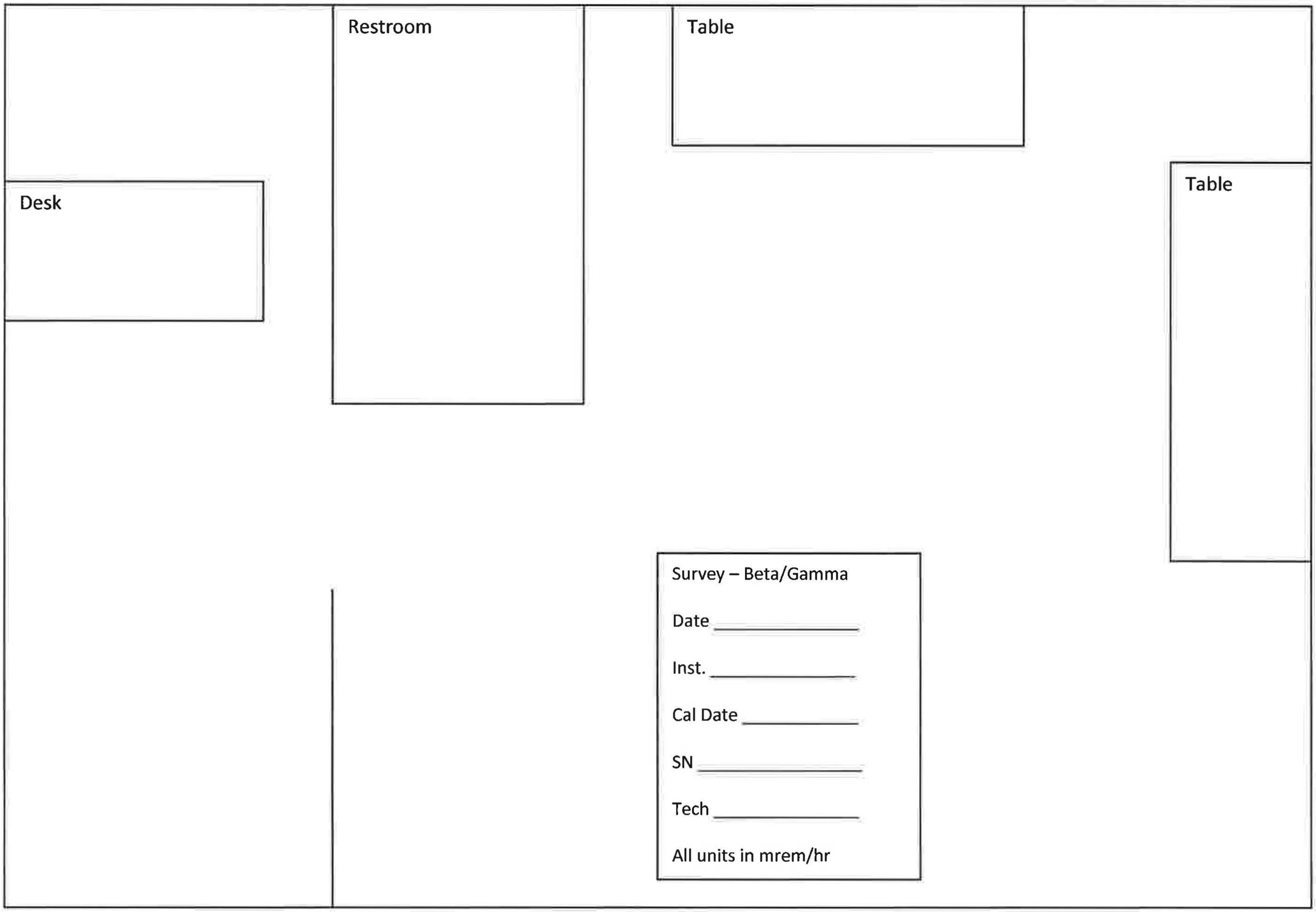
Administration Building



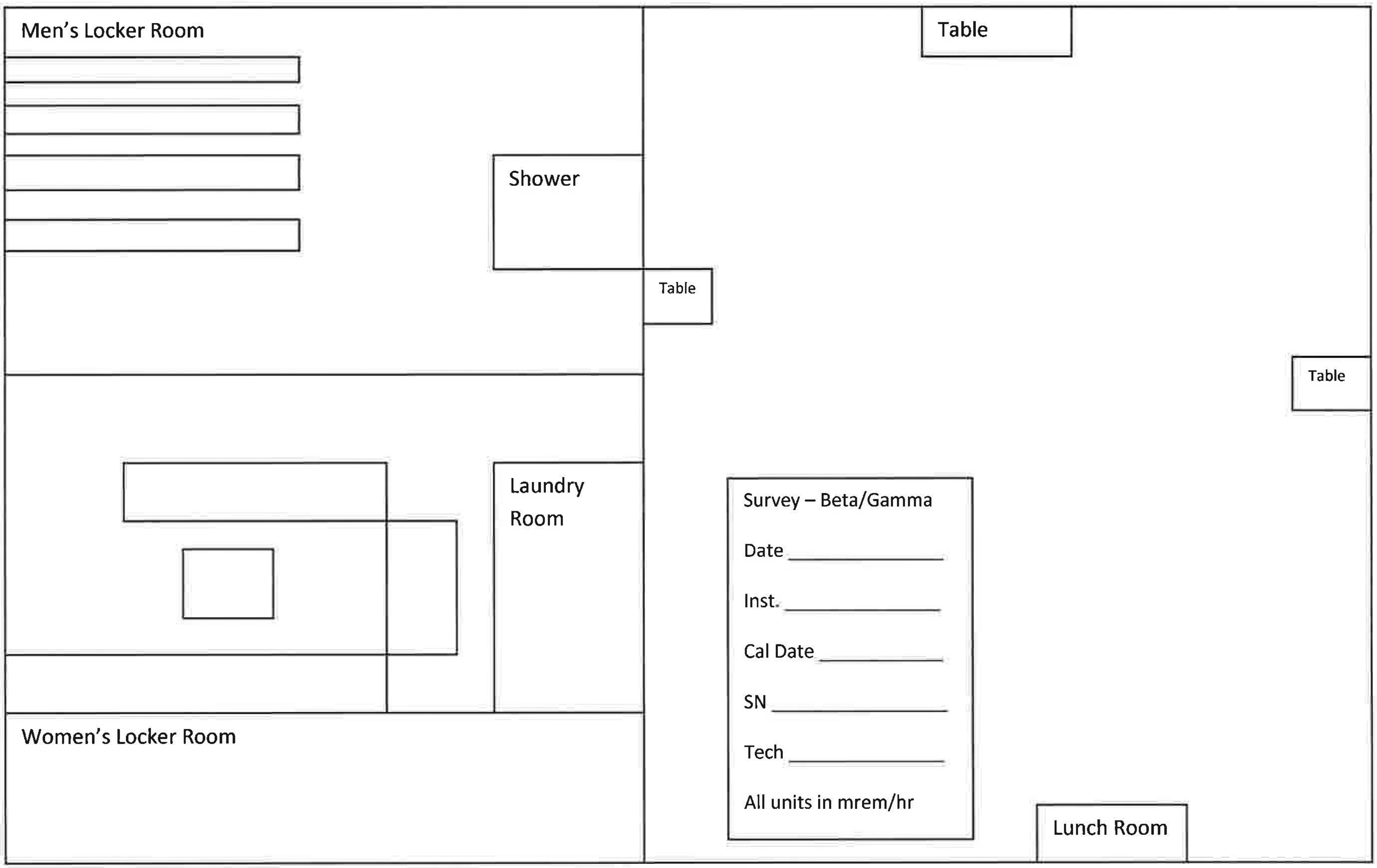
Central Control Room



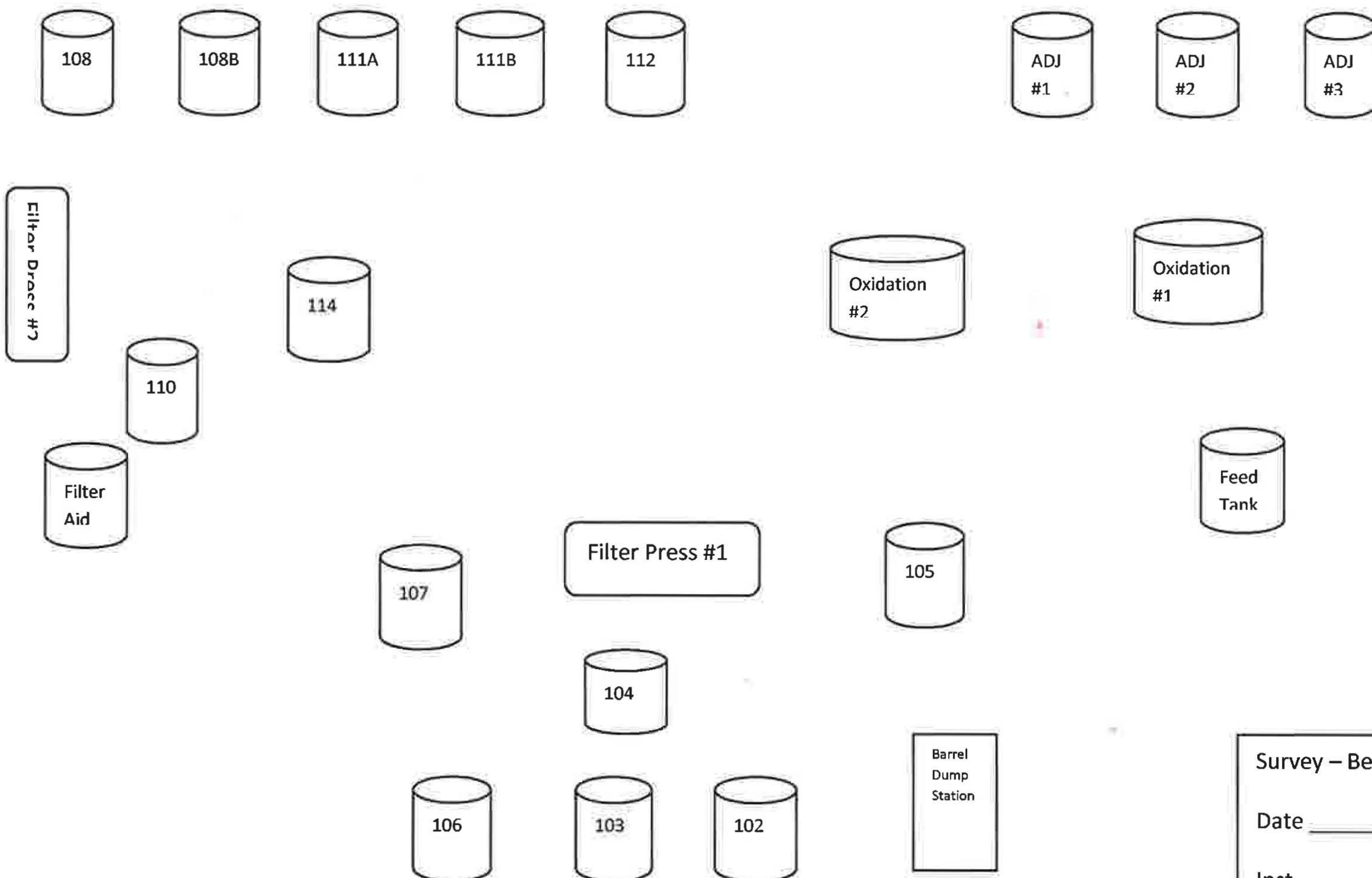
Scalehouse


Restroom
Table
Desk
Table
Survey – Beta/Gamma
Date ______________
Inst. ______________
Cal Date ___________
SN ________________
Tech ______________
All units in mrem/hr

Change/Lunch Room



Alternate Feed Circuit



Survey – Beta/Gamma

Date ______________

Inst. ______________

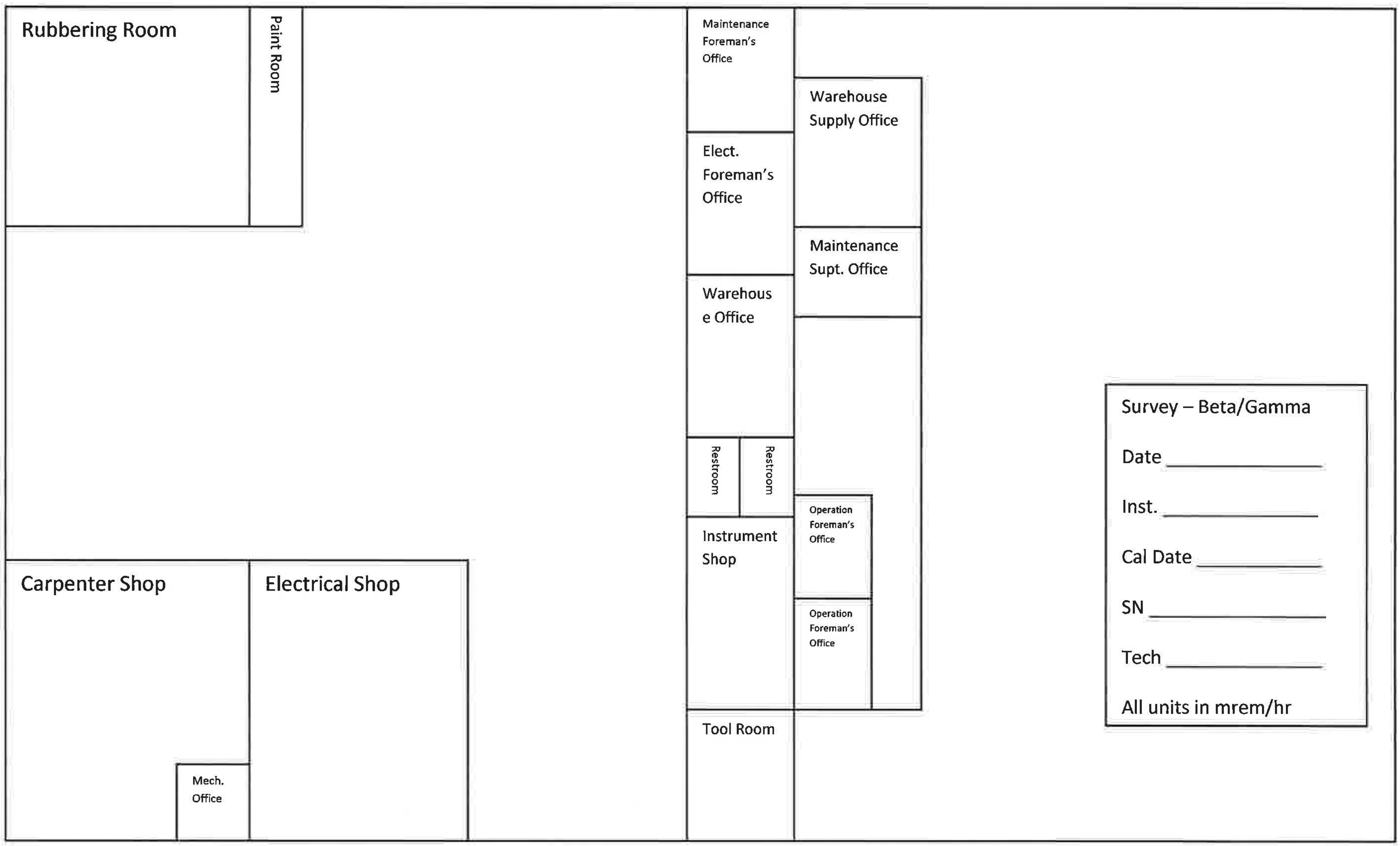
Cal Date ____________

SN ________________

Tech ______________

All units in mrem/hr

Maintenance and Warehouse Areas



Monthly Beta-Gamma Survey

Date: ______________________________

Technician: ______________________________

Function Check of Survey Instrument

Model #: ______________________

Serial #: ______________________

Calibration: ______________________

Source: ______________________

Source #: ______________________

Reading mrem/hr: ______________

All units are in mrem/hr.

RSO Reviewed: ________________________

RSO Comments: ________________________

Feedstock Areas

Feedstock Source	Reading

Survey – Beta/Gamma

Date ________________

Inst. ________________

Cal Date _____________

SN __________________

Tech ________________

All units in mrem/hr

Tails Area

Survey – Beta/Gamma

Date ________________

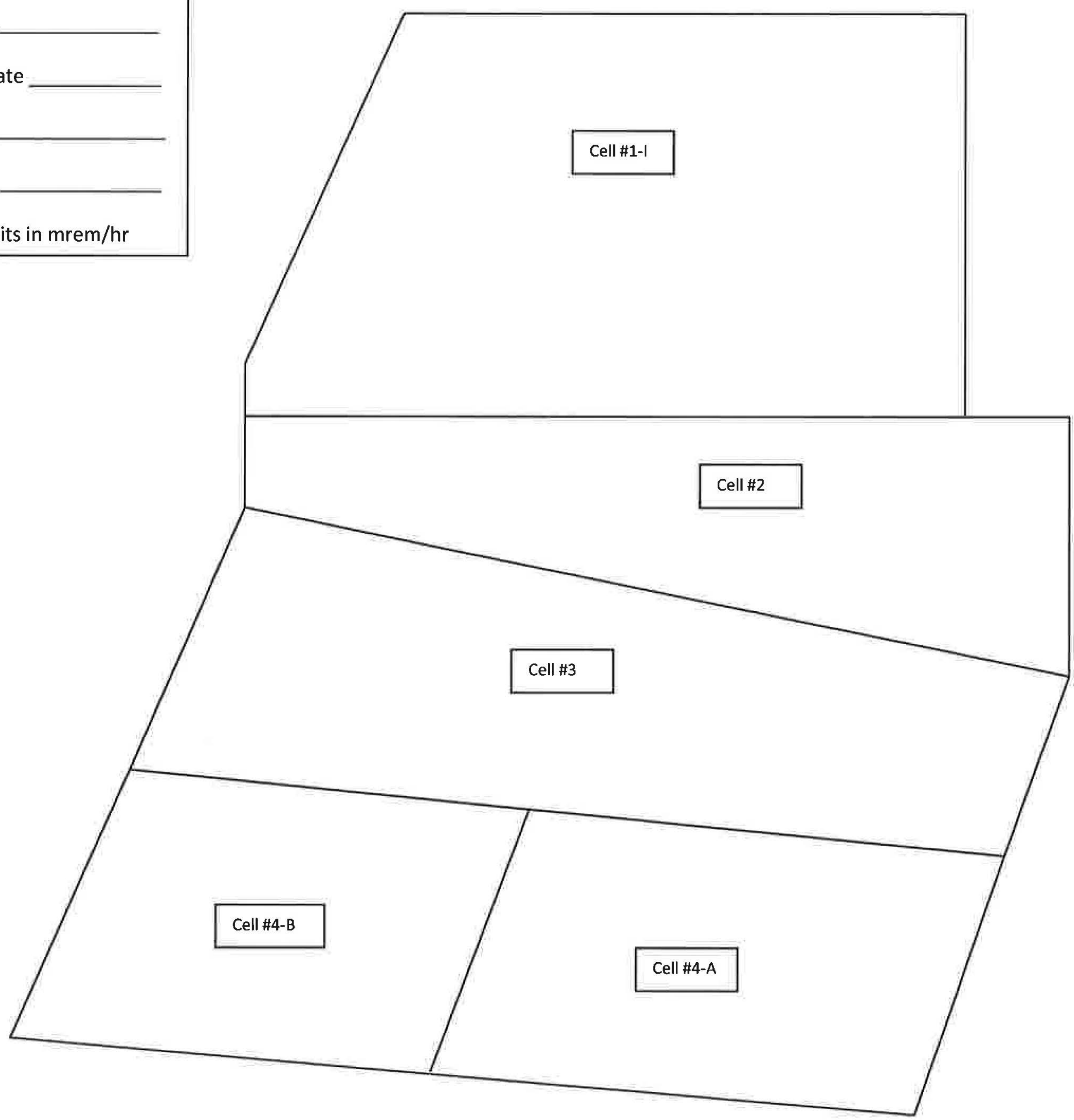
Inst. ________________

Cal Date ____________

SN __________________

Tech ________________

All units in mrem/hr



White Mesa Mill Weekly Alpha Survey

Date: ____________________________

Technician: ____________________________

Alpha Survey Instruments

Fixed	Removable
Model #: ____________	Model #: ____________
Serial #: ____________	Serial #: ____________
Calibration: ____________	Calibration: ____________
Efficiency: ____________	Efficiency: ____________
Factor: ____________	Factor: ____________
Background: ____________	Background: ____________
MDA: ____________	MDA: ____________

Notes:

All fixed readings are in dpm/100 cm^2

T or t = Total or Fixed Alpha Reading in dpm/100 cm^2

R or r = Removable Alpha Reading per swipe or filter (approximately 100 cm^2)

RSO Reviewed: ____________________

RSO Comments: ____________________

Energy Fuels Resources (USA) Inc.
White Mesa Mill
Radiation Survey of Equipment Released for Unrestricted Use

All equipment or material released from the White Mesa Mill to an unrestricted area must be surveyed for release in accordance with the following procedure.

1. Monitor for Gross alpha contamination with the appropriate survey meter.
2. If calculated assay exceeds 1,000 dpm/100cm^2, then perform swipe analysis at applicable points.
3. Decontaminate if a removable alpha exceeds 1,000 dpm/100cm^2 or fixed alpha exceeds 5,000 dpm/100cm^2.
4. Release equipment or material if alpha contamination and Beta-Gamma levels are below the following limit:

Removable alpha – 1,000 dpm/100cm^2
Fixed alpha- 5,000 dpm/100cm^2 average
15,000 dpm/100cm^2 maximum

Beta-Gamma- 0.2 mr/hr @1cm average
1.0 mr/hr @ 1cm maximum

Released from White Mesa Mill to: ____

Released by (print name): ______________________ Signature: ______________________

Date: __________

List of Equipment	Total Alpha dpm/100cm^2	Removable Alpha dpm/100cm^2	Beta/Gamma mr/hr
1.			
2.			
3.			
4.			
5.			

Instrument Function checks

Alpha Meter:
Inst. Model__________SN__________
Th-230 Source SN__________
dpm_______ cpm_______ eff_______
Efficiency Factor_________
Cal. Date: ______________
Bkg __________
MDA __________

Beta-Gamma Meter:
Inst. Model__________SN__________
Cs-137 Source SN_________
Inst. Response_________
Cal. Date: ____________

Removable Alpha:
Inst. Model__________SN__________
Th-230 Source SN_________
dpm_______ cpm_______eff________
Efficiency Factor_________
Cal. Date: ______________

Was a copy of this document offered to the recipient? Yes or No Signature of recipient ______________________

Comments: ____
____

ATTACHMENT E

EXISTING COVER DESIGN DOCUMENTS

ATTACHMENT E.1

TITAN ENVIRONMENTAL 1996 TAILNGS COVER DESIGN REPORT

(from approved Reclamation Plan Revision 3.2b)

TITAN Environmental

TAILINGS COVER DESIGN
White Mesa Mill

Prepared For:

Energy Fuels Nuclear, Inc.
1515 Arapahoe, Suite 900
Denver, CO 80202

September 1996

By:

TITAN Environmental Corporation
7939 East Arapahoe Road, Suite 230
Englewood, Colorado 80112

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ENERGY FUELS NUCLEAR

WHITE MESA MILL

TAILINGS COVER DESIGN

1.0 SOIL COVER DESIGN

A six-foot thick soil cover for the uranium tailings Cells 2, 3 and 4A was designed using on-site materials that will contain tailings and radon emissions in compliance with regulations by the United States Nuclear Regulatory Commission (NRC) and by reference, the Environmental Protection Agency (EPA). The cover consists of a one-foot thick layer of clay, available from within the site boundaries (Section 16), below two-feet of random fill, available from stockpiles on-site. The clay is underlain with three feet (minimum) random fill soil, also available on site. The cover layers will be compacted to 95 percent maximum dry density using standard construction techniques. In addition to the soil cover, a minimum 3 inch (on the cover top) to 12-inch (on the cover slopes) layer of riprap material will be placed over the compacted random fill to stabilize slopes and provide long-term erosion resistance.

Uranium tailings soil cover design requirements for agency compliance include:

- Attenuate radon flux to an acceptable level (20 picoCuries-per meter squared-per second [pCi/m^2/sec]) (NRC, 1989);
- Minimize infiltration into the reclaimed tailings cells;
- Maintain a design life of up to 1,000 years and at least 200 years; and
- Provide long-term slope stability and geomorphic durability to withstand erosional forces of wind, the probable maximum flood event, and a horizontal ground acceleration of 0.1g due to seismic events.

Several models/analyses were utilized in simulating the soil cover effectiveness: radon flux attenuation, hydrologic evaluation of infiltration, freeze/thaw effects, soil cover erosion protection, and static and pseudostatic slope stability analyses. These analyses and results are discussed in detail in Sections 1.1 through 1.5. The soil cover configuration presented above consisting of (from top to bottom); a minimum three inches of riprap material on the top cover, two feet compacted random fill, one foot compacted clay, and a minimum of three feet random fill beneath the clay meets NRC and EPA requirements.

The soil cover design for the uranium tailings Cells 2, 3, and 4A was developed based on two construction options:

- An integrated soil cover over Disposal Cells 2, 3, and 4A; and
- A cover over Cells 2 and 3, where Cell 4A tailings are excavated and placed into Cell 3.

For modeling/analysis purposes it was assumed that the physical and radiological parameters of the tailings in Cells 2, 3, and 4A are not dependent on the tailing volume in each individual cell. Therefore, each of the two construction options above resulted in the same soil cover configuration. The only variation between the options is in the required volumes of cover materials, which is dependent only on the surface area to be covered (see Section 1.7).

The final grading plans for the two options are presented on Figures 1 and 2, respectively. As indicated on the figures, the top slope of the soil cover will be constructed at 0.2 percent and the side slopes, as well as transitional areas between cells, will be graded to five horizontal to one vertical (5H:1V).

A minimum of three feet random fill is located beneath the compacted fill and clay layers (see cross-sections on Figures 3 and 4. The purpose of the fill is to raise the base of the cover to the desired subgrade elevation. In many areas, the required fill thickness will be much greater. However, the models and analyses were performed conservatively assuming only a three-foot layer. For modeling purposes, this lower, random fill layer was considered as part of the soil cover for performing the radon flux attenuation calculation, as it effectively contributes to the reduction of radon emissions (see Section 1.1). The fill was also evaluated in the slope stability analysis (see Section 1.5). However, it is not defined as part of the soil cover for other design calculations (infiltration, freeze/thaw, and cover erosion).

The following sections describe design considerations, complete with calculations performed and parameters utilized, in developing the tailings impoundment soil cover to meet regulatory requirements.

1.1 Radon Flux Attenuation

The Environmental Protection Agency (EPA) rules in 40 Code of Federal Regulation (CFR) Part 192 require that a "uranium tailings cover be designed to produce reasonable assurance that the radon-222 release rate would not exceed 20 pCi/m^2/sec for a period of 1,000 years to the extent reasonably achievable and in any case for at least 200 years when averaged over the disposal area over at least a one year period" (NRC, 1989). NRC regulations presented in 10 CFR Part 40 also restrict radon flux to less than 20 pCi/m^2/sec. The following sections present the analyses and design for a soil cover which meets this requirement.

1.1.1 Predictive Analysis

The soil cover for the tailings cells at White Mesa Mill was evaluated for attenuation of radon gas using the digital computer program, RADON, presented in the NRC's Regulatory Guide 3.64 (Task WM 503-4) entitled "Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers". The RADON model calculates radon-222 flux attenuation by multi-layered earthen uranium mill tailings covers, and determines the minimum cover thickness required to meet NRC and EPA standards. The RADON model uses the following soil properties in the calculation process:

- Soil layer thickness [centimeters (cm)];
- Soil porosity (percent);
- Density [grams-per-cubic centimeter (gm/cm^3)];
- Weight percent moisture (percent);
- Radium activity (piC/g);
- Radon emanation coefficient (unitless); and

- Diffusion coefficient [square centimeters-per-second (cm^2/sec)].

Physical and radiological properties for tailings and random fill were analyzed by Chen and Associates (1987) and Rogers and Associates (1988). Clay physical data from Section 16 was analyzed by Advanced Terra Testing (1996) and Rogers and Associates (1996). See Appendix A for laboratory test data results.

The Radon model was performed for the following cover section (from top to bottom):

- two feet compacted random fill;
- one foot compacted clay; and
- a minimum of three feet random fill occupying the freeboard space between the tailings and clay layer.

The three layers are compacted to 95 percent maximum dry density. The top riprap layer was not included as part of the soil cover for the radon attenuation calculation.

The results of the RADON modeling exercise show that the uranium tailings cover configuration will attenuate radon flux emanating from the tailings to a level of 17.6 $pCi/m^2/sec$. This number was conservatively calculated as it takes into account the freeze/thaw effect on the uppermost part (6.8 inches) of the cover (Section 1.3). The soil cover and tailing parameters used to run the RADON model, in addition to the RADON input and output data files, are presented in Appendix B as part of the Radon Calculation brief. Based on the model results, the soil cover design of six-foot thickness will meet the requirements of 40 CFR Part 192 and 10 CFR Part 40.

1.1.2 Empirical Data

Radon gas flux measurements have been made at the White Mesa Mill tailings piles over Cells 2 and 3 (see Appendix C). These cells are currently covered with three to four feet of random fill. Radon flux measurements, averaged over the covered areas, were as follows (EFN, 1996):

	1994	1995
Cell 2	7.7 pCi/m^2 sec	6.1 pCi/m^2 sec
Cell 3	7.5 pCi/m^2 sec	11.1 pCi/m^2 sec.

Empirical data suggest that the random fill cover, alone, is currently providing an effective barrier to radon flux. Thus, the proposed tailings cover configuration, which is thicker, moisture adjusted, contains a clay layer and is compacted, is expected to attenuate the radon flux to a level below that predicted by the Radon model. The field radon flux measurements confirm the conservatism of the cover design. This conservatism is necessary, however, to guarantee compliance with NRC regulations under long term climatic conditions over the required design life of 200 to 1,000 years.

1.2 Infiltration Analysis

The tailings ponds at White Mesa Mill are lined with synthetic geomembrane liners which could lead to the long-term accumulation of water from infiltration of precipitation. Therefore, the soil cover was evaluated to estimate the potential magnitude of infiltration into the capped tailings ponds. The Hydrologic Evaluation of Landfill Performance (HELP) model, Version 3.0 (EPA, 1994) was used for the analysis. HELP is a quasi two-dimensional hydrologic model of water movement across, into, through, and out of capped and lined impoundments. The model utilizes weather, soil, and engineering design data as input to the model, to account for the effects of surface storage, snowmelt, run-off, infiltration, evapotranspiration, vegetative growth, soil moisture storage, lateral subsurface drainage, and unsaturated vertical drainage on the specific design, at the specified location.

The soil cover was evaluated based on a two-foot compacted random fill layer over a one-foot thick, compacted clay layer. The soil cover layers were modeled based on material placement at a minimum of 95 percent of the maximum dry density, and within two percent of the optimum moisture content per American society for Testing and Materials (ASTM) requirements. The top riprap layer and the bottom random fill layer were not included as part of the soil cover for infiltration calculations.

The random fill will consist of clayey sands and silts with random amounts of gravel and rock-size materials. The average hydraulic conductivity of several samples of random fill was calculated, based on laboratory tests, to be 8.87×10^{-7} cm/sec. The hydraulic conductivity of the clay source from Section 16 was measured in the laboratory to be 3.7×10^{-8} cm/sec. Geotechnical soil properties and laboratory data are presented in Appendix A.

Key HELP model input parameters include:

- Blanding, Utah, monthly temperature and precipitation data, and HELP model default solar radiation, and evapotranspiration data from Grand Junction, Colorado. Grand Junction is located north east of Blanding in similar climate and elevation;
- Soil cover configuration identifying the number of layers, layer types, layer thickness', and the total covered surface area;
- Individual layer material characteristics identifying saturated hydraulic conductivity, porosity, wilting point, field capacity, and percent moisture; and
- Soil Conservation Service runoff curve numbers, evaporative zone depth, maximum leaf area index, and anticipated vegetation quality.

Water balance results, as calculated by the HELP model, indicate that precipitation would either run-off the soil cover or be evaporated. Thus, model simulations predict zero infiltration of surface water through the soil cover, as designed. These model results are conservative and take into account the freeze/thaw effects on the uppermost part (6.8 inches) of the cover (Section 1.3). The HELP model input and output for the tailings soil cover are presented in the HELP Model calculation brief included as Appendix D.

1.3 Freeze/Thaw Evaluation

The tailings soil cover of one foot of compacted clay covered by two feet of random fill was evaluated for freeze/thaw impacts. Repeated freeze/thaw cycles have been shown to increase the bulk soil permeability by breaking down the compacted soil structure.

The soil cover was evaluated for freeze/thaw effects using the modified Berggren equation as presented in Aitken and Berg (1968) and recommended by the NRC (U.S. Department of Energy, 1988). This evaluation was based on the properties of the random fill and clay soil, and meteorological data from both Blanding, Utah and Grand Junction, Colorado.

The results of the freeze/thaw evaluation indicate that the anticipated maximum depth of frost penetration on the soil cover would be less than 6.8 inches. Since the random fill layer is two feet thick, the frost depth would be confined to this layer and would not penetrate into the underlying clay layer. The performance of the soil cover to attenuate radon gas flux below the prescribed standards, and prevent surface water infiltration, would not be compromised. The input data and results of the freeze/thaw evaluation are presented in the Effects of Freezing on Tailings Covers Calculation brief included as Appendix E.

1.4 Soil Cover Erosion Protection

A riprap layer was designed for erosion protection of the tailings soil cover. According to NRC guidance, the design must be adequate to protect the soil/tailings against exposure and erosion for 200 to 1,000 years (NRC, 1990). Currently, there is no standard industry practice for stabilizing tailings for 1,000 years. However, by treating the embankment slopes as wide channels, the hydraulic design principles and practices associated with channel design were used to design stable slopes that will not erode. Thus, a conservative design based on NRC guidelines was developed. Engineering details and calculations are summarized in the Erosion Protection Calculation brief provided in Appendix F.

Riprap cover specifications for the top and side slopes were determined separately as the side slopes are much steeper than the slope of the top of the cover. The size and thickness of the riprap on the top of the cover was calculated using the Safety Factor Method (NUREG/CR-4651, 1987), while the Stephenson Method (NUREG/CR-4651, 1987) was used for the side slopes. These methodologies were chosen based on NRC recommendations (1990).

By the Safety Factor Method, riprap dimensions for the top slope were calculated in order to achieve a slope "safety factor" of 1.1. For the top of the soil cover, with a slope of 0.2 percent, the Safety Factor Method indicated a median diameter (D_{50}) riprap of 0.28 inches is required to stabilize the top slope. However, this dimension must be modified based on the long-term durability of the specific rock type to be used in construction. The suitability of rock to be used as a protective cover must be assessed by laboratory tests to determine the physical characteristics of the rocks. The sandstones from the confluence of Westwater and Cottonwood Canyons require an oversizing factor of 25 percent. Therefore, riprap created from this sandstone source should have a D_{50} size of at least 0.34 inches and should have an overall layer thickness of at least three inches on the top of the cover.

Riprap dimensions for the side slopes were calculated using Stephenson Method equations. The side slopes of the cover are designed at 5H:1V. At this slope, Stephenson's Method indicated the unmodified riprap D_{50} of 3.24 inches is required. Again assuming that the on-site sandstone will be used, the modified D_{50} size of the riprap should be at least 4.05 inches with an overall layer thickness of at least 12 inches.

The potential of erosion damage due to overland flow, sheetflow, and channel scouring on the top and side slopes of the cover, including the riprap layer, has been evaluated. Overland flow calculations were performed using site meteorological data, cap design specifications, and guidelines set by the NRC (NUREG/CR-4620, 1986). These calculations are included in Appendix F. According to the guidelines, overland flow velocity estimates are to be compared to "permissible velocities", which have been suggested by the NRC, to determine the potential for erosion damage. When calculated, overland flow velocity estimates exceed permissible velocities, additional cover protection should be considered. The permissible velocity for the tailings cover (including the riprap layer) is 5.0 to 6.0 feet-per-second (ft./sec.) (NUREG/CR 4620). The overland flow velocity calculated for the top of the cover is less than 2.0 ft/sec., and the calculated velocity on the side slopes is 4.9 ft/sec. Therefore, the erosion potential of the slopes, due to overland flow/channel scouring, is within acceptable limits and no additional erosion protection is required.

1.5 Slope Stability Analysis

Static and pseudostatic analyses were performed to establish the stability of the side slopes of the tailings soil cover. The side slopes are designed at an angle of 5H:1V. Because the side slope along the southern section of Cell 4A is the longest and the ground elevation drops rapidly at its base, this slope was determined to be critical and is thus the focus of the stability analyses.

The computer software package GSLOPE, developed by MITRE Software Corporation, has been used for these analyses to determine the potential for slope failure. GSLOPE applies Bishop's Method of slices to identify the critical failure surface and calculate a factor of safety (FOS). The slope geometry and properties of the construction materials and bedrock are input into the model. These data and drawings are included in the Stability Analysis of Side Slopes Calculation brief included as Appendix G. For this analysis, competent bedrock is designated at 10 feet below the lowest point of the foundation [i.e., at a 5,540-foot elevation above mean sea level (msl)]. This is a conservative estimate, based on the borehole logs supplied by Chen and Associates (1979), which indicate bedrock near the surface.

1.5.1 Static Analysis

For the static analysis, a FOS of 1.5 or more was used to indicate an acceptable level of stability. The calculated FOS is 2.91, which indicates that the slope should be stable under static conditions. Results of the computer model simulations are included in Appendix G.

1.5.2 Pseudostatic Analysis (Seismicity)

The slope stability analysis described above was repeated under pseudostatic conditions in order to estimate a FOS for the slope when a horizontal ground acceleration of 0.10g is applied. The slope geometry and material properties used in this analysis are identical to those used in the stability analysis. A FOS of 1.0 or more was used to indicate an acceptable level of stability under pseudostatic conditions. The calculated FOS is 1.903, which indicates that the slope should be stable under dynamic conditions. Details of the analysis and the simulation results are included in Appendix G.

Recently, Lawrence Livermore National Laboratory (LLNL) published a report on seismic activity in southern Utah, in which a horizontal ground acceleration of 0.12g was proposed for the White Mesa site. The evaluations made by LLNL were conservative to account for tectonically active regions that exist, for example, near Moab, Utah. Although, the LLNL report states that "...[Blanding] is located in a region known for its scarcity of recorded seismic events," the stability of the cap design slopes using the LLNL factor was evaluated. The results of a sensitivity analysis reveal that when considering a horizontal ground acceleration of 0.12g, the calculated FOS is 1.778 which is still above the required value of 1.0, indicating adequate safety under pseudostatic conditions. This analysis is also included in Appendix G.

1.6 Cover Material/Cover Material Volumes

Construction materials for reclamation will be obtained from on-site locations. Fill material will be available from the stockpiles that were generated from excavation of the cells for the tailings facility. If required, additional materials are available locally to the west of the site. A clay material source, identified in Section 16 at the southern end of the White Mesa Mill site, will be used to construct the one-foot compacted clay layer. Riprap material will be taken from on-site sandstone, located at the confluence of Westwater and Cottonwood Canyons.

Material quantities have been calculated for each of the components of the reclamation cover. Volume estimates were made for the two soil cover design options, as follows:

- Option 1: an integrated soil cover which incorporates Disposal Cells 2, 3, and 4A, and
- Option 2: a cover which includes Cells 2 and 3, where Cell 4A tailings have been excavated and placed in Cell 3.

The quantity of random fill required to bring the pond elevation up to the soil cover subgrade and construct the final slope was not calculated. This layer will be a minimum of three feet in depth and is dependent on the final tailings grade, which is not known.

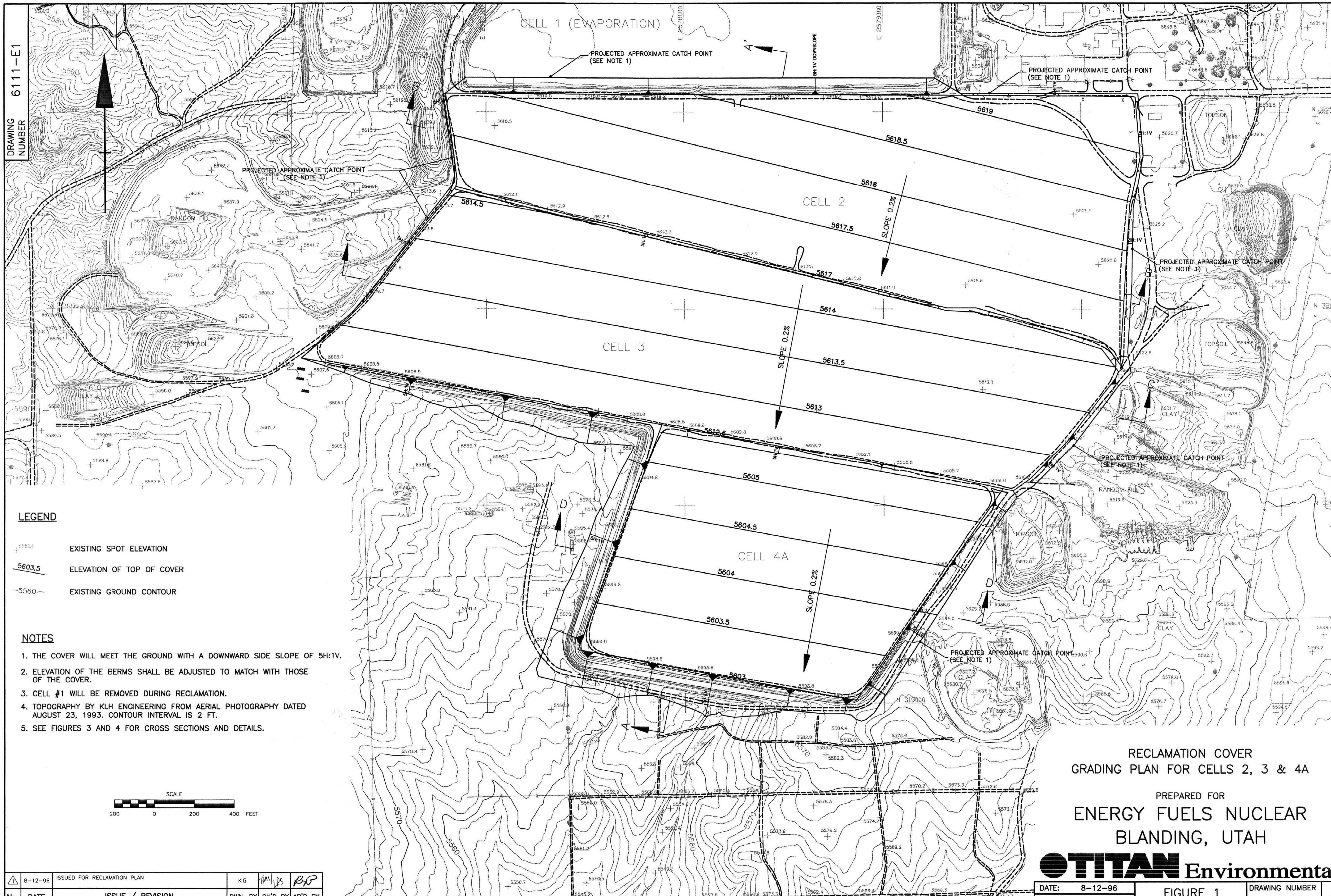
For Design Option 1, construction will require the following approximate quantities of materials:

Material	**Volume (cubic yards)**
Clay	365,082
Random Fill	737,717
Riprap (top of cover)	82,762
Riprap (side slopes)	41,588

For Design Option 2, construction will require the following approximate quantities of materials:

Material	**Volume (cubic yards)**
Clay	289,514
Random Fill	585,334
Riprap (top of cover)	64,984
Riprap (side slopes)	35,885

Material quantities calculations are provided in Appendix H as part of the Tailings Cover Material Volume Calculation brief.



LEGEND

+ 5582.6	EXISTING SPOT ELEVATION
5603.5	ELEVATION OF TOP OF COVER
~5560~	EXISTING GROUND CONTOUR

NOTES

1. THE COVER WILL MEET THE GROUND WITH A DOWNWARD SIDE SLOPE OF 5H:1V.
2. ELEVATION OF THE BERMS SHALL BE ADJUSTED TO MATCH WITH THOSE OF THE COVER.
3. CELL #1 WILL BE REMOVED DURING RECLAMATION.
4. TOPOGRAPHY BY KLH ENGINEERING FROM AERIAL PHOTOGRAPHY DATED AUGUST 23, 1993. CONTOUR INTERVAL IS 2 FT.
5. SEE FIGURES 3 AND 4 FOR CROSS SECTIONS AND DETAILS.

SCALE
200 0 200 400 FEET

No.	DATE	ISSUE / REVISION	DWN. BY	CK'D BY	AP'D BY
1	8-12-96	ISSUED FOR RECLAMATION PLAN	K.G.		

RECLAMATION COVER
GRADING PLAN FOR CELLS 2, 3 & 4A

PREPARED FOR
ENERGY FUELS NUCLEAR
BLANDING, UTAH

TITAN Environmental

DATE: 8-12-96	FIGURE 1	DRAWING NUMBER 6111-E1
SCALE: AS SHOWN		

DRAWING NUMBER 6111-E1

LEGEND

+ 5582.6	EXISTING SPOT ELEVATION
5603.5	ELEVATION OF TOP OF COVER
—5560—	EXISTING GROUND CONTOUR

NOTES

1. THE COVER WILL MEET THE GROUND WITH A DOWNWARD SIDE SLOPE OF 5H:1V.
2. ELEVATION OF THE BERMS SHOULD BE ADJUSTED TO MATCH WITH THOSE OF THE COVER.
3. CELL #1 WILL BE REMOVED DURING RECLAMATION.
4. TOPOGRAPHY BY KLH ENGINEERING FROM AERIAL PHOTOGRAPHY DATED AUGUST 23, 1993. CONTOUR INTERVAL IS 2 FT.
5. CELL 4A BOTTOM SHALL BE GRADED TO DRAIN THROUGH BREACH AREA. BREACH AREA SHALL BE CONSTRUCTED WITH SMOOTH TRANSITIONS INTO EXISTING GROUND AREAS. BREACH AREA SIDESLOPES TO BE GRADED TO A MAXIMUM 3H:1V.
6. SEE FIGURES 3 AND 4 FOR CROSS SECTIONS AND DETAILS.

SCALE
200 0 200 400 FEET

No.	DATE	ISSUE / REVISION	DWN. BY	CK'D BY	AP'D BY
1	8-12-96	ISSUED FOR RECLAMATION PLAN	K.G.	[signature]	[signature]

RECLAMATION COVER
GRADING PLAN FOR CELLS 2 & 3

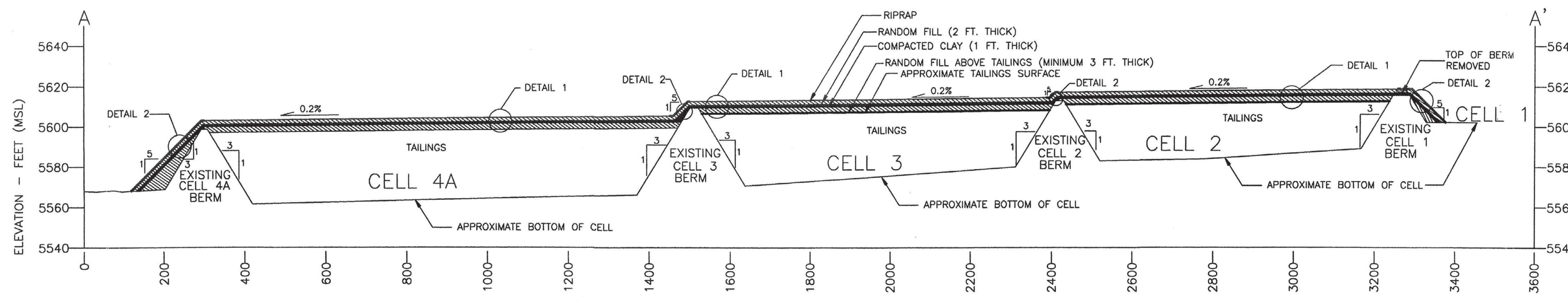
PREPARED FOR
ENERGY FUELS NUCLEAR
BLANDING, UTAH

TITAN Environmental

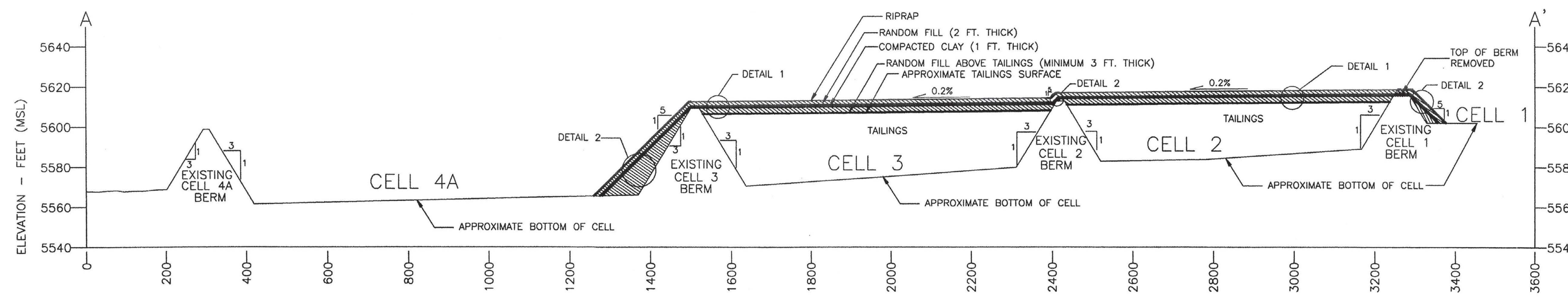
DATE: 8-12-96	FIGURE 2	DRAWING NUMBER 6111-E2	1
SCALE: AS SHOWN			

DRAWING NUMBER 6111-E2

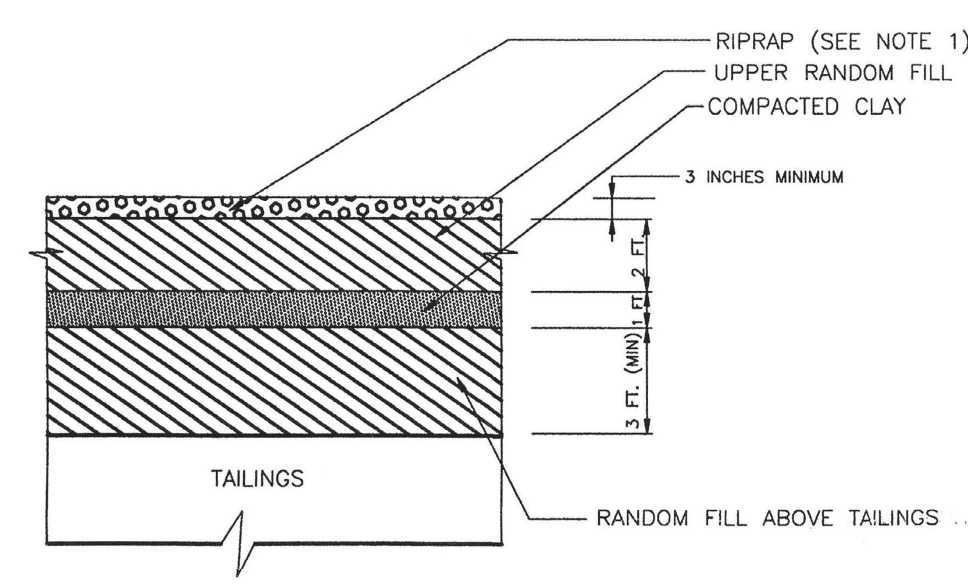
DRAWING NUMBER 6111-E3



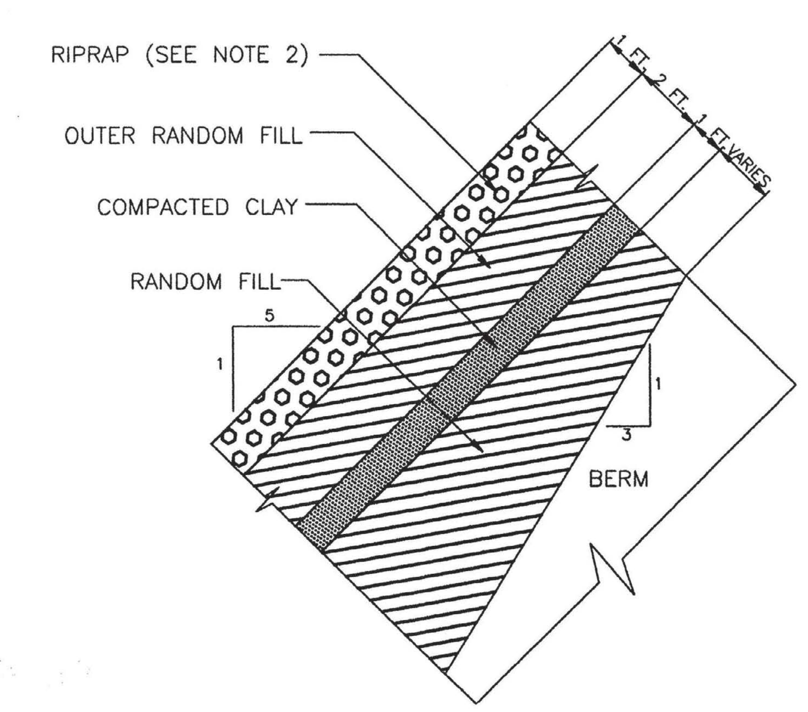
SECTION A–A' (WITH COVER ON CELLS 2, 3 & 4A)



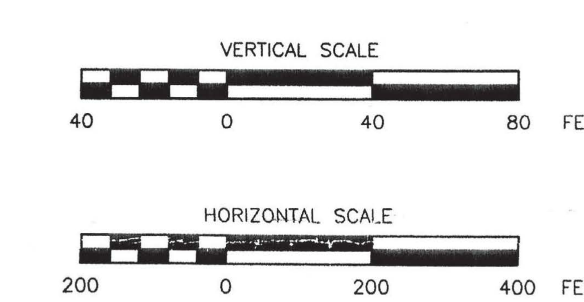
SECTION A–A' (WITH COVER ON CELLS 2 & 3)



DETAIL 1: COVER DETAIL FOR POND SURFACE AREAS
(NOT TO SCALE)



DETAIL 2: COVER DETAIL FOR SIDE SLOPES
(NOT TO SCALE)



NOTES:

1. RIPRAP PLACED ON THE TOP OF COVER WILL CONSIST OF ROCK WITH D50 MINIMUM OF 0.34 INCHES.
2. RIPRAP PLACED ON THE SIDE SLOPES OF COVER WILL CONSIST OF ROCK WITH D50 MINIMUM OF 4.1 INCHES.
3. POND BOTTOM ELEVATIONS INFERRED FROM 'CELL 4 PHASE A AND PHASE B PLAN', WESTERN ENGINEERS INC., (JANUARY 17, 1989).
4. SEE FIGURES 1 AND 2 FOR CROSS SECTION LOCATIONS

No.	DATE	ISSUE / REVISION	DWN. BY	CK'D BY	AP'D BY
⚠	8-12-96	ISSUED FOR RECLAMATION PLAN	K.G.	[signature]	[signature]

RECLAMATION COVER
CROSS SECTIONS & DETAILS
PREPARED FOR

ENERGY FUELS NUCLEAR
BLANDING, UTAH

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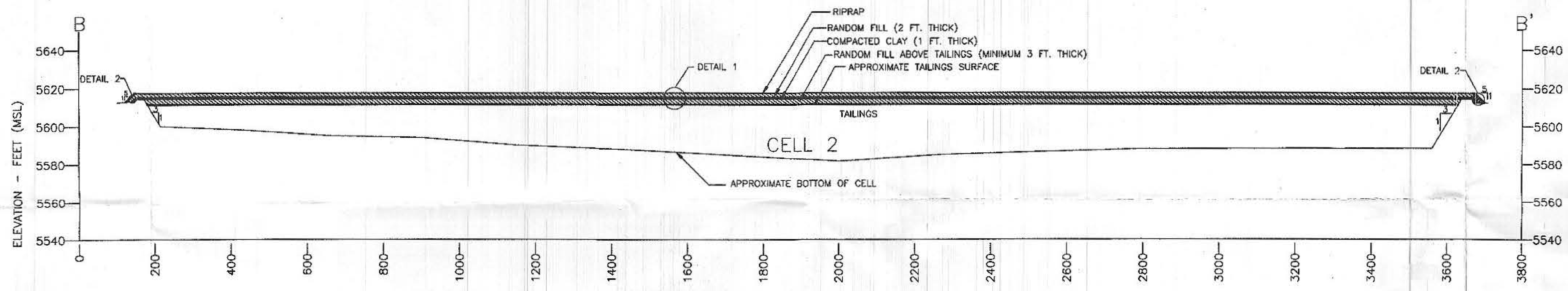
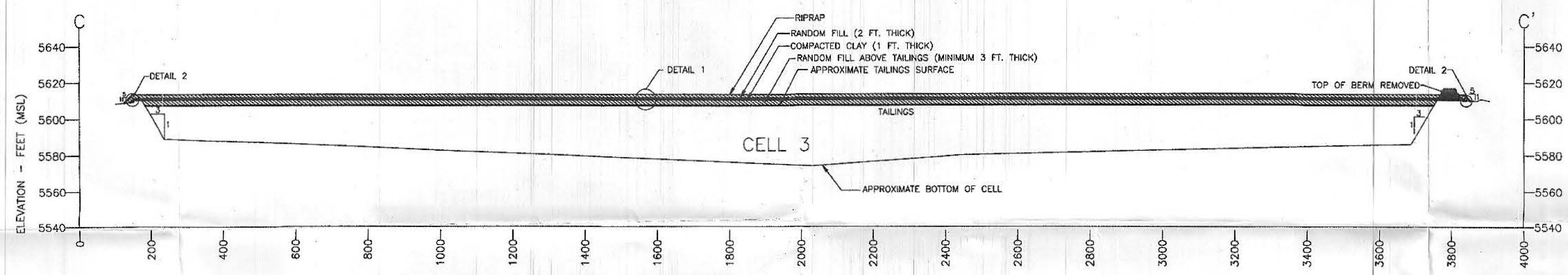
DATE: 8-12-96	FIGURE 3	DRAWING NUMBER 6111-E3	⚠
SCALE: AS SHOWN			

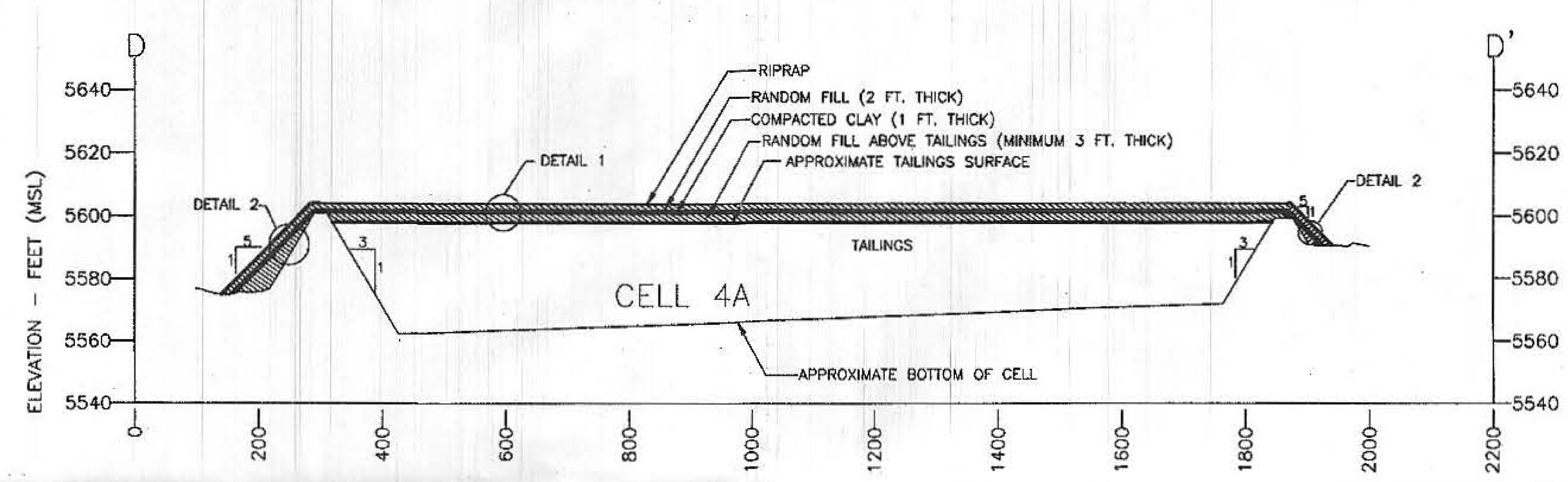
DRAWING NUMBER 6111-E4



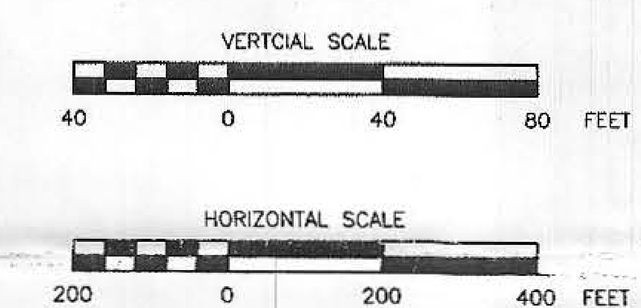
SECTION B–B'



SECTION C–C'



SECTION D–D'



NOTES:

1. FOR POND SURFACE AND SIDE SLOPE COVER DETAILS SEE FIGURE 3.
2. POND BOTTOM INFERRED FROM 'CELL 4 PHASE A AND PHASE B PLAN', WESTERN ENGINEERING INC., (JANUARY 17, 1989).
3. SEE FIGURES 1 AND 2 FOR CROSS SECTIONS LOCATIONS

RECLAMATION COVER
CROSS SECTIONS & DETAILS
PREPARED FOR

ENERGY FUELS NUCLEAR
BLANDING, UTAH

TITAN Environmental

DATE:	8-12-96	FIGURE 4	DRAWING NUMBER 6111-E4	△
SCALE:	AS SHOWN			

No.	DATE	ISSUE / REVISION	DWN. BY	CK'D BY	AP'D BY
△	8-12-96	ISSUED FOR RECLAMATION PLAN	K.G.	[signature]	[signature]

APPENDIX A

Laboratory Test Data

Table 3.4-1

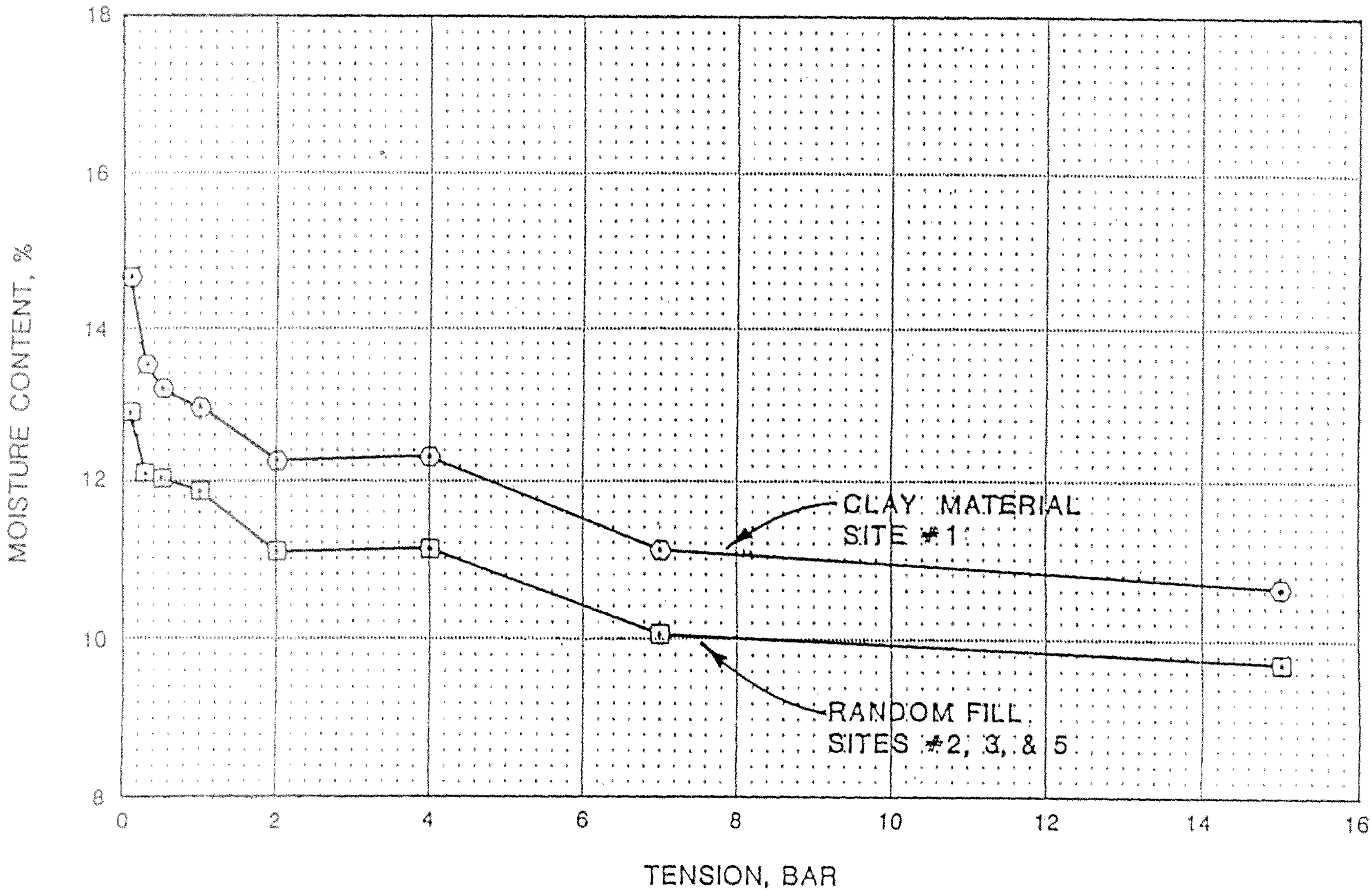
Physical Properties of Tailings

and

Proposed Cover Material

Material Type	Atterberg Limits LL	Atterberg Limits PI	Specific Gravity	% Passing No. 200 Sieve	Maximum Dry Density (pcf)	Optimum Moisture Content
Tailings	28	6	2.85	46	104.0	18.1
Random Fill	22	7	2.67	48	120.2	11.8

Note: Physical Soil Data from Chen and Associates (1987).

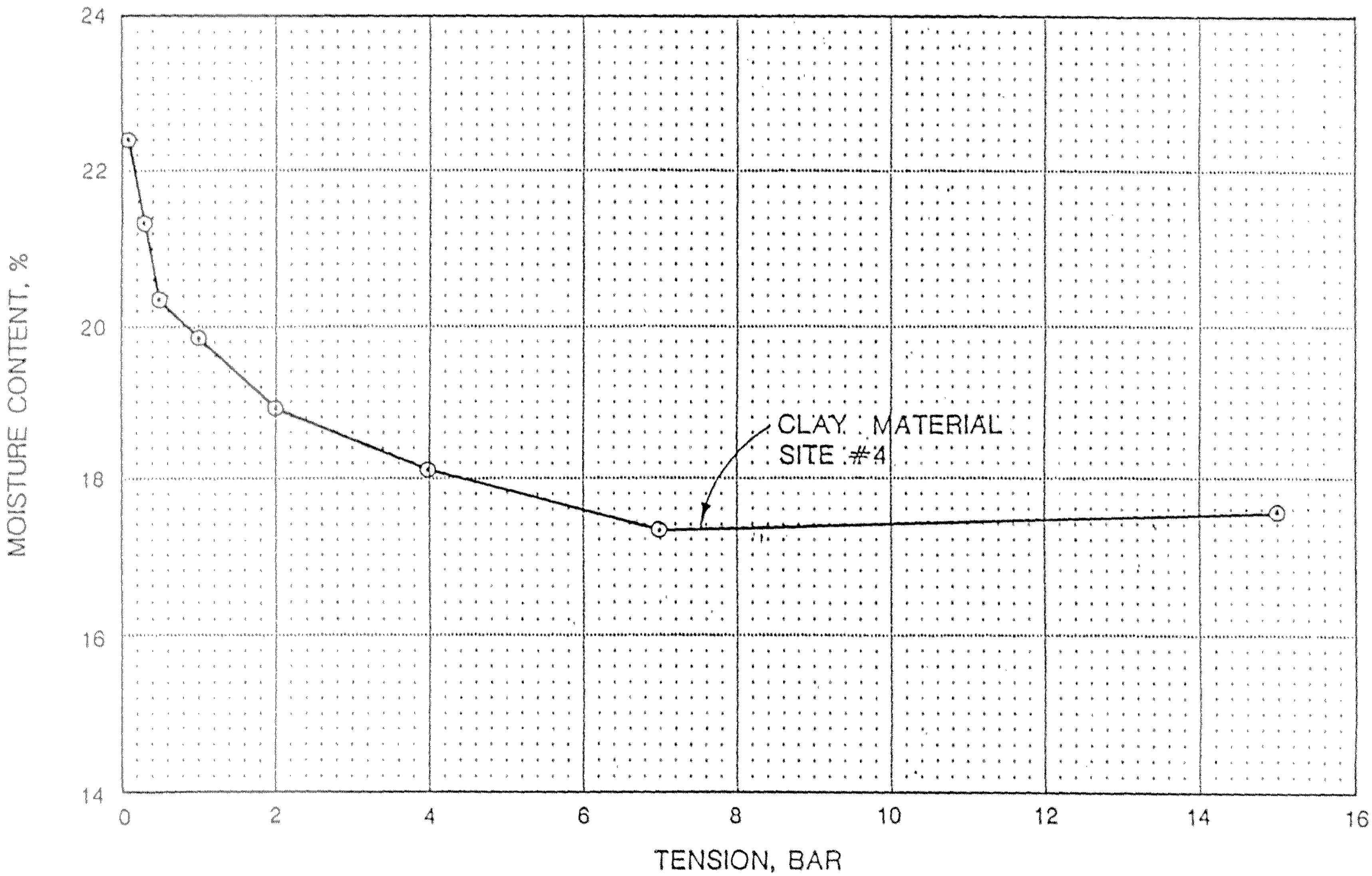


SUMMARY OF CAPILLARY MOISTURE RELATIONSHIP TEST RESULTS

WHITE MESA PROJECT

FIGURE 3.5-1

DATA FROM CHEN & ASSOCIATES



SUMMARY OF CAPILLARY MOISTURE RELATIONSHIP TEST RESULTS
WHITE MESA PROJECT
FIGURE 3.5-2

DATA FROM CHEN & ASSOCIATES

SECTION 6

ROGERS AND ASSOCIATES ENGINEERING
CORPORATION

Letter Dated March 4, 1988
Letter Dated May 9, 1988

Radiological Properties

R
A
E

Rogers & Associates Engineering Corporation

Post Office Box 330
Salt Lake City, Utah 84110
(801) 263-1600

March 4, 1988

Mr. C.O.Sealy
Umetco Minerals Corporation
P.O. Box 1029
Grand Junction, CO 81502

C8700/22

Dear Mr. Sealy:

We have completed the tests ordered on the four samples shipped to us. The results are as follows:

Sample	Radium pCi/gm	Emanation Fraction	Diffusion Coeffic.	(g/cm^3) Density	Moisture	Saturation
Tailings	981±4	0.19±0.01	2.0E-02	1.45	13.2	0.39
			8.4E-03	1.44	19.1	0.56
Composite (2,3,&5)			1.6E-02	1.85	6.5	0.40
			4.5E-04	1.84	12.5	0.75
Site #1			1.6E-02	1.85	8.1	0.48
			1.4E-03	1.84	12.6	0.76
Site #4			1.1E-02	1.65	15.4	0.63
			4.2E-04	1.65	19.3	0.80

The samples will be shipped back to you in the next few weeks. If you have any questions regarding the results on the samples please feel free to call.

Sincerely,

Renee Y. Bowser
Lab Supervisor

RYB/b

RAE Rogers & Associates Engineering Corporation

Post Office Box 330
Salt Lake City, Utah 84110
(801) 263-1600

MAY 12 1988

May 9, 1988

Mr. C.O. Sealy
UMETCO Minerals Corporation
P.O. Box 1029
Grand Junction, CO 81502

C8700/22

Dear Mr. Sealy:

The tests for radium content and radon emanation coefficient in the following samples have been completed and the results are as follows:

Sample	Radium (pCi/g)	Radon Emanation Coefficient
Random (2,3 & 5)	1.9 ± 0.1	0.19 ± 0.04
Site 1	2.2 ± 0.1	0.20 ± 0.03
Site 4	2.0 ± 0.1	0.11 ± 0.04

If you have any questions regarding these results please feel free to call Dr. Kirk Nielson or me.

Sincerely,

Renee Y. Bowser
Lab Supervisor

RYB:ms

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Titan Env.	JOB NO.	2234-04
BORING NO.		DATE SAMPLED	
DEPTH		DATE TESTED	7-25-96 WEB, RV
SAMPLE NO.	UT-1		
SOIL DESCR.			
TEST TYPE	ATTERBERG		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	3.34	4.06	3.42
Wt Dish & Dry Soil	2.96	3.57	3.03
Wt of Moisture	0.38	0.49	0.39
Wt of Dish	1.05	1.11	1.06
Wt of Dry Soil	1.91	2.46	1.97
Moisture Content	19.90	19.92	19.80

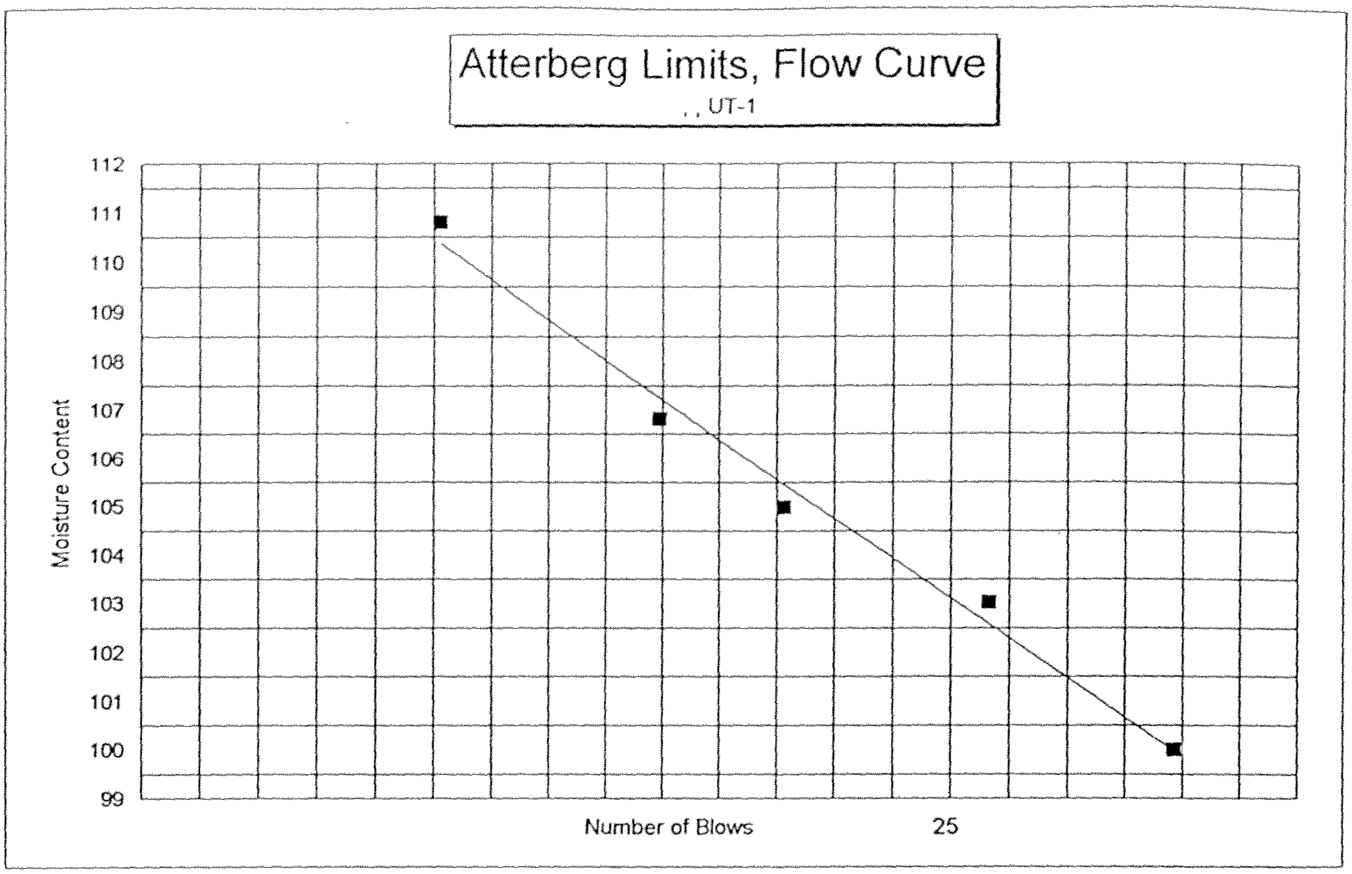
Liquid Limit Determination   Device Number 0258

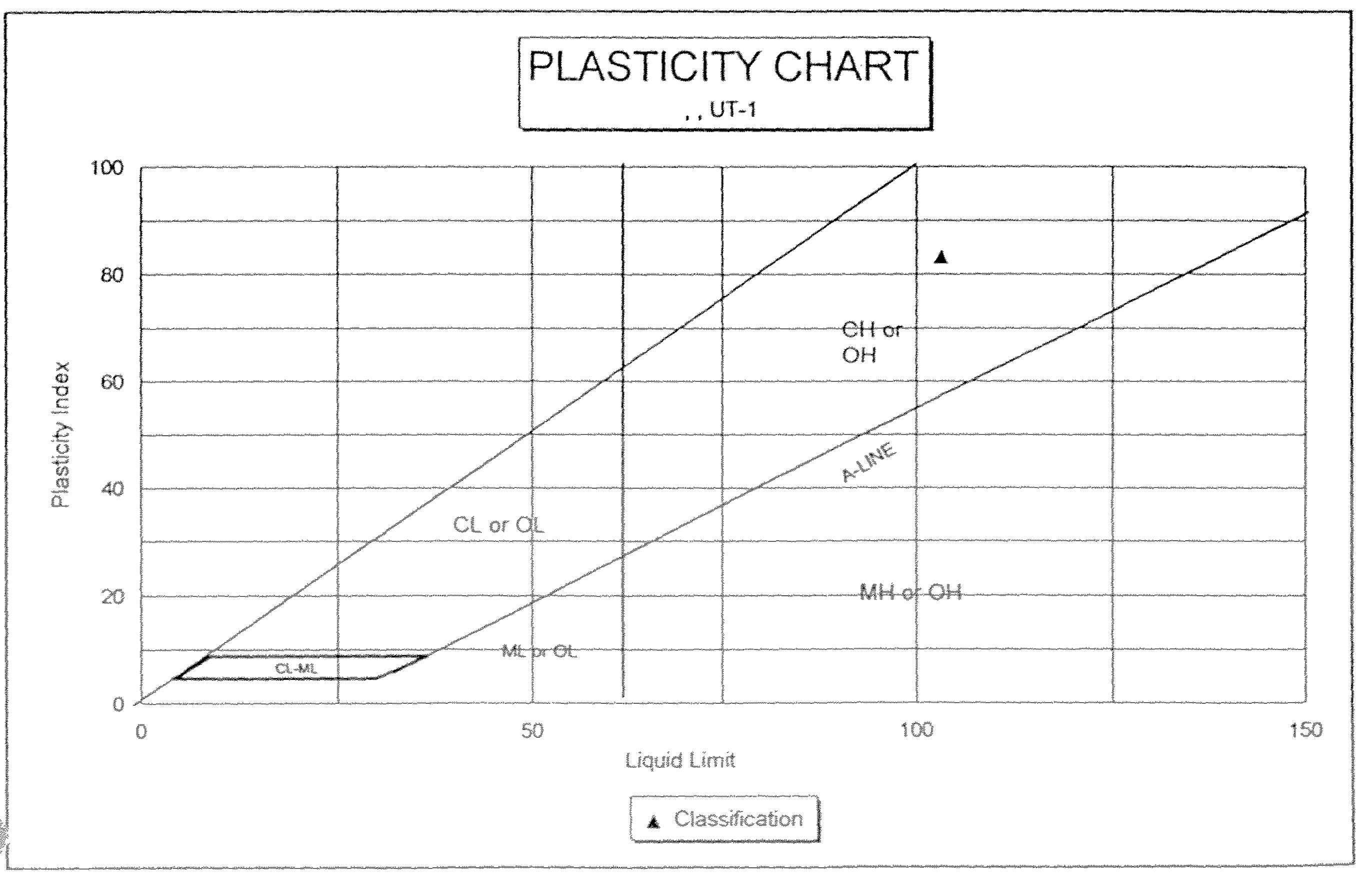
	1	2	3	4	5
Number of Blows	39	27	18	14	9
Wt Dish & Wet Soil	12.18	10.42	10.92	12.33	10.06
Wt Dish & Dry Soil	6.64	5.67	5.87	6.53	5.34
Wt of Moisture	5.54	4.75	5.05	5.80	4.72
Wt of Dish	1.10	1.06	1.06	1.10	1.08
Wt of Dry Soil	5.54	4.61	4.81	5.43	4.26
Moisture Content	100.00	103.04	104.99	106.81	110.80

Liquid Limit	103.1
Plastic Limit	19.9
Plasticity Index	83.3

Atterberg Classification CH

Data entry by: NAA   Date: 7-26-96
Checked by: [illegible]   Date: 7-26-96
FileName: TIGOUT1   ADVANCED TERRA TESTING, INC.


Atterberg Limits, Flow Curve
, , UT-1
112
111
110
109
108
107
106
105
104
103
102
101
100
99
Moisture Content
Number of Blows
25


PLASTICITY CHART
, , UT-1
100
80
60
40
20
0
Plasticity Index
0
50
100
150
Liquid Limit
CH or
OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
Classification

COMPACTION TEST
ASTM D 1557 A

CLIENT: TItan Env. JOB NO. 2234-04

BORING NO. SOIL DESCR.
DEPTH DATE SAMPLED
SAMPLE NO. UT-1 DATE TESTED 7-25-96 RV

Moisture determination

	1	2	3	4	5
Wt of Moisture added (ml)	100.00	150.00	250.00	350.00	450.00
Wt. of soil & dish (g)	384.26	393.92	291.42	244.20	281.17
Dry wt. soil & dish (g)	350.60	355.61	251.40	202.69	225.04
Net loss of moisture (g)	33.66	38.31	40.02	41.51	56.13
Wt. of dish (g)	8.01	8.34	8.31	8.29	8.43
Net wt. of dry soil (g)	342.59	347.27	243.09	194.40	216.61
Moisture Content (%)	9.83	11.03	16.46	21.35	25.91
Corrected Moisture Content					

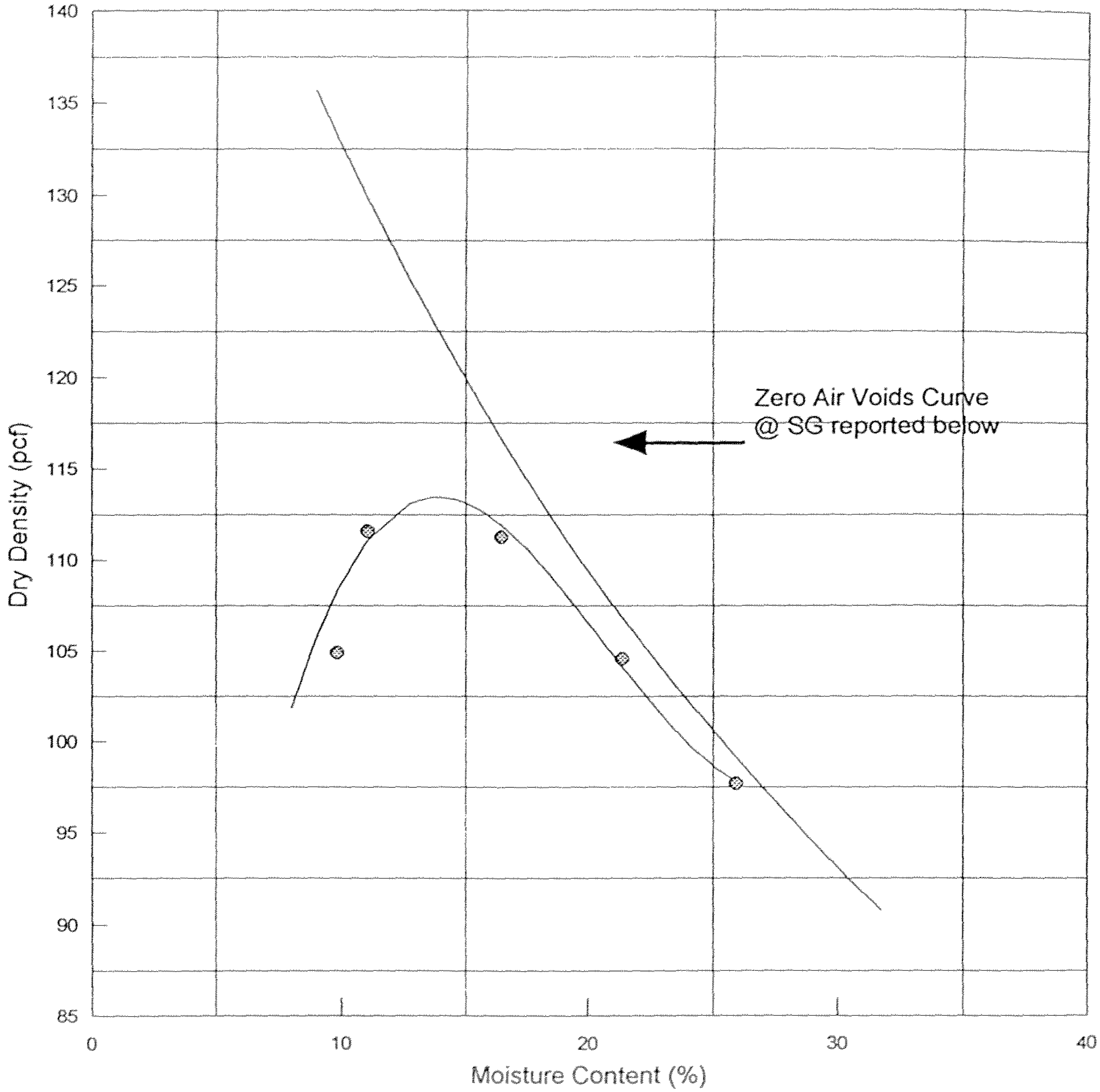
Density determination

Wt of soil & mold (lb)	14.20	14.49	14.68	14.59	14.46
Wt. of mold (lb)	10.36	10.36	10.36	10.36	10.36
Net wt. of wet soil (lb)	3.84	4.13	4.32	4.23	4.10
Net wt of dry soil (lb)	3.50	3.72	3.71	3.49	3.26
Dry Density, (pcf)	104.89	111.59	111.28	104.57	97.69
Corrected Dry Density (pcf)					
Volume Factor	30	30	30	30	30

Data entered by: RV Date: 7-26-96
Data checked by: [signature] Date: 7-26-96
FileName: TIPRUT-1 ADVANCED TERRA TESTING, INC

Proctor Compaction Test

, , UT-1



- Best Fit Curve
Actual Data
- Zero Air VoidsCurve @ SG = 2.70

OPTIMUM MOISTURE CONTENT = 13.9 MAXIMUM DRY DENSITY = 113.5
ASTM D 1557 A, Rock correction applied? N

ADVANCED TERRA TESTING, INC.

PERMEABILITY DETERMINATION
FALLING HEAD
FIXED WALL

CLIENT Titan Environmental JOB NO. 2234-04

BORING NO.		SAMPLED	
DEPTH		TEST STARTED	7-28-96 CAL
SAMPLE NO.	UT-1	TEST FINISHED	8-7-96 CAL
SOIL DESCR.	Remolded 95% Mod Pt. @ OMC	SETUP NO.	1
SURCHARGE	200		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil & Ring(s) (g)	386.9	404.5
Wt. Ring(s) (g)	93.0	93.0
Wt. Soil (g)	293.9	311.4
Wet Density PCF	122.3	120.5
Wt. Wet Soil & Pan (g)	302.4	319.9
Wt. Dry Soil & Pan (g)	266.2	266.2
Wt. Lost Moisture (g)	36.2	53.8
Wt. of Pan Only (g)	8.5	8.5
Wt. of Dry Soil (g)	257.7	257.7
Moisture Content %	14.1	20.9
Dry Density PCF	107.2	99.7
Max. Dry Density PCF	113.5	113.5
Percent Compaction	94.4	87.8

ELAPSED TIME (MIN)	BURETTE READING h1 (CC)	BURETTE READING h2 (CC)	PERCOLATION RATE FT/YEAR	PERCOLATION RATE CM/SEC
	0.2			
2599	10.8	10.8	0.14	1.4E-07
1427	14.2	14.2	0.09	8.4E-08
1440	16.8	16.8	0.07	6.5E-08
1440	18.6	18.6	0.05	4.6E-08
1440	20.2	20.2	0.04	4.1E-08
1440	21.6	21.6	0.04	3.7E-08
1469	23.0	23.0	0.04	3.6E-08
1440		24.4	0.04	3.7E-08

Data Entered By: NAA Date: 8-8-96
Date Checked By: [signature] Date: 8-8-96
Filename:TIFHUT1 ADVANCED TERRA TESTING, INC.

Rogers & Associates Engineering Corporation
Post Office Box 330
Salt Lake City, Utah 84110-0330
(801) 263-1600 • FAX (801) 262-1527

September 3, 1996

Pamela Anderson
Titan Environmental Corporation
7939 E. Arapahoe Rd., Suite 230
Englewood, CO 80112

C9600/9

Dear Ms. Anderson:

Enclosed are the results from the radium content, specific gravity, and radon emanation and diffusion coefficient measurements that were performed on the sample sent to our laboratory. We will be returning the sample within the month.

If you have any questions or if we can be of further assistance, please call.

Sincerely,

Bret Rogers

Bret C. Rogers
Scientist

Rogers & Associates Engineering Corporation

REPORT OF RADON DIFFUSION COEFFICIENT MEASUREMENTS
(TIME-DEPENDENT DIFFUSION TEST METHOD RAE-SQAP-3.6)

Report Date: 9/3/96
Contract: C9600/9
By: BCR
Date Received: 8/96

Sample Identification: Titan Environmental

Sample ID	Moisture (Dry Wt. %)	Density (g/cm^3)	Radon Diffusion Coefficient (cm^2/s)	Saturation ($M\rho/P$)	Specific Gravity (g/cm^3)
UT-1	14.5%	1.72	9.1E-03	0.89	2.39

RAE

Post Office Box 330
Salt Lake City • Utah 84110
(801) 263-1600

Rogers & Associates Engineering Corporation

REPORT OF RADIUM CONTENT AND EMANATION COEFFICIENT MEASUREMENTS

(LAB PROCEDURE RAE-SQAP-3.1)

Report Date: 9/3/96

Contract: C9600/9

By: BCR

Date Received: 8/96

Sample Identification: Titan Environmental

Sample ID	Moisture (Dry Wt. %)	Radon Emanation Coefficient	Radium-226 (pCi/g)	Comments
UT-1	14.6%	0.22 ± 0.04	1.5 ± 0.3	

RAE

Post Office Box 330
Salt Lake City • Utah 84110
(801) 263-1600

chen and associates, inc.
CONSULTING ENGINEERS

SOIL & FOUNDATION ENGINEERING
96 S. ZUNI • DENVER, COLORADO 80223 • 303/744-7105
1924 EAST FIRST STREET • CASPER, WYOMING 82601 • 307/234-2126

SECTION 2

Extracted Data From

SOIL PROPERTY STUDY
EARTH LINED TAILINGS RETENTION CELLS
WHITE MESA URANIUM PROJECT
BLANDING, UTAH

Prepared for:

ENERGY FUELS NUCLEAR, INC.

PARK CENTRAL
1515 ARAPAHOE STREET
DENVER, COLORADO 80202

Job No. 16,406

July 18, 1978

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Test Hole	Depth (Ft.)	NATURAL Moisture Content (%)	NATURAL Dry Density (pcf)	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	ATTERBERG LIMITS Liquid Limit (%)	ATTERBERG LIMITS Plasticity Index (%)	GRADATION ANALYSIS Maximum Size	GRADATION ANALYSIS Passing #200 (%)	GRADATION ANALYSIS Less than 2 μ (%)	REMOLDED Dry Density (pcf)	REMOLDED Moisture Content (%)	PERMEABILITY ft./yr.	PERMEABILITY cm./sec.	Specific Gravity	Soil Type
2	0-5			117.5	10.8	20	3	#16	58	19	111.6	16.4	0.57	5.5×10^{-7}		Sandy Silt
3	7-8	7.2				21	6	#16	62							Sandy Clayey Silt
5	7½-10			104.1	18.5	33	8	3/4 In.	56	12	102.1	22.0	0.085	8.2×10^{-8}	2.65	Calcareous Silty Clay
6	1-2	10.3				25	7	#16	77							Sandy Clayey Silt
6	8½-9	6.1				27	8	#4	70							Sandy Clay
8	5-5½	13.1					NP	3/4 In.	62							Calcareous Sandy Silt
9	0-1	8.1					NP	#16	53							Sand - Silt
10	4-6½					24	10	#4	73							Sandy Clay
11	5½-6½	14.0				26	6	#16	65							Siltstone-Claystone
12	2-5			101.0	20.6	53	35	#16	88	59	95.0	18.3	0.068	6.6×10^{-8}	2.67	Weathered Claystone
13	7-8	13.1				39	13	#8	84							Calcareous Silt Clay
14	1-2	19.3				40	21	#4	89							Weathered Claystone
15	1½-4½			106.8	19.0	26	8	3/8 In.	65	27	103.4	18.0	0.012	1.2×10^{-8}	2.64	Mod. Calcareous Sandy Clay
17	2-3	11.4				19	4	#8	59							Sandy Silt
19	0-3			117.5	12.8	23	6	#16	70		109.9	12.4	0.035	3.4×10^{-8}		Sandy Clayey Silt
22	1-2	13.2				26	10	#4	73							Sandy Clay
23	1-3					48	24	#30	87							Weathered Claystone
23	6-8					61	30	#30	96							Claystone
25	1-3½	13.3				26	9	#4	57							Sandy Clay
26	4½-5	15.3				41	20	#4	91							Weathered Claystone
28	0-2	12.7				28	10	3/8 In.	72							Sandy Clay
29	2-3	8.5				19	2	#16	59							Sandy Silt
32	8-8½	5.6				23	6	#30	73							Sandy Clayey Silt
37	0-4			118.8	11.5	23	5	#8	72		110.5	11.5	0.63	6.1×10^{-7}		Sandy Clayey Silt
38	5-7			111.0	16.7	29	14	3/8 In.	69		102.4	17.9	0.041	4.0×10^{-8}		Sandy Clay
40	4-5½			110.0	16.2	26	9	#8	64	27	106.4	16.4	0.017	1.6×10^{-8}	2.65	Sandy Clay

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Test Hole	Depth (Ft.)	NATURAL Moisture Content (%)	NATURAL Dry Density (pcf)	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	ATTERBERG LIMITS Liquid Limit (%)	ATTERBERG LIMITS Plasticity Index (%)	GRADATION ANALYSIS Maximum Size	GRADATION ANALYSIS Passing #200 (%)	GRADATION ANALYSIS Less than 2 μ (%)	REMOLDED Dry Density (pcf)	REMOLDED Moisture Content (%)	PERMEABILITY ft./yr.	PERMEABILITY cm./sec.	Specific Gravity	Soil Type
40	9-9½	6.8				22	8	3/8 In.	60							Sandy Clay
42	13½-14½	7.6				26	10	3/8 In.	73							Sandy Clay
43	11-12	12.1				41	22	#4	86							Claystone
43	13½-16½			110.0	16.9	40	24	3/8 In.	85	44	104.1	15.8	0.024	2.3×10^{-8}	2.62	Claystone
44	6½-7	7.5				30	11	3/8 In.	79							Calcareous Sandy Clay
46	0-2	12.3				22	6	#16	76							Sandy Clayey Silt
48	5-5½					30	9	3/8 In.	65							Sandy Clay
49	5-7			110.7	15.6	25	9	#16	71		105.2	13.9	0.33	3.2×10^{-8}		Sandy Clay
49	14-15					28	5	#8	55							Calcareous Sandy Silt
54	0-2	12.1				23	9	#8	64							Sandy Clay
55	5-5½	7.8				28	14	#30	71							Sandy Clay
55	9½-10½					28	13	#4	71							Sandy Clay
58	5½-6	12.5				35	11	#4	75							Sandy, Silty Clay
61	0-1	11.5				21	4	#16	75							Sandy Silt
62	11-11½	8.1					NP	1 In.	34							Calcareous Sand & Silt
63	4-6					30	14	#8	68							Sandy Clay
65	1-2	9.0					NP	#16	44							Silty Sand
68	7½-8	8.6				28	13	#8	67							Sandy Clay
70	3½-4½	16.4				27	4	1½ In.	46							Calcareous Sand & Silt
72	0-2	12.2				22	8	#16	59							Sandy Clay
75	10-11	12.4				41	25	#4	75							Weathered Claystone
75	12-14					45	22	#16	93							Claystone

#16,406

TABLE II

LABORATORY PERMEABILITY TEST RESULTS

Sample	Soil Type	Compaction: Dry Density (pcf)	Compaction: Moisture Content (%)	Compaction: % of ASTM D698	Surcharge Pressure (psf)	Permeability (Ft/Yr)	Permeability (Cm/
TH 2 @ 0'-5'	Sandy Silt	111.6	16.4	95	500	0.57	5.5x1
TH 5 @ 7½'-10'	Calcareous Silty Clay	102.1	22.0	101	500	0.085	8.2x1(
TH 12 @ 2'-5'	Weathered Claystone	95.0	18.3	94	500	0.068	6.6x1(
TH 15 @ 1½'-4½'	Calcareous Sandy Clay	103.4	18.0	97	500	0.012	1.2x1(
TH 19 @ 0'-3'	Sandy, Clayey Silt	109.9	12.4	94	500	0.035	3.4x1(
TH 37 @ 0'-4'	Sandy, Clayey Silt	110.5	11.5	93	500	0.63	6.1x1(
TH 38 @ 5'-7'	Sandy Clay	102.4	17.9	92	500	0.041	4.0x1(
TH 40 @ 4'-5½'	Sandy Clay	106.4	16.4	97	500	0.017	1.6x1(
TH 43 @ 13½-16½'	Claystone	104.1	15.8	95	500	0.024	2.3x1(
TH 49 @ 5'-7'	Sandy Clay	105.2	13.9	95	500	0.33	3.2x1(

ft / year	cm / sec
0.57	5.5E-07
0.085	8.2E-08
0.068	6.6E-08
0.012	1.2E-08
0.035	3.4E-08
0.63	6.1E-07
0.041	4.0E-08
0.017	1.6E-08
0.024	2.3E-08
0.33	3.2E-07

TABLE III

RESULTS OF ATTERBERG LIMITS

SAMPLE	SOIL TYPE	PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS			SHRINKAGE RATIO
			Liquid Limit (%)	Plastic Limit (%)	Shrinkage Limit (%)	
2 @ 0 - 5'	Sandy Silt	58	20	17	17.	1.81
5 @ 7½ - 10'	Calcareous Silty Clay	56	33	25	25	1.62
15 @ 1½-4½'	Calcareous Sandy Clay	65	26	18	17.5	1.76
19 @ 0-3'	Sandy, Clayey Silt	70	23	17	18	1.80
26 @ 4½-5'	Weathered Claystone	91	41	21	12	1.90
38 @ 5 - 7'	Sandy Clay	69	29	15	14	1.89

chen and associates, inc.
CONSULTING ENGINEERS

SOIL & FOUNDATION ENGINEERING · 96 S. ZUNI · DENVER, COLORADO 80223 · 303/744-7105

SECTION 3

Extracted Data From

SOIL PROPERTY STUDY
PROPOSED TAILINGS RETENTION CELLS
WHITE MESA URANIUM PROJECT
BLANDING, UTAH

Prepared for:

ENERGY FUELS NUCLEAR, INC.
1515 ARAPAHOE STREET
DENVER, COLORADO 80202

Job No. 17,130

January 23, 1979

CHEN AND ASSOCIATES

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

HOLE	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS		PERCENT PASSING NO. 200 SIEVE	SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)		DEVIATOR STRESS (PSF)	CONFINING PRESSURE (PSF)		
76	0 - 1	4.5		21	5				78	Sandy silt
	9.5 - 10	4.4			NP				26	Silty, gravelly sand
77	7.5 - 8	8.6		30	15				71	Sandy clay
79	0 - 1	4.1		20	5				83	Sandy silt
	5 - 5.5	5.5			NP				41	Calcareous sandy clay
80	4.5 - 7			39	20				78	Calcareous sandy clay
	8 - 8.5	10.1		40	20				86	Weathered claystone
81	3 - 4	6.3		26	8				64	Silty, sandy clay
83	4 - 6			24	7				64	Sandy, clayey silt
84	0 - 2			18	2				65	Sandy silt
	9 - 9.5	2.7			NP				27	Silty sand
86	8 - 8.5	2.6			NP				12	Sandstone
87	0 - 1	3.1		16	1				61	Sandy silt
89	0 - 3			21	5				66	Sandy silt
90	8 - 8.5	12.9		35	15				61	Weathered claystone
92	0 - 1	5.9		21	5				80	Sandy silt
94	5 - 5.5	13.7		27	10				68	Sandy clay
95	6 - 7			23	5				62	Sandy silt
96	0 - 2	5.2		21	4				79	Sandy silt
	8.5 - 9.5			32	6				66	Calcareous sandy clay
98	0 - 1	3.8		20	5				74	Sandy silt
	4 - 4.5	17.8		49	25				76	Weathered claystone
99	8 - 9.5			40	20				89	Weathered claystone

CHEN AND ASSOCIATES

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

HOLE	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS		PERCENT PASSING NO. 200 SIEVE	SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)		DEVIATOR STRESS (PSF)	CONFINING PRESSURE (PSF)		
99	11 - 12	13.5		26	10				73	Claystone
100	0 - 1			17	NP				44	Silty sand
	5.5 - 6	12.0			NP				61	Sandstone-siltstone
102	6.5 - 7	16.7		30	8				79	Calcareous sandy clay
	13.5 - 14	9.5		23	6				87	Claystone-siltstone
103	10 - 10.5	7.0		28	12				57	Sandy clay
104	8 - 8.5	9.2		33	9				70	Calcareous sandy clay
105	0 - 1	5.4		22	6				77	Sandy silt
	6.5 - 7	4.5			NP				86	Sandy silt
106	5 - 5.5	10.4		28	6				59	Claystone-sandstone
107	7.5 - 9				NP				23	Sandstone
108	0 - 1	4.0		18	3				69	Sandy silt
	9.5 - 10	9.9		38	16				93	Claystone
109	4 - 5			25	7				75	Sandy, clayey silt
111	9 - 9.5	5.8		25	10				53	Claystone
113	5 - 8			40	20				84	Weathered claystone
	10.5 - 11			24	10				54	Claystone-sandstone
114	0 - 2			22	6				58	Sandy, clayey silt
115	4.5 - 6				NP				58	Calcareous
116	0 - 3			22	5				72	Sandy silt
	7 - 8			24	10				42	Claystone-sandstone
117	1 - 2	10.6		25	5				77	Sandy silt
118	0 - 2			25	6				77	Sandy silt

CHEN AND ASSOCIATES

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

HOLE	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS DEVIATOR STRESS (PSF)	TRIAXIAL SHEAR TESTS CONFINING PRESSURE (PSF)	PERCENT PASSING NO. 200 SIEVE	SOIL TYPE
118	6.5 - 8.5			40	20				89	Weathered claystone
119	4.5 - 5	10.0		26	12				68	Sandy clay
120	1 - 2			25	8				69	Sandy, clayey silt
	5 - 5.5	15.5		29	10				78	Sandy clay
	11 - 11.5	11.6		42	24				90	Claystone
122	4 - 6			25	8				66	Sandy, silty clay
	14.5 - 15	6.4		26	8				66	Sandy clay
123	1 - 3			23	7				71	Sandy, clayey silt
124	4.5 - 5	6.0		23	7				69	Sandy, clayey silt
125	0 - 1	3.8		22	6				67	Sandy silt
127	5 - 6			54	34				89	Claystone
128	6 - 8			41	24				90	Claystone

.E II

LABORATORY PERMEABILITY TEST RESULTS

Sample	Classification	Compaction Dry Density (pcf)	Moisture Content (%)	% of ASTM D698	Surcharge Pressure (psf)	Permeability Ft./Yr.	Permeability Cm/Sec
TH 80 @ 4½-7'	Calcareous sandy clay -200=78; LL=39; PI=20	100.2	19.4	96	500	0.81	7.8×10^{-7}
TH 84 @ 0-2'	Sandy silt -200=65; LL=18; PI=2	113.8	11.7	96	500	4.45	4.3×10^{-6}
TH 96 @ 8½-9½'	Calcareous sandy clay -200=66; LL=32; PI=6	96.9	20.7	97	500	1.55	1.5×10^{-6}
TH 96 @ 8½-9½'	Calcareous sandy clay	95.7	20.3	96	500	26.90*	2.6×10^{-5}
TH 99 @ 8-9½'	Weathered claystone -200=89; LL=40; PI=20	99.8	18.5	95	500	0.22	2.1×10^{-7}
TH 100 @ 0-1'	Very silty sand -200=44; PI=NP	117.5	9.7	98	500	0.38	3.7×10^{-7}
TH 114 @ 0-2'	Sandy, clayey silt -200=58; LL=22; PI=6	112.4	12.9	95	500	0.60	5.8×10^{-7}
TH 120 @ 1-2'	Sandy, clayey silt -200=69; LL=24; PI=6	108.2	14.7	95	500	0.11	1.1×10^{-7}
TH 122 @ 4-6'	Sandy, silty clay -200=66; LL=25; PI=8	108.8	15.5	96	500	0.43	4.2×10^{-7}
TH 123 @ 1-3'	Sandy, clayey silt -200=71; LL=23; PI=7	110.9	12.6	95	500	0.56	5.4×10^{-7}
TH 128 @ 6-7'	Claystone -200=89; LL=41; PI=24	92.4	23.9	93	500	0.12	1.2×10^{-7}
TH 128 @ 6-7'	Claystone -200=89; LL=41; PI=4	93.1	22.1	94	500	0.52*	5.0×10^{-7}*

* 1.5 pH sulfuric acid liquor used during percolation test interval.

MRAP - 710063367 - GEOTECHNICAL DATA BASE FOR MONTICELLO MILLSITE CHARACTERIZATION – R.N. MORRIS; CREATED 09/30/91; LAST UPDATED 11/22/91

AREA	DATA SOURC	BORING OR TEST PIT NUMBER	SAMPLE NUMBER & TYPE	TOP OF SAMPLE (FEET)	BASE OF SAMPLE (FEET)	SAMPLE MIDPOINT (FEET)	USCS SYMBOL	MATERIAL TYPE	IN-PLACE DRY DENSITY (PCF)	NATURAL MOISTURE CONTENT (PERCENT)	SPECIFIC GRAVITY	FRACTION PASSING #4 SIEVE (PERCENT)	FRACTION PASSING #200 SIEVE (PERCENT)	LIQUID LIMIT	PLASTICITY INDEX	ASTM D 698 MAXIMUM DRY DENSITY (PCF)	ASTM D 698 OPTIMUM MOISTURE CONTENT (PERCENT)	OTHER TESTS
CARBONATE PILE	BENDIX	MRAP-85-01	MKB-682/ST	6.0	8.0	7.00	CL-ML(?)	Talus-silt(?)	89.8	4.5	2.87	100.0	97.0	NP	NP	NA	NA	Consol w/perm, CMR @ 15 bar
CARBONATE PILE	BENDIX	MRAP-85-02	MKB-681/ST	2.0	4.0	3.00	SM	Talus-sand	107.8	4.0	2.80	100.0	46.0	NP	NP	NA	NA	Consol w/perm, CMR @ 15 bar
CARBONATE PILE	BENDIX	MRAP-85-02*	MKB-757/BULK	1.0	1.8	1.00	ML	Cover	NA	NA	NA	100.0	88.0	NA	NA	114.7	14.8	
CARBONATE PILE	BENDIX	MRAP-85-02*	MKB-758/BULK	3.8	3.8	3.00	SP	Talus-sand	NA	NA	NA	NA	NA	NA	NA	102.8	13.8	
CARBONATE PILE	BENDIX	MRAP-85-02*	MKB-760/BULK	6.0	6.6	6.00	SC(?)	Talus-sand	NA	NA	2.70	NA	NA	NA	NA	94.8	38.3	
CARBONATE PILE	BENDIX	MRAP-85-03	MKB-748/ST	2.0	4.0	3.00	CL-ML	Talus-silt/sand	92.1	27.4	2.87	100.0	84.0	20.0	4.0	NA	NA	Consol w/perm, CMR @ 15 bar
CARBONATE PILE	D&M	31SW91-045	1/SS	2.0	4.0	3.00	CL	Talus-silt	NA	15.8	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	2/SS	4.8	8.8	5.25	SP-SM	Talus-sand	NA	3.3	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	3/SS	6.0	8.0	7.00	SP-SM	Talus-sand	NA	8.4	2.68	100.0	11.4	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	4/SS	10.0	12.0	11.00	SP-SM	Talus-sand	NA	4.8	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	6/SS	13.0	14.0	13.50	SM	Talus-sand	NA	9.5	NA	100.0	18.1	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	7/SS	14.9	16.0	15.00	SM	Talus-sand	NA	14.4	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	8/SS	17.4	18.0	17.70	CL-ML/SM	Talus-sand/silt	NA	27.8	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	9/SS	19.5	20.0	19.75	SM	Talus-sand	NA	3.7	2.88	100.0	15.8	NP	NP	NA	NA	
CARBONATE PILE	D&M	31SW91-045	10/SS	20.2	22.0	21.10	SM	Talus-sand	NA	8.3	NA	100.0	23.8	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	13/SS	26.2	28.2	27.20	SM	Talus-sand	NA	8.4	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	14/SS	28.3	30.0	29.15	SM	Talus-sand	NA	8.6	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	15/SS	31.2	31.8	31.40	ML/SM	Talus-sand/silt	NA	38.9	NA	NA	NA	NP	NP	NA	NA	
CARBONATE PILE	D&M	31SW91-045	16/SS	32.7	34.0	33.35	CL-ML/SM	Talus-sand/silt	NA	21.8	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	17/SS	33.6	36.0	34.80	CL-ML/SM	Talus-sand/silt	NA	22.9	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	18/SS	36.4	38.0	37.00	SP-SM	Talus-sand	NA	24.2	2.70	100.0	9.7	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	19/SS	40.0	42.0	41.00	SM	Talus-sand/silt	NA	23.2	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	20/SS	43.0	44.0	43.50	SM	Talus-sand/silt	NA	25.2	NA	100.0	14.8	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	21/SS	44.5	46.8	45.15	CL	Alluvium	NA	28.9	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	22/SS	46.4	47.5	46.95	CL	Alluvium	NA	28.8	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	23/SS	48.0	50.0	49.00	CL	Alluvium	NA	23.8	NA	NA	NA	NA	33.9	18.3	NA	NA	
CARBONATE PILE	D&M	31SW91-045	24/SS	51.0	52.8	51.90	CL	Alluvium	NA	23.0	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	25/SS	52.0	53.3	52.15	CL	Alluvium	NA	28.8	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-045	26/SS	54.8	56.0	55.35	CL	Alluvium	NA	56.6	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-044	28/SS	3.0	4.2	3.60	SC/CL	Cover(?)	NA	10.9	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-044	38/SS	4.2	5.0	4.60	SM	Talus-sand	NA	12.4	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-044	40/SS	8.0	10.0	9.00	CL	Alluvium	NA	20.1	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-050a	3/SS	3.8	5.0	4.30	SM	Talus-sand(Cover?)	NA	29.7	NA	88.2	12.5	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-050a	3/ST	5.5	7.5	6.50	SM	Talus-sand	88.8	21.4	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-050a	5/SS	10.0	10.5	10.25	SP-SM	Talus-sand	NA	21.3	NA	100.0	7.0	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-051	2/ST	8.5	9.4	8.75	SP-SM	Talus-sand	93.8	7.2	NA	100.0	10.2	NA	NA	NA	NA	Triax-CU/PP
CARBONATE PILE	D&M	31SW91-051	4/ST	13.0	15.5	14.25	SM	Talus-sand	82.5	6.8	NA	100.0	21.8	NA	NA	NA	NA	Triax-CU/PP, Perm
CARBONATE PILE	D&M	31SW91-051	5/ST	18.0	20.5	19.25	SM	Talus-sand	87.1	7.1	NA	100.0	18.3	NA	NA	NA	NA	Triax-CU/PP
CARBONATE PILE	D&M	31SW91-051	8/SS	33.0	35.0	34.00	SM	Talus-sand	NA	11.9	2.78	100.0	14.6	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-051	9/SS	38.0	39.5	38.75	SP	Talus-sand	NA	25.4	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-051	11/SS	43.8	44.4	43.90	CL	Alluvium	NA	25.5	NA	NA	NA	35.1	19.1	NA	NA	
CARBONATE PILE	D&M	31SW91-051	12/SS	48.0	49.3	48.65	CL	Alluvium	NA	24.8	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-052	1/SS	4.2	6.0	5.10	SM/CL	Talus-sand/silt	NA	7.7	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-052	2/SS	8.5	10.2	9.35	CL	Talus-silt	NA	21.1	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-052	5/SS	11.0	16.0	13.50	SM	Talus-sand	NA	6.2	NA	100.0	14.8	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-052	6/SS	19.0	20.4	19.50	SM	Talus-sand	NA	9.8	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-052	8/SS	29.2	31.0	30.10	CL	Alluvium	NA	27.8	2.58	NA	NA	48.0	23.9	NA	NA	
CARBONATE PILE	D&M	31SW91-052	9/SS	34.0	36.0	35.00	CL	Alluvium	NA	9.2	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-052	10/SS	39.0	41.0	40.00	CL	Alluvium	NA	22.2	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-052	12/SS	49.0	51.0	50.00	CL	Alluvium	NA	28.8	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-056	1/SS	4.8	5.8	5.00	SM	Talus-sand	NA	12.4	2.69	100.0	35.7	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-056	5/SS	19.0	19.4	19.30	CL	Alluvium	NA	15.5	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-056	6/SS	24.0	28.0	23.00	CL	Alluvium	NA	19.8	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-056	7/SS	29.0	31.0	30.00	CL	Alluvium	NA	19.4	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	31SW91-056	8/SS	34.5	34.8	34.75	Km	Shale	NA	3.8	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	TP-4	1/ST	3.5	4.0	3.75	SM	Talus-sand	96.1	4.7	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	TP-4	4/BULK	4.5	4.5	4.90	SM	Talus-sand	NA	8.1	NA	NA	NA	NP	NP	101.8	17.2	Consol, Perm
CARBONATE PILE	D&M	TP-4	2/ST	8.0	6.5	8.25	ML	Talus-silt(?)	88.3	20.2	NA	NA	NA	21.5	0.2	NA	NA	
CARBONATE PILE	D&M	TP-4	3/ST	9.0	9.5	9.25	ML	Talus-silt(?)	71.0	35.4	NA	NA	NA	NA	NA	NA	NA	

MRAP - 71002307 - GEOTECHNICAL DATA BASE FOR MONTICELLO MILLSITE CHARACTERIZATION - R.N. MORRIS; CREATED 09/30/91; LAST UPDATED 11/22/91

AREA	DATA SOURC	BORING OR TEST PIT NUMBER	SAMPLE NUMBER & TYPE	TOP OF SAMPLE (FEET)	BASE OF SAMPLE (FEET)	SAMPLE MIDPOINT (FEET)	USCS SYMBOL	MATERIAL TYPE	IN-PLACE DRY DENSITY (PCF)	NATURAL MOISTURE CONTENT (PERCENT)	SPECIFIC GRAVITY	FRACTION PASSING #4 SIEVE (PERCENT)	FRACTION PASSING #200 SIEVE (PERCENT)	LIQUID LIMIT	PLASTICITY INDEX	ASTM D 698 MAXIMUM DRY DENSITY (PCF)	ASTM D 698 OPTIMUM MOISTURE CONTENT (PERCENT)	OTHER TESTS
CARBONATE PILE	D&M	TP-6	4/ST	10.5	11.0	10.75	CL	Talc-slm	70.6	46.3	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	TP-6	6/ST	17.0	17.5	17.25	SM	Talc-sand	73.3	19.8	NA	NA	NA	NA	NA	NA	NA	
CARBONATE PILE	D&M	TP-6	-BULK	18.0	18.0	18.00	SM	Talc-sand(?)	NA	15.5	NA	100.0	48.4	NA	NA	NA	NA	
CARBONATE PILE	D&M	TP-11	-BULK	8.0	8.0	8.00	SM	Talc-sand(?)	NA	18.7	2.78	100.0	47.8	NA	NA	96.1	18.9	
CARBONATE PILE	D&M	TP-11	-BULK	15.0	15.0	15.00	CL	Talc-slm	NA	53.1	NA	100.0	91.3	NA	NA	103.7	18.0	Dir Shear, Perm, Mod Proct
VANADIUM PILE	BENDIX	MRAP-45-04	MKB-682/ST	4.0	6.0	5.00	SC	Talc-sand&slm	80.7	38.8	2.82	100.0	44.0	27.0	10.0	96.8	24.0	
VANADIUM PILE	BENDIX	MRAP-44-04*	MKB-783/BULK	1.0	1.0	1.00	ML	Cover	NA	NA	NA	NA	71.0	NA	NA	NA	NA	Consol w/perm, CMR @15 bar
VANADIUM PILE	BENDIX	MRAP-44-04*	MKB-784/BULK	2.0	2.0	2.00	SP	Talc-sand	NA	NA	2.67	NA	NA	NA	NA	114.3	13.7	
VANADIUM PILE	BENDIX	MRAP-44-04*	MKB-786/BULK	7.0	7.0	7.00	ML	Talc-slm	NA	NA	2.60	NA	NA	NA	NA	107.8	13.2	
VANADIUM PILE	BENDIX	MRAP-45-05	MKB-675/ST	8.0	8.0	8.00	CL-ML	Talc-slm	78.1	41.7	2.63	100.0	94.0	21.0	5.0	113.8	18.3	
VANADIUM PILE	D&M	31SWW1-031	3/ST	5.5	7.5	6.50	SM	Talc-sand	NA	8.4	2.89	100.0	21.4	38.1	17.1	NA	NA	Consol w/perm, CMR @15 bar
VANADIUM PILE	D&M	31SWW1-032	1/SS	2.0	3.5	2.75	SM/SC	Cover	NA	18.8	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	2/SS	3.5	5.0	4.25	SM/CL	Talc-sand/slm	NA	18.9	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	3/SS	5.0	6.5	5.75	SM	Talc-sand(?)	NA	18.0	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	4/SS	8.5	10.0	9.25	ML	Talc-slm	NA	34.1	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	6/SS	10.0	11.5	10.75	SM	Talc-sand&slm	NA	11.5	2.88	100.0	21.8	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	7/SS	11.5	13.0	12.25	ML	Talc-slm	NA	25.0	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	9/SS	15.0	16.5	15.75	SM/CL	Talc-sand/slm	NA	28.0	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	10/SS	16.5	18.0	17.25	SM/CL	Talc-sand/slm	NA	16.3	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	11/SS	18.0	19.5	18.75	CL	Alluvium	NA	20.9	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	12/SS	19.5	21.5	20.50	CL	Alluvium	NA	18.7	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	13/SS	21.5	23.5	22.50	CL	Alluvium	NA	20.1	NA	NA	NA	44.2	24.0	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	14/SS	24.0	25.0	24.50	CL	Alluvium	NA	18.0	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	15/SS	25.5	27.3	26.40	CL	Alluvium	NA	23.9	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	16/SS	27.5	29.5	28.50	CL	Alluvium	NA	17.6	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	17/SS	29.5	31.5	30.50	CL	Alluvium	NA	17.9	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	18/SS	31.5	33.5	32.50	CL	Alluvium	NA	18.5	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	19/SS	33.5	34.8	34.15	CL	Alluvium	NA	17.8	NA	NA	NA	27.9	19.1	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	20/SS	35.5	37.5	36.50	CL	Alluvium	NA	23.7	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	21/SS	37.5	39.5	38.50	CL	Alluvium	NA	22.2	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	22/SS	39.5	41.0	40.25	CL	Alluvium	NA	23.1	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	23/SS	41.5	42.8	42.15	SC/CL	Alluvium	NA	23.3	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	24/SS	43.5	44.9	44.20	GC	Alluvium	NA	18.9	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-032	25/SS	48.5	48.9	48.70	Km	Shale	NA	18.6	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-040	3/ST	6.0	7.5	6.75	CL	Talc-slm	95.1	25.3	NA	NA	NA	45.7	24.9	NA	NA	Perm, CMR
VANADIUM PILE	D&M	31SWW1-040	6/SS	13.5	14.8	14.15	CL	Talc-slm	NA	20.3	2.80	NA	NA	46.7	22.5	NA	NA	
VANADIUM PILE	D&M	31SWW1-040	9/SS	18.5	20.5	19.50	CL	Talc-slm	NA	19.4	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-040	11/SS	23.5	25.3	24.40	CL	Talc-slm	NA	23.4	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-041	1/SS	8.0	9.0	8.50	CL	Talc(?)-slm(?)	NA	23.8	NA	NA	NA	31.7	14.0	NA	NA	
VANADIUM PILE	D&M	31SWW1-041	2/SS	10.0	11.0	10.50	CL	Alluvium	NA	21.3	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-041	3/SS	14.0	16.0	15.00	CL	Alluvium	NA	18.8	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-041	6/SS	24.0	26.0	25.00	CL	Alluvium	NA	14.9	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-041	7/SS	29.0	31.0	30.00	CL	Alluvium	NA	19.3	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-041	8/SS	34.5	36.0	35.25	CL	Alluvium	NA	27.7	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-041	9/SS	38.0	40.0	39.00	SC	Alluvium	NA	13.2	NA	100.0	40.1	NA	NA	NA	NA	
VANADIUM PILE	D&M	31SWW1-041	10/SS	44.0	44.5	44.25	Kd	Sandstone	NA	1.3	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	TP-6	1/ST	4.5	5.0	4.75	SM	Talc-sand	90.1	7.4	NA	NA	NA	NP	NP	NA	NA	
VANADIUM PILE	D&M	TP-6	2/ST	5.5	6.0	5.75	CL	Talc-slm	78.7	51.6	NA	NA	NA	NA	NA	NA	NA	Uncon Comp
VANADIUM PILE	D&M	TP-6	4/ST	9.0	9.5	9.25	CL	Talc-slm	71.0	44.7	NA	NA	NA	NA	NA	NA	NA	Uncon Comp
VANADIUM PILE	D&M	TP-5	5/ST	11.0	11.5	11.25	CL	Talc-slm	64.5	18.2	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	TP-5	7/ST	14.0	14.5	14.25	CL	Talc(?)-slm(?)	68.5	51.5	NA	NA	NA	NA	NA	NA	NA	
VANADIUM PILE	D&M	TP-12	-BULK	6.0	6.0	6.00	CL	Talc-slm	NA	24.3	2.75	NA	NA	29.2	12.3	115.0	14.0	Perm, Mod Proct
VANADIUM PILE	D&M	TP-12	-BULK	12.0	12.0	12.00	CL	Talc-slm	NA	53.8	2.84	NA	NA	44.7	20.5	100.7	21.2	Triax-CUPP, Perm, Mod Proct, CMR
EAST PILE	BENDIX	MRAP-45-08	MKB-844/ST	2.0	4.0	3.00	SM	Talc-sand	96.4	5.2	2.87	100.0	42.0	NP	NP	NA	NA	Consol w/perm, CMR @15 bar
EAST PILE	BENDIX	MRAP-45-08*	MKB-779/BULK	1.0	1.0	1.00	ML	Cover	NA	NA	NA	100.0	52.0	NA	NA	111.2	14.1	
EAST PILE	BENDIX	MRAP-45-08*	MKB-780/BULK	3.0	3.0	3.00	SM(?)	Talc-sand	NA	NA	NA	NA	NA	NA	NA	107.1	15.3	
EAST PILE	BENDIX	MRAP-45-08*	MKB-782/BULK	15.0	15.0	15.00	SP(?)	Talc-sand(?)	NA	NA	2.70	NA	NA	NA	NA	103.8	15.5	
EAST PILE	BENDIX	MRAP-45-07	MKB-687/ST	2.0	4.0	3.00	SM	Talc-sand	94.0	9.9	2.81	100.0	19.0	NP	NP	NA	NA	Consol w/perm, CMR @15 bar
EAST PILE	BENDIX	MRAP-45-08	MKB-714/ST	12.0	14.0	13.00	CL	Talc-slm	108.8	34.4	2.70	100.0	61.0	41.0	22.0	NA	NA	Consol w/perm, CMR @15 bar
EAST PILE	BENDIX	MRAP-45-09	MKB-708/ST	4.0	6.0	5.00	ML	Talc-slm	100.7	21.4	2.82	100.0	64.0	42.0	13.0	NA	NA	Consol w/perm, CMR @15 bar
EAST PILE	D&M	31SWW1-002	1/SS	3.5	5.5	4.50	SP	Talc-sand	NA	12.2	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SWW1-002	2/SS	8.5	10.5	9.50	SM/ML	Talc-sand/slm	NA	15.8	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SWW1-002	3/SS	13.5	15.5	14.50	SM/ML	Talc-sand/slm	NA	15.3	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SWW1-002	NA	24.0	25.0	24.50	CL	Alluvium	NA	18.5	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SWW1-002	10/SS	28.0	30.0	29.00	CL	Alluvium	NA	18.5	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SWW1-003	3/SS	7.0	8.3	7.65	ML	MVP spoil	NA	7.2	NA	NA	NA	NA	NA	NA	NA	

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MRAP - 710002307 - GEOTECHNICAL DATA BASE FOR MONTICELLO MILLSITE CHARACTERIZATION - R.N. MORRIS; CREATED 09/30/91; LAST UPDATED 11/22/91

AREA	DATA SOURC	BORING OR TEST PIT NUMBER	SAMPLE NUMBER & TYPE	TOP OF SAMPLE (FEET)	BASE OF SAMPLE (FEET)	SAMPLE MIDPOINT (FEET)	USCS SYMBOL	MATERIAL TYPE	IN-PLACE DRY DENSITY (PCF)	NATURAL MOISTURE CONTENT (PERCENT)	SPECIFIC GRAVITY	FRACTION PASSING #4 SIEVE (PERCENT)	FRACTION PASSING #200 SIEVE (PERCENT)	LIQUID LIMIT	PLASTICITY INDEX	ASTM D 698 MAXIMUM DRY DENSITY (PCF)	ASTM D 698 OPTIMUM MOISTURE CONTENT (PERCENT)	OTHER TESTS
EAST PILE	D&M	31SW91-003	9/SS	20.5	23.0	21.25	CL	Tails-slm	NA	36.2	NA	NA	NA	48.4	22.3	NA	NA	
EAST PILE	D&M	31SW91-003	11/SS	24.5	26.0	25.25	CL/SM	Tails-snd/slm	NA	34.8	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-003	12/SS	26.5	28.0	27.25	CL/SM/ML	Tails-snd/slm	NA	40.1	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-003	13/SS	28.5	30.0	29.25	ML	Tails-snd&slm	NA	28.7	NA	100.0	73.5	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-003	19/SS	40.0	40.5	40.25	ML	Alluvium	NA	24.4	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-003	20/SS	42.0	42.7	42.35	ML	Alluvium	NA	23.8	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-003	21/SS	46.0	47.5	46.75	ML	Alluvium	NA	25.8	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-003	22/SS	48.0	49.7	48.85	ML	Alluvium	NA	24.8	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-004	1/SS	3.5	5.0	4.25	CL	MVP spoil	NA	18.4	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-004	2/SS	8.5	10.0	9.25	SM	Tails-snd	NA	28.4	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-004	3/U	14.5	15.0	14.75	CL	Tails-slm	82.1	33.1	NA	NA	NA	35.6	12.7	NA	NA	
EAST PILE	D&M	31SW91-004	4/U	19.5	20.0	19.75	CL	Alluvium	95.9	23.3	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-004	5/SS	23.5	25.0	24.25	CL	Alluvium	NA	19.8	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-004	6/SS	27.0	28.4	27.70	CL	Alluvium	NA	19.5	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-004	7/SS	28.5	30.0	29.25	CL	Alluvium	NA	18.4	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-004	8/SS	33.5	35.0	34.25	CL	Alluvium	NA	22.7	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-004	9/U	38.5	40.0	38.75	CL	Alluvium	100.2	22.5	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-006	1/U	4.5	5.0	4.75	SM	Tails-snd	99.2	7.0	NA	100.0	21.0	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-008	4/U	15.0	15.5	15.25	CL	Tails-slm	84.1	82.8	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-008	5/U	19.5	20.0	19.75	ML	Tails-slm	84.5	30.1	NA	NA	NA	23.2	2.8	NA	NA	
EAST PILE	D&M	31SW91-008	7/U	23.5	25.0	24.25	CH	Alluvium	87.3	87.4	NA	NA	NA	51.4	23.8	NA	NA	Triax-CUPP
EAST PILE	D&M	31SW91-008	8/U	28.5	30.0	29.25	CL	Alluvium	81.1	34.2	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-008	4/ST	16.0	17.5	16.75	CL	Tails-snd&slm	85.1	26.0	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-008	7/ST	20.0	22.0	21.00	CL	Tails-slm	90.0	66.3	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-010a	1/SS	9.0	10.5	9.75	CL	Alluvium	NA	10.8	NA	NA	NA	38.8	18.8	NA	NA	Unconf Comp, Consol, Perm, CHR
EAST PILE	D&M	31SW91-010a	3/SS	19.0	20.5	19.75	CL	Alluvium	NA	19.2	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-010a	4/SS	24.0	25.5	24.75	CL	Alluvium	NA	14.8	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-010a	5/SS	29.0	30.5	29.75	CL	Alluvium	NA	15.1	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-010b	3/SS	34.0	35.5	34.75	CL	Alluvium	NA	17.9	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-010b	4/SS	38.0	39.5	38.75	CL	Alluvium	NA	17.8	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-010a	5/SS	44.0	45.5	44.75	CL/SC	Alluvium	NA	21.1	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-010a	6/SS	48.0	48.5	48.25	SC	Alluvium	NA	12.7	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-013	3/ST	10.5	12.5	11.50	CL	Tails-slm	89.8	87.2	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-013	8/ST	25.5	27.5	26.50	CL-ML	Tails-snd/slm	88.7	80.8	NA	NA	NA	NA	NA	NA	NA	Unconf Comp
EAST PILE	D&M	31SW91-013	9/SS	28.5	30.5	29.50	CL/SM	Tails-snd/slm	NA	28.7	NA	NA	NA	NA	NA	NA	NA	Triax-CUPP, Consol
EAST PILE	D&M	31SW91-014	1/U	4.5	5.0	4.75	CL	MVP spoil	108.8	8.4	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-014	2/U	9.5	10.0	9.75	SM	Tails-snd	96.7	7.8	NA	100.0	22.0	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-014	3/U	14.5	15.0	14.75	CL	Alluvium(?)	90.4	25.1	NA	NA	NA	NA	NA	NA	NA	Dir Shear
EAST PILE	D&M	31SW91-014	7/U	19.5	20.0	19.75	CL	Alluvium(?)	55.0	79.9	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-014	8/U	24.0	24.5	24.25	CL	Alluvium(?)	62.8	82.4	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-014	16/SS	48.0	49.3	48.65	Km	Shale	NA	13.4	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-018b	1/U	2.5	3.8	3.15	SM	Tails-snd	88.3	7.8	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-018b	2/U	7.5	8.8	8.15	SM	Alluvium	85.8	29.4	2.81	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-018b	3/U	12.5	13.7	13.10	CL/SC	Alluvium	NA	15.5	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-019	1/SS	5.5	6.5	6.00	ML	Tails-snd&slm(?)	NA	10.3	NA	100.0	85.4	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-019	3/SS	8.0	9.5	8.75	SM	Tails-snd	NA	12.4	NA	99.2	46.1	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-019	5/SS	11.0	12.5	11.75	SM	Tails-snd	NA	8.2	NA	99.5	30.8	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-019	6/SS	12.5	14.0	13.25	SM	Tails-snd	NA	9.0	NA	100.0	33.2	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-019	7/SS	14.0	15.5	14.75	SM	Tails-snd	NA	17.7	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-019	8/SS	15.5	17.0	16.25	SM	Tails-snd	NA	17.9	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-019	9/SS	17.0	18.5	17.75	CL	Tails-slm	NA	43.7	NA	NA	NA	35.0	13.9	NA	NA	
EAST PILE	D&M	31SW91-019	10/SS	18.5	20.0	19.25	CL	Tails-slm	NA	34.4	NA	NA	NA	44.7	18.3	NA	NA	
EAST PILE	D&M	31SW91-019	11/SS	20.0	21.5	20.75	CL	Alluvium(?)	NA	25.8	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-019	12/SS	21.5	23.0	22.25	CL	Alluvium(?)	NA	24.7	NA	NA	NA	29.0	19.0	NA	NA	
EAST PILE	D&M	31SW91-019	15/SS	33.0	33.5	33.25	SC	Alluvium	NA	8.7	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-020	1/SS	4.0	5.5	4.75	CL	Alluvium	NA	10.9	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-020	2/SS	8.0	9.5	8.75	CL	Alluvium	NA	12.2	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-020	3/SS	14.0	15.5	14.75	CL	Alluvium	NA	18.8	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-020	4/SS	19.0	20.5	19.75	CL	Alluvium	NA	13.8	NA	NA	NA	45.0	23.8	NA	NA	
EAST PILE	D&M	31SW91-020	5/SS	24.0	25.5	24.75	CL	Alluvium	NA	19.0	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-020	6/SS	29.0	30.5	29.75	SC	Alluvium	NA	21.4	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-020	7/SS	34.0	35.0	34.50	GC	Alluvium	NA	19.7	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-025	3/U	13.0	13.7	13.35	CL	Alluvium	101.8	22.9	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-025	4/U	18.0	19.5	18.75	CL	Alluvium	98.5	25.3	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-025	5/SS	23.5	24.8	24.15	SC(?)	Alluvium	97.9	23.2	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	31SW91-025	6/U	29.3	29.8	29.55	Km	Shale	113.4	18.1	NA	NA	NA	NA	NA	NA	NA	

MRAP - 710002307 - GEOTECHNICAL DATA BASE FOR MONTICELLO MILLSITE CHARACTERIZATION -- R.N. MORRIS; CREATED 09/30/91; LAST UPDATED 11/22/91

AREA	DATA SOURC	BORING OR TEST PIT NUMBER	SAMPLE NUMBER & TYPE	TOP OF SAMPLE (FEET)	BASE OF SAMPLE (FEET)	SAMPLE MIDPOINT (FEET)	USCS SYMBOL	MATERIAL TYPE	IN-PLACE DRY DENSITY (PCF)	NATURAL MOISTURE CONTENT (PERCENT)	SPECIFIC GRAVITY	FRACTION PASSING #4 SIEVE (PERCENT)	FRACTION PASSING #200 SIEVE (PERCENT)	LIQUID LIMIT	PLASTICITY INDEX	ASTM D 698 MAXIMUM DRY DENSITY (PCF)	ASTM D 698 OPTIMUM MOISTURE CONTENT (PERCENT)	OTHER TESTS
EAST PILE	D&M	TP-1	1/ST	6.5	7.0	6.75	CL	MVP spoil	103.3	11.1	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	TP-1	-/BULK	7.0	7.0	7.00	CL	MVP spoil	NA	16.2	NA	NA	NA	NA	NA	103.1	18.1	Perm, Mod Proc
EAST PILE	D&M	TP-1	2/ST	9.0	9.5	9.25	CL	MVP spoil	96.5	23.4	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	TP-1	3/ST	14.0	14.5	14.25	SM	Talc-sand	101.5	7.4	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	TP-1	-/BULK	15.0	15.0	15.00	SM	Talc-sand	NA	10.8	NA	99.0	31.0	NA	NA	106.4	14.2	
EAST PILE	D&M	TP-2	1/ST	9.0	9.5	9.25	SM	Talc-silt	91.5	27.9	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	TP-2	-/BULK	10.0	10.0	10.00	ML	Talc-silt	NA	33.0	NA	NA	NA	NA	NA	103.0	20.0	Consol, CMR
EAST PILE	D&M	TP-2	2/ST	10.5	11.0	10.75	SM	Talc-sand	87.3	1.7	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	TP-2	3/ST	13.5	14.0	13.75	ML	Talc-sand&silt(?)	86.8	53.5	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	TP-2	-/BULK	14.0	14.0	14.00	ML	Talc-sand&silt(?)	NA	7.8	NA	100.0	54.4	NA	NA	103.5	17.1	CMR
EAST PILE	D&M	TP-2	4/ST	14.5	15.0	14.75	ML	Talc-sand&silt(?)	74.0	25.4	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	TP-4	-/BULK	8.0	8.0	8.00	ML	Talc-sand&silt	NA	32.4	NA	100.0	91.6	NA	NA	96.8	21.5	Dir Shear, Perm, CMR
EAST PILE	D&M	TP-4	1/ST	9.5	10.0	9.75	ML	Talc-sand&silt	89.8	7.9	NA	NA	NA	NA	NA	NA	NA	
EAST PILE	D&M	TP-4	-/BULK	14.0	14.0	14.00	ML	Talc-sand&silt	NA	14.7	2.71	100.0	56.8	NA	NA	101.8	17.3	Perm, CMR
EAST PILE	D&M	TP-4	5/ST	14.5	15.0	14.75	ML	Talc-sand&silt	81.8	57.1	NA	100.0	96.1	NA	NA	NA	NA	
ACID PILE	BENDIX	MRAP-44-10	MKB-721/ST	4.0	6.0	5.00	CL	Talc-silt	86.1	41.5	2.83	100.0	78.0	29.0	11.0	NA	NA	
ACID PILE	BENDIX	MRAP-44-10*	MKB-791/BULK	1.0	1.0	1.00	SM	Cover	NA	NA	NA	100.0	48.0	NA	NA	111.5	16.9	
ACID PILE	BENDIX	MRAP-44-10*	MKB-792/BULK	3.0	3.0	3.00	SP	Talc-sand	NA	NA	NA	NA	NA	NA	NA	113.4	12.4	
ACID PILE	BENDIX	MRAP-44-10*	MKB-793/BULK	5.0	5.0	5.00	CL	Talc-silt	NA	NA	2.78	NA	NA	NA	NA	94.5	26.3	
ACID PILE	BENDIX	MRAP-45-11	MKB-741/ST	4.0	6.0	5.00	CL	Talc-silt	74.8	38.8	2.68	100.0	72.0	44.0	20.0	NA	NA	Consol w/perm, CMR @15 bar
ACID PILE	BENDIX	MRAP-45-12	MKB-722/ST	4.0	6.0	5.00	ML	Talc-silt	78.4	40.5	2.68	100.0	87.0	47.0	10.0	NA	NA	Consol w/perm, CMR @15 bar
ACID PILE	D&M	315WW91-026	1/SS	4.5	5.0	4.75	CL	Talc-sand&silt	NA	30.0	NA	NA	NA	33.8	13.1	NA	NA	
ACID PILE	D&M	315WW91-026	2/SS	8.5	9.0	8.75	CL	Alluvium	NA	12.8	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-026	5/SS	13.5	14.5	14.00	CL	Alluvium	NA	17.1	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-027	3/ST	6.0	8.0	7.00	CH	Alluvium	71.5	46.0	NA	NA	NA	58.9	28.7	NA	NA	Triax-CUPP, Unconf Comp, Perm, CMR
ACID PILE	D&M	315WW91-027	4/ST	9.0	11.5	10.25	CH	Alluvium	96.0	75.2	NA	NA	NA	66.5	31.4	NA	NA	Triax-CUPP, Unconf Comp, Consol
ACID PILE	D&M	315WW91-027	6/ST	19.0	20.5	19.75	CL/SC	Alluvium	108.3	11.3	NA	NA	NA	37.4	21.0	NA	NA	Triax-CUPP, Unconf Comp, Perm, CMR
ACID PILE	D&M	315WW91-028	2/SS	4.0	6.0	5.00	SM	Talc-sand(?)	NA	17.2	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-028	3/SS	6.0	6.9	6.44	SM	Talc-sand	NA	17.2	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-028	4/SS	9.0	10.0	9.50	CL-ML	Talc-silt	NA	37.8	2.70	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-028	5/SS	10.5	12.0	11.25	ML	Talc-silt	NA	38.5	NA	NA	NA	34.8	9.4	NA	NA	
ACID PILE	D&M	315WW91-028	6/SS	13.5	15.0	14.25	ML	Talc-sand&silt	NA	27.9	NA	100.0	51.7	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-028	7/SS	15.0	17.0	16.00	SM	Talc-sand&silt	NA	18.5	NA	100.0	34.7	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-028	8/SS	18.0	19.0	18.50	ML	Talc-silt	NA	43.3	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-028	9/SS	19.0	21.0	20.00	ML	Talc-silt	NA	38.0	NA	100.0	85.9	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-028	10/SS	22.5	23.0	22.75	SM	Talc-sand	NA	80.5	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-028	11/SS	24.0	25.0	24.50	ML/CL	Talc-sand&silt	NA	53.1	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-028	12/SS	25.0	27.0	26.00	ML/CL	Talc-sand&silt	NA	58.3	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-028	13/SS	27.0	29.0	28.00	CL	Talc-sand&silt	NA	56.9	NA	100.0	92.0	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-028	14/SS	29.0	30.5	29.75	ML/CL	Talc-sand&silt	NA	51.4	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-028	15/SS	31.0	33.0	32.00	CL	Talc-sand&silt	NA	64.7	NA	NA	NA	48.8	21.2	NA	NA	
ACID PILE	D&M	315WW91-028	16/SS	33.5	34.0	33.75	ML	Talc-sand&silt	NA	41.3	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-028	17/SS	36.0	37.0	36.50	ML/SC	Alluvium(?)	NA	19.1	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-028	18/SS	37.5	39.0	38.25	SC/CL	Alluvium	NA	20.9	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-028	19/SS	39.0	41.0	40.00	CL	Alluvium	NA	24.5	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-034	1/SS	5.0	6.0	5.50	ML/CL	Talc-silt	NA	57.3	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-034	3/SS	14.0	16.0	15.00	CL-ML	Talc-silt	NA	57.3	2.86	NA	NA	47.4	17.8	NA	NA	
ACID PILE	D&M	315WW91-034	7/SS	29.0	29.5	29.25	Km	Shale	NA	10.1	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-033	3/SS	5.0	5.5	5.25	SM	Talc-sand	NA	4.8	NA	100.0	20.7	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-033	4/SS	10.0	10.5	10.25	SM	Talc-sand	NA	5.1	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-033	6/SS	15.0	15.5	15.25	SM	Talc-sand	NA	15.3	NA	100.0	28.0	NA	NA	NA	NA	
ACID PILE	D&M	315WW91-033	9/ST	18.0	20.0	19.00	SM	Talc-sand	100.8	13.4	NA	100.0	17.2	NA	NA	NA	NA	Dir Shear, Perm, CMR
ACID PILE	D&M	315WW91-033	12/SS	24.5	25.0	24.75	CL/ML	Talc-silt	NA	19.4	NA	NA	NA	46.0	16.3	NA	NA	
ACID PILE	D&M	TP-7	-/BULK	2.0	2.0	2.00	SM	Talc-sand	NA	9.4	2.71	100.0	42.3	NP	NP	109.0	14.5	Triax-CUPP, Consol, Perm, Mod Proc, CMR
ACID PILE	D&M	TP-7	2/ST	5.0	5.5	5.25	CL	Talc-silt	82.5	62.6	NA	NA	NA	NA	NA	NA	NA	Unconf Shear
ACID PILE	D&M	TP-7	3/ST	6.5	7.0	6.75	CL	Talc-silt	86.1	54.4	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	TP-7	4/ST	9.5	10.0	9.75	CL	Talc-silt	51.3	65.0	NA	NA	NA	NA	NA	NA	NA	Unconf Shear
ACID PILE	D&M	TP-7	5/ST	12.5	13.0	12.75	CL	Talc-silt	53.1	74.1	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	TP-7	6/ST	16.5	17.0	16.75	CL	Talc-silt	51.4	85.1	NA	NA	NA	NA	NA	NA	NA	Unconf Shear
ACID PILE	D&M	TP-8	1/ST	2.5	3.0	2.75	SM/ML	Talc-sand/silt	78.5	11.5	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	TP-8	2/ST	4.5	5.0	4.75	SM	Talc-sand	90.0	8.5	2.82	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	TP-8	-/BULK	4.5	4.5	4.50	SM	Talc-sand	NA	7.6	NA	100.0	28.9	NA	NA	103.8	15.5	Dir Shear, Perm, Mod Proc, CMR
ACID PILE	D&M	TP-8	3/ST	6.0	6.5	6.25	SM	Talc-sand(?)	82.5	14.3	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	TP-8	4/ST	10.0	10.5	10.25	ML	Talc-silt	85.7	30.8	2.78	100.0	63.5	NA	NA	NA	NA	
ACID PILE	D&M	TP-8	5/ST	12.0	12.5	12.25	CL	Talc-silt	59.2	70.9	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	TP-8	-/BULK	13.0	13.0	13.00	CL	Talc-silt	NA	NA	NA	NA	NA	NA	NA	NA	NA	Perm

MRAP - 710002307 - GEOTECHNICAL DATA BASE FOR MONTICELLO MILLSITE CHARACTERIZATION - R.N. MORRIS: CREATED 09/30/81: LAST UPDATED 11/22/81

AREA	DATA SOURC	BORING OR TEST PIT NUMBER	SAMPLE NUMBER & TYPE	TOP OF SAMPLE (FEET)	BASE OF SAMPLE (FEET)	SAMPLE MIDPOINT (FEET)	USCS SYMBOL	MATERIAL TYPE	IN-PLACE DRY DENSITY (PCF)	NATURAL MOISTURE CONTENT (PERCENT)	SPECIFIC GRAVITY	FRACTION PASSING #4 SIEVE (PERCENT)	FRACTION PASSING #200 SIEVE (PERCENT)	LIQUID LIMIT	PLASTICITY INDEX	ASTM D 698 MAXIMUM DRY DENSITY (PCF)	ASTM D 698 OPTIMUM MOISTURE CONTENT (PERCENT)	OTHER TESTS
ACID PILE	D&M	TP-8	1/ST	1.5	2.0	1.75	SM	Tails-sand	88.4	4.5	NA	NA	NA	NA	NA	NA	NA	
ACID PILE	D&M	TP-8	2/ST	3.0	3.5	3.25	SM	Tails-sand	84.0	8.6	NA	100.0	19.8	NA	NA	NA	NA	
ACID PILE	D&M	TP-6	/BULK	10.0	10.0	10.00	ML	Alluvium	NA	23.4	NA	93.8	89.0	34.2	18.1	114.0	14.9	Perm, Med Prod, CMR
SOMERVILLE TRACT	BENDIX	MRAP-85-17	MKB-786/SS	0.0	2.0	1.00	SC	Alluvium	NA	48.2	2.63	100.0	31.0	33.0	10.0	NA	NA	Perm, CMR @15 bar
SOMERVILLE TRACT	BENDIX	MRAP-85-17	MKB-600/BULK	0.0	5.0	2.50	ML	Alluvium(Shale?)	NA	NA	NA	87.0	81.0	NA	NA	106.3	17.0	
SOMERVILLE TRACT	BENDIX	MRAP-85-18	MKB-785/SS	0.0	2.0	1.00	CL	Alluvium	NA	14.3	2.35	100.0	86.0	32.0	14.0	NA	NA	Perm, Consol w/perm, CMR @15 bar
SOMERVILLE TRACT	BENDIX	MRAP-85-18	MKB-633/BULK	0.0	5.0	2.50	ML	Alluvium	NA	NA	NA	100.0	80.0	NA	NA	103.3	19.0	
BLM COMPOUND	BENDIX	MRAP-85-20	MKB-723/SS	0.0	2.0	1.00	OL	Alluvium	NA	10.5	2.62	100.0	80.0	41.0	7.0	NA	NA	Perm, CMR @15 bar
BLM COMPOUND	BENDIX	MRAP-85-20	MKB-634/BULK	0.0	3.0	1.50	OL	Alluvium	NA	NA	NA	100.0	71.8	NA	NA	101.9	18.8	
BLM COMPOUND	D&M	385E81-058	2/SS	3.5	4.5	4.00	CL	Alluvium	NA	25.4	NA	NA	NA	40.7	20.0	NA	NA	
BLM COMPOUND	D&M	385E81-059	3/SS	4.5	5.5	5.00	CL	Alluvium	NA	31.8	NA	NA	NA	36.0	15.6	NA	NA	
BLM COMPOUND	D&M	385E81-064	4/SS	7.0	10.5	8.75	ML	Alluvium	NA	27.1	NA	100.0	71.2	NA	NA	NA	NA	
VALLEY BOTTOM	BENDIX	MRAP-85-21	MKB-756/SS	0.0	2.0	1.00	OL	Alluvium	NA	7.5	2.60	NA	NA	30.0	10.5	NA	NA	Perm, CMR @15 bar
VALLEY BOTTOM	BENDIX	MRAP-85-21	MKB-626/BULK	0.0	3.0	1.50	SM	Tails-sand	NA	NA	NA	100.0	43.0	NA	NA	115.2	13.8	
VALLEY BOTTOM	D&M	315W81-001	3/SS	3.5	4.8	4.15	CL	Alluvium	NA	12.8	NA	NA	NA	NA	NA	NA	NA	
VALLEY BOTTOM	D&M	315W81-001	7/SS	8.5	10.0	9.25	CL	Alluvium	NA	15.8	NA	NA	NA	NA	NA	NA	NA	
VALLEY BOTTOM	D&M	315W81-001	8/SS	13.5	14.3	13.90	CL	Alluvium	NA	15.3	NA	NA	NA	NA	NA	NA	NA	
VALLEY BOTTOM	D&M	315W81-001	11/BULK	24.0	25.0	24.50	GC	Alluvium	NA	16.8	NA	NA	NA	NA	NA	NA	NA	
VALLEY BOTTOM	D&M	315W81-023	2/SS	8.5	8.9	8.75	SC	Alluvium	NA	9.9	NA	NA	NA	NA	NA	NA	NA	
VALLEY BOTTOM	D&M	315W81-023	3/SS	13.5	13.8	13.65	SW	Alluvium	NA	6.4	NA	NA	NA	NA	NA	NA	NA	
VALLEY BOTTOM	D&M	315W81-030	1/SS	4.0	6.0	5.00	CL	Alluvium	NA	16.9	NA	NA	NA	NA	NA	NA	NA	
VALLEY BOTTOM	D&M	315W81-030	2/SS	9.5	11.0	10.25	SC	Alluvium	NA	12.5	NA	NA	NA	NA	NA	NA	NA	
VALLEY BOTTOM	D&M	315W81-030	3/SS	14.3	14.7	14.50	Km	Shale	NA	12.3	NA	NA	NA	NA	NA	NA	NA	
VALLEY BOTTOM	D&M	385E81-071	1/SS	3.5	4.0	3.75	SM	Alluvium	NA	10.2	NA	83.1	46.7	NA	NA	NA	NA	
VALLEY BOTTOM	D&M	385E81-071	4/SS	9.5	10.0	9.75	SP	Alluvium	NA	8.1	NA	NA	NA	NA	NA	NA	NA	
VALLEY BOTTOM	D&M	385E81-071	6/SS	14.0	14.5	14.25	SM	Alluvium	NA	13.8	NA	80.4	18.5	NA	NA	NA	NA	
VALLEY BOTTOM	D&M	385E81-072	1/SS	4.5	5.0	4.75	ML	Alluvium	NA	10.7	NA	87.3	71.3	NA	NA	NA	NA	
VALLEY BOTTOM	D&M	385E81-064a	3/SS	8.0	8.5	8.25	ML	Alluvium(?)	NA	9.8	NA	100.0	51.4	NA	NA	NA	NA	
VALLEY BOTTOM	D&M	385E81-064a	4/SS	10.0	10.5	10.25	ML	Alluvium(?)	NA	9.9	NA	NA	NA	NA	NA	NA	NA	
VALLEY BOTTOM	D&M	385E81-064a	5/SS	13.5	14.5	14.00	CL	Alluvium(?)	NA	13.2	NA	NA	NA	NA	NA	NA	NA	
VALLEY BOTTOM	D&M	TP-13	/BULK	5.0	5.0	5.00	GC	Alluvium	NA	20.2	NA	48.1	41.8	38.4	17.8	114.1	13.2	
MAIN MILLSITE	D&M	315W81-006b	6/SS	8.0	8.5	8.25	CL	Alluvium	NA	27.7	NA	NA	NA	NA	NA	NA	NA	
MAIN MILLSITE	D&M	315W81-006b	9A/SS	9.3	9.8	9.63	CL	Alluvium	NA	28.8	NA	NA	NA	NA	NA	NA	NA	
MAIN MILLSITE	D&M	315W81-006b	10/SS	13.5	15.0	14.25	CL	Alluvium	NA	31.8	NA	NA	NA	NA	NA	NA	NA	
MAIN MILLSITE	D&M	385E81-067	3/SS	3.5	4.8	4.15	CL	Alluvium(Shale?)	NA	23.9	NA	NA	NA	NA	NA	NA	NA	
MAIN MILLSITE	D&M	385E81-067a	18/SS	0.5	2.0	1.25	CL	Fill	NA	11.8	NA	NA	NA	48.3	22.9	NA	NA	
SOUTH VALLEY WALL	D&M	315W81-011	3/SS	10.0	10.5	10.25	CL	Alluvium(Shale?)	NA	23.8	NA	NA	NA	NA	NA	NA	NA	
SOUTH VALLEY WALL	D&M	315W81-021	4/SS	8.5	9.0	8.75	CL	Alluvium	NA	7.3	NA	NA	NA	NA	NA	NA	NA	
SOUTH VALLEY WALL	D&M	315W81-022	4/SS	10.0	10.5	10.25	CL	Alluvium	NA	10.8	NA	NA	NA	NA	NA	NA	NA	
SOUTH VALLEY WALL	D&M	315W81-036	1/SS	2.0	2.5	2.25	CL	Alluvium	NA	8.8	NA	NA	NA	NA	NA	NA	NA	
SOUTH VALLEY WALL	D&M	315W81-036	3/SS	9.4	10.3	9.86	CL	Alluvium	NA	14.2	NA	NA	NA	NA	NA	NA	NA	
SOUTH VALLEY WALL	D&M	315W81-036	4/SS	10.3	11.0	10.65	SC	Alluvium	NA	14.6	NA	NA	NA	NA	NA	NA	NA	
SOUTH VALLEY WALL	D&M	315W81-036	5/SS	14.0	14.2	14.10	CL	Alluvium	NA	12.2	NA	NA	NA	NA	NA	NA	NA	
SOUTH VALLEY WALL	D&M	315W81-054	4/SS	4.5	5.0	4.75	CL	Alluvium	NA	11.4	NA	100.0	80.4	43.2	23.4	NA	NA	
NORTH VALLEY WALL	D&M	315W81-018	1B/SS	3.5	5.5	4.50	CL	Alluvium(?)	NA	12.9	NA	NA	NA	38.2	17.1	NA	NA	
NORTH VALLEY WALL	D&M	315W81-018	2B/SS	8.5	10.5	9.50	CL	Alluvium(?)	NA	20.1	NA	100.0	87.8	NA	NA	NA	NA	
NORTH VALLEY WALL	D&M	315W81-033	1/SS	2.0	4.0	3.00	CL	Alluvium	NA	14.2	NA	NA	NA	NA	NA	NA	NA	
NORTH VALLEY WALL	D&M	315W81-033	3/SS	9.0	11.0	10.00	CL	Alluvium	NA	10.8	NA	NA	NA	33.4	13.8	NA	NA	
NORTH VALLEY WALL	D&M	315W81-063	3B/SS	8.5	9.0	8.75	CL	Alluvium(?)	NA	21.2	NA	NA	NA	NA	NA	NA	NA	
NORTH VALLEY WALL	D&M	315W81-063	6B/SS	14.5	15.0	14.75	CL	Alluvium(?)	NA	23.8	2.70	NA	NA	48.3	23.0	NA	NA	
NORTH VALLEY WALL	D&M	315W81-063	7B/SS	18.5	19.0	18.75	CL	Alluvium(?)	NA	23.8	NA	NA	NA	NA	NA	NA	NA	
BLM PROPERTY-NORT	D&M	385E81-073	1/SS	3.5	3.8	3.65	CL	Alluvium	NA	11.9	NA	NA	NA	38.1	15.9	NA	NA	
BLM PROPERTY-NORT	D&M	385E81-073	3/SS	13.5	14.3	13.90	CL	Alluvium	NA	13.8	NA	NA	NA	NA	NA	NA	NA	
BLM PROPERTY-NORT	D&M	385E81-073	4/SS	20.0	20.5	20.25	CL	Alluvium	NA	30.1	NA	NA	NA	44.8	22.8	NA	NA	
BLM PROPERTY-NORT	D&M	385E81-076	3/SS	5.0	5.5	5.25	CL	Alluvium	NA	23.9	NA	NA	NA	41.3	20.7	NA	NA	
BLM PROPERTY-NORT	D&M	385E81-076	4/SS	9.5	10.0	9.75	CL	Alluvium	NA	17.5	NA	NA	NA	NA	NA	NA	NA	
BLM PROPERTY-NORT	D&M	385E81-076	6/SS	15.0	15.5	15.25	CL	Alluvium	NA	18.8	NA	NA	NA	27.0	8.4	NA	NA	
BLM PROPERTY-NORT	D&M	385E81-076	7/SS	20.0	20.5	20.25	CL	Alluvium	NA	19.1	NA	NA	NA	NA	NA	NA	NA	
BLM PROPERTY-NORT	D&M	385E81-077	2/SS	3.5	4.3	3.90	CL	Alluvium(Loess?)	NA	17.4	NA	NA	NA	49.9	22.7	NA	NA	
BLM PROPERTY-NORT	D&M	385E81-077	3/SS	8.5	9.5	9.00	CL	Alluvium(Loess?)	NA	15.8	NA	NA	NA	NA	NA	NA	NA	
BLM PROPERTY-NORT	D&M	385E81-078	2/SS	8.5	9.5	9.00	CL	Alluvium	NA	18.0	NA	NA	NA	NA	NA	NA	NA	
BLM PROPERTY-NORT	D&M	385E81-078	3/SS	13.5	14.3	13.90	CL	Alluvium	NA	15.8	NA	NA	NA	NA	NA	NA	NA	
BLM PROPERTY-NORT	D&M	385E81-080	2/SS	5.0	6.0	5.50	CL	Alluvium	NA	15.9	NA	NA	NA	44.7	22.4	NA	NA	
BLM PROPERTY-NORT	D&M	385E81-080	3/SS	10.0	10.8	10.40	SW	Alluvium	NA	6.9	NA	NA	NA	NA	NA	NA	NA	
BLM PROPERTY-NORT	D&M	385E81-082	2/SS	3.5	4.0	3.75	SM	Alluvium	NA	6.9	NA	88.9	38.4	NA	NA	NA	NA	
BLM PROPERTY-NORT	D&M	385E81-082	3/SS	8.5	10.5	9.50	CL	Alluvium(?)	NA	23.5	NA	NA	NA	NA	NA	NA	NA	

MMRAP - 710002307 - GEOTECHNICAL DATA BASE FOR MONTICELLO MILLSITE CHARACTERIZATION - R.N. MORRIS: CREATED 08/30/91; LAST UPDATED 11/22/91

AREA	DATA SOURC	BORING OR TEST PIT NUMBER	SAMPLE NUMBER & TYPE	TOP OF SAMPLE (FEET)	BASE OF SAMPLE (FEET)	SAMPLE MIDPOINT (FEET)	USCS SYMBOL	MATERIAL TYPE	IN-PLACE DRY DENSITY (PCF)	NATURAL MOISTURE CONTENT (PERCENT)	SPECIFIC GRAVITY	FRACTION PASSING #4 SIEVE (PERCENT)	FRACTION PASSING #200 SIEVE (PERCENT)	LIQUID LIMIT	PLASTICITY INDEX	ASTM D 698 MAXIMUM DRY DENSITY (PCF)	ASTM D 698 OPTIMUM MOISTURE CONTENT (PERCENT)	OTHER TESTS
BLM PROPERTY-NORT	D&M	TP-10	*1BULK	5.0	5.0	5.00	CL	Loess[?]	NA	10.9	NA	100.0	88.8	29.5	11.1	107.7	14.2	Mod Proct
BLM PROPERTY-NORT	D&M	TP-10	3ST	4.0	8.5	6.25	CL	Loess[?]	91.7	8.2	NA	NA	NA	27.9	9.8	NA	NA	Unconf Comp
BLM PROPERTY-NORT	D&M	TP-10	4ST	11.0	11.5	11.25	CL	Loess[?]	109.3	10.7	NA	NA	NA	43.8	21.8	NA	NA	Perm

KEY:

USCS	United Soil Classification System group symbol, ASTM D 2487 or D2488 (For rocks, symbol indicates geologic unit)
ASTM	Test designations of the American Society for Testing and Materials
BENDIX	"Data Collection for Engineering for the Uranium Mill Tailings Site and Adjacent Peripheral Properties, Monticello, Utah," Bendix Field Engineering Corporation, September 1988
D&M	"Final Report, Monticello Remedial Action Project, 1991 Millsite Characterization Study," Dames & Moore, September 17, 1991
*	Sample taken from a test pit excavated next to the designated borehole.
[?]	Questionable value or identification

MATERIAL TYPE:

Tails-snd	Tailings sands
Tails-slm	Tailings slimes
Tails-snd/slm	Tailings sands and slimes, interbedded
Tails-snd&slm	Tailings sands and slimes, mixed
Cover	Cover material in place on tailings piles
MVP spoils	Material removed from Monticello Vicinity Properties
Alluvium	Miscellaneous surficial deposits, mostly stream-laid
Loess	Windblown fine-grained deposits
Shale	Mancos Shale, usually weathered
Sandstone	Dakota Sandstone
Fill	Miscellaneous man-made fill

OTHER TESTS:

Mod Proct	Modified Proctor compaction
Unconf Comp	Unconfined compressive strength
Dir Shear	Direct shear, consolidated-drained
Triax-CUPP	Triaxial shear, consolidated-undrained with pore pressure measurements
Consol	One-dimensional consolidation
Perm	Permeability, falling-head or flexible-membrane
CMR	Capillary moisture rise

SAMPLE TYPES:

BULK	Disturbed bag sample of loose cuttings or material from test pit.
SS	Disturbed sample from 2.0" O.D. standard split-spoon drive sampler
ST	Relatively undisturbed sample from 3.0" O.D. thin-walled (Shelby) tube sampler
U	Relatively undisturbed sample from Dames & Moore Type "U" ring-lined drive sampler

All data in this table compiled or interpreted from consultant's reports by R.N. Morris, Chem-Nuclear Geotech, Inc., October 1991. Checked by L.H. Golden & corrected by R.N. Morris, November 1991.

AUG-09-1996 11:06 602 820 2941 97% P.17

APPENDIX B

Radon Calculation

Purpose: To determine the required soil cover thicknesses to limit radon emissions from the White Mesa tailings impoundments to 20 pCi/m^2/sec using United States Nuclear Regulatory Commission (NRC) approved methods and inputs. The White Mesa Mill site is located in Blanding, Utah.

Method: Determine the geotechnical and radiological properties of the tailings and cover materials based on NRC-accepted methods and existing database values previously collected. Input parameters into the computer modeling program "RADON" to determine the radon flux values through the cover materials. A variety of scenarios adjusting cover thicknesses were run to determine the optimum thickness of cover materials to meet NRC specifications. It was assumed that the tailings located in the three cells at the White Mesa Mill site (Cells 2, 3, and 4A) have similar properties (Figure 1). Therefore, cover layer configurations as determined by the RADON model are applicable to the three tailings cells.

Results: A 2-layer uranium mill tailings cover composed of (from top to bottom) a 2-foot layer of random fill and a 1-foot compacted clay layer will meet NRC specifications. In addition to the tailings cover materials, a minimum of 3 feet of random fill will be placed between the tailings and soil cover to fill the currently existing freeboard. This 3 foot layer was included for modeling purposes since it will assist in reducing the radon flux from the tailings impoundments. This layer, however, is not considered a part of the actual soil cover. The resulting radon flux exiting the top cover layer of the tailings impoundment will be 13.6 pCi/m^2/sec (see Appendix A1 for RADON output).

As indicated in the "Effects of Freezing on Uranium Mill Tailings Covers Calculation Brief" (6/17/96), 6.8 inches of the top random fill cover layer will be effected by freeze/thaw conditions at Blanding Utah. This suggests that 6.8 inches of the top layer may not contribute to reductions of radon emanation from the tailings covers. To conservatively compensate for effects from freezing and thawing, 6.8 inches were subtracted from the top random fill cover layer. Executing the RADON model based on this cover configuration resulted in a radon flux emanation of 17.6 pCi/m^2/sec (see Appendix A2 for RADON output).

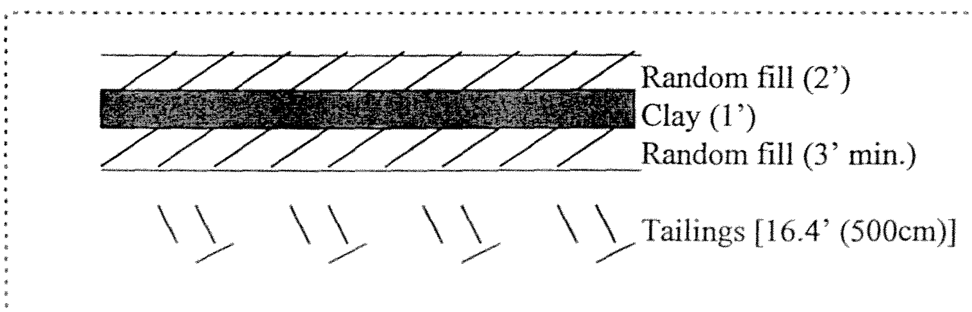
NRC specifications (Regulatory Guide 3.64) requires that a uranium tailings cover "..produce resonable assurance that the radon-222 release rate would not exceed 20 pCi/m^2/sec for a period of 1,000 years to the extent reasonably achievable and in any case for at least 200 years when averaged over the disposal area over at least a one-year period" (NRC, 1989). Therefore, the above design with accounting for freezing and thawing conditions is adequate.

Parameters: The RADON model requires input of the following parameters for all tailings and soil cover layers:

- layer thickness (centimeter (cm));
- porosity;
- mass density (g/cm^3);
- radium activity (pCi/gr), source term, or ore grade percentage;
- emanation coefficient;
- weight percent moisture (long-term) (percent), and;
- diffusion coefficient (cm^2/sec).

Physical and radiological properties for Tailings and Random Fill were analyzed by Chen and Associates (1987) and Rogers and Associates (1988) respectively. See Appendix B1 for analysis results. Clay physical data input for RADON modeling are included in Appendix B2 and were analyzed by Advanced Terra Testing (1996) and Rogers and Associates (1996).

The following cover profile was modeled.



This cover configuration represents the actual cover layer thicknesses which would be constructed on site. The cover profile above was adjusting for modeling purposes to account for freezing and thawing conditions. The modeled profile is identical to the one above with the exception of the top random fill layer which was reduced to 1.4 feet (2 feet minus 6.8 inches). It is assumed that 6.8 inches of the top cover layer effected by freeze/thaw conditions will not contribute to reductions in radon emanation from the tailings covers.

Layer thicknesses

The thickness of the tailings was assumed to be effectively an infinitely thick radon source. In accordance with NRC criteria (Reg. Guide 3.64, p. 3.64-5) a tailings thickness greater than about 100-200 cm is considered to be effectively, infinitely thick. A value of 500 cm represents an equivalent infinitely thick tailings source. The actual tailings thickness of Cell 3 at White Mesa is approximately 28 feet (850 cm), therefore, a value of 500 cm was used for the RADON model.

A minimum of 3-feet (91.5 cm) of random fill will cover the tailings to fill the existing freeboard and bring the tailings piles up to the subgrade elevation of the soil cover. A 1-foot (30.5 cm) layer of compacted clay covers the random fill with an additional 2 feet (61 cm) of random fill overlying the clay layer. Adjusting for freeze/thaw conditions results in a (43 cm) random fill layer overlaying the clay layer.

Porosity

Porosity is calculated from the specific gravity and dry bulk density according to the following equations;

1. Dry bulk density = [(specific gravity)(density of water)]/[1 + e] (Ref.: Principles & Practice of Civil Engineering, 1996, equation 14.5.6). See Appendix C.
2. Porosity = [e / (1+e)] x 100 (Ref.: Principles & Practice of Civil Engineering, 1996, equation 14.5.4). See Appendix C.

	Max. Dry Density (lb/ft^3)	Bulk Dry Density (lb/ft^3) (1)	Specific Gravity	Density of Water (lb/ft^3)	"e" (2)	**porosity (3)**
Tailings (4)	104.0	98.8	2.85	62.4	0.80	**44%**
Clay (5)	113.5	107.8	2.39	62.4	0.38	**28%**
Random fill (4)	120.2	114.2	2.67	62.4	0.46	**31.5%**

Notes:
1. Bulk dry density is 95% of the ASTM Proctor maximum dry density for all materials.
2. Calculated using Equation 1 above where "e" is the volume of voids per volume of solids.
3. Calculated using Equation 2 above.
4. Physical tailings and random fill data from Chen and Associates (1987) included in Appendix B1.
5. Clay physical data from Advanced Terra Testing (1996) and Rogers and Associates (1996) included in Appendix B2.

Mass Density

Mass densities were measured by Rogers and Associates (1988 and 1996) to be (see Appendix B1 and B2):

Tailings	= 1.45 g/cm^3
Clay	= 1.72 g/cm^3
Random Fill	= 1.85 g/cm^3

Radium Activity, Source Term, or Ore Grade %

Radium activity values from Rogers & Associates (1988 and 1996), were input for White Mesa tailings and cover materials (Appendix B1 and B2). The radium activity values are:

Tailings	= 981 pCi/gm
Clay	= 1.5 pCi/gm
Random Fill	= 1.9 pCi/gm.

Emanation Coefficient

Emanation coefficient input for the tailings and cover materials are measured values from Rogers & Associates (1988 and 1996), included in Appendix B1 and B2. The coefficients are:

Tailings	= 0.19
Clay	= 0.22
Random Fill	= 0.19

Note: Use of NRC's default value of E=0.35 is not considered appropriate since laboratory analyses of emanation coefficients are available.

Weight Percent Moisture

Long-term moisture content (weight percent moisture) was assumed to be 6% for the tailings. NRC Regulatory Guide 3.64 states, "if acceptable documented alternative information is not furnished by the applicant, the staff will use a reference value of 6% for the tailings moisture content because 6% is a lower bound for moisture in western soils" (NRC, 1989). Laboratory data does not exist to determine the actual weight percent moisture of tailings therefore, this is a conservative assumption.

The weight percent moisture of the new clay source (UT-1) is also unknown therefore, it was assumed that the average weight percent moisture from clay (site #1 and site #4) would be equivalent to the new clay source (UT-1). This is also a conservative assumption as the new clay source is believed to be of better quality. Weight percent moisture values for clay and random fill were derived from the "Summary of Capillary Moisture Relationship Test Results" figures included in Appendix B1. Weight percent moisture values used for modeling purposes are:

Tailings	= 6%
Clay	= 14.1%
Random Fill	= 9.8%

Diffusion Coefficient

Diffusion coefficient input for the tailings and cover materials are measured values from Rogers & Associates (1988 and 1996), included in Appendix B1 and B2. The coefficients used for tailings and random fill were an average of the two values presented. The coefficients for each material are as follows:

Tailings	= 0.0142 cm^2/sec
Clay	= 0.0091 cm^2/sec
Random Fill	= 0.0082 cm^2/sec

References:

Advanced Terra Testing, 1996, Physical soil data, White Mesa Project, Blanding Utah, July 25, 1996.

Chen and Associates, 1987. Physical soil data, White Mesa Project Blanding Utah.

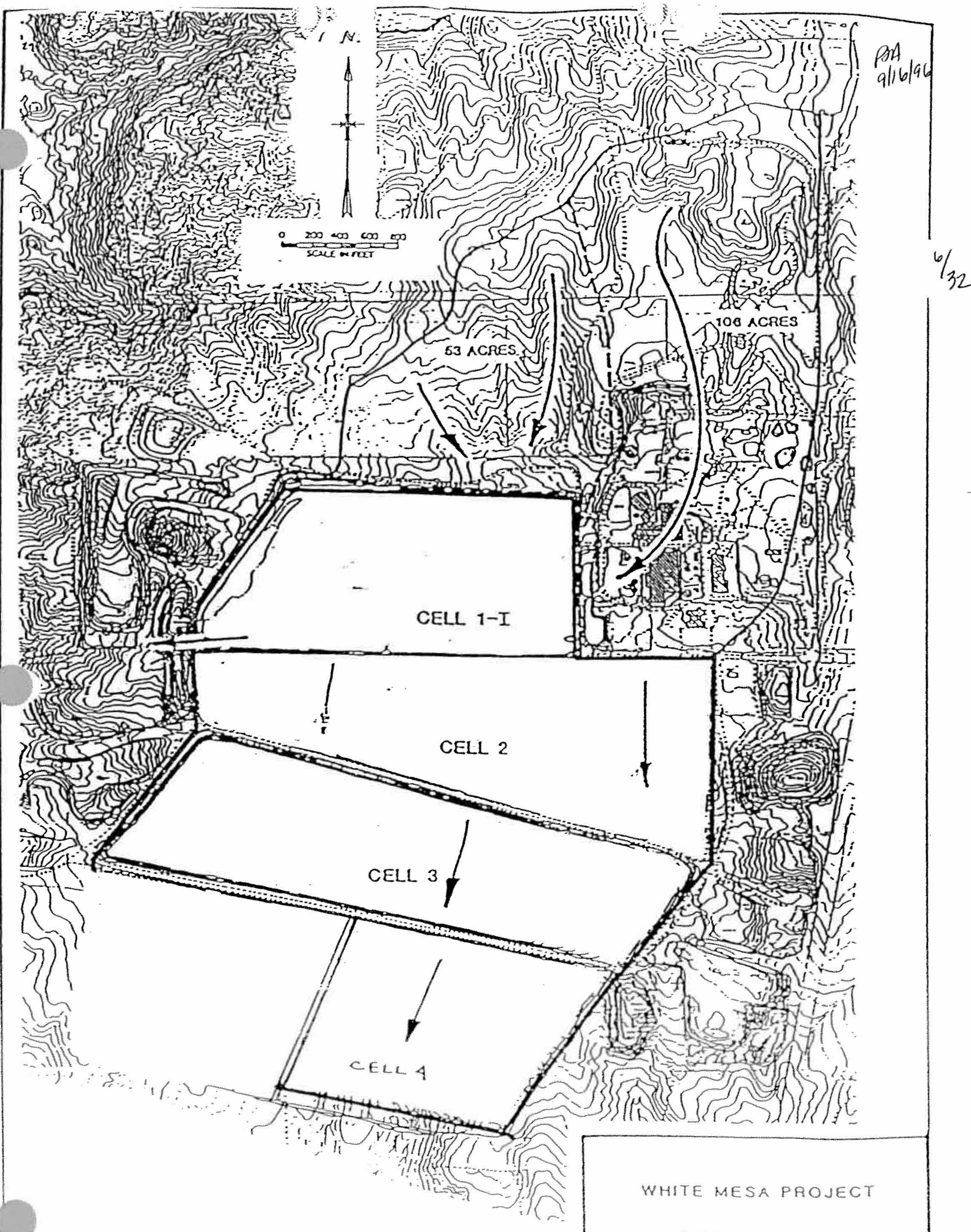
Freeze R. Allan and Cherry, John A., 1979, "Groundwater".

Principles & Practice of Civil Engineering, 2nd Edition, 1996.

Rogers and Associates Engineering Company, 1988. Radiological Properties Letters to C.O. Sealy from R.Y. Bowser dated March 4 and May 9, 1988.

Rogers and Associates Engineering Company, 1996. Report of Radon Diffusion Coefficient Measurements, Radium Content, and Emanation Coefficient Measurements, September 3, 1996.

U.S. Nuclear Regulatory Commission (NRC), 1989. "Regulatory Guide 3.64 (Task WM 503-4) Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers", March 1989.



WHITE MESA PROJECT

SITE DRAINAGE

FIGURE: 1

Appendix A1

-----*****! RADON !*****-----

Version 1.2 - MAY 22, 1989 - G.F. Birchard tel.# (301)492-7000
U.S. Nuclear Regulatory Commission Office of Research

8/32

RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS

DATE/TIME OF THIS RUN
09-10-1996/18:06:33

EFN - WHITE MESA

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	4	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
LAYER THICKNESS NOT OPTIMIZED		
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
RADON FLUX INTO LAYER 1	0	pCi m^-2 s^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 TAILINGS

THICKNESS	500	cm
POROSITY	.44	
MEASURED MASS DENSITY	1.45	g cm^-3
MEASURED RADIUM ACTIVITY	981	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.19	
CALCULATED SOURCE TERM CONCENTRATION	1.290D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.198	
MEASURED DIFFUSION COEFFICIENT	.0142	cm^2 s^-1

LAYER 2 RANDOM FILL (FILL FREEBOARD)

THICKNESS	91.5	cm
POROSITY	.315	
MEASURED MASS DENSITY	1.85	g cm^-3
MEASURED RADIUM ACTIVITY	1.9	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.19	
CALCULATED SOURCE TERM CONCENTRATION	4.452D-06	pCi cm^-3 s^-1
WEIGHT % MOISTURE	9.800000000000001	%
MOISTURE SATURATION FRACTION	.576	
MEASURED DIFFUSION COEFFICIENT	8.200000000000001D-03	cm^2 s^-1

9/32

LAYER 3 CLAY (UT-1)

THICKNESS	30.5	cm
ROSITY	.28	
MEASURED MASS DENSITY	1.72	g cm^-3
MEASURED RADIUM ACTIVITY	1.5	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.22	
CALCULATED SOURCE TERM CONCENTRATION	4.257D-06	pCi cm^-3 s^-1
WEIGHT % MOISTURE	14.1	%
MOISTURE SATURATION FRACTION	.866	
MEASURED DIFFUSION COEFFICIENT	.0091	cm^2 s^-1

LAYER 4 RANDOM FILL

THICKNESS	61	cm
POROSITY	.315	
MEASURED MASS DENSITY	1.85	g cm^-3
MEASURED RADIUM ACTIVITY	1.9	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.19	
CALCULATED SOURCE TERM CONCENTRATION	4.452D-06	pCi cm^-3 s^-1
WEIGHT % MOISTURE	9.800000000000001	%
MOISTURE SATURATION FRACTION	.576	
MEASURED DIFFUSION COEFFICIENT	8.200000000000001D-03	cm^2 s^-1

DATA SENT TO THE FILE 'RNDATA' ON DEFAULT DRIVE

N	F01	CN1	ICOST	CRITJ	ACC
4	0.000D+00	0.000D+00	0	2.000D+01	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	1.420D-02	4.400D-01	1.290D-03	1.977D-01	1.450
2	9.150D+01	8.200D-03	3.150D-01	4.452D-06	5.756D-01	1.850
3	3.050D+01	9.100D-03	2.800D-01	4.257D-06	8.661D-01	1.720
4	6.100D+01	8.200D-03	3.150D-01	4.452D-06	5.756D-01	1.850

BARE SOURCE FLUX FROM LAYER 1: 4.667D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	1.233D+02	4.519D+05
2	9.150D+01	2.562D+01	7.892D+04
3	3.050D+01	1.962D+01	2.276D+04
4	6.100D+01	1.361D+01	0.000D+00

Appendix A2

-----*****! RADON !*****-----

Version 1.2 - MAY 22, 1989 - G.F. Birchard tel.# (301)492-7000
U.S. Nuclear Regulatory Commission Office of Research

12/32

RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS

DATE/TIME OF THIS RUN
09-10-1996/14:46:46

EFN - WHITE MESA (ACCOUNTING FOR FREEZE/THAW CONDITIONS)

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	4	
DESIRED RADON FLUX LIMIT	20	pCi m^-2 s^-1
LAYER THICKNESS NOT OPTIMIZED		
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
RADON FLUX INTO LAYER 1	0	pCi m^-2 s^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 TAILINGS

THICKNESS	500	cm
POROSITY	.44	
MEASURED MASS DENSITY	1.45	g cm^-3
MEASURED RADIUM ACTIVITY	981	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.19	
CALCULATED SOURCE TERM CONCENTRATION	1.290D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.198	
MEASURED DIFFUSION COEFFICIENT	.0142	cm^2 s^-1

LAYER 2 RANDOM FILL

THICKNESS	91.5	cm
POROSITY	.315	
MEASURED MASS DENSITY	1.85	g cm^-3
MEASURED RADIUM ACTIVITY	1.9	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.19	
CALCULATED SOURCE TERM CONCENTRATION	4.452D-06	pCi cm^-3 s^-1
WEIGHT % MOISTURE	9.800000000000001	%
MOISTURE SATURATION FRACTION	.576	
MEASURED DIFFUSION COEFFICIENT	8.200000000000001D-03	cm^2 s^-1

LAYER 3 CLAY

13/32

THICKNESS	30.5	cm
POROSITY	.28	
MEASURED MASS DENSITY	1.72	g cm^-3
MEASURED RADIUM ACTIVITY	1.5	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.22	
CALCULATED SOURCE TERM CONCENTRATION	4.257D-06	pCi cm^-3 s^-1
WEIGHT % MOISTURE	14.1	%
MOISTURE SATURATION FRACTION	.866	
MEASURED DIFFUSION COEFFICIENT	.0091	cm^2 s^-1

LAYER 4 RANDOM FILL

THICKNESS	43	cm
POROSITY	.315	
MEASURED MASS DENSITY	1.85	g cm^-3
MEASURED RADIUM ACTIVITY	1.9	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.19	
CALCULATED SOURCE TERM CONCENTRATION	4.452D-06	pCi cm^-3 s^-1
WEIGHT % MOISTURE	9.800000000000001	%
MOISTURE SATURATION FRACTION	.576	
MEASURED DIFFUSION COEFFICIENT	8.200000000000001D-03	cm^2 s^-1

DATA SENT TO THE FILE 'RNDATA' ON DEFAULT DRIVE

N	F01	CN1	ICOST	CRITJ	ACC
4	0.000D+00	0.000D+00	0	2.000D+01	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	1.420D-02	4.400D-01	1.290D-03	1.977D-01	1.450
2	9.150D+01	8.200D-03	3.150D-01	4.452D-06	5.756D-01	1.850
3	3.050D+01	9.100D-03	2.800D-01	4.257D-06	8.661D-01	1.720
4	4.300D+01	8.200D-03	3.150D-01	4.452D-06	5.756D-01	1.850

BARE SOURCE FLUX FROM LAYER 1: 4.667D+02 pCi m^-2 s^-1

14/32

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	1.237D+02	4.514D+05
2	9.150D+01	2.679D+01	7.622D+04
3	3.050D+01	2.123D+01	1.944D+04
4	4.300D+01	1.756D+01	0.000D+00

Appendix B1

TAILINGS AND RANDOM FILL PROPERTIES

Table 3.4-1

Physical Properties of Tailings

and

Proposed Cover Materials

Material Type	Atterberg Limits LL	Atterberg Limits PI	Specific Gravity	% Passing No. 200 Sieve	Maximum Dry Density (pcf)	Optimum Moisture Content
Tailings	28	6	2.85	46	104.0	18.1
Random Fill	22	7	2.67	48	120.2	11.8
Clay	29	14	2.69	56	121.3	12.1
Clay	36	19	2.75	68	108.7	18.5

Note: Physical Soil Data from Chen and Associates (1987).

R
A
E

Rogers & Associates Engineering Corporation

Post Office Box 330
Salt Lake City, Utah 84110
(801) 263-1600

17/32

March 4, 1988

Mr. C.O.Sealy
Umetco Minerals Corporation
P.O. Box 1029
Grand Junction, CO 81502

C8700/22

Dear Mr. Sealy:

We have completed the tests ordered on the four samples shipped to us. The results are as follows:

Sample	Radium pCi/gm	Emanation Fraction	Diffusion Coeffic.	(g/cm^3) Density	Moisture	Saturation
Tailings	981±4	0.19±0.01	2.0E-02	1.45	13.2	0.39
			8.4E-03	1.44	19.1	0.56
Composite (2,3,&5)			1.6E-02	1.85	6.5	0.40
			4.5E-04	1.84	12.5	0.75
Site #1			1.6E-02	1.85	8.1	0.48
			1.4E-03	1.84	12.6	0.76
Site #4			1.1E-02	1.65	15.4	0.63
			4.2E-04	1.65	19.3	0.80

The samples will be shipped back to you in the next few weeks. If you have any questions regarding the results on the samples please feel free to call.

Sincerely,

Renee Y. Bowser

Renee Y. Bowser
Lab Supervisor

RYB/b

R
A
E

Rogers & Associates Engineering Corporation

Post Office Box 330
Salt Lake City, Utah 84110
(801) 263-1600

18/32

MAY 12 1988

May 9, 1988

Mr. C.O. Sealy
UMETCO Minerals Corporation
P.O. Box 1029
Grand Junction, CO 81502

C8700/22

Dear Mr. Sealy:

The tests for radium content and radon emanation coefficient in the following samples have been completed and the results are as follows:

Sample	Radium (pCi/g)	Radon Emanation Coefficient
Random (2,3 & 5)	1.9 ± 0.1	0.19 ± 0.04
Site 1	2.2 ± 0.1	0.20 ± 0.03
Site 4	2.0 ± 0.1	0.11 ± 0.04

If you have any questions regarding these results please feel free to call Dr. Kirk Nielson or me.

Sincerely,

Renee Y. Bowser
Lab Supervisor

RYB:ms

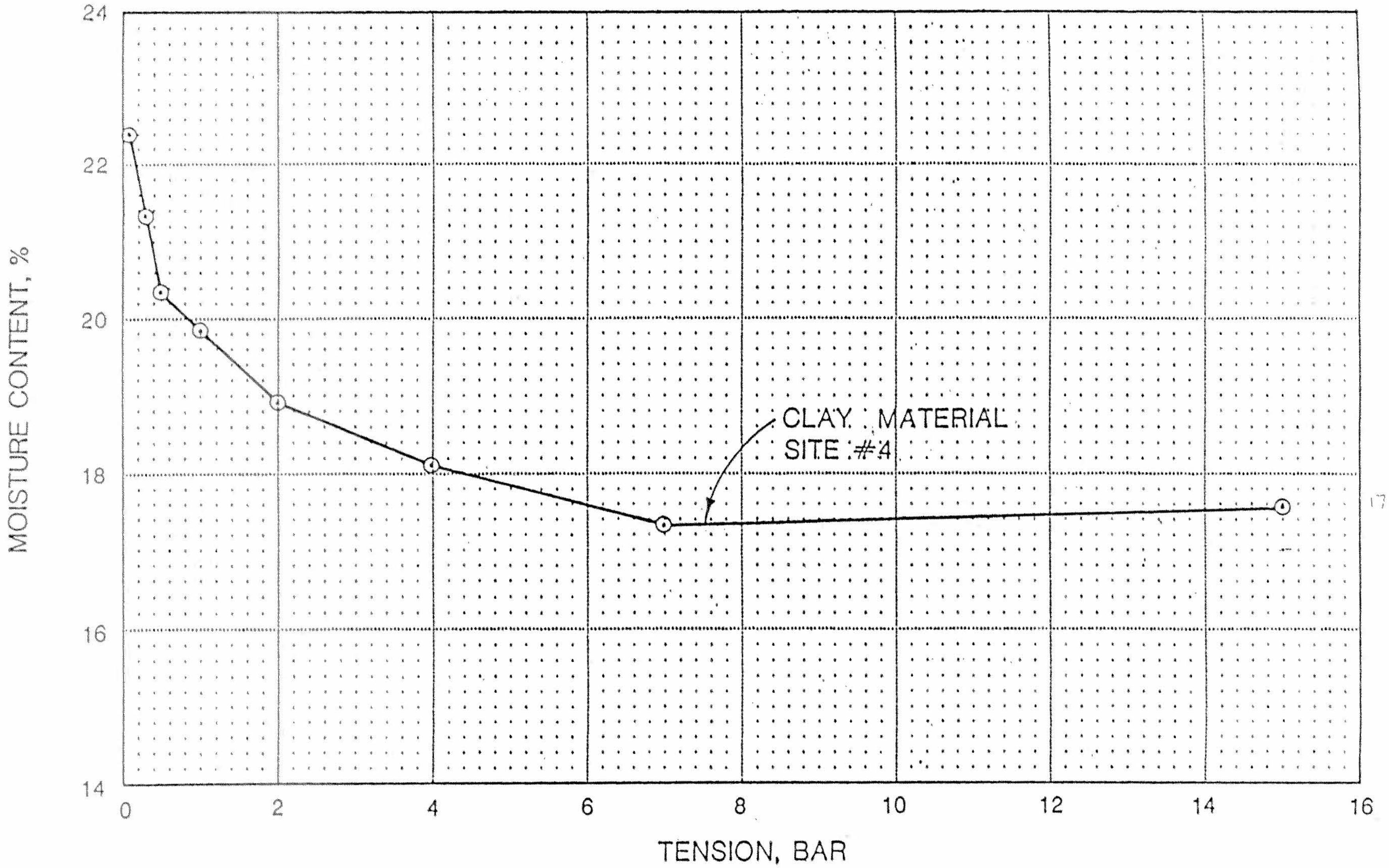


FIGURE 4.4-2
SUMMARY OF CAPILLARY MOISTURE
RELATIONSHIP TEST RESULTS
WHITE MESA PROJECT

DATA FROM CHEN & ASSOCIATES

19/52

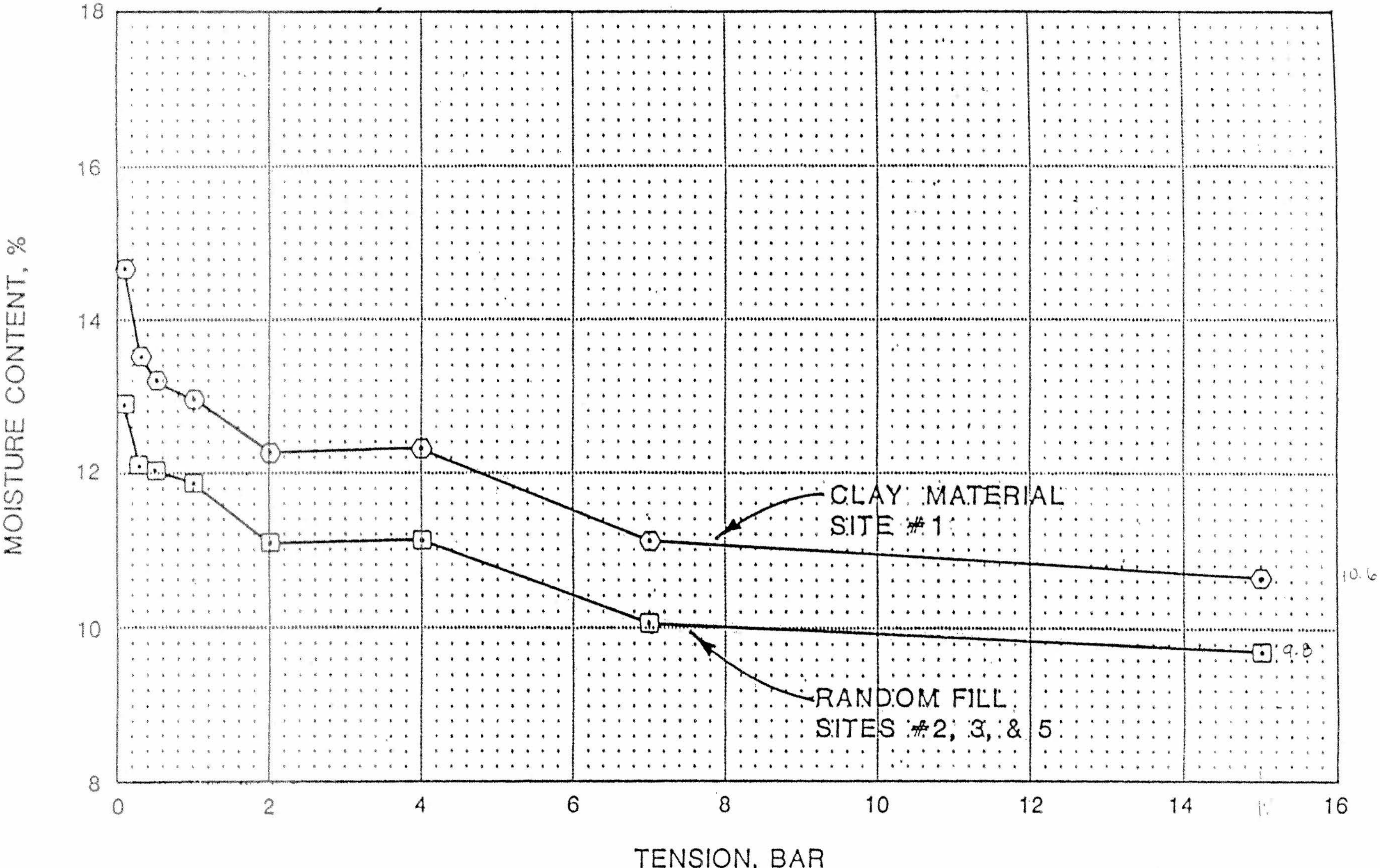


FIGURE 4.4-1
SUMMARY OF CAPILLARY MOISTURE RELATIONSHIP TEST RESULTS
WHITE MESA PROJECT

DATA FROM CHEN & ASSOCIATES

Appendix B2

22/32

ADVANCED TERRA TESTING inc

833 Parfet Street
Lakewood, Colorado 80215
(303) 232-8308

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT Titan Env. JOB NO. 2234-04

BORING NO.
DEPTH
SAMPLE NO. UT-1
SOIL DESCR.
TEST TYPE ATTERBERG

DATE SAMPLED
DATE TESTED 7-25-96 WEB, RV

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	3.34	4.06	3.42
Wt Dish & Dry Soil	2.96	3.57	3.03
Wt of Moisture	0.38	0.49	0.39
Wt of Dish	1.05	1.11	1.06
Wt of Dry Soil	1.91	2.46	1.97
Moisture Content	19.90	19.92	19.80

Liquid Limit Determination Device Number 0258

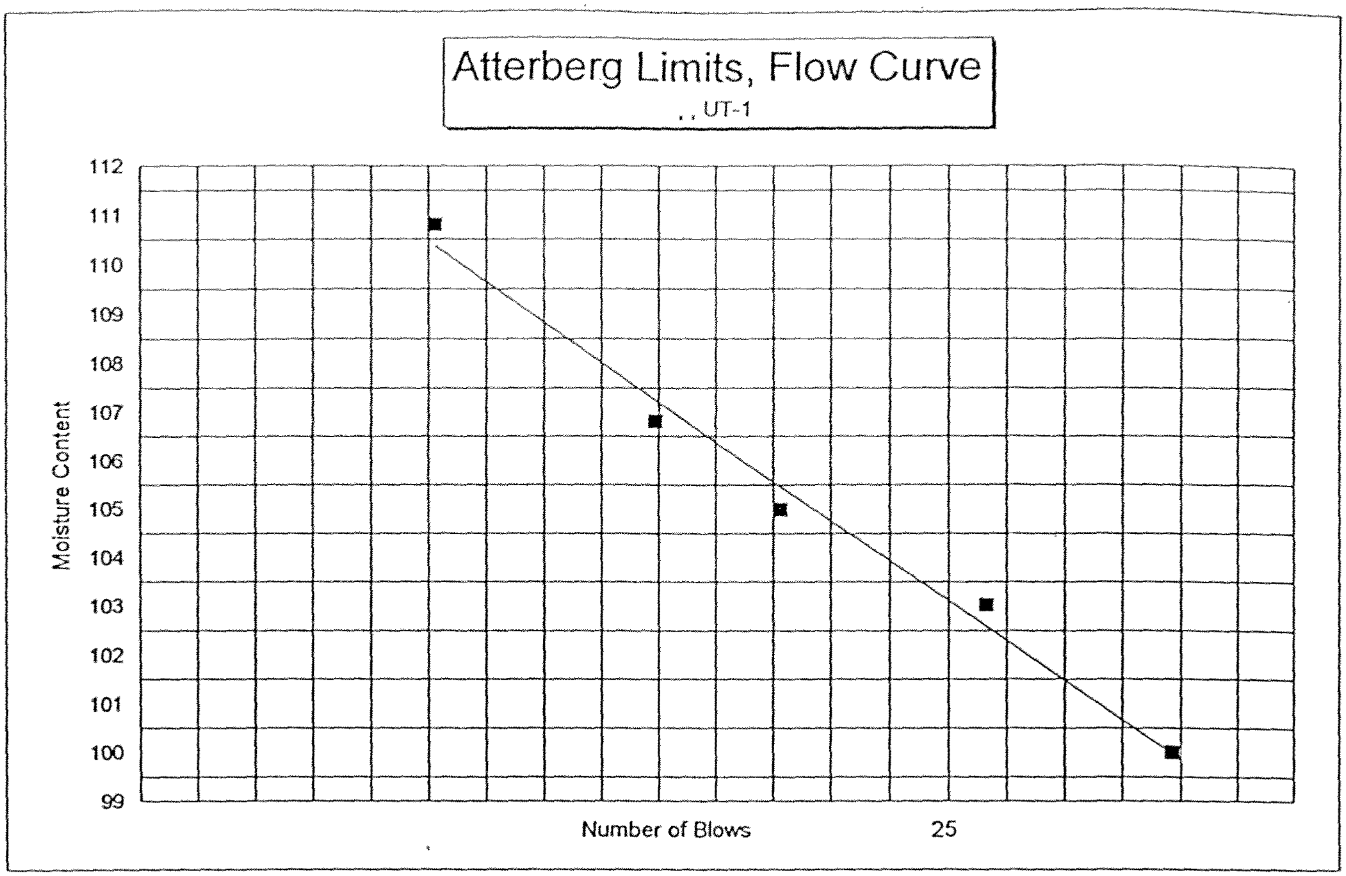
	1	2	3	4	5
Number of Blows	39	27	18	14	9
Wt Dish & Wet Soil	12.18	10.42	10.92	12.33	10.06
Wt Dish & Dry Soil	6.64	5.67	5.87	6.53	5.34
Wt of Moisture	5.54	4.75	5.05	5.80	4.72
Wt of Dish	1.10	1.06	1.06	1.10	1.08
Wt of Dry Soil	5.54	4.61	4.81	5.43	4.26
Moisture Content	100.00	103.04	104.99	106.81	110.80

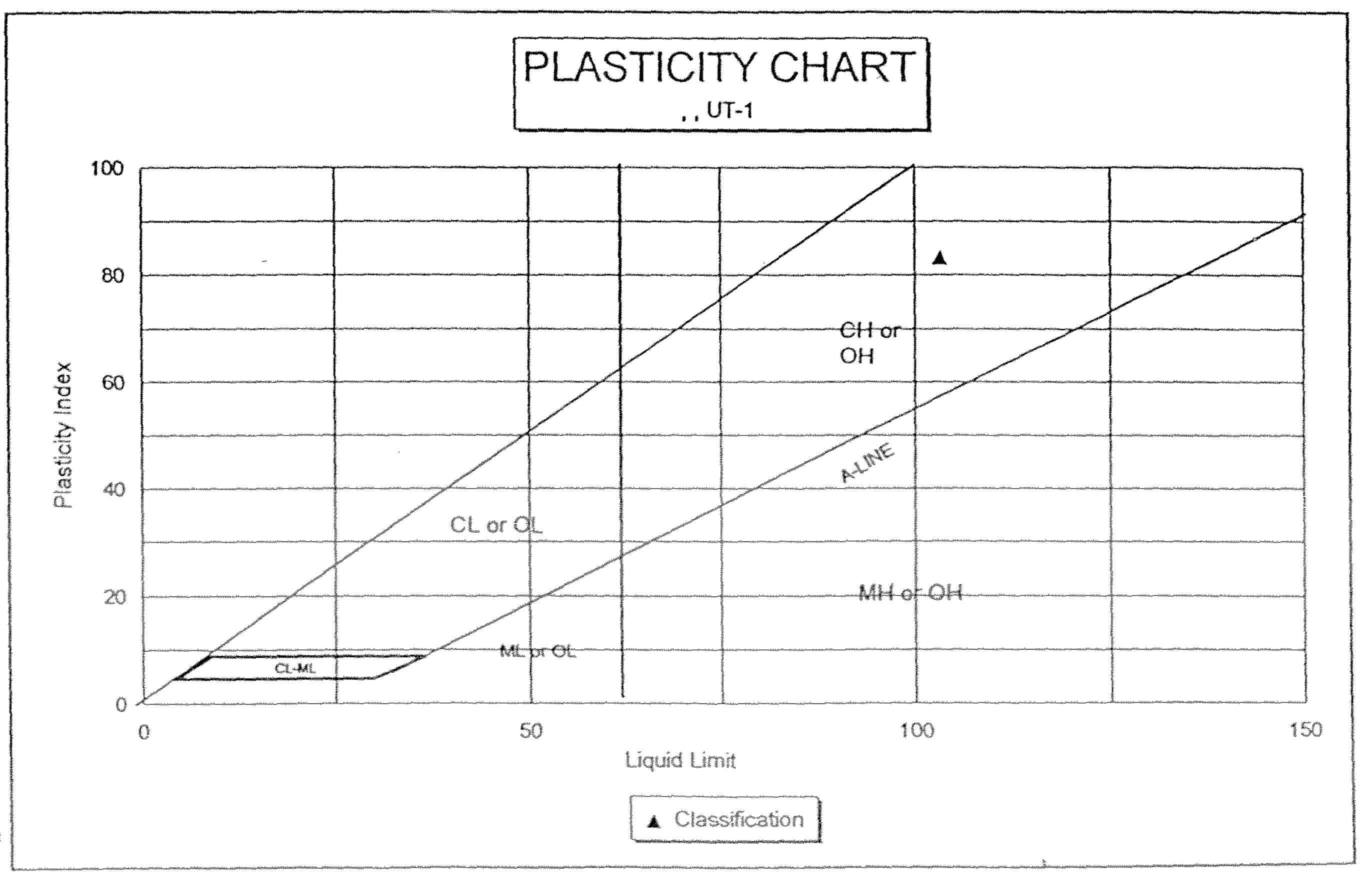
Liquid Limit 103.1
Plastic Limit 19.9
Plasticity Index 83.3

Atterberg Classification CH

Data entry by: NAA Date: 7-26-96
Checked by: [signature] Date: 7-26-96
FileName: TIGOUT1

ADVANCED TERRA TESTING, INC.


Atterberg Limits, Flow Curve
, , UT-1
112
111
110
109
108
107
106
105
104
103
102
101
100
99
Moisture Content
Number of Blows
25


PLASTICITY CHART
, , UT-1
100
80
60
40
20
0
Plasticity Index
0
50
100
150
Liquid Limit
CH or
OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
▲ Classification

C :PACTION TEST
ASTM D 1557 A

CLIENT: TItan Env. JOB NO. 2234-04

25/32

BORING NO. SOIL DESCR.
EPTH DATE SAMPLED
SAMPLE NO. UT-1 DATE TESTED 7-25-96 RV

Moisture determination

	1	2	3	4	5
Wt of Moisture added (ml)	100.00	150.00	250.00	350.00	450.00
Wt. of soil & dish (g)	384.26	393.92	291.42	244.20	281.17
Dry wt. soil & dish (g)	350.60	355.61	251.40	202.69	225.04
Net loss of moisture (g)	33.66	38.31	40.02	41.51	56.13
Wt. of dish (g)	8.01	8.34	8.31	8.29	8.43
Net wt. of dry soil (g)	342.59	347.27	243.09	194.40	216.61
Moisture Content (%)	9.83	11.03	16.46	21.35	25.91
Corrected Moisture Content					

Density determination

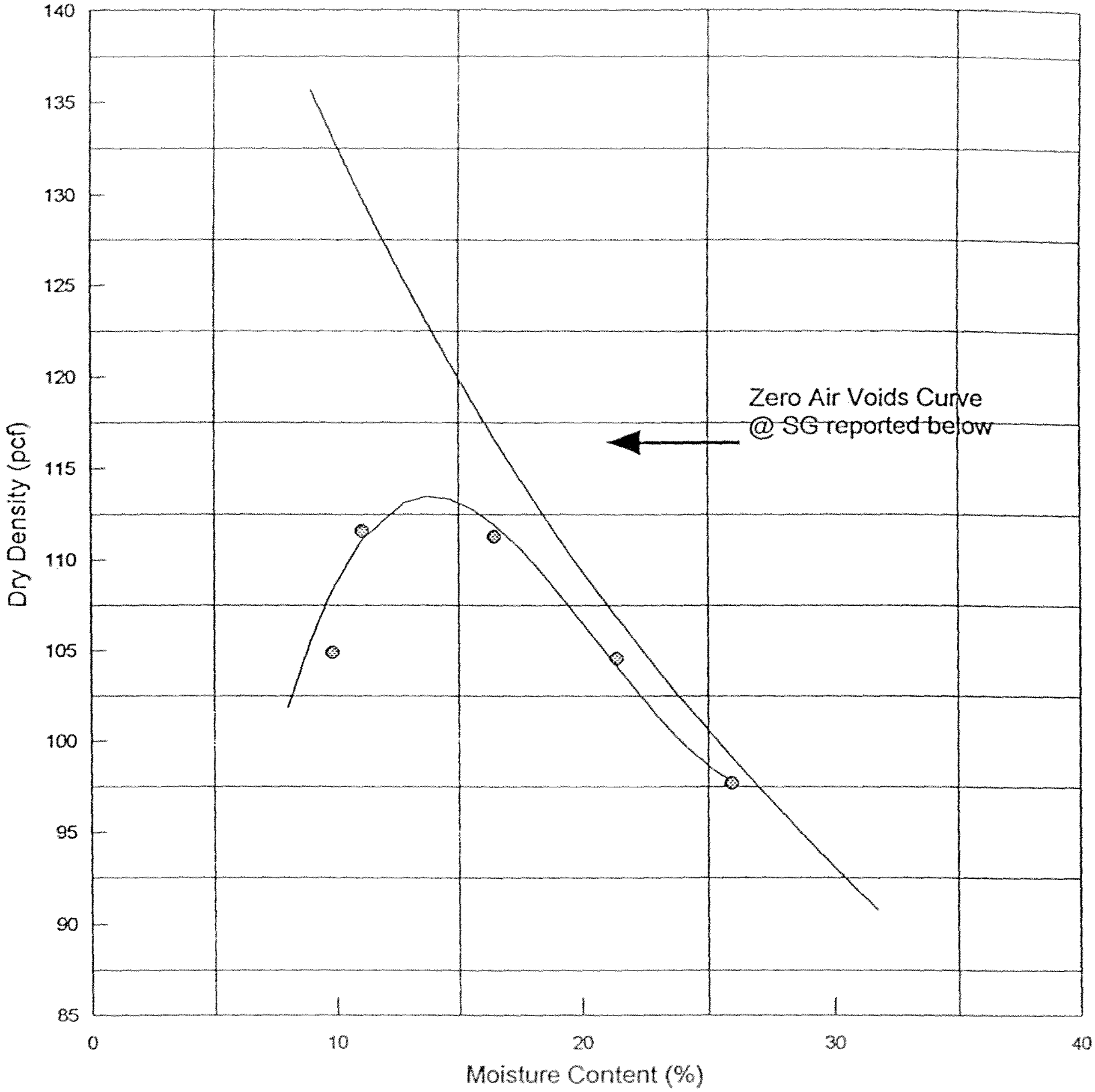
Wt of soil & mold (lb)	14.20	14.49	14.68	14.59	14.46
Wt. of mold (lb)	10.36	10.36	10.36	10.36	10.36
Net wt. of wet soil (lb)	3.84	4.13	4.32	4.23	4.10
'et wt of dry soil (lb)	3.50	3.72	3.71	3.49	3.26
.y Density, (pcf)	104.89	111.59	111.28	104.57	97.69
Corrected Dry Density (pcf)					
Volume Factor	30	30	30	30	30

ata entered by: RV Date: 7-26-96
ata checked by: [signature] Date: 7-26-96
FileName: TIPRUT-1 ADVANCED TERRA TESTING, INC

Proctor Compaction Test

, , UT-1

26/32



- Best Fit Curve
- Actual Data
- Zero Air VoidsCurve @ SG = 2.70

OPTIMUM MOISTURE CONTENT = 13.9 MAXIMUM DRY DENSITY = 113.5
ASTM D 1557 A, Rock correction applied? N

ADVANCED TERRA TESTING, INC.

PERMEABILITY DETERMINATION
FALLING HEAD
FIXED WALL

27/32

CLIENT	Titan Environmental	JOB NO.	2234-04
BORING NO.		SAMPLED	
DEPTH		TEST STARTED	7-28-96 CAL
SAMPLE NO.	UT-1	TEST FINISHED	8-7-96 CAL
SOIL DESCR.	Remolded 95% Mod Pt. @ OMC	SETUP NO.	1
SURCHARGE	200		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil & Ring(s) (g)	386.9	404.5
Wt. Ring(s) (g)	93.0	93.0
Wt. Soil (g)	293.9	311.4
Wet Density PCF	122.3	120.5
Wt. Wet Soil & Pan (g)	302.4	319.9
Wt. Dry Soil & Pan (g)	266.2	266.2
Wt. Lost Moisture (g)	36.2	53.8
Wt. of Pan Only (g)	8.5	8.5
Wt. of Dry Soil (g)	257.7	257.7
Moisture Content %	14.1	20.9
Dry Density PCF	107.2	99.7
Max. Dry Density PCF	113.5	113.5
Percent Compaction	94.4	87.8

ELAPSED TIME (MIN)	BURETTE READING h1 (CC)	BURETTE READING h2 (CC)	PERCOLATION RATE FT/YEAR	PERCOLATION RATE CM/SEC
	0.2			
2599	10.8	10.8	0.14	1.4E-07
1427	14.2	14.2	0.09	8.4E-08
1440	16.8	16.8	0.07	6.5E-08
1440	18.6	18.6	0.05	4.6E-08
1440	20.2	20.2	0.04	4.1E-08
1440	21.6	21.6	0.04	3.7E-08
1469	23.0	23.0	0.04	3.6E-08
1440		24.4	0.04	3.7E-08

Data Entered By: NAA Date: 8-8-96
Date Checked By: [illegible] Date: 8-8-96
Filename:TIFHUT1

ADVANCED TERRA TESTING, INC.

Rogers & Associates Engineering Corporation

28/32

REPORT OF RADON DIFFUSION COEFFICIENT MEASUREMENTS
(TIME-DEPENDENT DIFFUSION TEST METHOD RAE-SQAP-3.6)

Report Date: 9/3/96

Contract: C960019

By: BCR

Date Received: 8/96

Sample Identification: Titan Environmental

Sample ID	Moisture (Dry Wt. %)	Density (g/cm^3)	Radon Diffusion Coefficient (cm^2/s)	Saturation (Mp/P)	Specific Gravity (g/cm^3)
UT-1	14.6%	1.72	9.1E-03	0.89	2.39

RAE

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Rogers & Associates Engineering Corporation

29/32

REPORT OF RADIUM CONTENT AND EMANATION
COEFFICIENT MEASUREMENTS

(LAB PROCEDURE RAE-SQAP-3.1)

Report Date: 9/3/96

Contract: C960019

By: BCR

Date Received: 8/96

Sample Identification: Titan Environmental

Sample ID	Moisture (Dry Wt. %)	Radon Emanation Coefficient	Radium-226 (pCi/g)	Comments
UT-1	14.6%	0.22 ± 0.04	1.5 ± 0.3	

RAE

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Appendix C

31/32

...from the Professors who know it best...

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	David A. Hamilton, MS, PE	Hydrology
	Ronald Harichandran, PhD, PE	Structures
	Thomas L. Maleck, PhD, PE	Transportation
	George E. Mase, PhD	Mechanics
	Merle C. Potter, PhD, PE	Fluid Mechanics
	David C. Wiggert, PhD,PE	Hydraulics
	Thomas F. Wolff, PhD, PE	Soils

The authors are professors at Michigan State University, with the exception of R. W. Furlong, who teaches at the University of Texas at Austin and D. A. Hamilton who is employed by the Michigan Department of Natural Resources.

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14.5 Other Useful Equations for Weight-Volume Problems

It is strongly recommended that weight-volume problems be solved using phase diagrams rather than only formulas, as completing a phase diagram clearly indicates whether sufficient information is known to complete the problem, whether information is insufficient and assumptions must be made, or whether too much information is present and the problem is overconstrained. For example, it may not be immediately apparent from the information given whether a soil is saturated until all quantities are calculated. Nevertheless, following are given additional useful equations that may be used to solve certain classes of weight-volume problems.

A very useful equation relating four different quantities is

$$Se = wG_s \tag{14.5.1}$$

For saturated soils (S = 100%) there results

$$e = wG_s \tag{14.5.2}$$

The relationships between the void ratio and porosity are

$$e = \frac{n}{1-n} \tag{14.5.3}$$

and

$$* \quad n = \frac{e}{1+e} \tag{14.5.4}$$

n = porosity
e = Volume of Voids / Volume of Solids

The total unit weight can be obtained as

$$\gamma = \frac{(G_s + Se)\gamma_w}{1+e} = \frac{(1+w)\gamma_w}{w/S + 1/G_s} \tag{14.5.5}$$

The dry unit weight can be obtained as

$$* \quad \gamma_d = \frac{G_s\gamma_w}{1+e} = \frac{G_s\gamma_w}{1+(wG_s/S)} \tag{14.5.6}$$

γ_d: Dry Bulk Density
G_s: Specific Gravity
γ_w: Density of Water

EXAMPLE 14.8

Rework example 14.6 using equations introduced in this section.

Solution.

$$Se = wG_s$$

$$S = wG_s/e = (.20)(2.65)/(0.800) = 0.6625 \text{ or } 66.3\%$$

$$n = \frac{e}{1+e} = \frac{0.800}{1+0.800} = 0.444$$

$$\gamma = \frac{(1+w)\gamma_w}{w/S + 1/G_s} = \frac{(1.20)(62.4)}{0.2/0.6625 + 1/2.65} = 110.2 \text{ lb/ft}^3$$

$$\gamma_d = \frac{G_s\gamma_w}{1+e} = \frac{(2.65)(62.4)}{1+0.800} = 91.9 \text{ lb/ft}^3$$

APPENDIX D

HELP Model

Purpose: To determine the required soil cover thicknesses to minimize surface water infiltration through the White Mesa tailings impoundments so that precipitation will not fully penetrate the soil cover. The White Mesa Mill site is located in Blanding, Utah. The performance of the tailings cover was evaluated using the Hydrologic Evaluation of Landfill Performance (HELP) Model. The HELP model was developed to facilitate rapid, economical estimation of the amounts of surface runoff, subsurface drainage, and leachate that may be expected to result from the operation of a wide variety of possible cover designs.

Method: Determine the soil properties of the cover materials and climatic properties of Blanding, Utah based on existing database values previously collected, and acceptable default parameters. Input parameters into the computer modeling program "HELP" to determine the percolation through the cover materials. A variety of scenarios adjusting cover thicknesses were run to determine the optimum thicknesses of cover materials to eliminate percolation through the bottom cover layer. The modeled tailings cover consists of a compacted clay layer over the tailings, with a random fill soil layer covering the clay.

The model was developed for Cell 3 at the White Mesa Mill since it is the largest of the three cells to be covered (Cells 2, 3, and 4A). Figure 1 shows the location of the cells. The cover requirements determined for Cell 3 will be applied to the remaining cells as well. This is a conservative approach since the remaining cells are smaller in size and require less time and distance for precipitation runoff.

Results: A two-layer uranium mill tailings cover composed of a 2-foot layer of random fill over a 1-foot compacted clay layer will reduce percolation into the tailings material to a negligible quantity (see Appendix A for HELP results). As indicated by the model results, precipitation will either runoff the soil cover or be evaporated.

The cover thicknesses recommended above were also determined to be the minimum thickness requirements for White Mesa tailings covers based on results from radon flux calculations (see "Calculation of Radon Flux from the White Mesa Tailings Cover", 9/11/96). As indicated in the Radon Flux calculation, to restrict radon flux to 20 pCi/m2/sec, (Regulatory Guide 3.64), a cover consisting of 2-feet random fill and 1-foot compacted clay is required.

Parameters: The HELP model requires input of the following parameters for the cover materials:

- Weather Data:
  - Evapotranspiration
  - Precipitation
  - Temperature
  - Solar Radiation
- Soil and Design Data:
  - Landfill area (area of Cell 3)
  - Percent of area where runoff is possible
  - Moisture content initialization
- Cover Layer Data:
  - Layer type
  - Default soil/material texture number
  - Runoff curve number

Weather Data

Evapotranspiration and *solar radiation* data was input using the default parameters from Grand Junction, Colorado. Grand Junction is located north east of Blanding Utah in a similar climate and elevation. The elevation at Grand Junction is 4,600 feet and the elevation at Blanding Utah is 5,600 feet. Figure 1 in Appendix B shows the locations of Blanding and Grand Junction in relation to one another.

Precipitation data from 1988 to 1993 (skipping 1989) was obtained from Utah State University (see Appendix C). Daily precipitation values for the five years were input manually into the HELP model. *Temperature* data was obtained from the Dames & Moore (1978) and is also included in Appendix C. Daily temperature data was not available for manual entry therefore, the computer calculated mean monthly temperatures based on the default location (Grand Junction, Colorado). These values were then edited to match the actual mean monthly temperatures for Blanding, Utah.

Soil and Design Data

The surface area of Cell 3 at the White Mesa Mill, Blanding, Utah was used for the landfill area value. The surface area, as indicated on Figure 1, is 78.7 acres. It was assumed that runoff was possible over 100% of this area and that no rain would sit on the tailings cover.

Cover Layer Data

Layer Thickness:
A two-layer cover over approximately 28 feet of uranium mill tailings was used to run the HELP model. Actual cover thicknesses which would be constructed on site consist of 2-feet of random fill over a 1-foot compacted clay layer. This cover profile was adjusted for modeling purposes to account for freezing and thawing conditions. As indicated in the "Effects of Freezing on Uranium Mill Tailings Covers Calculation Brief" (6/17/96), 6.8 inches of the top random fill cover layer will be effected by freeze/thaw conditions at Blanding, Utah. This suggests that 6.8 inches of the top layer may not contribute to reductions of infiltration into the tailings piles. To conservatively compensate for effects from freezing and thawing, 6.8 inches were subtracted from the top random fill cover layer. Therefore, modeled layer thicknesses consisted of 17.2 inches of random fill over 12 inches of clay.

Layer Type:
The random fill soil layer was classified as a vertical percolation layer. Vertical percolation layers are composed of moderate to high permeability material that drains vertically, primarily as unsaturated flow. The clay layer was classified as a barrier soil liner. This material consists of low permeability soil designed to limit percolation/leakage and drains only vertically as a saturated flow.

Moisture Storage Parameters:
Required moisture storage parameters such as; porosity, field capacity, wilting point, initial soil water content, and permeability, are interrelated with the exception of permeability. The porosity must be greater than zero but less than 1. The field capacity must be between zero and 1 but must be smaller than the porosity. The wilting point must be greater than zero but less than the field capacity, and the initial moisture content must be greater than or equal to the wilting point and less than or equal to the porosity (U.S. EPA, 1994).

Based on these relations, actual measured porosity and permeability values were input for random fill (Chen and Associates, 1987) and clay (Advanced Terra Testing, 1996, sample UT-1). See Appendix D for physical property data. In addition, wilting point data for the layers was set equal to the long-term moisture content of the materials and the soil water content was adjusted to equal the optimum moisture content. Field capacity values just less than the porosity's were assumed to maintain the interrelationship of the parameters.

Runoff Curve Number
The runoff curve number was calculated by the HELP model based on a minimum surface slope of 0.2%, slope length of 1,200 feet, soil texture of the top layer, and vegetation. A slope length of 1,200 feet was assumed to be the maximum distance which precipitation would travel over the soil cover. The top layer on the tailings cover will be minimum 3" of rock riprap (sandstone) therefore, no vegetation will exist. This top layer, however, was not included in the model to determine percolation quantities.

References:

Advanced Terra Testing, 1996, Physical soil data, White Mesa Project, Blanding Utah, July 25, 1996.

Chen and Associates, 1987. Physical soil data, White Mesa Project, Blanding, Utah.

Dames & Moore, 1978. "Environmental Report, White Mesa Uranium Project, San Juan County Utah", January 20, 1978, revised May 15, 1978.

Principles & Practice of Civil Engineering, 2nd Edition, 1996.

U.S. Environmental Protection Agency (EPA), 1994. "The Hydrologic Evaluation of Landfill Performance (HELP) Model", September, 1994.

Utah Climate Center, Utah State University, Daily Precipitation Values, Station #42073807, Blanding, Utah, January 1988 through December 1993.

PBA 9/96

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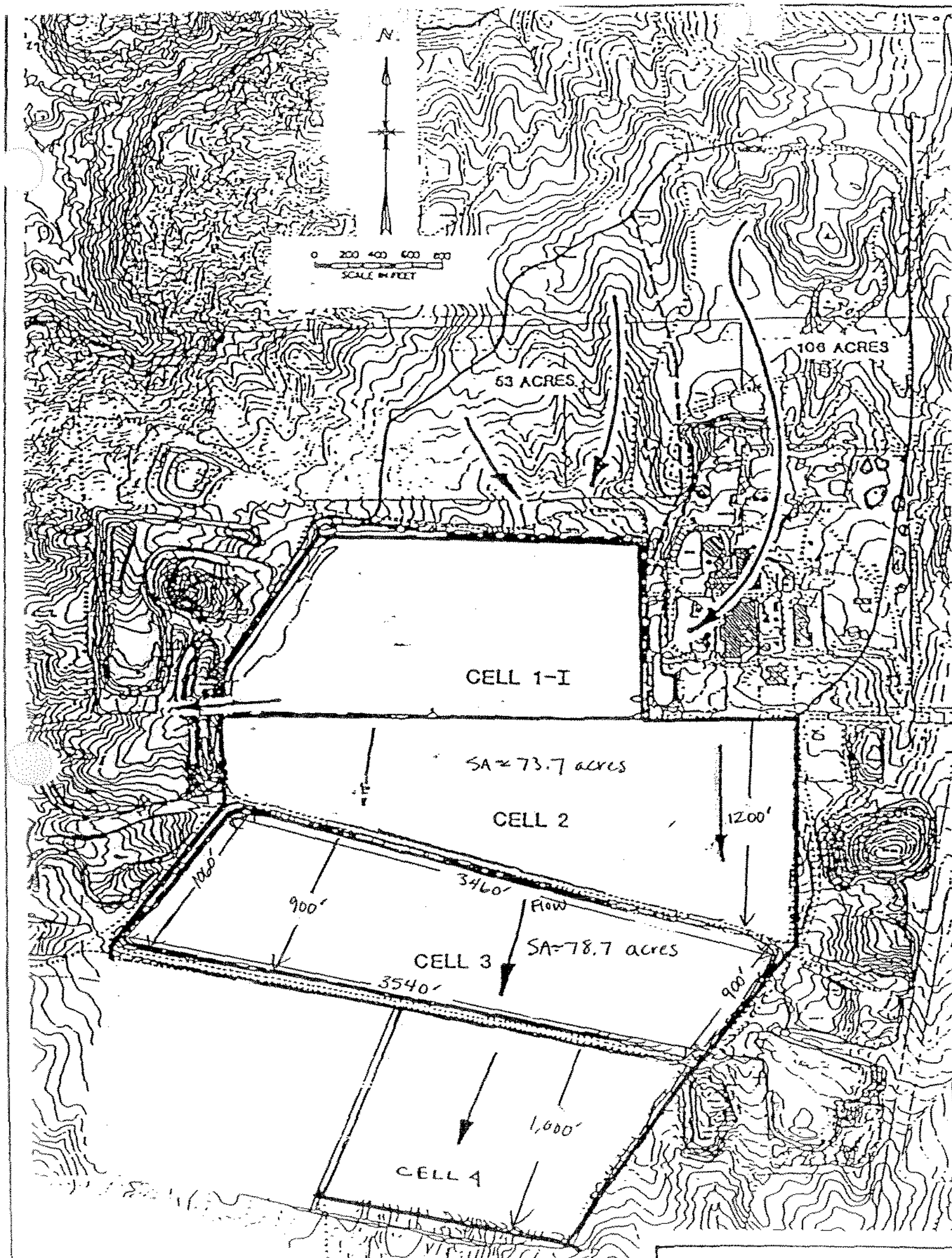


Max. distance water will travel over
Cells = 1,200' + 900' + 1,000' = 3,100'

WHITE MESA PROJECT

SITE DRAINAGE

FIGURE: 1

Appendix A

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.01    (14 OCTOBER 1994)                 **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************
```

7/34

```
PRECIPITATION DATA FILE:     C:\HELP3\PRECIP.D4
TEMPERATURE DATA FILE:       C:\HELP3\TEMP2.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\SOLAR.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\EVAP.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\efn-fin2.D10
OUTPUT DATA FILE:            C:\HELP3\efn-fin2.OUT


TIME:  14: 9     DATE:   9/11/1996


******************************************************************************

     TITLE:  EFN - White Mesa

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                       LAYER  1
                                       --------

                          TYPE 1 - VERTICAL PERCOLATION LAYER
                              MATERIAL TEXTURE NUMBER  88
          THICKNESS                     =     17.20   INCHES
          POROSITY                      =      0.3150 VOL/VOL
          FIELD CAPACITY                =      0.3140 VOL/VOL
          WILTING POINT                 =      0.0980 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.1180 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.886999999000E-06 CM/SEC


                                       LAYER  2
```

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 89

8/34

THICKNESS	=	12.00 INCHES
POROSITY	=	0.2800 VOL/VOL
FIELD CAPACITY	=	0.2799 VOL/VOL
WILTING POINT	=	0.1410 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2800 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.369999995000E-07 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #27 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 0.% AND A SLOPE LENGTH OF 1200. FEET.

SCS RUNOFF CURVE NUMBER	=	96.40	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	78.700	ACRES
EVAPORATIVE ZONE DEPTH	=	17.2	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.030	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	5.418	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.686	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	5.390	INCHES
TOTAL INITIAL WATER	=	5.390	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM GRAND JUNCTION COLORADO

MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	109
END OF GROWING SEASON (JULIAN DATE)	=	293
AVERAGE ANNUAL WIND SPEED	=	8.10 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	60.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	36.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	36.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	57.00 %

NOTE: PRECIPITATION DATA FOR BLANDING UTAH WAS ENTERED BY THE USER.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR GRAND JUNCTION COLORADO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

9/34

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
27.50	32.90	38.10	47.10	57.40	66.90
73.60	70.90	63.00	51.60	38.50	28.90

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR GRAND JUNCTION COLORADO

STATION LATITUDE = 39.07 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1988 THROUGH 1993

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.10	1.32	0.92	0.46	1.31	0.60
	1.17	1.37	1.16	1.24	1.07	1.18
STD. DEVIATIONS	1.85	1.43	0.72	0.37	0.71	0.62
	0.92	0.43	0.35	0.66	0.51	0.71
RUNOFF						
TOTALS	1.455	0.999	0.542	0.265	0.871	0.389
	0.774	0.885	0.802	0.785	0.713	0.568
STD. DEVIATIONS	1.967	1.206	0.425	0.240	0.472	0.494
	0.691	0.350	0.220	0.495	0.432	0.441
EVAPOTRANSPIRATION						
TOTALS	0.700	0.411	0.331	0.224	0.413	0.231
	0.353	0.490	0.424	0.394	0.402	0.534
STD. DEVIATIONS	0.072	0.246	0.236	0.110	0.296	0.201
	0.243	0.211	0.223	0.235	0.141	0.191
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 2

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1988 THROUGH 1993

	INCHES		CU. FEET	PERCENT
PRECIPITATION	13.90	(2.614)	3971537.7	100.00
RUNOFF	9.048	(2.4802)	2584718.25	65.081
EVAPOTRANSPIRATION	4.908	(0.7521)	1402180.62	35.306
PERCOLATION/LEAKAGE THROUGH FROM LAYER 2	0.00000	(0.00000)	0.000	0.00000
AVERAGE HEAD ACROSS TOP OF LAYER 2	0.000	(0.000)		
CHANGE IN WATER STORAGE	-0.054	(0.1827)	-15362.23	-0.387

****

****

PEAK DAILY VALUES FOR YEARS 1988 THROUGH 1993 11/34

	(INCHES)	(CU. FT.)
PRECIPITATION	1.33	379955.719
RUNOFF	1.684	481108.4370
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.000000	0.00000
AVERAGE HEAD ACROSS LAYER 2	0.000	
SNOW WATER	2.96	845040.4370

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.1182
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0962

****

****

FINAL WATER STORAGE AT END OF YEAR 1993

12/34

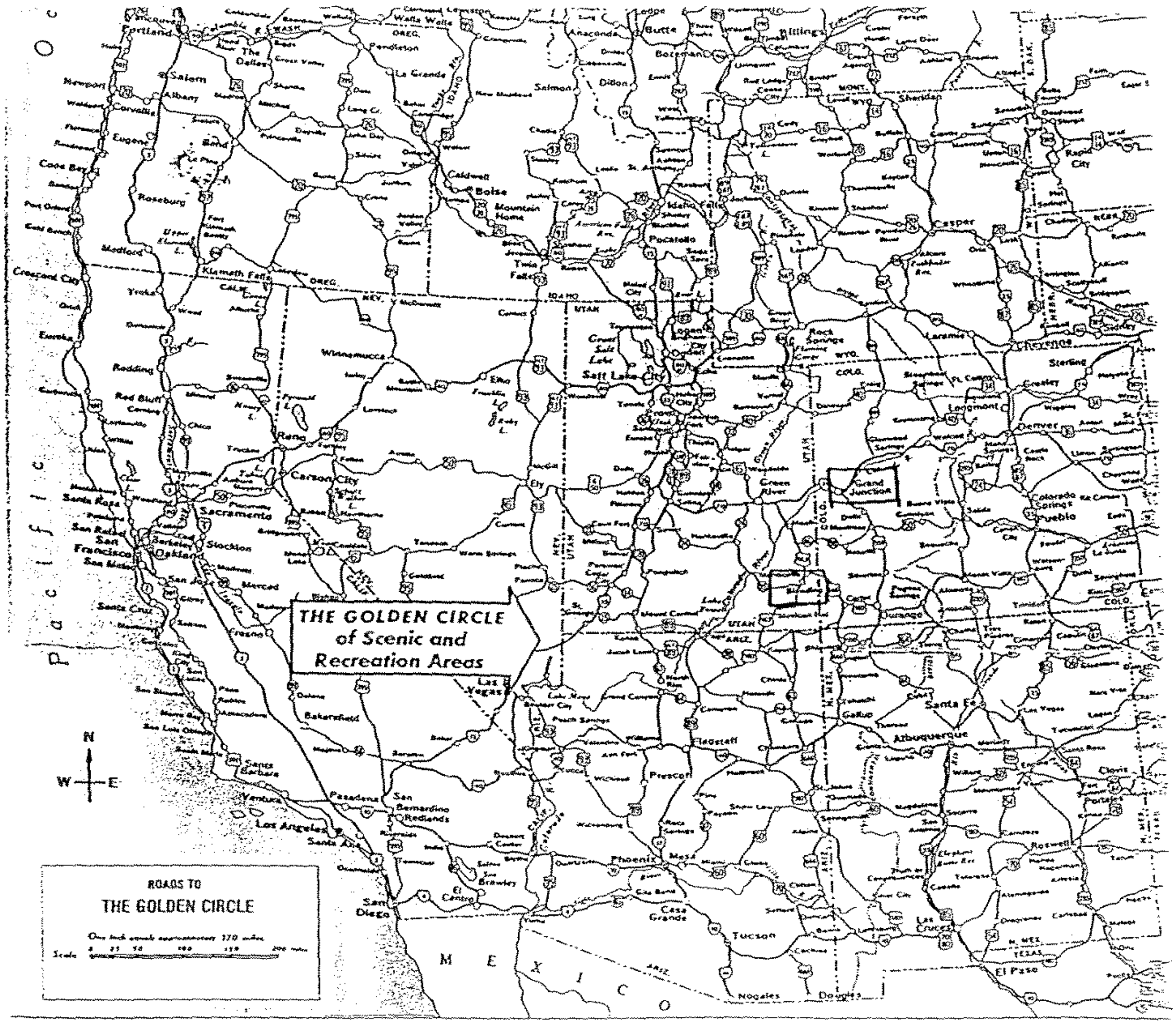
LAYER	(INCHES)	(VOL/VOL)
1	1.7607	0.1024
2	3.3600	0.2800
SNOW WATER	0.000	

****
****

Appendix B

14/34

FIGURE 1
SHOWS LOCATION OF BLANDING to GRAND JUNCTION



ɜest Of The West . . .

ɪah combines the best of the West. 'ithin Utah's 85,000 square miles is a oncentrated collage of western folk-re, scenery and history.

ɛer into Utah and sample some of our ve national parks, seven national mon-ɔeats and two national recreation eas. Drive into our 43 state parks or ght national forests. Explore the ountry on this map and you'll soon cho the statement first made by pio-ɛer settlers to Utah: "This Is the Place."

IVE NATIONAL PARKS

Southeastern Utah is the place for the world's greatest—and most concen-trated—repertory of stone arches. Arches National Park's trademark is Delicate Arch, although Landscape Arch is a world record-holder with a span of 291 feet.

WHITE WATER CANYONS

The Colorado River glides past Arches and churns into Canyonlands National Park 40 miles southwest. *National Geo-graphic* labels Canyonlands "the realm of rock and far horizon. The Colorado

Eighty percent of Utah's 1.2 million people live along the foothills of the Wasatch Mountains. Salt Lake City is not only the cultural and social hub of Utah, but also the international base for the Mormon Church.

The Utah Symphony, Ballet West, Utah Repertory Dance Theater and the Pio-neer Memorial Theater all lend a cos-mopolitan atmosphere to Salt Lake City. Professional sports are represented by the Golden Eagles hockey club and the Salt Lake Gulls baseball team.

Appendix C

Yearly Total (in) »

Daily Precipitation Values, Station #42073807, Blanding, Utah
January, 1988 through February, 1994

11.40		13.39		11.74		15.32		17.66	
Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)
1/1/88	0	1/1/90	0	1/1/91	0	1/1/92	0	1/1/93	0
1/2/88	0	1/2/90	0	1/2/91	0	1/2/92	0	1/2/93	0
1/3/88	0	1/3/90	0.2	1/3/91	0.15	1/3/92	0.04	1/3/93	0
1/4/88	0.06	1/4/90	0	1/4/91	0.96	1/4/92	0.31	1/4/93	0
1/5/88	0.19	1/5/90	0	1/5/91	0.08	1/5/92	0.02	1/5/93	0
1/6/88	0.17	1/6/90	0	1/6/91	0	1/6/92	0.42	1/6/93	0.34
1/7/88	0	1/7/90	0	1/7/91	0	1/7/92	0.03	1/7/93	0.36
1/8/88	0.01	1/8/90	0	1/8/91	0	1/8/92	0	1/8/93	1
1/9/88	0	1/9/90	0	1/9/91	0	1/9/92	0	1/9/93	0.01
1/10/88	0	1/10/90	0	1/10/91	0	1/10/92	0	1/10/93	0.51
1/11/88	0								
1/12/88	0.	1/11/90	0	1/11/91	0	1/11/92	0	1/11/93	0.41
1/13/88	0	1/12/90	0	1/12/91	0	1/12/92	0	1/12/93	0
1/14/88	0	1/13/90	0.04	1/13/91	0.01	1/13/92	0	1/13/93	0.21
1/15/88	0	1/14/90	0	1/14/91	0	1/14/92	0	1/14/93	0.2
1/16/88	0	1/15/90	0.14	1/15/91	0.02	1/15/92	0	1/15/93	0
1/17/88	0.89	1/16/90	0.03	1/16/91	0	1/16/92	0	1/16/93	0.49
1/18/88	0.71	1/17/90	0.06	1/17/91	0	1/17/92	0	1/17/93	0.16
1/19/88	0	1/18/90	0.29	1/18/91	0	1/18/92	0	1/18/93	0.88
1/20/88	0	1/19/90	0.32	1/19/91	0	1/19/92	0	1/19/93	0.31
1/21/88	0	1/20/90	0	1/20/91	0	1/20/92	0	1/20/93	0
1/22/88	0	1/21/90	0	1/21/91	0	1/21/92	0	1/21/93	0
1/23/88	0	1/22/90	0	1/22/91	0	1/22/92	0	1/22/93	0
1/24/88	0	1/23/90	0	1/23/91	0	1/23/92	0	1/23/93	0
1/25/88	0	1/24/90	0	1/24/91	0	1/24/92	0	1/24/93	0
1/26/88	0	1/25/90	0	1/25/91	0	1/25/92	0	1/25/93	0
1/27/88	0	1/26/90	0	1/26/91	0	1/26/92	0	1/26/93	0
1/28/88	0	1/27/90	0	1/27/91	0	1/27/92	0	1/27/93	0
1/29/88	0	1/28/90	0	1/28/91	0	1/28/92	0	1/28/93	0
1/30/88	0	1/29/90	0	1/29/91	0	1/29/92	0	1/29/93	0
1/31/88	0	1/30/90	0	1/30/91	0	1/30/92	0	1/30/93	0.22
2/1/88	0	1/31/90	0.03	1/31/91	0	1/31/92	0	1/31/93	0.21
2/2/88	0.4	2/1/90	0.06	2/1/91	0	2/1/92	0	2/1/93	0.16
2/3/88	0.06	2/2/90	0.03	2/2/91	0	2/2/92	0	2/2/93	0
2/4/88	0	2/3/90	0	2/3/91	0	2/3/92	0	2/3/93	0
2/5/88	0	2/4/90	0	2/4/91	0	2/4/92	0.01	2/4/93	0
2/6/88	0	2/5/90	0	2/5/91	0	2/5/92	0	2/5/93	0
2/7/88	0	2/6/90	0	2/6/91	0	2/6/92	0	2/6/93	0
2/8/88	0	2/7/90	0	2/7/91	0	2/7/92	0	2/7/93	0
2/9/88	0	2/8/90	0	2/8/91	0	2/8/92	0.02	2/8/93	1.16
2/10/88	0	2/9/90	0	2/9/91	0	2/9/92	0	2/9/93	0.48
2/11/88	0	2/10/90	0	2/10/91	0	2/10/92	0.3	2/10/93	0.02
2/12/88	0	2/11/90	0	2/11/91	0	2/11/92	0.27	2/11/93	0
2/13/88	0	2/12/90	0	2/12/91	0	2/12/92	0.05	2/12/93	0
2/14/88	0	2/13/90	0	2/13/91	0	2/13/92	0.66	2/13/93	0
2/15/88	0	2/14/90	0.16	2/14/91	0	2/14/92	0	2/14/93	0.01
2/16/88	0	2/15/90	0.06	2/15/91	0	2/15/92	0	2/15/93	0.01
2/17/88	0	2/16/90	0	2/16/91	0.03	2/16/92	0.23	2/16/93	0.08
2/18/88	0	2/17/90	0	2/17/91	0.02	2/17/92	0	2/17/93	0
2/19/88	0	2/18/90	0.03	2/18/91	0	2/18/92	0	2/18/93	0.05
2/20/88	0	2/19/90	0.01	2/19/91	0	2/19/92	0	2/19/93	0.62
2/21/88	0	2/20/90	0.03	2/20/91	0	2/20/92	0	2/20/93	0.7
2/22/88	0	2/21/90	0	2/21/91	0	2/21/92	0	2/21/93	0
2/23/88	0	2/22/90	0	2/22/91	0	2/22/92	0	2/22/93	0
2/24/88	0	2/23/90	0	2/23/91	0	2/23/92	0	2/23/93	0
2/25/88	0	2/24/90	0	2/24/91	0	2/24/92	0	2/24/93	0.4
2/26/88	0	2/25/90	0	2/25/91	0	2/25/92	0	2/25/93	0.04
2/27/88	0.04	2/26/90	0	2/26/91	0	2/26/92	0	2/26/93	0
2/28/88	0	2/27/90	0	2/27/91	0	2/27/92	0	2/27/93	0
2/29/88	0	2/28/90	0	2/28/91	0.4	2/28/92	0	2/28/93	0
3/1/88	0	3/1/90	0.02	3/1/91	0.9	2/29/92	0	3/1/93	0
3/2/88	0	3/2/90	0	3/2/91	0	3/1/92	0	3/2/93	0
3/3/88	0	3/3/90	0	3/3/91	0	3/2/92	0	3/3/93	0
3/4/88	0	3/4/90	0	3/4/91	0	3/3/92	0.34	3/4/93	0

TABLE 1

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Daily Precipitation Values, Station #42073807, Blanding, Utah January, 1988 through February, 1994									
Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)
3/5/88	0	3/5/90	0	3/5/91	0	3/4/92	0	3/5/93	0
3/6/88	0.01	3/6/90	0.01	3/6/91	0	3/5/92	0	3/6/93	0
3/7/88	0	3/7/90	0	3/7/91	0	3/6/92	0	3/7/93	0
3/8/88	0	3/8/90	0	3/8/91	0	3/7/92	0	3/8/93	0
3/9/88	0	3/9/90	0	3/9/91	0	3/8/92	0.25	3/9/93	0
3/10/88	0.01	3/10/90	0.02	3/10/91	0	3/9/92	0.03	3/10/93	0
3/11/88	0	3/11/90	0.15	3/11/91	0	3/10/92	0	3/11/93	0
3/12/88	0	3/12/90	0.23	3/12/91	0	3/11/92	0	3/12/93	0
3/13/88	0	3/13/90	0.06	3/13/91	0	3/12/92	0	3/13/93	0
3/14/88	0	3/14/90	0	3/14/91	0.06	3/13/92	0	3/14/93	0
3/15/88	0	3/15/90	0	3/15/91	0.01	3/14/92	0	3/15/93	0
3/16/88	0.01	3/16/90	0	3/16/91	0	3/15/92	0	3/16/93	0
3/17/88	0	3/17/90	0	3/17/91	0	3/16/92	0	3/17/93	0
3/18/88	0	3/18/90	0	3/18/91	0	3/17/92	0	3/18/93	0.19
3/19/88	0	3/19/90	0	3/19/91	0.03	3/18/92	0	3/19/93	0
3/20/88	0	3/20/90	0	3/20/91	0	3/19/92	0	3/20/93	0
3/21/88	0	3/21/90	0	3/21/91	0.14	3/20/92	0	3/21/93	0
3/22/88	0	3/22/90	0	3/22/91	0	3/21/92	0.03	3/22/93	0
3/23/88	0	3/23/90	0	3/23/91	0	3/22/92	0.02	3/23/93	0
3/24/88	0	3/24/90	0	3/24/91	0	3/23/92	0.05	3/24/93	0
3/25/88	0	3/25/90	0	3/25/91	0	3/24/92	0.02	3/25/93	0
3/26/88	0	3/26/90	0	3/26/91	0.26	3/25/92	0	3/26/93	0.06
3/27/88	0	3/27/90	0	3/27/91	0	3/26/92	0	3/27/93	0.47
3/28/88	0	3/28/90	0	3/28/91	0	3/27/92	0.5	3/28/93	0
3/29/88	0	3/29/90	0	3/29/91	0	3/28/92	0.37	3/29/93	0.01
3/30/88	0	3/30/90	0.08	3/30/91	0	3/29/92	0	3/30/93	0
3/31/88	0	3/31/90	0	3/31/91	0	3/30/92	0.13	3/31/93	0
4/1/88	0	4/1/90	0	4/1/91	0	3/31/92	0.11	4/1/93	0
4/2/88	0	4/2/90	0	4/2/91	0	4/1/92	0.05	4/2/93	0
4/3/88	0	4/3/90	0	4/3/91	0	4/2/92	0	4/3/93	0
4/4/88	0.02	4/4/90	0	4/4/91	0	4/3/92	0	4/4/93	0.03
4/5/88	0	4/5/90	0	4/5/91	0	4/4/92	0	4/5/93	0.04
4/6/88	0	4/6/90	0	4/6/91	0	4/5/92	0	4/6/93	0.5
4/7/88	0	4/7/90	0.06	4/7/91	0	4/6/92	0	4/7/93	0
4/8/88	0	4/8/90	0.11	4/8/91	0	4/7/92	0	4/8/93	0
4/9/88	0	4/9/90	0	4/9/91	0	4/8/92	0	4/9/93	0
4/10/88	0	4/10/90	0	4/10/91	0	4/9/92	0	4/10/93	0
4/11/88	0	4/11/90	0	4/11/91	0	4/10/92	0	4/11/93	0
4/12/88	0	4/12/90	0	4/12/91	0	4/11/92	0	4/12/93	0
4/13/88	0	4/13/90	0	4/13/91	0	4/12/92	0	4/13/93	0
4/14/88	0.06	4/14/90	0	4/14/91	0	4/13/92	0	4/14/93	0
4/15/88	0.2	4/15/90	0	4/15/91	0	4/14/92	0	4/15/93	0
4/16/88	0.16	4/16/90	0	4/16/91	0	4/15/92	0.03	4/16/93	0.02
4/17/88	0.2	4/17/90	0	4/17/91	0	4/16/92	0.03	4/17/93	0
4/18/88	0.02	4/18/90	0	4/18/91	0	4/17/92	0	4/18/93	0
4/19/88	0	4/19/90	0	4/19/91	0	4/18/92	0	4/19/93	0
4/20/88	0	4/20/90	0	4/20/91	0	4/19/92	0	4/20/93	0
4/21/88	0.01	4/21/90	0	4/21/91	0	4/20/92	0	4/21/93	0
4/22/88	0.08	4/22/90	0	4/22/91	0	4/21/92	0	4/22/93	0
4/23/88	0.01	4/23/90	0	4/23/91	0.01	4/22/92	0	4/23/93	0
4/24/88	0.02	4/24/90	0.48	4/24/91	0	4/23/92	0	4/24/93	0
4/25/88	0	4/25/90	0	4/25/91	0	4/24/92	0	4/25/93	0
4/26/88	0	4/26/90	0	4/26/91	0	4/25/92	0	4/26/93	0
4/27/88	0	4/27/90	0	4/27/91	0	4/26/92	0	4/27/93	0
4/28/88	0	4/28/90	0	4/28/91	0	4/27/92	0	4/28/93	0
4/29/88	0	4/29/90	0.09	4/29/91	0	4/28/92	0	4/29/93	0
4/30/88	0	4/30/90	0.06	4/30/91	0	4/29/92	0	4/30/93	0
5/1/88	0	5/1/90	0.83	5/1/91	0	4/30/92	0	5/1/93	0
5/2/88	0	5/2/90	0	5/2/91	0	5/1/92	0	5/2/93	0
5/3/88	0	5/3/90	0	5/3/91	0	5/2/92	0	5/3/93	0
5/4/88	0	5/4/90	0	5/4/91	0	5/3/92	0	5/4/93	0.05
5/5/88	0	5/5/90	0	5/5/91	0	5/4/92	0.07	5/5/93	0.5
5/6/88	0	5/6/90	0	5/6/91	0	5/5/92	0	5/6/93	0
5/7/88	0	5/7/90	0	5/7/91	0	5/6/92	0	5/7/93	0.06

Table 1 (cont.)

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Daily Precipitation Values, Station #42073807, Blanding, Utah
January, 1988 through February, 1994

Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)
5/8/88	0	5/8/90	0	5/8/91	0	5/7/92	0.19	5/8/93	0.15
5/9/88	0	5/9/90	0	5/9/91	0	5/8/92	0	5/9/93	0
5/10/88	0	5/10/90	0	5/10/91	0	5/9/92	0.96	5/10/93	0
5/11/88	0	5/11/90	0	5/11/91	0	5/10/92	0	5/11/93	0
5/12/88	0	5/12/90	0	5/12/91	0	5/11/92	0	5/12/93	0
5/13/88	0	5/13/90	0	5/13/91	0	5/12/92	0	5/13/93	0
5/14/88	0	5/14/90	0	5/14/91	0	5/13/92	0	5/14/93	0
5/15/88	0	5/15/90	0	5/15/91	0.06	5/14/92	0	5/15/93	0.02
5/16/88	0	5/16/90	0	5/16/91	0	5/15/92	0	5/16/93	0.08
5/17/88	0.64	5/17/90	0	5/17/91	0	5/16/92	0	5/17/93	0.35
5/18/88	0.3	5/18/90	0	5/18/91	0	5/17/92	0	5/18/93	0
5/19/88	0.15	5/19/90	0	5/19/91	0	5/18/92	0	5/19/93	0
5/20/88	0	5/20/90	0	5/20/91	0	5/19/92	0.06	5/20/93	0.01
5/21/88	0	5/21/90	0	5/21/91	0	5/20/92	0.05	5/21/93	0
5/22/88	0	5/22/90	0	5/22/91	0	5/21/92	0.06	5/22/93	0
5/23/88	0	5/23/90	0	5/23/91	0	5/22/92	0.36	5/23/93	0
5/24/88	0	5/24/90	0	5/24/91	0	5/23/92	0.02	5/24/93	0
5/25/88	0	5/25/90	0	5/25/91	0	5/24/92	0.2	5/25/93	0.05
5/26/88	0	5/26/90	0	5/26/91	0	5/25/92	0.15	5/26/93	0.11
5/27/88	0	5/27/90	0	5/27/91	0	5/26/92	0.13	5/27/93	0.19
5/28/88	0	5/28/90	0	5/28/91	0	5/27/92	0.05	5/28/93	0.05
5/29/88	0.17	5/29/90	0.02	5/29/91	0	5/28/92	0	5/29/93	0
5/30/88	0.01	5/30/90	0	5/30/91	0	5/29/92	0.03	5/30/93	0
5/31/88	0	5/31/90	0	5/31/91	0.43	5/30/92	0	5/31/93	0
6/1/88	0	6/1/90	0	6/1/91	0	5/31/92	0	6/1/93	0
6/2/88	0	6/2/90	0	6/2/91	0	6/1/92	0	6/2/93	0
6/3/88	0	6/3/90	0	6/3/91	0	6/2/92	0	6/3/93	0
6/4/88	0	6/4/90	0	6/4/91	0	6/3/92	0	6/4/93	0
6/5/88	0	6/5/90	0	6/5/91	0	6/4/92	0.01	6/5/93	0
6/6/88	0	6/6/90	0	6/6/91	0	6/5/92	0.03	6/6/93	0.01
6/7/88	0	6/7/90	0	6/7/91	0	6/6/92	0	6/7/93	0.01
6/8/88	0	6/8/90	0	6/8/91	0	6/7/92	0	6/8/93	0.06
6/9/88	0	6/9/90	0.04	6/9/91	0	6/8/92	0.16	6/9/93	0
6/10/88	0	6/10/90	1.09	6/10/91	0	6/9/92	0	6/10/93	0
6/11/88	0	6/11/90	0	6/11/91	0	6/10/92	0	6/11/93	0
6/12/88	0	6/12/90	0	6/12/91	0	6/11/92	0	6/12/93	0
6/13/88	0	6/13/90	0	6/13/91	0	6/12/92	0	6/13/93	0
6/14/88	0	6/14/90	0	6/14/91	0.05	6/13/92	0	6/14/93	0
6/15/88	0	6/15/90	0	6/15/91	0	6/14/92	0	6/15/93	0
6/16/88	0	6/16/90	0	6/16/91	0	6/15/92	0	6/16/93	0
6/17/88	0	6/17/90	0	6/17/91	0	6/16/92	0	6/17/93	0.04
6/18/88	0	6/18/90	0	6/18/91	0	6/17/92	0	6/18/93	0
6/19/88	0	6/19/90	0	6/19/91	0	6/18/92	0	6/19/93	0
6/20/88	0	6/20/90	0	6/20/91	0	6/19/92	0	6/20/93	0
6/21/88	0	6/21/90	0	6/21/91	0	6/20/92	0	6/21/93	0
6/22/88	0.02	6/22/90	0	6/22/91	0	6/21/92	0	6/22/93	0
6/23/88	0.01	6/23/90	0	6/23/91	0	6/22/92	0	6/23/93	0
6/24/88	0.05	6/24/90	0	6/24/91	0	6/23/92	0	6/24/93	0
6/25/88	0.27	6/25/90	0	6/25/91	0	6/24/92	0	6/25/93	0
6/26/88	0.11	6/26/90	0	6/26/91	0	6/25/92	0.08	6/26/93	0
6/27/88	0.52	6/27/90	0	6/27/91	0	6/26/92	0	6/27/93	0
6/28/88	0.42	6/28/90	0	6/28/91	0	6/27/92	0	6/28/93	0
6/29/88	0	6/29/90	0	6/29/91	0	6/28/92	0.01	6/29/93	0
6/30/88	0	6/30/90	0	6/30/91	0	6/29/92	0	6/30/93	0
7/1/88	0	7/1/90	0	7/1/91	0	6/30/92	0	7/1/93	0
7/2/88	0	7/2/90	0	7/2/91	0	7/1/92	0	7/2/93	0
7/3/88	0	7/3/90	0	7/3/91	0	7/2/92	0	7/3/93	0
7/4/88	0	7/4/90	0	7/4/91	0	7/3/92	0	7/4/93	0
7/5/88	0	7/5/90	0	7/5/91	0	7/4/92	0	7/5/93	0
7/6/88	0	7/6/90	0	7/6/91	0	7/5/92	0	7/6/93	0
7/7/88	0	7/7/90	0.78	7/7/91	0	7/6/92	0	7/7/93	0
7/8/88	0	7/8/90	0.73	7/8/91	0.1	7/7/92	0	7/8/93	0
7/9/88	0	7/9/90	0.02	7/9/91	0.45	7/8/92	0.4	7/9/93	0
7/10/88	0	7/10/90	0	7/10/91	0.01	7/9/92	0	7/10/93	0

Table 1 (cont.)

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Daily Precipitation Values, Station #42073807, Blanding, Utah

January, 1988 through February, 1994

Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)
7/11/88	0	7/11/90	0	7/11/91	0	7/10/92	0	7/11/93	0
7/12/88	0	7/12/90	0	7/12/91	0	7/11/92	0	7/12/93	0
7/13/88	0	7/13/90	0	7/13/91	0	7/12/92	1.33	7/13/93	0
7/14/88	0	7/14/90	0.05	7/14/91	0	7/13/92	0.02	7/14/93	0
7/15/88	0	7/15/90	0	7/15/91	0	7/14/92	0	7/15/93	0
7/16/88	0	7/16/90	0	7/16/91	0	7/15/92	0	7/16/93	0
7/17/88	0.05	7/17/90	0	7/17/91	0	7/16/92	0	7/17/93	0
7/18/88	0	7/18/90	0.01	7/18/91	0	7/17/92	0	7/18/93	0
7/19/88	0	7/19/90	0	7/19/91	0	7/18/92	0.08	7/19/93	0
7/20/88	0	7/20/90	0	7/20/91	0.28	7/19/92	0	7/20/93	0
7/21/88	0	7/21/90	0.03	7/21/91	0	7/20/92	0	7/21/93	0
7/22/88	0	7/22/90	0	7/22/91	0	7/21/92	0	7/22/93	0
7/23/88	0	7/23/90	0.01	7/23/91	0.04	7/22/92	0.1	7/23/93	0
7/24/88	0	7/24/90	0.02	7/24/91	0.23	7/23/92	0.08	7/24/93	0.01
7/25/88	0	7/25/90	0.05	7/25/91	0.08	7/24/92	0	7/25/93	0
7/26/88	0.16	7/26/90	0	7/26/91	0.01	7/25/92	0.17	7/26/93	0
7/27/88	0	7/27/90	0	7/27/91	0	7/26/92	0	7/27/93	0
7/28/88	0	7/28/90	0.02	7/28/91	0	7/27/92	0	7/28/93	0
7/29/88	0.13	7/29/90	0	7/29/91	0	7/28/92	0.02	7/29/93	0
7/30/88	0.05	7/30/90	0.19	7/30/91	0	7/29/92	0	7/30/93	0
7/31/88	0.12	7/31/90	0	7/31/91	0	7/30/92	0	7/31/93	0
8/1/88	0.13	8/1/90	0	8/1/91	0.03	7/31/92	0	8/1/93	0
8/2/88	0	8/2/90	0.25	8/2/91	0.04	8/1/92	0	8/2/93	0
8/3/88	0	8/3/90	0	8/3/91	0.08	8/2/92	0	8/3/93	0
8/4/88	0	8/4/90	0	8/4/91	0	8/3/92	0	8/4/93	0.01
8/5/88	0.38	8/5/90	0	8/5/91	0.01	8/4/92	0	8/5/93	0
8/6/88	0.02	8/6/90	0	8/6/91	0.56	8/5/92	0.02	8/6/93	0.03
8/7/88	0	8/7/90	0	8/7/91	0	8/6/92	0.01	8/7/93	0.03
8/8/88	0	8/8/90	0	8/8/91	0	8/7/92	0	8/8/93	0.03
8/9/88	0	8/9/90	0	8/9/91	0	8/8/92	0	8/9/93	0.03
8/10/88	0	8/10/90	0	8/10/91	0	8/9/92	0.03	8/10/93	0.01
8/11/88	0.04	8/11/90	0.04	8/11/91	0	8/10/92	0	8/11/93	0
8/12/88	0.07	8/12/90	0	8/12/91	0.36	8/11/92	0.04	8/12/93	0
8/13/88	0	8/13/90	0.15	8/13/91	0	8/12/92	0	8/13/93	0
8/14/88	0	8/14/90	0.07	8/14/91	0	8/13/92	0	8/14/93	0
8/15/88	0.09	8/15/90	0.05	8/15/91	0.01	8/14/92	0	8/15/93	0
8/16/88	0.05	8/16/90	0.24	8/16/91	0	8/15/92	0	8/16/93	0
8/17/88	0	8/17/90	0	8/17/91	0	8/16/92	0	8/17/93	0
8/18/88	0	8/18/90	0	8/18/91	0.06	8/17/92	0.19	8/18/93	0
8/19/88	0	8/19/90	0	8/19/91	0	8/18/92	0	8/19/93	0.03
8/20/88	0.24	8/20/90	0	8/20/91	0	8/19/92	0	8/20/93	0
8/21/88	0.15	8/21/90	0	8/21/91	0	8/20/92	0	8/21/93	0.02
8/22/88	0	8/22/90	0	8/22/91	0	8/21/92	0	8/22/93	0
8/23/88	0	8/23/90	0	8/23/91	0	8/22/92	0.37	8/23/93	0
8/24/88	0	8/24/90	0	8/24/91	0	8/23/92	0.16	8/24/93	0
8/25/88	0	8/25/90	0	8/25/91	0	8/24/92	0	8/25/93	0.08
8/26/88	0	8/26/90	0	8/26/91	0	8/25/92	0	8/26/93	0.74
8/27/88	0	8/27/90	0	8/27/91	0.01	8/26/92	0	8/27/93	0
8/28/88	0	8/28/90	0	8/28/91	0	8/27/92	0	8/28/93	0.73
8/29/88	0	8/29/90	0	8/29/91	0	8/28/92	0	8/29/93	0
8/30/88	0.18	8/30/90	0	8/30/91	0	8/29/92	0	8/30/93	0
8/31/88	0.47	8/31/90	0	8/31/91	0.02	8/30/92	0.28	8/31/93	0.05
9/1/88	0.01	9/1/90	0.01	9/1/91	0	8/31/92	0.16	9/1/93	0
9/2/88	0	9/2/90	0.32	9/2/91	0	9/1/92	0	9/2/93	0
9/3/88	0	9/3/90	0.1	9/3/91	0	9/2/92	0	9/3/93	0
9/4/88	0	9/4/90	0	9/4/91	0	9/3/92	0	9/4/93	0
9/5/88	0	9/5/90	0.08	9/5/91	0	9/4/92	0	9/5/93	0
9/6/88	0	9/6/90	0.1	9/6/91	0.93	9/5/92	0	9/6/93	0
9/7/88	0	9/7/90	0	9/7/91	0.25	9/6/92	0	9/7/93	0
9/8/88	0	9/8/90	0	9/8/91	0	9/7/92	0	9/8/93	0
9/9/88	0	9/9/90	0	9/9/91	0	9/8/92	0	9/9/93	0
9/10/88	0.32	9/10/90	0	9/10/91	0	9/9/92	0	9/10/93	0
9/11/88	0.05	9/11/90	0	9/11/91	0.13	9/10/92	0	9/11/93	0
9/12/88	0.58	9/12/90	0	9/12/91	0	9/11/92	0	9/12/93	0.01

Table 1 (cont)

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Daily Precipitation Values, Station #42073807, Blanding, Utah
January, 1988 through February, 1994

Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)
9/13/88	0	9/13/90	0	9/13/91	0.01	9/12/92	0	9/13/93	0.6
9/14/88	0	9/14/90	0	9/14/91	0	9/13/92	0	9/14/93	0
9/15/88	0	9/15/90	0	9/15/91	0	9/14/92	0	9/15/93	0
9/16/88	0	9/16/90	0	9/16/91	0	9/15/92	0.13	9/16/93	0
9/17/88	0	9/17/90	0	9/17/91	0	9/16/92	0	9/17/93	0
9/18/88	0	9/18/90	0.63	9/18/91	0	9/17/92	0	9/18/93	0.22
9/19/88	0	9/19/90	0	9/19/91	0	9/18/92	0.22	9/19/93	0
9/20/88	0	9/20/90	0.16	9/20/91	0	9/19/92	0.47	9/20/93	0
9/21/88	0.08	9/21/90	0	9/21/91	0	9/20/92	0.08	9/21/93	0
9/22/88	0	9/22/90	0	9/22/91	0	9/21/92	0	9/22/93	0
9/23/88	0	9/23/90	0.06	9/23/91	0	9/22/92	0	9/23/93	0
9/24/88	0	9/24/90	0	9/24/91	0	9/23/92	0	9/24/93	0
9/25/88	0	9/25/90	0	9/25/91	0	9/24/92	0	9/25/93	0
9/26/88	0	9/26/90	0	9/26/91	0	9/25/92	0	9/26/93	0
9/27/88	0.03	9/27/90	0	9/27/91	0	9/26/92	0	9/27/93	0
9/28/88	0	9/28/90	0.23	9/28/91	0	9/27/92	0	9/28/93	0
9/29/88	0	9/29/90	0	9/29/91	0	9/28/92	0	9/29/93	0
9/30/88	0	9/30/90	0	9/30/91	0	9/29/92	0	9/30/93	0
10/1/88	0	10/1/90	0.01	10/1/91	0	9/30/92	0	10/1/93	0
10/2/88	0	10/2/90	1.1	10/2/91	0	10/1/92	0	10/2/93	0
10/3/88	0	10/3/90	0.02	10/3/91	0	10/2/92	0	10/3/93	0
10/4/88	0	10/4/90	0	10/4/91	0	10/3/92	0	10/4/93	0
10/5/88	0	10/5/90	0	10/5/91	0	10/4/92	0	10/5/93	0
10/6/88	0.02	10/6/90	0	10/6/91	0	10/5/92	0	10/6/93	0.61
10/7/88	0.04	10/7/90	0.1	10/7/91	0	10/6/92	0	10/7/93	0.21
10/8/88	0.02	10/8/90	0	10/8/91	0	10/7/92	0	10/8/93	0.19
10/9/88	0	10/9/90	0	10/9/91	0	10/8/92	0	10/9/93	0
10/10/88	0	10/10/90	0	10/10/91	0	10/9/92	0	10/10/93	0.01
10/11/88	0	10/11/90	0	10/11/91	0	10/10/92	0	10/11/93	0.1
10/12/88	0	10/12/90	0	10/12/91	0	10/11/92	0	10/12/93	0
10/13/88	0	10/13/90	0	10/13/91	0	10/12/92	0	10/13/93	0
10/14/88	0	10/14/90	0	10/14/91	0	10/13/92	0	10/14/93	0
10/15/88	0	10/15/90	0	10/15/91	0	10/14/92	0	10/15/93	0
10/16/88	0	10/16/90	0	10/16/91	0	10/15/92	0	10/16/93	0.09
10/17/88	0	10/17/90	0	10/17/91	0	10/16/92	0	10/17/93	0.2
10/18/88	0	10/18/90	0.2	10/18/91	0	10/17/92	0	10/18/93	0.02
10/19/88	0	10/19/90	0.28	10/19/91	0	10/18/92	0	10/19/93	0
10/20/88	0	10/20/90	0.11	10/20/91	0	10/19/92	0	10/20/93	0
10/21/88	0	10/21/90	0	10/21/91	0	10/20/92	0	10/21/93	0
10/22/88	0	10/22/90	0	10/22/91	0.02	10/21/92	0.11	10/22/93	0
10/23/88	0	10/23/90	0	10/23/91	0	10/22/92	0	10/23/93	0
10/24/88	0	10/24/90	0	10/24/91	0.08	10/23/92	0	10/24/93	0
10/25/88	0	10/25/90	0	10/25/91	0	10/24/92	0.37	10/25/93	0
10/26/88	0	10/26/90	0	10/26/91	0	10/25/92	0.15	10/26/93	0
10/27/88	0	10/27/90	0	10/27/91	0.69	10/26/92	0	10/27/93	0
10/28/88	0	10/28/90	0	10/28/91	0.26	10/27/92	0.04	10/28/93	0
10/29/88	0	10/29/90	0	10/29/91	0.26	10/28/92	0.26	10/29/93	0
10/30/88	0.02	10/30/90	0	10/30/91	0.1	10/29/92	0.12	10/30/93	0
10/31/88	0	10/31/90	0	10/31/91	0	10/30/92	0.22	10/31/93	0
11/1/88	0	11/1/90	0	11/1/91	0	10/31/92	0.19	11/1/93	0
11/2/88	0	11/2/90	0.35	11/2/91	0	11/1/92	0	11/2/93	0
11/3/88	0	11/3/90	0.37	11/3/91	0	11/2/92	0	11/3/93	0
11/4/88	0	11/4/90	0	11/4/91	0	11/3/92	0	11/4/93	0
11/5/88	0	11/5/90	0	11/5/91	0	11/4/92	0	11/5/93	0
11/6/88	0	11/6/90	0.01	11/6/91	0	11/5/92	0	11/6/93	0
11/7/88	0	11/7/90	0.12	11/7/91	0	11/6/92	0	11/7/93	0
11/8/88	0	11/8/90	0	11/8/91	0	11/7/92	0	11/8/93	0
11/9/88	0	11/9/90	0	11/9/91	0	11/8/92	0	11/9/93	0
11/10/88	0	11/10/90	0	11/10/91	0.03	11/9/92	0	11/10/93	0
11/11/88	0.56	11/11/90	0	11/11/91	0	11/10/92	0.14	11/11/93	0.64
11/12/88	0	11/12/90	0	11/12/91	0	11/11/92	0	11/12/93	0.3
11/13/88	0	11/13/90	0	11/13/91	0	11/12/92	0	11/13/93	0.14
11/14/88	0	11/14/90	0	11/14/91	0.49	11/13/92	0	11/14/93	0
11/15/88	0.25	11/15/90	0	11/15/91	0.95	11/14/92	0	11/15/93	0

Table 1 (cont)

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Daily Precipitation Values, Station #42073807, Blanding, Utah

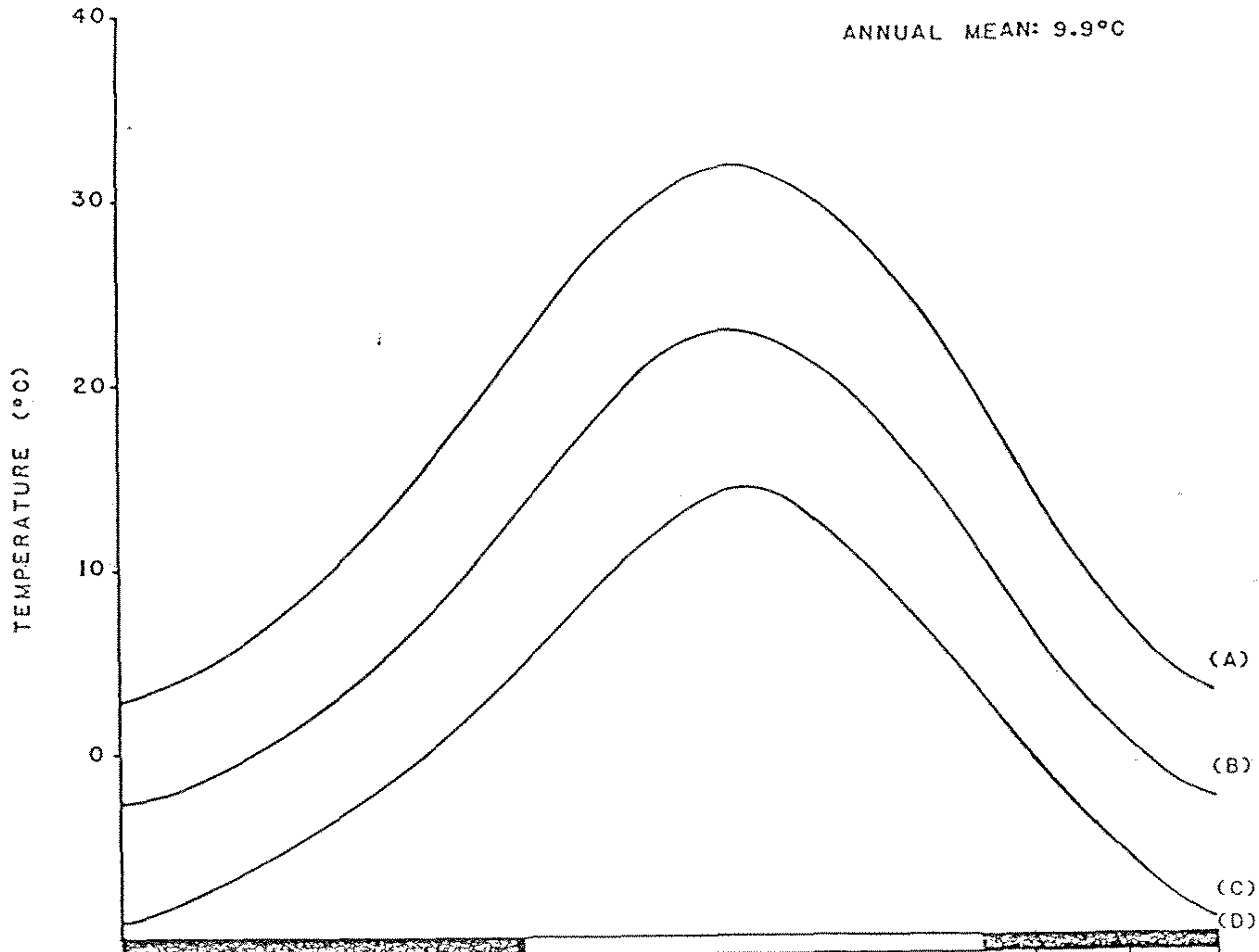
January, 1988 through February, 1994

Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)	Date	Precipitation (inches)
11/16/88	0	11/16/90	0	11/16/91	0.03	11/15/92	0	11/16/93	0
11/17/88	0.02	11/17/90	0	11/17/91	0	11/16/92	0	11/17/93	0
11/18/88	0	11/18/90	0	11/18/91	0.07	11/17/92	0	11/18/93	0
11/19/88	0	11/19/90	0	11/19/91	0	11/18/92	0.01	11/19/93	0
11/20/88	0	11/20/90	0.09	11/20/91	0	11/19/92	0	11/20/93	0
11/21/88	0	11/21/90	0	11/21/91	0	11/20/92	0.12	11/21/93	0
11/22/88	0	11/22/90	0	11/22/91	0	11/21/92	0	11/22/93	0
11/23/88	0	11/23/90	0	11/23/91	0	11/22/92	0	11/23/93	0
11/24/88	0	11/24/90	0	11/24/91	0	11/23/92	0	11/24/93	0
11/25/88	0.07	11/25/90	0	11/25/91	0	11/24/92	0	11/25/93	0
11/26/88	0.11	11/26/90	0.48	11/26/91	0	11/25/92	0	11/26/93	0
11/27/88	0	11/27/90	0.01	11/27/91	0	11/26/92	0	11/27/93	0
11/28/88	0	11/28/90	0	11/28/91	0	11/27/92	0	11/28/93	0
11/29/88	0	11/29/90	0	11/29/91	0	11/28/92	0	11/29/93	0
11/30/88	0	11/30/90	0	11/30/91	0.01	11/29/92	0	11/30/93	0
12/1/88	0.03	12/1/90	0	12/1/91	0	11/30/92	0	12/1/93	0
12/2/88	0	12/2/90	0	12/2/91	0	12/1/92	0	12/2/93	0
12/3/88	0	12/3/90	0	12/3/91	0	12/2/92	0	12/3/93	0
12/4/88	0	12/4/90	0	12/4/91	0	12/3/92	0	12/4/93	0
12/5/88	0	12/5/90	0	12/5/91	0	12/4/92	0.13	12/5/93	0
12/6/88	0	12/6/90	0	12/6/91	0	12/5/92	0.81	12/6/93	0
12/7/88	0	12/7/90	0	12/7/91	0	12/6/92	0	12/7/93	0
12/8/88	0	12/8/90	0	12/8/91	0	12/7/92	-99999	12/8/93	0
12/9/88	0	12/9/90	0	12/9/91	0	12/8/92	0.28	12/9/93	0
12/10/88	0	12/10/90	0	12/10/91	0.02	12/9/92	0	12/10/93	0
12/11/88	0	12/11/90	0	12/11/91	0.26	12/10/92	0	12/11/93	0
12/12/88	0	12/12/90	0.27	12/12/91	0	12/11/92	0	12/12/93	0.07
12/13/88	0	12/13/90	0.04	12/13/91	0	12/12/92	0.5	12/13/93	0
12/14/88	0	12/14/90	0	12/14/91	0	12/13/92	0	12/14/93	0
12/15/88	0	12/15/90	0.06	12/15/91	0	12/14/92	0	12/15/93	0.07
12/16/88	0	12/16/90	0.11	12/16/91	0	12/15/92	0	12/16/93	0.18
12/17/88	0	12/17/90	0	12/17/91	0	12/16/92	0	12/17/93	0
12/18/88	0	12/18/90	0	12/18/91	0.54	12/17/92	0	12/18/93	0
12/19/88	0	12/19/90	0.06	12/19/91	0.43	12/18/92	0.2	12/19/93	0
12/20/88	0.05	12/20/90	0.36	12/20/91	0	12/19/92	0	12/20/93	0
12/21/88	0.38	12/21/90	0	12/21/91	0	12/20/92	0	12/21/93	0
12/22/88	0	12/22/90	0	12/22/91	0	12/21/92	0	12/22/93	0
12/23/88	0.2	12/23/90	0	12/23/91	0	12/22/92	0	12/23/93	0
12/24/88	0.13	12/24/90	0	12/24/91	0	12/23/92	0	12/24/93	0
12/25/88	0.09	12/25/90	0	12/25/91	0	12/24/92	0	12/25/93	0
12/26/88	0	12/26/90	0	12/26/91	0	12/25/92	0	12/26/93	0
12/27/88	0	12/27/90	0	12/27/91	0	12/26/92	0	12/27/93	0.1
12/28/88	0	12/28/90	0	12/28/91	0	12/27/92	0	12/28/93	0
12/29/88	0	12/29/90	0	12/29/91	0.05	12/28/92	0.3	12/29/93	0
12/30/88	0	12/30/90	0	12/30/91	0.11	12/29/92	0	12/30/93	0
12/31/88	0	12/31/90	0	12/31/91	0.02	12/30/92	0.07	12/31/93	0
						12/31/92	0		
Notes:	Source: Utah Climet Center, Utah State University, Logan, UT.								

Table 1 (cont.)

TABLE 2

MONTHLY MEANS AND EXTREMES OF TEMPERATURES BLANDING, UTAH



MONTH	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
EXTREME MAX.	16	18	24	27	33	38	38	37	34	29	21	15
MEAN MAX.	3.8	6.9	10.9	16.3	22.8	28.7	31.9	30.2	26.0	18.8	10.2	4.5
MEAN	−2.5	0.5	3.4	8.4	14.1	19.4	23.1	21.6	17.2	10.9	3.6	−1.7
MEAN MIN.	−8.8	−5.9	−3.2	0.4	5.4	10.1	14.2	13.1	8.4	2.9	−3.2	−7.8
EXTREME MIN.	−29	−22	−15	−11	−6	−1	8	3	−5	−12	−19	−22

(A) MEAN DAILY MAXIMUM
(B) MEAN MONTHLY
(C) MEAN DAILY MINIMUM
(D) FREEZE DATES

DAMES & MOORE

Appendix D

24/34

TAILINGS AND RANDOM FILL PROPERTIES

Table 3.4-1

Physical Properties of Tailings

and

Proposed Cover Materials

Material Type	Atterberg Limits LL	Atterberg Limits PI	Specific Gravity	% Passing No. 200 Sieve	Maximum Dry Density (pcf)	Optimum Moisture Content
Tailings	28	6	2.85	46	104.0	18.1
Random Fill	22	7	2.67	48	120.2	11.8
Clay	29	14	2.69	56	121.3	12.1
Clay	36	19	2.75	68	108.7	18.5

Note: Physical Soil Data from Chen and Associates (1987).

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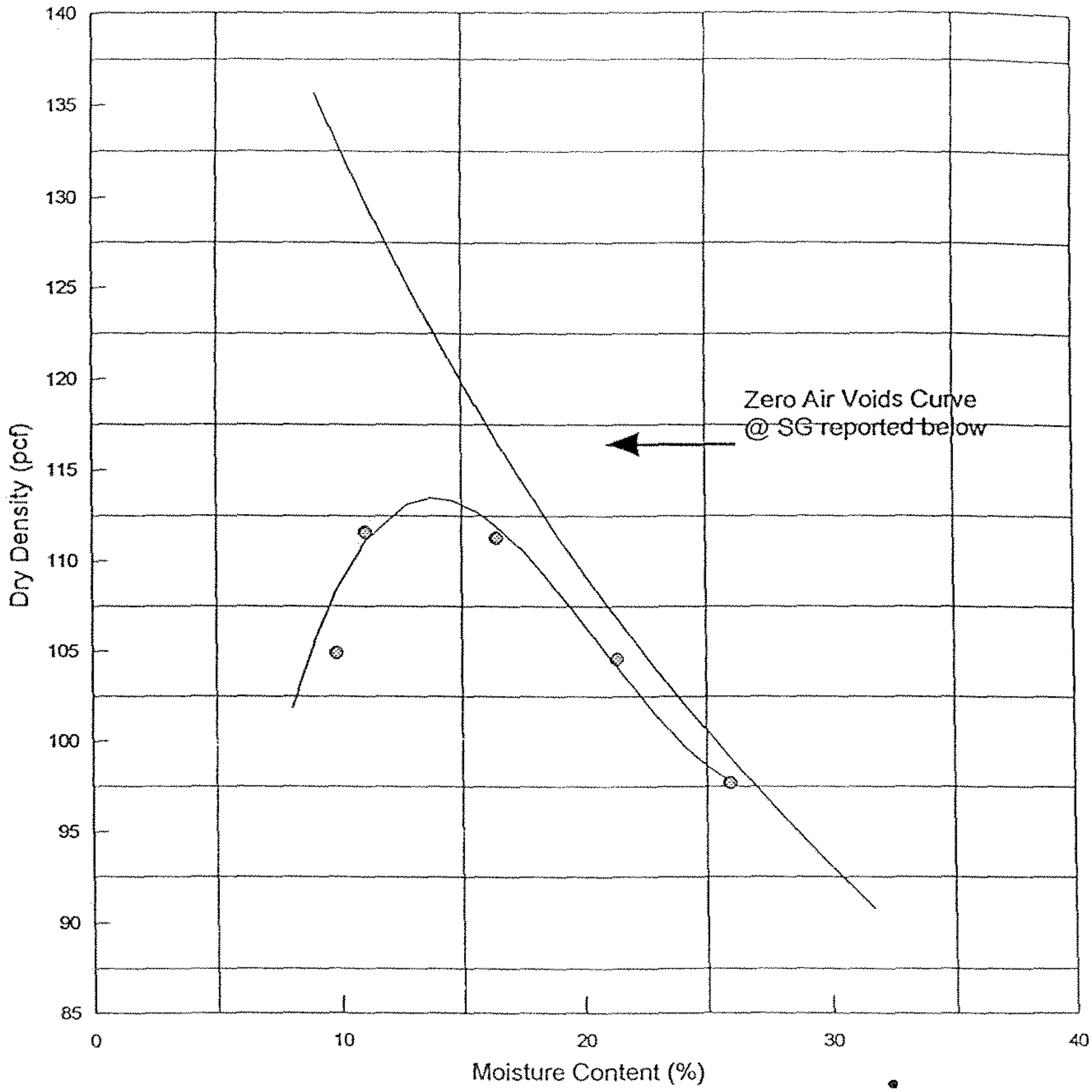
ADVANCED TERRA TESTING inc

833 Parfet Street
Lakewood, Colorado 80215
(303) 232-8308

Proctor Compaction Test

, , UT-1



- Best Fit Curve
⊗ Actual Data
- Zero Air VoidsCurve @ SG = 2.70

CLAY

OPTIMUM MOISTURE CONTENT = 13.9 MAXIMUM DRY DENSITY = 113.5
ASTM D 1557 A, Rock correction applied? N

ADVANCED TERRA TESTING, INC.

26/34

PERMEABILITY DETERMINATION
FALLING HEAD
FIXED WALL

27/34

CLIENT Titan Environmental JOB NO. 2234-04

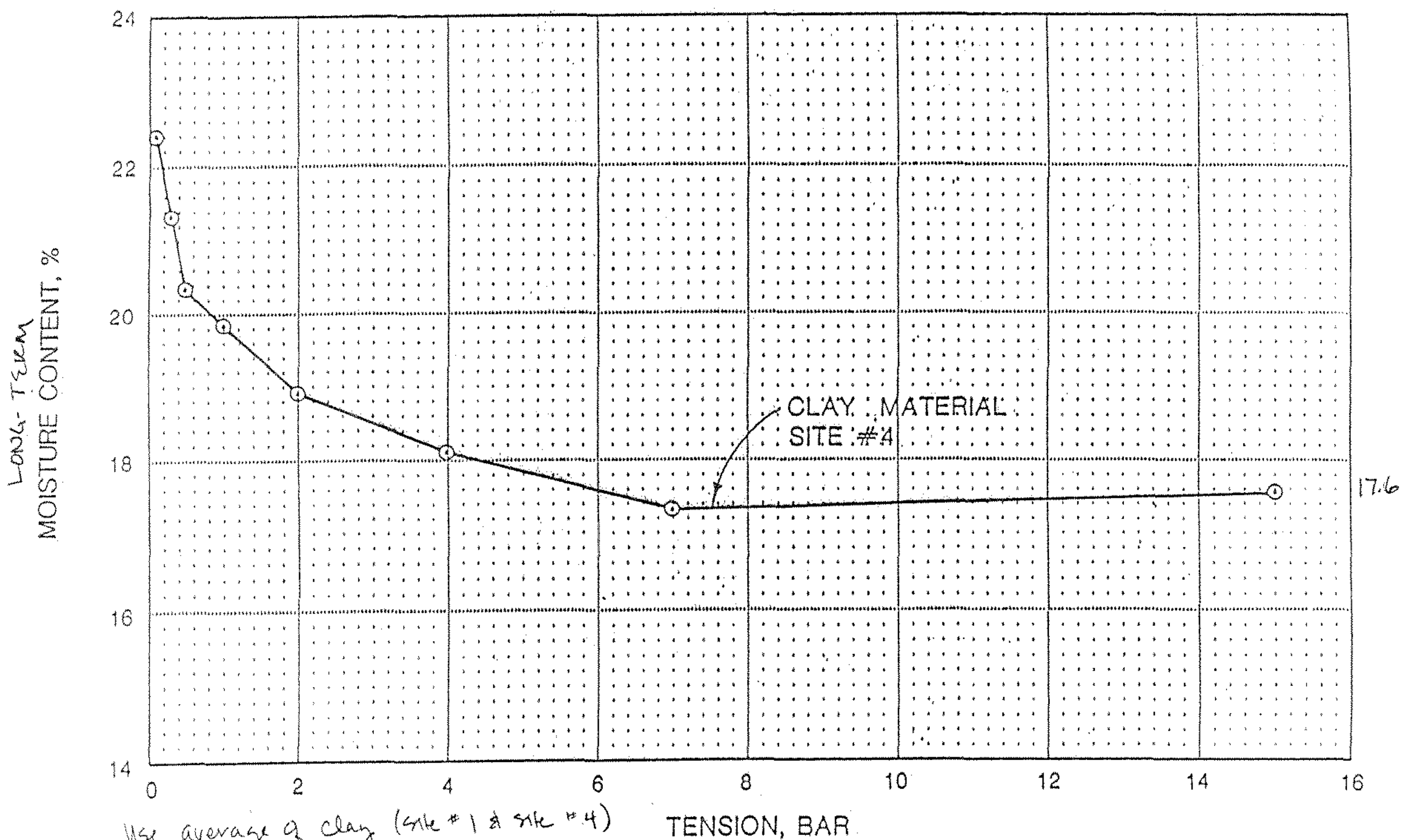
BORING NO.		SAMPLED	
DEPTH		TEST STARTED	7-28-96 CAL
SAMPLE NO.	UT-1	TEST FINISHED	8-7-96 CAL
SOIL DESCR.	Remolded 95% Mod Pt. @ OMC	SETUP NO.	1
SURCHARGE	200		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil & Ring(s) (g)	386.9	404.5
Wt. Ring(s) (g)	93.0	93.0
Wt. Soil (g)	293.9	311.4
Wet Density PCF	122.3	120.5
Wt. Wet Soil & Pan (g)	302.4	319.9
Wt. Dry Soil & Pan (g)	266.2	266.2
Wt. Lost Moisture (g)	36.2	53.8
Wt. of Pan Only (g)	8.5	8.5
Wt. of Dry Soil (g)	257.7	257.7
Moisture Content %	14.1	20.9
Dry Density PCF	107.2	99.7
Max. Dry Density PCF	113.5	113.5
Percent Compaction	94.4	87.8

ELAPSED TIME (MIN)	BURETTE READING h1 (CC)	BURETTE READING h2 (CC)	PERCOLATION RATE FT/YEAR	PERCOLATION RATE CM/SEC
	0.2			
2599	10.8	10.8	0.14	1.4E-07
1427	14.2	14.2	0.09	8.4E-08
1440	16.8	16.8	0.07	6.5E-08
1440	18.6	18.6	0.05	4.6E-08
1440	20.2	20.2	0.04	4.1E-08
1440	21.6	21.6	0.04	3.7E-08
1469	23.0	23.0	0.04	3.6E-08
1440		24.4	0.04	3.7E-08 = Permeability (CLAY)

Data Entered By: NAA Date: 8-8-96
Date Checked By: [signature] Date: 8-8-96
Filename:TIFHUT1

ADVANCED TERRA TESTING, INC.



Use average of clay (site #1 & site #4) for long-term moisture content of clay

FIGURE 4.4-2
SUMMARY OF CAPILLARY MOISTURE RELATIONSHIP TEST RESULTS
WHITE MESA PROJECT

DATA FROM CHEN & ASSOCIATES

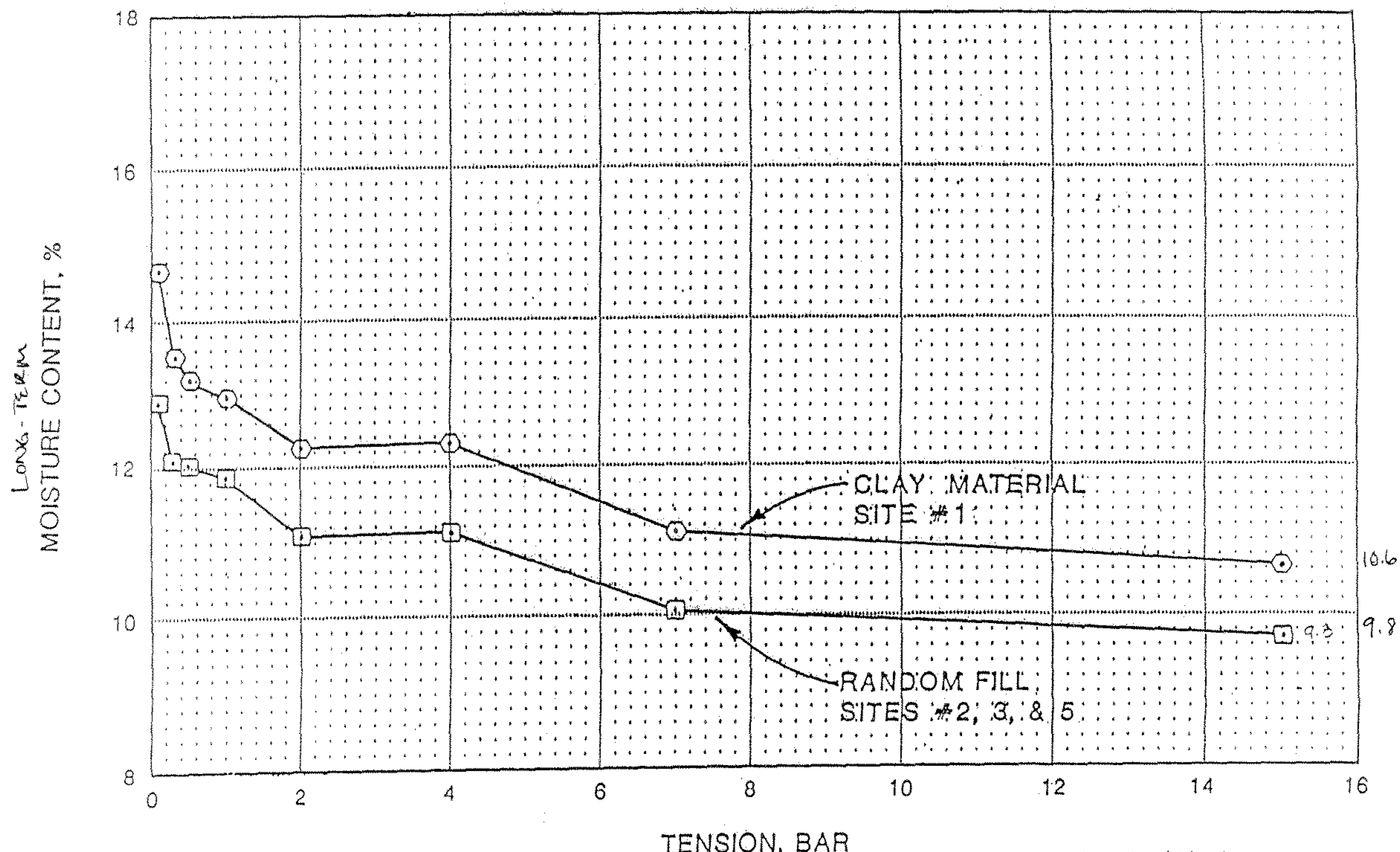


FIGURE 4.4-1
SUMMARY OF CAPILLARY MOISTURE
RELATIONSHIP TEST RESULTS
WHITE MESA PROJECT

DATA FROM CHEN & ASSOCIATES

Porosity

Porosity is calculated from the specific gravity and dry bulk density according to the following equations;

1. Dry bulk density = [(specific gravity)(density of water)]/[1 + e] (Ref: Principles & Practice of Civil Engineering, 1996). See Appendix C.
2. Porosity = [e / (1+e)] x 100 (Ref: Principles & Practice of Civil Engineering, 1996). See Appendix C.

	Max. Dry Density (lb/ft^3) (1)	Dry Bulk Density (lb/ft^3) (2)	Specific Gravity (1)	Density of Water (lb/ft^3)	"e" (3)	**porosity (4)**
Tailings	104.0	93.6	2.85	62.4	0.90	47%
Clay (5)	115.0	103.5	2.72	62.4	0.64	39%
Random fill	120.2	108.2	2.67	62.4	0.54	35%

<u>Notes:</u>
1. Physical soil data from Chen and Associates (1987) included in Appendix B.
2. Bulk dry density is 90% of the ASTM Proctor maximum dry density for all materials.
3. Calculated using Equation 1 above.
4. Calculated using Equation 2 above.
5. Clay physical data are average values from site #1 and site #4 clay stockpiles as given by Umetco Minerals Corp. 1988.

1/5" × 1/5"

Determination of Parameters (Contd.)

Permeability; No permeability data is available for tailings.

Clay material - The permeability of the clay material is an average for all clay materials near the site as given by Chen & Associates (1978, 79) as "Laboratory Permeability Test Results."

The permeability value is an average of the following values;

Permeability; 8.2×10^{-8} cm/s
6.6×10^{-8}
1.2×10^{-8}
4.0×10^{-8}
1.6×10^{-8}
2.3×10^{-8}
3.2×10^{-8}
7.8×10^{-7}
1.5×10^{-6}
} Chen & Associates (7/18/78)

(Assume permeabilities for site #1 & site #4 clays are similar)

2.1×10^{-7}
4.2×10^{-7}
1.2×10^{-7}
5.0×10^{-7}
} (1/25/79)

Ave. = 2.92×10^{-7}

Random fill - The permeability of the random fill material is an average for all sand and silt material as given by Chen & Associates (1978, 79) as "Laboratory Permeability Test Results."

The permeability is an average of the following values;

Permeability; 5.5×10^{-7}
3.4×10^{-8}
6.1×10^{-7}
} Chen & Ass. (7/18/78)

4.3×10^{-6}
3.7×10^{-7}
5.8×10^{-7}
1.1×10^{-7}
5.4×10^{-7}
} (1/23/79)

Permeability (Random fill) = Ave. = 8.87×10^{-7} cm/s

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Test Hole	Depth (Ft.)	NATURAL Moisture Content (%)	NATURAL Dry Density (pcf)	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	ATTERBERG LIMITS Liquid Limit (%)	ATTERBERG LIMITS Plasticity Index (%)	GRADATION ANALYSIS Maximum Size	GRADATION ANALYSIS Passing #200 (%)	GRADATION ANALYSIS Less than 2 μ (%)	REMOLDED Dry Density (pcf)	REMOLDED Moisture Content (%)	PERMEABILITY ft./yr.	PERMEABILITY cm./sec.	Specific Gravity	Soil Type
2	0-5			117.5	10.8	20	3	#16	58	19	111.6	16.4	0.57	5.5×10^{-7}		Sandy Silt
3	7-8	7.2				21	6	#16	62							Sandy Clayey Silt
5	7½-10			104.1	18.5	33 ✓	8	3/4 In.	56	12	102.1	22.0	0.085	8.2×10^{-8}	2.65	Calcareous Silty Clay
6	1-2	10.3				25	7	#16	77							Sandy Clay Silt
6	8½-9	6.1				27 ✓	8	#4	70							Sandy Clay
8	5-5½	13.1					NP	3/4 In.	62							Calcareous Sandy Silt
9	0-1	8.1					NP	#16	53							Sand - Silt
10	4-6½					24	10	#4	73							Sandy Clay
11	5½-6½	14.0				26	6	#16	65							Siltstone-Claystone
12	2-5			101.0	20.6	53 ✓	35	#16	88	59	95.0	18.3	0.068	6.6×10^{-8}	2.67	Weathered Claystone
13	7-8	13.1				39 ✓	13	#8	84							Calcareous Silt Clay
14	1-2	19.3				40 ✓	21	#4	89							Weathered Claystone
15	1½-4½			106.8	19.0	26 ✓	8	3/8 In.	65	27	103.4	18.0	0.012	1.2×10^{-8}	2.64	Mod. Calcareous Sandy Clay
17	2-3	11.4				19	4	#8	59							Sandy Silt
19	0-3			117.5	12.8	23	6	#16	70		109.9	12.4	0.035	3.4×10^{-8}		Sandy Clayey Silt
22	1-2	13.2				26 ✓	10	#4	73							Sandy Clay
23	1-3					48 ✓	24	#30	87							Weathered Claystone
23	6-8					61 ✓	30	#30	96							Claystone
25	1-3½	13.3				26 ✓	9	#4	57							Sandy Clay
26	4½-5	15.3				41 ✓	20	#4	91							Weathered Claystone
28	0-2	12.7				28 ✓	10	3/8 In.	72							Sandy Clay
29	2-3	8.5				19	2	#16	59							Sandy Silt
32	8-8½	5.6				23	6	#30	73							Sandy Clayey Silt
37	0-4			118.8	11.5	23	5	#8	72		110.5	11.5	0.63	6.1×10^{-7}		Sandy Clayey Silt
38	5-7			111.0	16.7	29 ✓	14	3/8 In.	69		102.4	17.9	0.041	4.0×10^{-8}		Sandy Clay
40	4-5½			110.0	16.2	26 ✓	9	#8	64	27	106.4	16.4	0.017	1.6×10^{-8}	2.65	Sandy Clay

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Test Hole	Depth (Ft.)	NATURAL Moisture Content (%)	NATURAL Dry Density (pcf)	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	ATTERBERG LIMITS Liquid Limit (%)	ATTERBERG LIMITS Plasticity Index (%)	GRADATION ANALYSIS Maximum Size	GRADATION ANALYSIS Passing #200 (%)	GRADATION ANALYSIS Less than 2 µ (%)	REMOLDED Dry Density (pcf)	REMOLDED Moisture Content (%)	PERMEABILITY ft./yr.	PERMEABILITY cm./sec.	Specific Gravity	Soil Type
40	9-9½	6.8				22	8	3/8 In.	60							Sandy Clay
42	13½-14½	7.6				26	10	3/8 In.	73							Sandy Clay
43	11-12	12.1				41	22	#4	86							Claystor
43	13½-16½			110.0	16.9	40	24	3/8 In.	85	44	104.1	15.8	0.024	2.3×10^{-8}	2.62	Claystone
44	6½-7	7.5				30	11	3/8 In.	79							Calcareous Sandy Clay
46	0-2	12.3				22	6	#16	76							Sandy Clayey Silt
48	5-5½					30	9	3/8 In.	65							Sandy Clay
49	5-7			110.7	15.6	25	9	#16	71		105.2	13.9	0.33	3.2×10^{-8}		Sandy Clay
49	14-15					28	5	#8	55							Calcareous Sandy Silt
54	0-2	12.1				23	9	#8	64							Sandy Clay
55	5-5½	7.8				28	14	#30	71							Sandy Clay
55	9½-10½					28	13	#4	71							Sandy Clay
58	5½-6	12.5				35	11	#4	75							Sandy, Silty Clay
61	0-1	11.5				21	4	#16	75							Sandy Silt
62	11-11½	8.1					NP	1 In.	34							Calcareous Sand & [illegible]
63	4-6					30	14	#8	68							Sandy C[illegible]
65	1-2	9.0					NP	#16	44							Silty S[illegible]
68	7½-8	8.6				28	13	#8	67							Sandy Clay
70	3½-4½	16.4				27	4	1½ In.	46							Calcareous Sand & Silt
72	0-2	12.2				22	8	#16	59							Sandy Clay
75	10-11	12.4				41	25	#4	75							Weathered Claystone
75	12-14					45	22	#16	93							Claystone

#16,406

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TABLE II

LABORATORY PERMEABILITY TEST RESULTS

Sample	Soil Type	Compaction: Dry Density (pcf)	Compaction: Moisture Content (%)	Compaction: % of ASTM D698	Surcharge Pressure (psf)	Permeability (Ft/Yr)	Permeability (Cm/S)
TH 2 @ 0'-5'	Sandy Silt	111.6	16.4	95	500	0.57	5.5[illegible]
TH 5 @ 7½'-10'	Calcareous Silty Clay	102.1	22.0	101	500	0.085	8.2[illegible]
TH 12 @ 2'-5'	Weathered Claystone	95.0	18.3	94	500	0.068	$6.6 \times 10^{-}$[illegible]
TH 15 @ 1½'-4½'	Calcareous Sandy Clay	103.4	18.0	97	500	0.012	$1.2 \times 10^{-}$[illegible]
TH 19 @ 0'-3'	Sandy, Clayey Silt	109.9	12.4	94	500	0.035	$3.4 \times 10^{-}$[illegible]
TH 37 @ 0'-4'	Sandy, Clayey Silt	110.5	11.5	93	500	0.63	$6.1 \times 10^{-}$[illegible]
TH 38 @ 5'-7'	Sandy Clay	102.4	17.9	92	500	0.041	$4.0 \times 10^{-}$[illegible]
TH 40 @ 4'-5½'	Sandy Clay	106.4	16.4	97	500	0.017	$1.6 \times 10^{-}$[illegible]
TH 43 @ 13½-16½'	Claystone	104.1	15.8	95	500	0.024	$2.3 \times 10^{-}$[illegible]
TH 49 @ 5'-7'	Sandy Clay	105.2	13.9	95	500	0.33	3.2[illegible]

APPENDIX E

Freeze/Thaw Evaluation

Purpose: To determine if freeze/thaw conditions will impact the performance of the White Mesa uranium mill tailings cover. This calculation brief predicts the depth of frost which may be anticipated at the mill site. Only frost depth is evaluated since this would have the greatest impact on cover integrity (i.e. increasing permeability or damage by frost heave).

Method: A digital computer program of the modified Berggren equation for calculating the depth of freeze or thaw in a multi-layered soil system was used for purposes presented in this calculation. This method, used for determining the frost depth, is considered adequate for Uranium Mill Tailings Remedial Action (UMTRA) Projects by the U.S. Department of Energy for the following reasons:

- It calculates depth of frost based on a zero degrees Celsius isotherm, whereas the frozen front occurs some distance above this line.
- Extrapolation of current weather records beyond 200 years is not reliable.
- Extreme changes in temperatures for the 1,000 year design life are not anticipated based on geomorphic evidence.

Parameters for the cover materials based on accepted methods and existing database values previously collected, were input into the computer modeling program to determine the depth of frost penetration. A cover thickness of 2 feet random fill over 1 foot of compacted clay (as determined by HELP and RADON computer modeling) was used.

Assumptions: The model assumes:

- One-dimensional heat flow with the entire soil mass at its mean annual temperature prior to the start of the freezing season.
- At the start of the freezing season, the surface temperature changes suddenly from the mean annual temperature to a temperature below freezing and remains at this temperature throughout the entire freezing season.
- The effect of latent heat is considered as a heat sink at the moving frost line.
- Soil freezes at a temperature of 32 degrees Fahrenheit.

Results: The total frost penetration depth is less than 6.8 inches. Therefore, the 2-foot layer of random fill will provide adequate protection to the underlying 1-foot clay layer. See Appendix A for computer modeling results.

Parameters: The computer program requires input of the following parameters for the soil cover layers:

- freezing index (degree);
- length of season (days);
- mean annual temperature (degrees Fahrenheit);
- n-factor;
- layer thickness' (inches);
- water content (percent);
- dry unit weight (lbs/cubic foot);
- heat capacity (Btu/cubic foot-deg F);
- thermal conductivity (Btu/foot-hour-deg F), and;
- latent heat of fusion (Btu/cubic foot).

Freezing Index/Length of Season/Mean Annual Temperature

Default values from Grand Junction, Colorado were used for the freezing index and length of season. Grand Junction, Colorado was used for default parameters since it is similar in elevation and climate to Blanding Utah. An actual mean annual temperature for Blanding Utah from Dames & Moore (1978) was used for modeling purposes (see Appendix B).

N-factor

A default n-factor of 0.70 for sand and gravel surface type was used as per recommended in the freeze/thaw model guidelines (Aitken and Berg, 1968).

Soil type

Soil type was considered to be fine grained soil for both cover layers. Soil type number is 5.

Layer thickness'

The thickness of the cover materials were determined by infiltration and radon flux modeling programs to be 2 feet of random fill over 1 foot of clay. For this calculation, a single 36-inch layer was used. This was used because the random fill and clay soil have very similar properties.

Moisture Content

Optimum moisture content from Chen and Associates (1987) and Advanced Terra Testing (1996) was used for the random fill and the clay (UT-1) layer respectively. This data is included in Appendix B.

Optimum moisture content:

random fill	=11.8%
clay	=13.9%

A weighted averaged moisture content of 12.5 percent was used for this analysis.

Soil Density

Soil dry density was determined from Chen and Associates (1987) for random fill and Advanced Terra Testing (1996) for clay. The maximum dry density for the random fill was measured to be 120.2 pounds per cubic foot (pcf) and the maximum dry density for the clay was measured to be 113.5 pcf. Assuming the soil will be compacted to 95 percent of the maximum density, the weighted average bulk soil density would be 112 pcf.

Heat Capacity

Based on the nomographs presented in Aitken and Berg (1968) and included herein as Figure 1, using an average soil density of 112 pcf and an average moisture content of 12.5 percent yields a heat capacity of 30 Btu/ft^3 ° F.

Thermal Conductivity

Thermal conductivity of the soil cover was assumed to be similar to that for a dry sand. The thermal conductivity of a dry sand is reported to be 0.19 Btu/ hr. ft °F (Perry, Robert H. et al., 1984) (see Table 1).

Latent Heat

Based on the nomographs presented in Aitken and Berg (1968) and included herein as Figure 1, using an average soil density of 112 pcf and an average moisture content of 12.5 percent yields a Latent Heat of 2000 Btu/ ft^3 .

References:

Advanced Terra Testing, 1996. Physical soil data, White Mesa Project, Blanding Utah, July 25, 1996.

Aitken, George W. and Berg, Richard L., 1968, "Digital Solution of Modified Berggren Equation to Calculate Depths of Freeze or Thaw in Multilayered Systems", October, 1968.

Chen and Associates, 1987. Physical soil data, White Mesa Project Blanding Utah.

Dames & Moore, 1978. "Environmental Report, White Mesa Uranium Project, San Juan County, Utah, January 20, 1978, revised May 15, 1978.

Perry, Robert H. et al., 1984. "Perry's Chemical Engineers' Handbook, Sixth Edition", McGraw Hill Book Company, 1984.

U.S. Department of Energy, 1988, "Effect of Freezing and Thawing on UMTRA Covers" Albuquerque, New Mexico, October 1988.

TABLE 1

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~~TABLE 3-320~~ **Thermal Conductivities of Some Building and Insulating Materials***

k = Btu/(h·ft²)(°F/ft)

Material	Apparent density ρ, lb./cu. ft. at room temperature	t, °C.	k
Aerogel, silica, opacified	8.5	120	0.013
		290	.026
Asbestos-cement boards	120	20	.43
Asbestos sheets	55.5	51	.096
Asbestos slate	112	0	.087
	112	60	.114
Asbestos	29.3	−200	.043
	29.3	0	.090
	36	0	.087
	36	100	.111
	36	200	.120
	36	400	.129
	43.5	−200	.090
	43.5	0	.135
Aluminum foil (7 air spaces per 2.5 in.)	0.2	38	.025
		177	.038
Ashes, wood	......	0–100	.041
Asphalt	132	20	.43
Boiler scale (Note 1)			
Bricks:			
Alumina (92–99% Al_2O_3 by wt.) fused	......	427	1.8
Alumina (64–65% Al_2O_3 by wt.)	......	1315	2.7
(See also Bricks, fire clay)	115	800	0.62
	115	1100	.63
Building brick work	......	20	.4
Carbon	96.7	....	3.0
Chrome brick (32% Cr_2O_3 by wt.)	200	200	.67
	200	650	.85
	200	1315	1.0
Diatomaceous earth, natural, across strata (Note 2)	27.7	204	0.051
	27.7	871	.077
Diatomaceous, natural, parallel to strata (Note 2)	27.7	204	.081
	27.7	871	.106
Diatomaceous earth, molded and fired (Note 2)	38	204	.14
	38	871	.18
Diatomaceous earth and clay, molded and fired (Note 2)	42.3	204	.14
	42.3	871	.19
Diatomaceous earth, high burn, large pores (Note 3)	37	200	.13
	37	1000	.34
Fire clay (Missouri)	......	200	.58
		600	.85
		1000	.95
		1400	1.02
Kaolin insulating brick (Note 3)	27	500	0.15
	27	1150	.26
Kaolin insulating firebrick (Note 4)	19	200	.050
	19	760	.113
Magnesite (86.8% MgO, 6.3% Fe_2O_3, 3% CaO, 2.6% SiO_2 by wt.)	158	204	2.2
	158	650	1.6
	158	1200	1.1
Silicon carbide brick, recrystallized (Note 3)	129	600	10.7
	129	800	9.2
	129	1000	8.0
	129	1200	7.0
	129	1400	6.3
Calcium carbonate, natural	162	30	1.3
White marble	......	....	1.7
Chalk	96	....	0.4
Calcium sulfate ($4H_2O$), artificial	84.6	40	.22
plaster (artificial)	132	75	.43
(building)	77.9	25	.25
Cambric (varnished)	......	38	.091
Carbon, gas	......	0–100	2.0
Carbon stock	94	−184	0.55
	1	0	3.6
Cardboard, corrugated	......	....	0.037
Celluloid	87.3	30	.12
Charcoal flakes	11.9	80	.043
	15	80	.051
Clinker (granular)	......	0–700	.27
Coke, petroleum	......	100	3.4
		500	2.9
Coke, petroleum (20–100 mesh)	62	400	0.55
Coke (powdered)	......	0–100	.11
Concrete (cinder)	......	....	.20
(stone)	......	....	.54
(1:4 dry)	......	....	.44

Material	Apparent density ρ, lb./cu. ft. at room temperature	t, °C.	k
Cotton wool	5	30	0.024
Cork board	10	30	.025
Cork (regranulated)	8.1	30	.026
(ground)	9.4	30	.025
Diatomaceous earth powder, coarse (Note 2)	20.0	38	.036
	20.0	871	.082
fine (Note 2)	17.2	204	.040
	17.2	871	.074
molded pipe covering (Note 2)	26.0	204	.051
	26.0	871	.088
4 vol. calcined earth and 1 vol. cement, poured and fired (Note 2)	61.8	204	.16
	61.8	871	.23
Dolomite	167	50	1.0
Ebonite	......	....	0.10
Enamel, silicate	38	....	0.5–0.75
Felt, wool	20.6	30	0.03
Fiber insulating board	14.8	21	.028
Fiber, red	80.5	20	.27
(with binder, baked)	......	20–97	.097
Gas carbon	......	0–100	2.0
Glass	......	....	0.2–0.73
Borosilicate type	139	30–75	0.63
Window glass	......	....	0.3–0.61
Soda glass	......	....	0.3–0.44
Granite	......	....	1.0–2.3
Graphite, longitudinal	......	20	95.
powdered, through 100 mesh	30	40	0.104
Gypsum (molded and dry)	78	20	.25
Hair felt (perpendicular to fibers)	17	30	.021
Ice	57.5	0	1.3
Infusorial earth, see diatomaceous earth			
Kapok	0.88	20	0.020
Lampblack	10	40	.038
Lava	......	....	.49
Leather, sole	62.4	....	.092
Limestone (15.3 vol. % H_2O)	103	24	.54
Linen	......	30	.06
Magnesia (powdered)	49.7	47	.35
Magnesia (light carbonate)	13	21	0.034
Magnesium oxide (compressed)	49.9	20	.32
Marble	......	....	1.2–1.7
Mica (perpendicular to planes)	......	50	0.25
Mill shavings	......	....	0.033–0.05
Mineral wool	9.4	30	0.0225
	19.7	30	.024
Paper	......	....	.075
Paraffin wax	......	0	.14
Petroleum coke	......	100	3.4
	......	500	2.9
Porcelain	......	200	0.88
Portland cement, see concrete	......	90	.17
Pumice stone	......	21–66	.14
Pyroxylin plastics	......	....	.075
Rubber (hard)	74.8	0	.087
(para)	......	21	.109
(soft)	......	21	0.075–0.092
Sand (dry)	94.6	20	0.19
Sandstone	140	40	1.06
Sawdust	12	21	0.03
Scale (Note 1)			
Silk	6.3	....	.026
varnished	......	38	.096
Slag, blast furnace	......	24–127	.064
Slag wool	12	30	.022
Slate	......	94	.86
Snow	34.7	0	.27
Sulfur (monoclinic)	......	100	0.09–0.097
(rhombic)	......	21	0.16
Wall board, insulating type	14.8	21	.028
Wall board, stiff paste board	43	30	.04
Wood shavings	8.8	30	.034
Wood (across grain):			
Balsa	7–8	30	0.025–0.03
Oak	51.5	15	0.12
Maple	44.7	50	.11
Pine, white	34.0	15	.087
Teak	40.0	15	.10
White fir	28.1	60	.062
Wood (parallel to grain):			
Pine	34.4	21	.20
Wool, animal	6.9	30	.021

* Marks, "Mechanical Engineers' Handbook," 4th ed., McGraw-Hill, New York, 1941. "International Critical Tables," McGraw-Hill, 1929, and other sources. For additional data, see pp. 458–459.

Note 1: B. Kamp [*Z. tech. Physik*, 12, 30 (1931)] shows the effect of increased porosity in decreasing thermal conductivity of boiler scale. Partridge [University of Michigan, *Eng. Research Bull.* 15, 1930] has published a 170-page treatise on Formation and Properties of Boiler Scale.

Note 2: Townshend and Williams, *Chem. & Met.*, 39, 219 (1932).

Note 3: Norton, "Refractories," 2d ed., McGraw-Hill, New York, 1942.

Note 4: Norton, private communication.

REF: PERRY'S CHEMICAL ENGINEERS' HANDBOOK, 1984, 6TH EDITION.

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FIGURE 1

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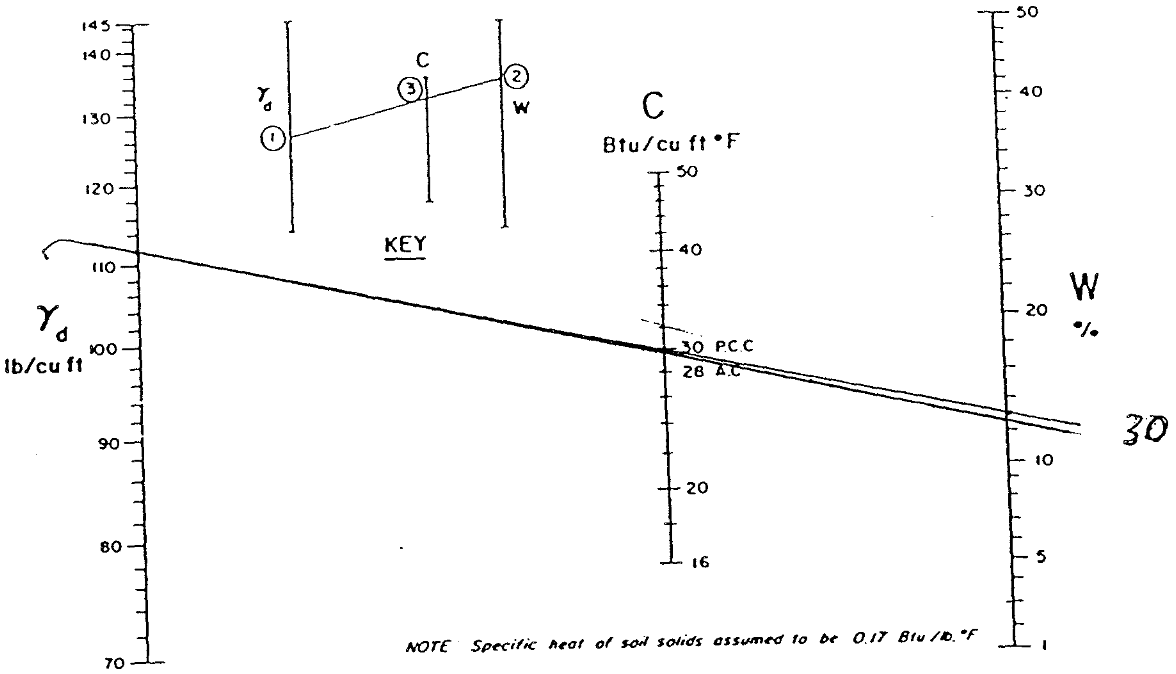

Figure 8. Average volumetric heat capacity for soils (after Aldrich and Paynter, 1953).

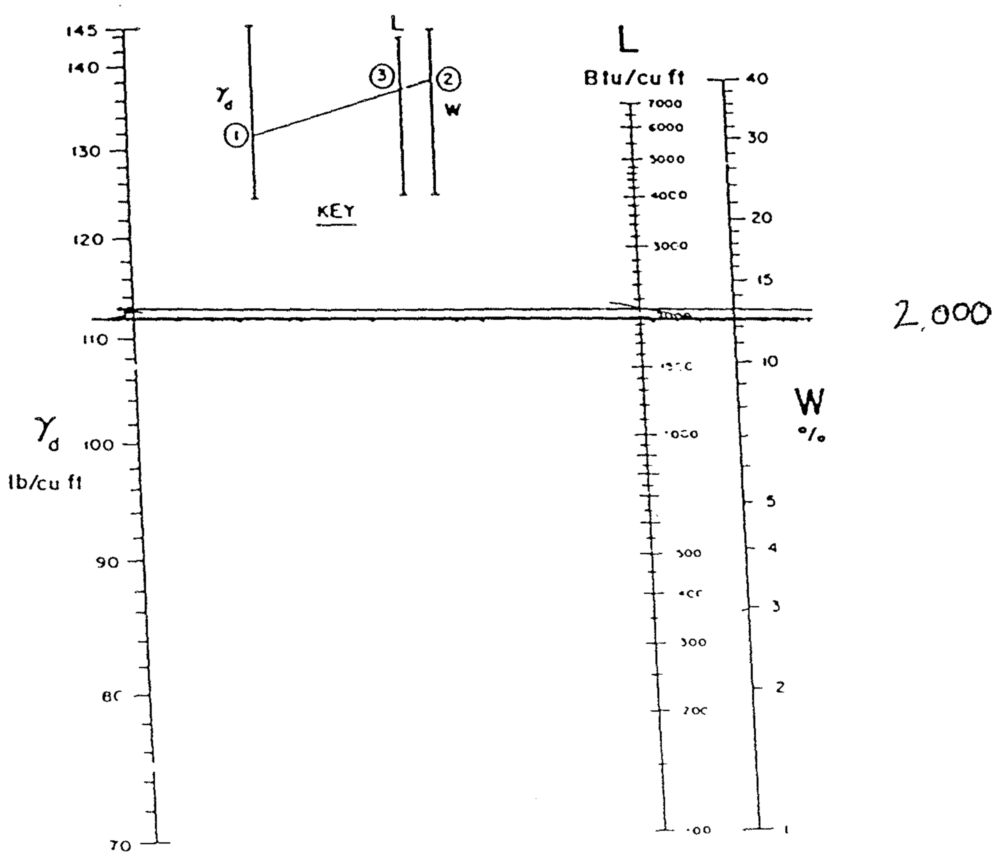

Figure 9. Volumetric latent heat for soils (after Aldrich and Paynter, 1953).

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Appendix A

WEATHER STATIONS in Colorado:

Station Location	Design Freezing Index (°F days)	Mean Annual Temp. (°F)	Length of Freezing Season (days)
1 = Alamosa	2274	41.3	159
2 = Buckley ANGB	577	50.3	88
3 = Colorado Springs	633	48.7	67
4 = Denver	629	50.3	71
5 = Grand Junction	1101	52.6	86
6 = Pueblo	676	52.3	65

Enter the number representing the data you want:
(0 to input your own data):

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LOCATION and WEATHER DATA

Input weather data for your location in Colorado:

DESIGN AIR FREEZING Index (F-Days): 1101

MEAN ANNUAL TEMPERATURE (F): 49.8

LENGTH of FREEZING SEASON (Days): 86

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CHOOSE an APPROPRIATE N-FACTOR

Surface Type	N-Factor * (Freezing)
1 = Portland Cement (snow-free)	0.75
2 = Asphalt (snow-free)	0.70
3 = Snow	1.00
4 = Sand and Gravel (snow-free)	0.70
5 = Turf (snow-free)	0.50

0 = To input your own N-Factor

Enter your option: 4

* N-Factor varies with lattitude, wind speed, cloud cover, and other climatic conditions.

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INFORMATION for LAYER 1:

Choose the appropriate soil type for this layer --

1 = Portland Cement stabilized layer
2 = Asphalt stabilized layer
3 = Snow
4 = Course-grained soil
5 = Fine-grained soil
6 = Insulating layer
7 = Organic soil

Enter your option: 5

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LAYER PARAMETERS

Parameters for LAYER 1, Fine-grained	Default Values	Values Used
Layer Thickness (inches)	12.0	36.0
Moisture Content (% dry weight)	17.0	12.5
Dry Unit Weight (lbs/cubic foot)	122.0	112.0
Heat Capacity (Btu/cubic foot °F)	* 29.5	30.0
Thermal Conductivity (Btu/foot hour °F)	* 0.90	0.19
Latent Heat of Fusion (Btu/cubic foot)	* 2016.0	2000

* recalculated based upon new MOISTURE CONTENT/WEIGHT value(s).

...<return> for Default Values...

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9/11/94

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 1101 F-days
Design Freezing Index (SURFACE) = 771 F-days
Mean Annual Temperature = 49.8 °F
Length of Freezing Season = 86 Days

LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accum	
1: Fine-grained	< 6.8	145	←	Berggren Calculations could not converge Surface DFI

------------------ End of Frost Penetration ------------------

TOTAL FROST PENETRATION = 6.8 inches

Do you want a hard copy of this data (Y or default N)?

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Appendix B

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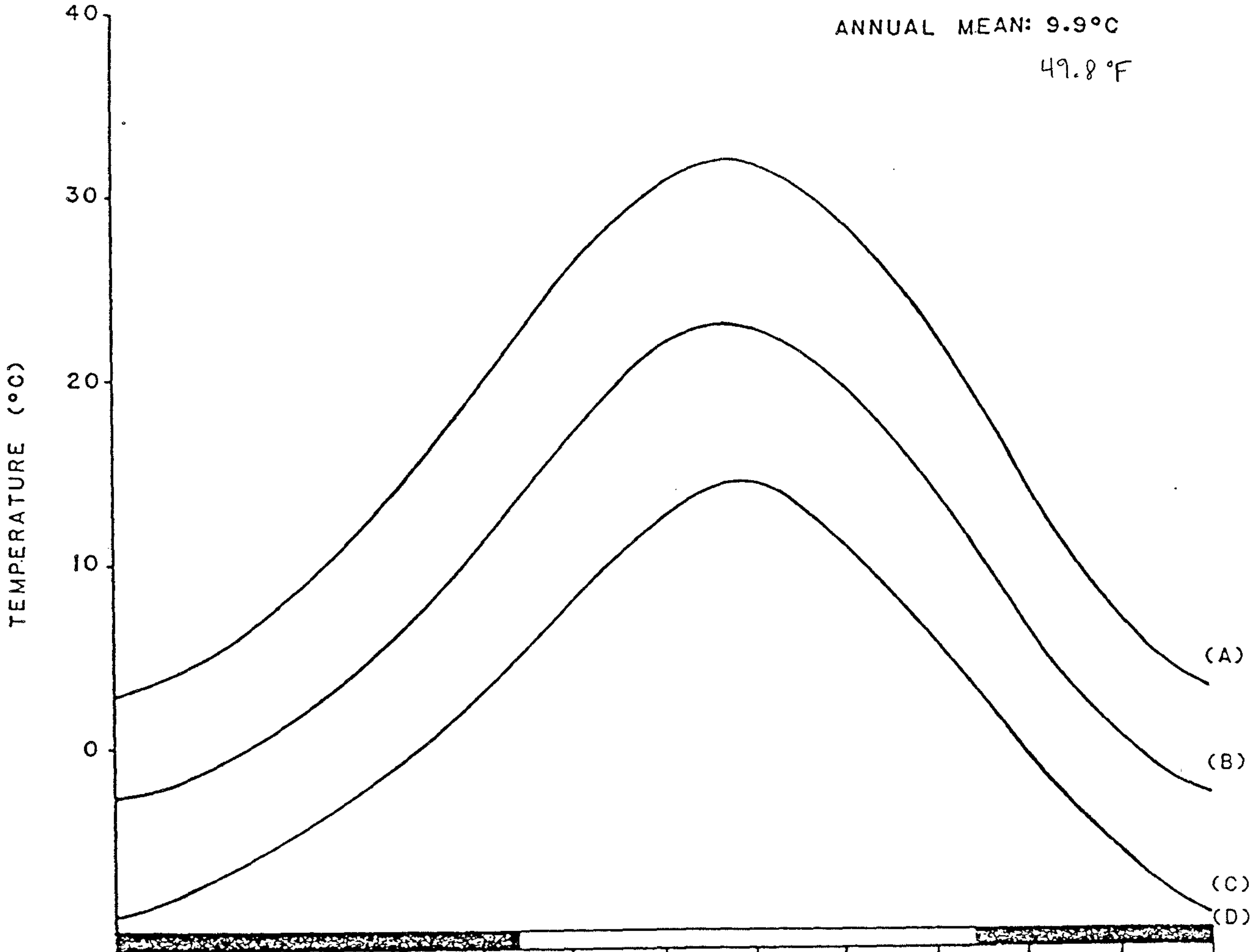
MONTHLY MEANS AND EXTREMES OF TEMPERATURES BLANDING, UTAH



MONTH	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
EXTREME MAX.	16	18	24	27	33	38	38	37	34	29	21	15
MEAN MAX.	3.8	6.9	10.9	16.3	22.8	28.7	31.9	30.2	26.0	18.8	10.2	4.5
MEAN	−2.5	0.5	3.4	8.4	14.1	19.4	23.1	21.6	17.2	10.9	3.6	−1.7
MEAN MIN.	−8.8	−5.9	−3.2	0.4	5.4	10.1	14.2	13.1	8.4	2.9	−3.2	−7.8
EXTREME MIN.	−29	−22	−15	−11	−6	−1	8	3	−5	−12	−19	−22

(A) MEAN DAILY MAXIMUM
(B) MEAN MONTHLY
(C) MEAN DAILY MINIMUM
(D) FREEZE DATES

DAMES & MOORE

TAILINGS AND RANDOM FILL PROPERTIES

Table 3.4-1

Physical Properties of Tailings

and

Proposed Cover Materials

Material Type	Atterberg Limits LL	Atterberg Limits PI	Specific Gravity	% Passing No. 200 Sieve	Maximum Dry Density (pcf)	Optimum Moisture Content
Tailings	28	6	2.85	46	104.0	18.1
Random Fill	22	7	2.67	48	120.2	11.8
Clay	29	14	2.69	56	121.3	12.1
Clay	36	19	2.75	68	108.7	18.5

Note: Physical Soil Data from Chen and Associates (1987).

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ADVANCED TERRA TESTING inc

833 Parfet Street
Lakewood, Colorado 80215
(303) 232-8308

Proctor Compaction Test

, , UT-1

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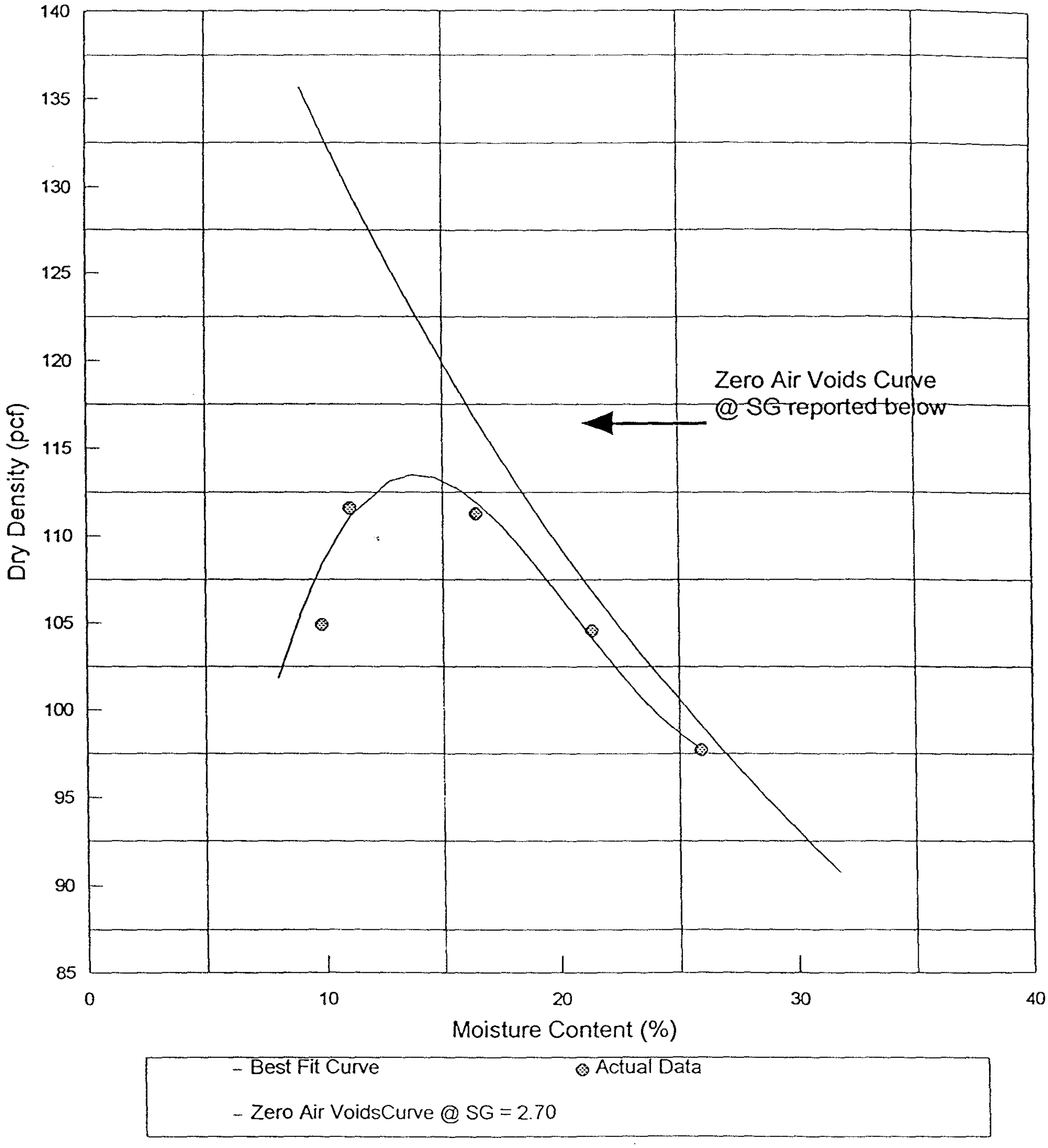

OPTIMUM MOISTURE CONTENT = 13.9 MAXIMUM DRY DENSITY = 113.5

ASTM D 1557 A, Rock correction applied? N

ADVANCED TERRA TESTING, INC.

APPENDIX F

Erosion Protection

PURPOSE:

Design of Erosion Protection layer of Riprap for the Cover of Uranium Tailings

An erosion protection layer of rock riprap is required to protect the soil cover for the uranium mill tailings at Blanding, Utah. The cover is supposed to have a design life of 1000 years according to requirements set by U.S. Nuclear Regulatory Commission [Ref: "Final Staff Technical Position - Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites", 1990; U.S. Nuclear Regulatory Commission (U.S.N.R.C.)]. Hence the erosion protection layer should be designed accordingly. A design for the stone size and overall riprap thickness required for erosion protection is provided in this document.

METHODOLOGY:

The design for rock riprap for protection of top and side slopes of the cover is based on the guidelines provided by the following documents:

a) "Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments" (NUREG/CR-4620), 1986; U.S. Nuclear Regulatory Commission

b) "Final Staff Technical Position - Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites", 1990; U.S. Nuclear Regulatory Commission (U.S.N.R.C.)

c) "Development of Riprap Design Criteria by Riprap Testing in Flumes"(NUREG/CR-4651), 1987; U.S. Nuclear Regulatory Commission

The top of the cover and the side slopes will be designed separately as the side slopes are much steeper than the top of the cover. Overland flow calculations will be determined based on the guidelines set by Nuclear Regulatory Commission and the site data. The size of the riprap placed on top of the tailings cover will be determined using the Safety Factor method (NUREG/CR-4651), while the Stephenson method (NUREG/CR-4651) will be applied for those placed along the side slopes.

A: Overland Flow Calculations

The methods for overland flow calculations are same for top and side slopes of the cover. The results have been tabulated under Table 1A and 2A respectively. The formulas, methodologies and equations used for overland flow calculations are discussed in this part of the document. The calculations are based on unit width of drainage area.

Average Slope 'S' and Length of drainage basin 'L': Figure 1 shows the direction of drainage for cells 2, 3 & 4. Table 1A calculates the flow parameters by varying slopes and slope lengths of cells 2, 3 & 4. Runoff and flow calculations have been provided for slopes ranging from 0.001 to 0.008 for cells 2 and 4 and from 0.001 to 0.005 for cell 3. As the slopes are very gentle, for each cell the drainage length varies negligibly and hence has been considered constant for calculation purpose. The drainage lengths have been measured from the site map. For erosion protection design of the side slopes, a side slope of 5H:1V and the maximum value of drainage lengths for cells 2, 3 & 4 have been considered (Table 2A).

Probable Maximum Precipitation (PMP): The 1-hour local storm PMP for White Mesa is 7.76 inches (data from NOAA, 1977).

Time of Concentration of Rainfall, T_c:

$$T_c = 0.00013\frac{L^{0.77}}{S^{0.385}}\text{hours} = 0.00013\frac{L^{0.77}}{S^{0.385}} \times 60\,\text{mins}$$ (Ref: Equation 4.44 in NUREG/CR-4620)

where, S = average slope of drainage basin and L = length of drainage basin in feet
The percentage of 1-hour precipitation is obtained by interpolating from Table 2.1 of NUREG/CR-4620. The minimum value of T_c used in this table is 2.5 minutes.

% PMP: The percentage for 1-hour precipitation (PMP) is obtained by interpolating from table 2.1 of NUREG/CR-4620.

Rainfall Depth:
Precipitation Amount (inches) = % PMP × PMP = % of 1-hour precipitation × PMP (Ref: Eqn. 2.1, NUREG/CR-4620).

Precipitation intensity, 'i':
Precipitation intensity in inches/hour can be computed as (Ref: Eqn. 2.2, NUREG/CR-4620):
i = rainfall depth (inches) × [60 / {rainfall duration T_c (minute)}]

Runoff Coefficient, C: Runoff coefficient depends on climatic conditions, the type of terrain, permeability, and storage potential of the basin. Runoff Coefficient has been assumed to be 0.8 for the top of cover and the side slopes (Ref: Appendix D, section 2.4 (Example) in "Final Staff Technical Position", U.S.N.R.C.).

Unit Area, A: Area of 1-ft wide drainage basin
A = Length of drainage basin (ft.) × width (ft.) = L × 1 sq. ft. = [L×1/(43560)] Acres

Peak discharge per unit width for the drainage basin, q:
By Rational method, q = CiA, where C, i & A have their usual meanings [q in cu. ft./sec (cfs), i in inches/hour and A in acres] (Ref: Eqns. 4.42 and 4.43, NUREG/CR-4620).

Flow Concentration Factor:
From section 4.9 of NUREG/CR-4620, "...it is reasonable to assume that values between 2 and 3 are attainable with only a slight evolutionary change in cover." Thus, a flow concentration factor of 3 and 2 have been assumed for top and side slopes respectively (as the top of cover is flatter than the side slopes, it has been assumed that concentration of flow will be higher on the top than along the side slopes).

Concentrated discharge per unit width for the drainage basin, q_c:
q_c (cu. ft./sec) = q × flow concentration factor

Manning's Roughness coefficient, n:
Assumed n = 0.03 for graded loam to cobbles (Ref: table 4.2, NUREG/CR-4620)

Depth of water, D:

Depth of water in ft., $D = \left[\frac{q_c \times n}{1.486\sqrt{S}}\right]^{\frac{3}{5}}$ (Ref: Eqn. 4.46, NUREG/CR-4620), where q_c is in cu. ft./sec

Permissible Velocity:
The cover permissible velocity is between 5 to 6 ft./sec (Ref: section 4.11.3, NUREG/CR-4620)

Flow Velocity, V:
Using continuity equation,
discharge = velocity × cross-sectional area

$$\therefore q_c = V \times (D \times \text{unit width}) = V \times D \times 1$$

$$\therefore V(\text{in ft./sec}) = \frac{q_c}{D \times 1}$$

For all the calculations provided in Table 1A and 2A for top of cover and side slopes respectively, $V_{developed} < V_{permissible}$

B: Calculation for Preliminary Size (D_{50}) of Rock Riprap used for Erosion Protection

B.1 Preliminary Size (D_{50}) of Riprap along Top of Cover

According to recommendations by U.S.N.R.C. [Ref: Appendix D, section 2.2 (step 5), "Final Staff Technical Position"], recent studies have indicated that Safety Factor method is more applicable for designing rock for slopes less than 10%. The slopes along top of the cover for all the cells 2, 3 and 4 do not exceed 10%. Hence the Safety Factor method has been adopted to calculate the median diameter D_{50} of the rock particles used for riprap.

According to the Safety Factor method for determination of stone size, if the Safety Factor (S.F.) is greater than unity, the riprap is considered to be safe from failure (Ref: Section 3.4.1,"Development of Riprap Design Criteria by Riprap Testing in Flumes", NUREG/CR-4651). For calculations to determine the riprap size for top of cover, a safety factor of 1.1 has been assumed and the D_{50} corresponding to this safety factor has been computed. Table 1B tabulates the results for the safety factor method.

The equations 3.5 through 3.9 of NUREG/CR-4651 (see appendix) for Safety Factor method are provided below :

$$SF = \frac{\cos\theta \tan\phi}{\eta' \tan\phi + \sin\theta \cos\beta}$$ ....eqn. A_1 (eqn. 3.5 of NUREG/CR-4651)

$$\eta' = \eta\left[\frac{1+\sin(\lambda+\beta)}{2}\right]$$ ....eqn. B_1 (eqn. 3.6 of NUREG/CR-4651)

$$\eta = \frac{21\tau_0}{(G_s-1)\gamma_w \times D_{50}}$$ ....eqn. C_1 (eqn. 3.7 of NUREG/CR-4651)

$$\tau_0 = \gamma_w DS$$ ....eqn. D_1 (eqn. 3.8 of NUREG/CR-4651)

$$\beta = \tan^{-1}\left[\frac{\cos\lambda}{\frac{2\sin\theta}{\eta\tan\phi} + \sin\lambda}\right]$$ ....eqn. E_1 (eqn 3.9 of NUREG/CR-4651)

where,

- λ = angle between a horizontal line and the velocity vector compoment measured in the plane of side slope (refer to fig. 3.1of NUREG/CR-4651)
- θ = side slope angle
- S = side slope = tan θ
- ϕ = angle of repose (friction angle) of rock

τ_0 = bed shear stress
D_{50} = representative stone size
G_s = Specific gravity or relative density of the rock
D = depth of flow
γ_w = specific weight of the liquid (in this case, water)
η & η' = stability numbers
β = angle between vector component of the weight, Ws, directed down the side slope and the direction of particle movement

For top of the cover, as slopes are very gentle, for all practical purposes, λ can be considered to be equal to zero (Ref: pg 22, NUREG/CR-4651)

Thus for $\lambda = 0$: $\cos\lambda = 1$, $\sin\lambda = 0$.

Hence, equation 3.9 of NUREG/CR-4651 can be reduced to

$$\beta = \tan^{-1}\left[\frac{\eta\tan\phi}{2\sin\theta}\right] \text{.......eqn } E_2 \text{ (eqn 3.10 of NUREG/CR-4651)}$$

Also, equation 3.6 of NUREG/CR-4651 can be reduced to

$$\eta' = \eta\left[\frac{1+\sin\beta}{2}\right] \text{.......eqn. } B_2$$

ϕ = 40° (see Table 3)
G_s = 2.48 (see Table 3)
γ_w = 62.4 lb./ft^3

The values for depth of water 'D' have been computed in Table 1A. Table 1B provides the preliminary D_{50} size for each of cells 2, 3 & 4 by varying the slope and the length of the drainage basin.

D_{50} calculated by CSU method

According to CSU method (Ref: NUREG/CR-4651, Phase-II),

$D_{50} = 5.23 \times (\text{slope})^{0.43} \times (\text{discharge})^{0.56}$

The results of D_{50} computed by CSU method have been included in table 1B (values of discharge have been computed in table 1A to compare with those obtained by Safety Factor method.

B.2 Preliminary Size (D_{50}) of Riprap along Side Slopes

According to recommendations by U.S.N.R.C. (Ref: Appendix D, section 2.2 (step 5), "Final Staff Technical Position"), recent studies have indicated that Stephenson method is more applicable for designing rock for slopes less than 10%. As the side slopes (5H:1V) have a value of S = 1/5 = 0.2 = 20%(>10%), the Stephenson method (Ref: "Development of Riprap Design Criteria by Riprap Testing in Flumes", NUREG/ CR-4651) will be most appropriate.

By **Stephenson method**, the median size for rock, D_{50} is given by the following equation (Ref: eqn. 3.15, NUREG/CR-4651):

$$D_{50} = \left[\frac{q_c (\tan\theta)^{\frac{7}{6}} \times n_p^{\frac{1}{6}}}{C\sqrt{g} \times [(1-n_p)(G_s-1)(\cos\theta)(\tan\phi - \tan\theta)]^{\frac{5}{3}}} \right]^{\frac{2}{3}}$$

where, q_c = Concentrated discharge in cu. ft./sec
θ = Slope angle = $\tan^{-1}$ (S) = $\tan^{-1}$ (0.2) = 11.31°
ϕ = Friction angle of the rock = 40° (see Table 3)
G_s = Relative Density of the rock = 2.48 (see Table 3)
g = Acceleration due to gravity = 32.2 ft./sec^2
n_p = Porosity of the rock = 0.30 (for sandstone) [Ref: (a) "Origin of Sedimentary Rocks" and (b) Table 3
C = Empirical factor [0.22 for gravel/pebble and 0.27 for crushed granite]
Also, K = Oliver's constant [1.2 for gravel and 1.8 for crushed rock]

The results for q_c from table 2A have been substituted into the above equation and the solution tabulated in table 2B. The value of D_{50} has been multiplied by the Oliver's constant K to insure stability.

D_{50} calculated by CSU method

According to CSU method (Ref: NUREG/CR-4651, Phase-II),

$D_{50} = 5.23 \times (\text{slope})^{0.43} \times (\text{discharge})^{0.56}$

The results of D_{50} computed by CSU method have been included in table 2B to compare with those obtained by Stephenson method.

C: Oversizing of Riprap based on durability and Overall Riprap Thickness

C.1 Modification of Size (D_{50}) of Riprap based on Durability

Tables 3 and 4 include the properties of the rock to be used as protective cover material. Based on these values and according to the scoring criteria set by U.S.N.R.C. (Ref: Appendix D, sections 6.2, 6.2.1,6.2.2 and table D-1 in "Final Staff Technical Position"), a rock rating analysis has been provided in Table 4. The results show a rock rating of 55.74%, which according to U.S.N.R.C. can be used for non critical areas like top slopes and side slopes.

Thus the oversizing required = 80-55.74 = 24.26%
[ref: (a) Appendix D, section 6.2.2B, "Final Staff Technical Position"; U.S.N.R.C. (oversizing required based on a 80-rating), (b) Appendix D, section 6.4 (example), "Final Staff Technical Position" and (c) Table 4.
However a oversizing factor of 25 % has been used. Thus the nominal diameter D_{50} obtained in tables 1B and 2B has been multiplied with 1.25 to obtain a modified rock size D_{50} (tables 1C and 2C).

C.2 Overall Riprap Thickness

According to the Safety Factor method, it is recommended that the riprap thickness be at least 1.5 times the D_{50} value whereas according to the Stephenson method the riprap thickness should be at least 2 times the D_{50} value. The results based on the above recommendations are shown in tables 1C and 2C respectively.

RESULTS:

Results of the calculations have been tabulated under tables 1A, 1B, 1C, 2A, 2B, 2C respectively.

REFERENCE:

a) "Final Staff Technical Position - Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites", 1990; U.S. Nuclear Regulatory Commission (U.S.N.R.C.)

b) Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments" (NUREG/CR-4620), 1986; U.S. Nuclear Regulatory Commission

c) "Development of Riprap Design Criteria by Riprap Testing in Flumes" (NUREG/CR-4651), 1987; U.S. Nuclear Regulatory Commission

d) National Oceanic and Atmospheric Administration (NOAA), 1977. Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages. Hydrometeorological Report (HMR) No. 49.

e) "Origin of Sedimentary Rocks", second edition; Harvey Blatt, Gerard Middleton and Raymond Murray

TABLES

TITAN ENVIRONMENTAL

Project #: 6111-001
Client: EFN, White Mesa
Location: Blanding, Utah

Date: June 1996
Prepared by: KG
Checked by:

Overland Flow Calculations for Top Portion of the Cover

Table 1A: Calculation for Runoff and Flow parameters

Cell No.	Maximum Length "L" of Drainage Basin (appx.)	Average Slope "S"	Drainage Area per ft. run A = L x 1 ft.		Manning's Roughness Coefficient n	1-hour precipitation amount	Design Storm	Time of Concentration, Tc: Calculated value (using Eqn.4.44, NUREG 4620)	Time of Concentration, Tc: Minimum value, based on table 2.1, NUREG 4620	Time of Concentration, Tc: Value used	%PMP = % of 1-hour precipitation (Table 2.1, NUREG 4620)	Rainfall Depth	Precipitation Intensity "I"	Runoff Coefficient "C"	Flow Concentration Factor	Peak Discharge per unit ft. width q = CIA	Concentrated Discharge per unit ft. width q_c	Depth of water, "D" (eqn. 4.46, NUREG 4620)	Flow Velocity, V = Discharge / c.s. Area	Permissible Velocity
	ft.	ft./ft.	sq. ft.	Acres		inches		minutes	minutes	minutes		inches	inches/hr.			cu.ft./sec.	cu.ft./sec.	ft.	ft./sec.	ft./sec.
	1350	0.0080	1350	0.0310	0.03	7.76	PMP	12.88	2.5	12.88	68.90	5.35	24.92	0.8	3	0.62	1.85	0.593	3.13	
	1350	0.0072	1350	0.0310	0.03	7.76	PMP	13.41	2.5	13.41	70.18	5.45	24.37	0.8	3	0.60	1.81	0.604	3.00	
2	1350	0.0070	1350	0.0310	0.03	7.76	PMP	13.55	2.5	13.55	70.53	5.47	24.23	0.8	3	0.60	1.80	0.607	2.97	
	1350	0.0060	1350	0.0310	0.03	7.76	PMP	14.38	2.5	14.38	72.52	5.63	23.48	0.8	3	0.58	1.75	0.624	2.80	
	1350	0.0050	1350	0.0310	0.03	7.76	PMP	15.43	2.5	15.43	74.69	5.80	22.54	0.8	3	0.56	1.68	0.643	2.61	
	1350	0.0040	1350	0.0310	0.03	7.76	PMP	16.81	2.5	16.81	76.90	5.97	21.30	0.8	3	0.53	1.58	0.664	2.38	
	1350	0.0030	1350	0.0310	0.03	7.76	PMP	18.78	2.5	18.78	80.05	6.21	19.84	0.8	3	0.49	1.48	0.694	2.13	
	1350	0.0020	1350	0.0310	0.03	7.76	PMP	21.96	2.5	21.96	83.37	6.47	17.68	0.8	3	0.44	1.31	0.731	1.80	
	1350	0.0010	1350	0.0310	0.03	7.76	PMP	28.67	2.5	28.67	88.07	6.83	14.30	0.8	3	0.35	1.06	0.793	1.34	
	1100	0.0050	1100	0.0253	0.03	7.76	PMP	13.18	2.5	13.18	69.63	5.40	24.60	0.8	3	0.50	1.49	0.599	2.49	
	1100	0.0040	1100	0.0253	0.03	7.76	PMP	14.36	2.5	14.36	72.47	5.62	23.49	0.8	3	0.47	1.42	0.623	2.29	5 - 6
3	1100	0.0030	1100	0.0253	0.03	7.76	PMP	16.04	2.5	16.04	75.67	5.87	21.96	0.8	3	0.44	1.33	0.652	2.04	
	1100	0.0020	1100	0.0253	0.03	7.76	PMP	18.75	2.5	18.75	80.00	6.21	19.86	0.8	3	0.40	1.20	0.694	1.74	
	1100	0.0013	1100	0.0253	0.03	7.76	PMP	22.14	2.5	22.14	83.50	6.48	17.56	0.8	3	0.35	1.06	0.733	1.45	
	1100	0.0010	1100	0.0253	0.03	7.76	PMP	24.49	2.5	24.49	85.14	6.61	16.19	0.8	3	0.33	0.98	0.755	1.30	
	1250	0.0080	1250	0.0287	0.03	7.76	PMP	12.13	2.5	12.13	67.12	5.21	25.75	0.8	3	0.59	1.77	0.577	3.07	
	1250	0.0070	1250	0.0287	0.03	7.76	PMP	12.77	2.5	12.77	68.66	5.33	25.02	0.8	3	0.57	1.72	0.591	2.92	
4	1250	0.0060	1250	0.0287	0.03	7.76	PMP	13.56	2.5	13.56	70.53	5.47	24.23	0.8	3	0.56	1.67	0.607	2.75	
	1250	0.0057	1250	0.0287	0.03	7.76	PMP	13.83	2.5	13.83	71.18	5.52	23.97	0.8	3	0.55	1.65	0.612	2.70	
	1250	0.0050	1250	0.0287	0.03	7.76	PMP	14.54	2.5	14.54	72.90	5.66	23.34	0.8	3	0.54	1.61	0.627	2.57	
	1250	0.0040	1250	0.0287	0.03	7.76	PMP	15.85	2.5	15.85	75.35	5.85	22.14	0.8	3	0.51	1.52	0.649	2.35	
	1250	0.0030	1250	0.0287	0.03	7.76	PMP	17.70	2.5	17.70	78.32	6.08	20.60	0.8	3	0.47	1.42	0.678	2.09	
	1250	0.0020	1250	0.0287	0.03	7.76	PMP	20.69	2.5	20.69	82.48	6.40	18.56	0.8	3	0.43	1.28	0.719	1.78	
	1250	0.0010	1250	0.0287	0.03	7.76	PMP	27.02	2.5	27.02	86.92	6.74	14.98	0.8	3	0.34	1.03	0.778	1.33	

Rainfall Duration (min.)	% of 1-hr. precipitation
2.5	27.5
5	45
10	62
15	74
20	82
30	89
45	95
60	100

Table 2.1 of NUREG 4620

WMARMOR2.XLS

TITAN ENVIRONMENTAL

Project #: 6111-001
Client: EFN, White Mesa
Location: Blanding, Utah

Date: June 1996
Prepared by: KG
Checked by:

Riprap Design for Top portion of the Cover

Table 1B: Calculation for preliminary sizing of riprap, D50

Cell No.	Slope of Channel S	Slope of Channel θ	Depth of flow, D	Specific Weight of water γ_w	Bed Shear Stress $\tau_0 = \gamma_w DS$	Rock Specific Gravity G_s	Angle of friction ϕ	λ	cos θ	sin θ	cos λ	sin λ	tan φ	D_{50} by Safety Factor method	D_{50} by Safety Factor method	η	tan β	β	cos β	η'	Safety Factor	D_{50} by CSU method
	ft./ft.	degrees	ft.	lb./cu. ft.	lb./sq. ft.		degrees	degrees						inches	ft.			degrees				inches
2	0.0080	0.458	0.593	62.4	0.296	2.48	40	0	1.000	0.008	1.000	0.000	0.839	0.89	0.074	0.907	47.582	88.796	0.021	0.907	1.10	0.93
	0.0072	0.413	0.604	62.4	0.271	2.48	40	0	1.000	0.007	1.000	0.000	0.839	0.82	0.068	0.908	52.920	88.917	0.019	0.908	1.10	0.87
	0.0070	0.401	0.607	62.4	0.266	2.48	40	0	1.000	0.007	1.000	0.000	0.839	0.80	0.066	0.910	54.520	88.949	0.018	0.910	1.10	0.86
	0.0060	0.344	0.624	62.4	0.233	2.48	40	0	1.000	0.006	1.000	0.000	0.839	0.70	0.058	0.910	63.634	89.100	0.016	0.910	1.10	0.79
	0.0050	0.286	0.643	62.4	0.201	2.48	40	0	1.000	0.005	1.000	0.000	0.839	0.60	0.050	0.912	76.519	89.251	0.013	0.912	1.10	0.72
	0.0040	0.229	0.664	62.4	0.166	2.48	40	0	1.000	0.004	1.000	0.000	0.839	0.50	0.041	0.912	95.661	89.401	0.010	0.912	1.10	0.63
	0.0030	0.172	0.694	62.4	0.130	2.48	40	0	1.000	0.003	1.000	0.000	0.839	0.39	0.033	0.909	127.126	89.549	0.008	0.909	1.10	0.53
	0.0020	0.115	0.731	62.4	0.091	2.48	40	0	1.000	0.002	1.000	0.000	0.839	0.28	0.023	0.906	189.975	89.698	0.005	0.906	1.10	0.42
	0.0010	0.057	0.793	62.4	0.049	2.48	40	0	1.000	0.001	1.000	0.000	0.839	0.15	0.012	0.912	382.675	89.850	0.003	0.912	1.10	0.28
3	0.0050	0.286	0.599	62.4	0.187	2.48	40	0	1.000	0.005	1.000	0.000	0.839	0.56	0.047	0.911	76.416	89.250	0.013	0.911	1.10	0.67
	0.0040	0.229	0.623	62.4	0.156	2.48	40	0	1.000	0.004	1.000	0.000	0.839	0.47	0.039	0.913	95.721	89.401	0.010	0.913	1.10	0.59
	0.0030	0.172	0.652	62.4	0.122	2.48	40	0	1.000	0.003	1.000	0.000	0.839	0.37	0.030	0.913	127.661	89.551	0.008	0.913	1.10	0.50
	0.0020	0.116	0.694	62.4	0.087	2.48	40	0	1.000	0.002	1.000	0.000	0.839	0.26	0.022	0.908	190.567	89.699	0.005	0.908	1.10	0.40
	0.0013	0.074	0.733	62.4	0.059	2.48	40	0	1.000	0.001	1.000	0.000	0.839	0.18	0.015	0.912	294.196	89.805	0.003	0.912	1.10	0.31
	0.0010	0.057	0.755	62.4	0.047	2.48	40	0	1.000	0.001	1.000	0.000	0.839	0.14	0.012	0.906	379.944	89.849	0.003	0.906	1.10	0.27
4	0.0080	0.458	0.577	62.4	0.288	2.48	40	0	1.000	0.008	1.000	0.000	0.839	0.87	0.072	0.909	47.686	88.799	0.021	0.909	1.10	0.90
	0.0070	0.401	0.591	62.4	0.258	2.48	40	0	1.000	0.007	1.000	0.000	0.839	0.78	0.065	0.908	54.460	88.948	0.018	0.908	1.10	0.84
	0.0060	0.344	0.607	62.4	0.227	2.48	40	0	1.000	0.006	1.000	0.000	0.839	0.68	0.057	0.912	63.742	89.101	0.016	0.912	1.10	0.77
	0.0057	0.327	0.612	62.4	0.218	2.48	40	0	1.000	0.006	1.000	0.000	0.839	0.66	0.055	0.907	66.776	89.142	0.015	0.907	1.10	0.75
	0.0050	0.286	0.627	62.4	0.196	2.48	40	0	1.000	0.005	1.000	0.000	0.839	0.59	0.049	0.912	76.531	89.251	0.013	0.912	1.10	0.70
	0.0040	0.229	0.649	62.4	0.162	2.48	40	0	1.000	0.004	1.000	0.000	0.839	0.49	0.040	0.912	95.624	89.401	0.010	0.912	1.10	0.62
	0.0030	0.172	0.678	62.4	0.127	2.48	40	0	1.000	0.003	1.000	0.000	0.839	0.38	0.032	0.911	127.413	89.550	0.008	0.911	1.10	0.52
	0.0020	0.115	0.719	62.4	0.090	2.48	40	0	1.000	0.002	1.000	0.000	0.839	0.27	0.023	0.907	190.227	89.699	0.005	0.907	1.10	0.41
	0.0010	0.057	0.778	62.4	0.048	2.48	40	0	1.000	0.001	1.000	0.000	0.839	0.15	0.012	0.908	380.792	89.850	0.003	0.908	1.10	0.27

Table 1C: Diameter of Riprap modified based on durability, and Overall Riprap Thickness

Cell No.	Slope of channel S	D_{50} based on Safety Factor Method	Oversizing Factor based on Rock Quality (from previous report)	Modified D_{50} after oversizing	Thicknes of Riprap layer =1.5xD_{50}	Overall Riprap Thickness suggested
	ft./ft.	inches		inches	inches	inches
2	0.0080	0.89	1.25	1.11	1.67	
	0.0072	0.82	1.25	1.02	1.53	
	0.0070	0.80	1.25	0.99	1.49	
	0.0060	0.70	1.25	0.88	1.31	
	0.0050	0.60	1.25	0.75	1.13	
	0.0040	0.50	1.25	0.62	0.93	
	0.0030	0.39	1.25	0.49	0.73	
	0.0020	0.28	1.25	0.34	0.52	
	0.0010	0.15	1.25	0.19	0.28	
3	0.0050	0.56	1.25	0.70	1.05	3
	0.0040	0.47	1.25	0.58	0.87	
	0.0030	0.37	1.25	0.46	0.68	
	0.0020	0.26	1.25	0.33	0.49	
	0.0013	0.18	1.25	0.22	0.33	
	0.0010	0.14	1.25	0.18	0.27	
4	0.0080	0.87	1.25	1.08	1.62	
	0.0070	0.78	1.25	0.97	1.45	
	0.0060	0.68	1.25	0.85	1.28	
	0.0057	0.66	1.25	0.82	1.23	
	0.0050	0.59	1.25	0.73	1.10	
	0.0040	0.49	1.25	0.61	0.91	
	0.0030	0.38	1.25	0.48	0.71	
	0.0020	0.27	1.25	0.34	0.51	
	0.0010	0.15	1.25	0.18	0.27	

TITAN ENVIRONMENTAL

Project #: 6111-001
Client: EFN, White Mesa
Location: Blanding, Utah

Date: June 1996
Prepared by: KG
Checked by:

Overland Flow Calculations for Side Slopes of the Cover

Table 2A: Calculation for Runoff and Flow parameters

Maximum Length, "L" of Drainage Basin (appx)	Average Slope "S"	Drainage Area per ft. run A = L x 1 ft.		Manning's Roughness Coefficient n	1-hour precipitation amount	Design storm	Time of Concentration,Tc			% PMP % of 1-hour precipitation (Table 2.1, NUREG 4620	Precipitation Amount	Precipitation intensity "i"	Runoff Coefficient "C"	Flow Concentra-tion Factor	Peak Discharge per unit ft. width q = CiA	Concentrated Discharge per unit ft. width q_c	Depth of water, "D" (eqn. 4.46, NUREG 4620)	Flow Velocity,V = Discharge / c.s. Area	Permissible Velocity (sec. 4.11.3 of (NUREG 4620)
							Calculated value (using Eqn.4.44, NUREG 4620)	Minimum value based on table 2.1, NUREG 4620	Value used										
ft.	ft./ft.	sq. ft.	Acres		inches		minutes	minutes	minutes		inches	inches/hr.			cu.ft./sec.	cu.ft./sec.	ft.	ft./sec.	ft./sec.
275	0.2000	275	0.0063	0.03	7.76	PMP	1.10	2.5	2.5	27.5	2.13	51.22	0.8	2	0.26	0.52	0.105	4.93	5 - 6

Rainfall Duration (min.)	% of 1-hr. precipitation
2.5	27.5
5	45
10	62
15	74
20	82
30	89
45	95
60	100

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TITAN ENVIRONMENTAL

Project #: 6111-001
Client: EFN, White Mesa
Location: Blanding, Utah

Date: June 1996
Prepared by: KG
Checked by:

Riprap Design for Side Slopes of the Cover

Table 2B: Calculation for preliminary sizing of riprap, D_{50}

Slope of Channel S (ft./ft.)	Slope of Channel θ (degrees)	Angle of friction for rock ϕ (degrees)	Concentrated discharge per unit ft. width, q_c (cu. ft./sec)	Relative density of Rock G_s	Porosity n_p	Type of Riprap	Stephenson Constant C	tan θ	cos θ	tan ϕ	D_{50} by Stephenson Method (Eqn. 4.28 of NUREG 4620) (ft.)	D_{50} by Stephenson Method (inches)	Oliver's Constant K	Modified D_{50} (inches)	D_{50} based on CSU method (ft.)
0.200	11.310	40	0.52	2.48	0.3	gravel/pebbles	0.22	0.200	0.981	0.839	0.22	2.70	1.2	3.235	1.81
0.200	11.310	40	0.52	2.48	0.3	crushed granite	0.27	0.200	0.981	0.839	0.20	2.35	1.8	4.234	1.81

Table 2C: Diameter of Riprap modified based on durability, and Overall Riprap Thickness

Slope of channel S (ft./ft.)	D_{50} based on Stephenson Method (inches)	Oversizing Factor based on Rock Quality (from previous report)	Modified D_{50} after oversizing (inches)	Thickness of Riprap layer = 2 x D_{50} (inches)	Overall Riprap Thickness suggested (inches)	Type of Riprap
0.200	3.235	1.25	4.04	8.09	12	gravel/pebbles
0.200	4.234	1.25	5.29	10.58	12	crushed granite

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TABLE 3

WHITE MESA CHANNEL A ROCK APRON — WITH 24% OVERSIZE

RIPRAP SIZING – STEPHENSON'S METHOD

	ENTER		WITH 24% OVERSIZE
UNIT FLOW RATE "q"	4.27	CFS/FT	
ROCKFILL POROSITY – n	0.3		
SLOPE ANGLE	11.3	DEGREES	
FRICTION ANGLE	40	DEGREES	
SPECIFIC GRAVITY OF ROCK	2.48		
D–100 (BASED ON 1.25xD50)	12.00	INCHES	14.88"
D–50	9.60	INCHES	12.6"

WHITE MESA CHANNEL B ROCK APRON

RIPRAP SIZING – STEPHENSON'S METHOD

	ENTER		
UNIT FLOW RATE "q"	3.26	CFS/FT	
ROCKFILL POROSITY – n	0.3		
SLOPE ANGLE	11.3	DEGREES	
FRICTION ANGLE	40	DEGREES	
SPECIFIC GRAVITY OF ROCK	2.48		
D–100 (BASED ON 1.5xD50)	12.03	INCHES	14.9"
D–50	8.02	INCHES	9.94"

TABLE 4

<u>NRC SCORING CRITERIA FOR DETERMINING ROCK QUALITY</u>

WHITE MESA ROCK PROTECTION

ROCK TYPE: 2

Limestone = 1
Sandstone = 2
Igneous = 3

LABORATORY TEST	TEST RESULT	SCORE	WEIGHT	SCORE * WEIGHT	MAX. SCORE
Specific Gravity	2.48	4.60	6	27.60	60.00
Absorption, %	1.75	3.50	5	17.50	50.00
Sodium Sulfate, %	0.60	10.00	3	30.00	30.00
L/A Abrasion (100 revs), %	8.40	5.94	8	47.53	80.00
Schmidt Hammer	0.00	0.00	13	0.00	0.00
Tensile Strength, psi	0.00	0.00	4	0.00	0.00

ROCK RATING, % 55.74

RATING ANALYSIS:

Critical Areas– REJECTED
Oversizing, % =

Non–Critical Areas– OVERSIZING REQUIRED
Oversizing, % = 24

FIGURE

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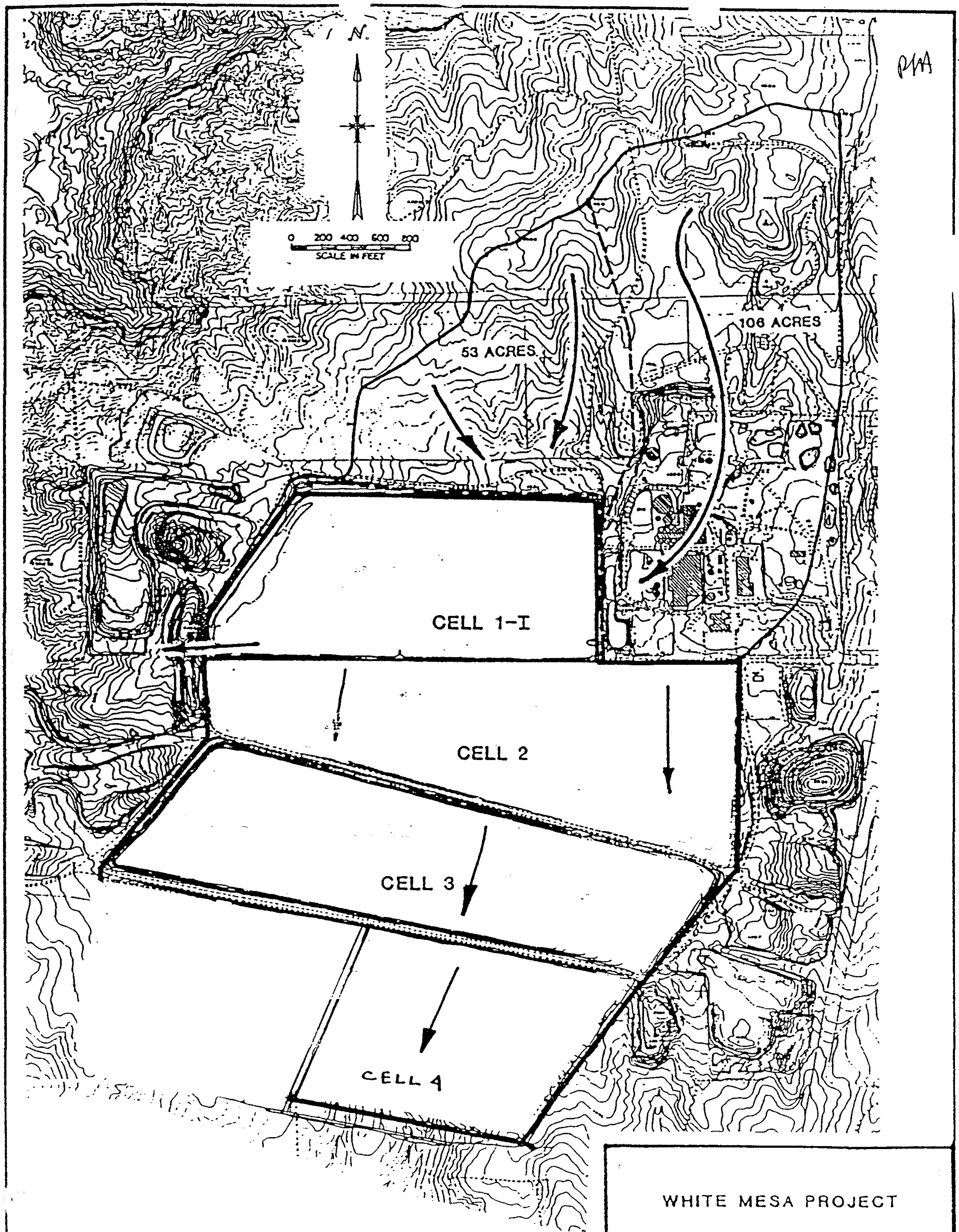

WHITE MESA PROJECT

SITE DRAINAGE

FIGURE: 1

APPENDIX

FINAL

STAFF TECHNICAL POSITION

DESIGN OF EROSION PROTECTION COVERS FOR STABILIZATION OF URANIUM MILL TAILINGS SITES

U. S. Nuclear Regulatory Commission

August 1990

FINAL
STAFF TECHNICAL POSITION
DESIGN OF EROSION PROTECTION COVERS FOR
STABILIZATION OF URANIUM MILL TAILINGS SITES

1. INTRODUCTION

Criteria and standards for environmental protection may be found in the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 (PL 95-604) (see Ref. 1) and 10 CFR Section 20.106, "Radioactivity in Effluents to Unrestricted Areas." In 1983, the U. S. Environmental Protection Agency (EPA) established standards (40 CFR Part 192) for the final stabilization of uranium mill tailings for inactive (Title I) and active (Title II) sites. In 1980, the United States Nuclear Regulatory Commission (NRC) promulgated regulations (10 CFR Part 40, Appendix A) for active sites and later revised Appendix A to conform to the standards in 40 CFR Part 192. These standards and regulations establish the criteria to be met in providing long-term stabilization.

These regulations also prescribe criteria for control of tailings. For the purpose of this staff technical position (STP), control of tailings is defined as providing an adequate cover to protect against exposure or erosion of the tailings. To help licensees and applicants meet Federal guidelines, this STP describes design practices the NRC staff has found acceptable for providing such protection for 200 to 1000 years and focuses principally on the design of tailings covers to provide that protection.

Presently, very little information exists on designing covers to remain effective for 1000 years. Numerous examples can be cited where covers for protection of tailings embankments and other applications have experienced significant erosion over relatively short periods (less than 50 years). Experience with reclamation of coal-mining projects, ror example, indicates that it is usually necessary to provide relatively flat slopes to maintain overall site stability (Wells and Jercinovic, 1983, see Ref. 2).

Because of the basic lack of design experience and technical information in this area, this position attempts to adapt standard hydraulic design methods and empirical data to the design of erosion protection covers. The design methods discussed here are based either on: (1) the use of documented hydraulic procedures that are generally applicable in any area of hydraulic design; or (2) the use of procedures developed by technical assistance contractors specifically for long-term stability applications.

It should be emphasized that a standard industry practice for stabilizing tailings for 1000 years does not currently exist. However, standard practice does exist for providing stable channel sections. This practice is widely used to design drainage channels that do not erode when subjected to design flood flows. Since an embankment slope can be treated as a wide channel, the staff concludes that the hydraulic design principles and practice associated with

2.1.2 Long-Term Stability

As required by 40 CFR 192.02 and 10 CFR Part 40, Appendix A, Criterion 6, stabilization designs must provide reasonable assurance of control of radiological hazards for a 1000-year period, to the extent practicable, but in any case, for a minimum 200-year period. The NRC staff has concluded that the risks from tailings could be accommodated by a design standard that requires that there be reasonable assurance that the tailings remain stable for a period of 1000 (or at least 200) years, preferably with reliance placed on passive controls (such as earth and rock covers), rather than routine maintenance.

2.1.3 Design for Minimal Maintenance

Criteria for tailings stabilization, with minimal reliance placed on active maintenance, are established in 40 CFR Part 192 and 10 CFR Part 40, Appendix A, Criteria 1 and 12. Criterion 1 of 10 CFR Part 40, Appendix A specifically states that: "Tailings should be disposed of in a manner [such] that no active maintenance is required to preserve conditions of the site." Criterion 12 states that: "The final disposition of tailings or wastes at milling sites should be such that ongoing active maintenance is not necessary to preserve isolation."

It is evident that remedial action designs are intended to last for a long time, without the need for active maintenance. Therefore, in accordance with regulatory requirements, the NRC staff has concluded that the goal of any design for long-term stabilization to meet applicable design criteria should be to provide overall site stability for very long time periods, with no reliance placed on active maintenance.

For the purposes of this STP, active maintenance is defined as any maintenance that is <u>needed</u> to assure that the design will meet specified longevity requirements. Such maintenance includes even minor maintenance, such as the addition of soil to small rills and gullies. The question that must be answered is whether longevity is dependent on the maintenance. If it is necessary to repair gullies, for example, to prevent their growth and ultimate erosion into tailings, then that maintenance is considered to be active maintenance.

2.1.4 Radon Release Limits

Titles 40 CFR 192.02 and 10 CFR Part 40, Appendix A require that earthen covers be placed over tailings at the end of milling operations to limit releases of radon-222 to not more than an average of 20 picocuries per square meter per second (pCi/m^2s), when averaged over the entire surface of the disposal site and over at least a one-year period, for the control period of 200 to 1000 years. Before placement of the cover, radon release rates are calculated in designing the protective covers and barriers for uranium mill tailings. Additionally, recent regulations promulgated under the Clean Air Act design follows the procedure for a soil cover, because the layer is predominantly soil, rather than rock.

2.2 Design Procedures

A step-by-step procedure for designing riprap for the top and side slopes of a reclaimed pile is presented below:

Step 1. Determine the drainage areas for both the top slope and the side slope. These drainage areas are normally computed on a unit-width basis.

Step 2. Determine time of concentration (tc).

The tc is usually a difficult parameter to estimate in the design of a rock layer. Based on a review of the various methods for calculating tc, the NRC staff concludes that a method such as the Kirpich method, as discussed by Nelson, et al. (1986, see Ref. D2), should be used. The tc may be calculated using the formula:

$$tc = (11.9L^3/H)^{.385}$$, where L = drainage length (in miles)

H = elevation difference (in feet)

Step 3. Determine Probable Maximum Flood (PMF) and Probable Maximum Precipitation (PMP).

Techniques for PMP determinations have been developed for the entire United States, primarily by the National Oceanographic and Atmospheric Administration, in the form of hydrometeorological reports for specific regions. These techniques are commonly accepted and provide straightforward procedures for assessing rainfall potential, with minimal variability. Acceptable methods for determining the total magnitude of the PMP and various PMP intensities for specific times of concentration are given by Nelson, et al. (1986, see Ref. D2, Section 2.1).

Step 4. Calculate peak flow rate.

The Rational Formula, as discussed by Nelson et al. (1986, see Ref. D2), may be used to calculate peak flow rates for these small drainage areas. Other methods that are more precise are also acceptable; the Rational Formula was chosen for its simplicity and ease of computation.

Step 5. Determine rock size.

Using the peak flow rate calculated in Step 4, the required D_{50} may be determined. Recent studies performed for the NRC staff (Abt, et al., 1988, see Ref. D3) have indicated that the Safety Factors Method is more applicable for designing rock for slopes less than 10 percent and that the Stephenson Method is more applicable for slopes greater than 10 percent. Other methods may also be used, if properly justified.

2.3 Recommendations

Since it is unlikely that clogging of the riprap voids will not occur over a long period of time, it is suggested that no credit be taken for flow through the riprap voids. Even if the voids become clogged, it is unlikely that stability will be affected, as indicated by tests performed for the NRC staff by Abt, et al. (1987, see Ref. D4).

If rounded rather than angular rock is used, some increase in the average rock size may be necessary, since the rock will not be as stable. Computational models, such as the Safety Factors Method, provide stability coefficients for different angles of repose of the material. The need for oversizing of rounded rock is further discussed by Abt, et al. (1987, see Ref. D4).

2.4 Example of Procedure Application

Determine the riprap requirements for a tailings pile top slope with a length of 1000 feet and a slope of 0.02 and for the side slope with an additional length of 250 feet and a slope of 0.2 (20 percent).

Step 1. The drainage areas for the top slope (A1) and the side slope (A2) on a unit-width basis are computed as follows:

$$A1 = (1000)\ (1)\ /\ 43560 = 0.023 \text{ acres}$$

$$A2 = (1000 + 250)\ (1)\ /\ 43560 = 0.029 \text{ acres.}$$

Step 2. The tcs are individually computed for the top and side slopes, using the Kirpich Method, as discussed by Nelson, et al. (1986, see Ref. D2).

$$tc = [(11.9)(L)^3/H]^{.385}$$

For L = 1000 feet and H = 20 feet,

tc = 0.12 hours = 7.2 minutes for the top slope

For L = 250 feet and H = 50 feet,

tc = 1.0 minute for the side slope.

Therefore, the total tc for the side slope is equal to 7.2 + 1.0, or 8.2 minutes.

Step 3. The rainfall intensity is determined using procedures discussed by Nelson, et al. (1986, see Ref. D2), based on a 7.2-minute PMP of 4.2 inches for the top slope and an 8.2-minute PMP of approximately 4.5 inches for the side slope. These incremental PMPs are based on a one-hour PMP of 8.0 inches for northwestern New Mexico and were derived using procedures discussed by Nelson, et al. (1986, see Ref. D2).

Rainfall intensities, for use in the Rational Formula, are computed as follows:

i_1 = (60)(4.2)/7.2 = 35 inches/hr for the top slope

i_2 = (60)(4.5)/8.2 = 33 inches/hr for the side slope.

Step 4. Assuming a runoff coefficient (C) of 0.8, the peak flow rates are calculated using the Rational Formula, as follows:

Q1 = (0.8) (35) (0.023) = 0.64 cfs/ft, for the top slope, and

Q2 = (0.8) (33) (0.029) = 0.77 cfs/ft, for the side slope.

Step 5. Using the Safety Factors Method, the required rock size for the pile top slope is calculated to be:

D_{50} = 0.6 inches.

Using the Stephenson Method, the required rock size for the side slopes is calculated to be:

D_{50} = 3.1 inches.

2.5 Limitations

The use of the aforementioned procedures is widely applicable. The Stephenson Method is an empirical approach and is not applicable to gentle slopes. The Safety Factors Method is conservative for steep slopes. Other methods may also be used, if properly justified.

3. RIPRAP DESIGN FOR DIVERSION CHANNELS

3.1 Technical Basis

The Safety Factors Method or other shear stress methods are generally accepted as reliable methods for determining riprap requirements for channels. These methods are based on a comparison of the stresses exerted by the flood flows with the allowable stress permitted by the rock. Documented methods are readily available for determining flow depths and Manning "n" values.

3.2 Design Procedures

3.2.1 Normal Channel Designs

In designing the riprap for a diversion channel where there are no particularly difficult erosion considerations, the design of the erosion protection is relatively straightforward.

1. The Safety Factors Method or other shear stress methods may be used to determine the riprap requirements.

2. The peak shear stress should be used for design purposes and can be determined by substituting the value of the depth of flow (y) in the shear

6. OVERSIZING OF MARGINAL-QUALITY EROSION PROTECTION

6.1 Technical Basis

The ability of some rock to survive without significant degradation for long time periods is well-documented by archaeological and historic evidence (Lindsey, et al., 1982, see Ref. D13). However, very little information is available to quantitatively assess the quality of rock needed to survive for long periods, based on its physical properties.

In assessing the long-term durability of erosion protection materials, the NRC staff has relied principally on the results of durability tests at several sites and on information, analyses, and methodology presented in NUREG/CR-4620 (Nelson, et al., see Ref. D2). This document provides a quantitative method for determining the oversizing requirements for a particular rock type to be placed at specific locations on or near a remediated uranium mill tailings pile.

Staff review of actual field data from several tailings sites has indicated that the methodology may not be sufficiently flexible to allow the use of "borderline" quality rock, where a particular type of rock fails to meet minimum qualifications for placement in a specific zone, but fails to qualify by only a small amount. This may be very important, since the selection of a particular rock type and rock size depends on its quality and where it will be placed on the embankment.

Based on NRC staff review of the actual field data, the methodology previously derived has been modified to incorporate additional flexibility. These revisions include modifications to the quality ratings required for use in a particular placement zone, re-classification of the placement zones, reassessment of weighting factors based on the rock type, and more detailed procedures for computing rock quality and the amount of oversizing required.

Based on an examination of the actual field performance of various types and quality of rock (Esmiol, 1967, see Ref. D14), the NRC staff considers it important to determine rock properties with a petrographic examination. The case history data indicated that the singlemost important factor in rock deterioration was the presence of smectites and expanding lattice clay minerals. Therefore, if a petrographic examination indicates the presence of such minerals, the rock will not be suitable for long-term applications.

6.2 Design Procedures

Design procedures and criteria have been developed by the NRC staff for use in selecting and evaluating rock for use as riprap to survive long time periods. The methods are considered to be flexible enough to accommodate a wide range of rock types and a wide range of rock quality for use in various long-term stability applications.

The first step in the design process is to determine the quality of the rock, based on its physical properties. The second step is to determine the amount of oversizing needed, if the rock is not of good quality. Various combinations of good-quality rock and oversized marginal-quality rock may also be considered in the design, if necessary.

6.2.1 Procedures for Assessing Rock Quality

The suitability of rock to be used as a protective cover should be assessed by laboratory tests to determine the physical characteristics of the rocks. Several durability tests should be performed to classify the rock as being of poor, fair (intermediate), or good quality. For each rock source under consideration, the quality ratings should be based on the results of about three to four different durability test methods for initial screening and about six test methods for final sizing of the rock(s) selected for inclusion in the design. Procedures for determining the rock quality and determining a rock quality "score" are developed in Table D1.

6.2.2 Oversizing Criteria

Oversizing criteria vary, depending on the location where the rock will be placed. Areas that are frequently saturated are generally more vulnerable to weathering than occasionally-saturated areas where freeze/thaw and wet/dry cycles occur less frequently. The amount of oversizing to be applied will also depend on where the rock will be placed and its importance to the overall performance of the reclamation design. For the purposes of rock oversizing, the following criteria have been developed:

A. Critical Areas. These areas include, as a minimum, frequently-saturated areas, all channels, poorly-drained toes and aprons, control structures, and energy dissipation areas.

Rating

80-100 - No Oversizing Needed

65-80 - Oversize using factor of (80-Rating), expressed as the percent increase in rock diameter. For example, a rock with a rating of 70 will require oversizing of 10 percent. (See example of procedure application, given in Section 6.4, p. D-28)

Less than 65 - Reject

B. Non-Critical Areas. These areas include occasionally-saturated areas, top slopes, side slopes, and well-drained toes and aprons.

Rating

80-100	-	No Oversizing Needed
50-80	-	Oversize using factor of (80-Rating), expressed as the percent increase in rock diameter

Less than 50 - Reject

TABLE D1

Scoring Criteria for Determining Rock Quality

Laboratory Test	Weighting Factor			Score										
	Limestone	Sandstone	Igneous	10	9	8	7	6	5	4	3	2	1	0
				Good				Fair			Poor			
Sp. Gravity	12	6	9	2.75	2.70	2.65	2.60	2.55	2.50	2.45	2.40	2.35	2.40	2.25
Absorption, %	13	5	2	.1	.3	.5	.67	.83	1.0	1.5	2.0	2.5	3.0	3.[illegible]
Sodium Sulfate, %	4	3	11	1.0	3.0	5.0	6.7	8.3	10.0	12.5	15.0	20.0	25.0	30.0
L/A Abrasion (100 revs), %	1	8	1	1.0	3.0	5.0	6.7	8.3	10.0	12.5	15.0	20.0	25.0	30.0
Schmidt Hammer	11	13	[illegible]	70.0	65.0	60.0	54.0	47.0	40.0	32.0	24.0	16.0	8.0	0.0
Tensile Strength, psi	6	4	10	1400	1200	1000	833	666	500	400	300	200	100	0

1. Scores were derived from Tables 6.2, 6.5, and 6.7 of NUREG/CR-2642 - "Long-Term Survivability of Riprap for Armoring Uranium Mill Tailings and Covers: A Literature Review," 1982 (see Ref. D13).

2. Weighting Factors are derived from Table 7 of "Petrographic Investigations of Rock Durability and Comparisons of Various Test Procedures," by G. W. DuPuy, Engineering Geology, July, 1965 (see Ref. D15). Weighting factors are based on inverse of ranking of test methods for each rock type. Other tests may be used; weighting factors for these tests may be derived using Table 7, by counting upward from the bottom of the table.

3. Test methods should be standardized, if a standard test is available and should be those used in NUREG/CR-2642 (see Ref. D13), so that proper correlations can be made. This is particularly important for the tensile strength test, where several methods may be used; the method discussed by Nilsson (1962, see Ref. D16) for tensile strength was used in the scoring procedure.

6.3 Recommendations

Based on the performance histories of various rock types and the overall intent of achieving long-term stability, the following recommendations should be considered in assessing rock quality and determining riprap requirements for a particular design.

1. The rock that is to be used should first be qualitatively rated at least "fair" in a petrographic examination conducted by a geologist or engineer experienced in petrographic analysis. See NUREG/CR-4620, Table 6.4 (see Ref. D2), for general guidance on qualitative petrographic ratings. In addition, if a rock contains smectites or expanding lattice clay minerals, it will not be acceptable.

2. An occasionally-saturated area is defined as an area with underlying filter blankets and slopes that provide good drainage and are steep enough to preclude ponding, considering differential settlement, and are located well above normal groundwater levels; otherwise, the area is classified as frequently-saturated. Natural channels and relatively flat man-made diversion channels should be classified as frequently-saturated. Generally, any toe or apron located below grade should be classified as frequently-saturated; such toes and aprons are considered to be poorly-drained in most cases.

3. Using the scoring criteria given in Table D1, the results of a durability test determines the score; this score is then multiplied by the weighting factor for the particular rock type. The final rating should be calculated as the percentage of the maximum possible score for all durability tests that were performed. See example of procedure application for additional guidance on determining final rating.

4. For final selection and oversizing, the rating may be based on the durability tests indicated in the scoring criteria. Other tests may also

be substituted or added, as appropriate, depending on rock type and site-specific factors. The durability tests given in Table D1 are not intended to be all-inclusive. They represent some of the more commonly-used tests or tests where data may be published or readily-available. Designers may wish to use other tests than those presented; such an approach is acceptable. Scoring criteria may be developed for other tests, using procedures and references recommended in Table D1. Further, if a rock type barely fails to meet minimum criteria for placement in a particular area, with proper justification and documentation, it may be feasible to throw out the results of a test that may not be particularly applicable and substitute one or more tests with higher weighting factors, depending on the rock type or site location. In such cases, consideration should be given to performing several additional tests. The additional tests should be those that are among the most applicable tests for a specific rock type, as indicated by the highest weighting factors given in the scoring criteria for that rock type.

5. The percentage increase of oversizing should be applied to the diameter of the rock.

6. The oversizing calculations represent minimum increases. Rock sizes as large as practicable should be provided. (It is assumed, for example, that a 12-inch layer of 4-inch rock costs the same as a 12-inch layer of 6-inch rock.) The thickness of the rock layer should be based on the constructability of the layer, but should be at least 1.5 x D_{50}. Thicknesses of less than 6 inches may be difficult to construct, unless the rock size is relatively small.

6.4 Example of Procedure Application

It is proposed that a sandstone rock source will be used. The rock has been rated "fair" in a petrographic examination. Representative test results are given. Compute the amount of oversizing necessary.

Using the scoring criteria in Table D1, the following ratings are computed:

Lab Test	Result	Score	Weight	Score x Weight	Max. Score
Sp. Gr.	2.61	7	6	42	60
Absorp., %	1.22	4	5	20	50
Sod. Sulf., %	6.90	6	3	18	30
L.A. Abr., %	8.70	5	8	40	80
Sch. Ham.	51	6	13	78	130
Tens. Str., psi	670	6	4	24	40
Totals				222	390

The final rating is computed to be 222/390 or 57 percent. As discussed in Section 6.2, the rock is not suitable for use in frequently-saturated areas, but is suitable for use in occasionally-saturated areas, if oversized. The oversizing needed is equal to (80 - 57), or a 23 percent increase in rock diameter.

6.5 Limitations

The procedure previously presented is intended to provide an approximate quantitative method of assessing rock quality and rock durability. Although the procedure should provide rock of reasonable quality, additional data and studies are needed to establish performance histories of rock types that have a score of a specific magnitude. It should be emphasized that the procedure is only a more quantitative estimate of rock quality, based on USBR classification standards.

It should also be recognized that durability tests are not generally intended to determine if rock will actually deteriorate enough to adversely affect the stability of a reclaimed tailings pile for a design life of 200 to 1000 years. These tests are primarily intended to determine acceptability of rock for various construction purposes for design lifetimes much shorter than 1000 years. Therefore, although higher scores give a higher degree of confidence that significant deterioration will not occur, there is not complete assurance that deterioration will not occur. Further, typical construction projects rely on planned maintenance to correct deficiencies. It follows, then, that there is also less assurance that the oversizing methodology will actually result in rock that will only deteriorate a given amount in a specified time period. The amount of oversizing resulting from these calculations is based on the engineering judgment of the NRC staff, with the assistance of contractors. However, in keeping with the Management Position (USNRC, 1989, see Ref. D17), the staff considers that this methodology will provide reasonable assurance of the effectiveness of the rock over the design lifetime of the project.

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Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments

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The rainfall depth for a specific site is estimated by determining the rainfall duration and/or appropriate time of concentration. The resulting rainfall depth in inches, is

$$\text{PMP rainfall depth} = (\%\ \text{PMP}) \times (\text{PMP}) \qquad (2.1)$$

where the percent PMP is obtained from Table 2.1 and the PMP is obtained from the appropriate PMP design storm presented in Section 2.1.1.

The rainfall intensity, i, in inches per hour can be computed as

$$i = \text{rainfall depth (inches)} \times \frac{60}{\text{rainfall duration (minutes)}} \qquad (2.2)$$

The rainfall intensity determined from Equation 2.2 is generally a conservative value and represents the peak rainfall intensity of the design storm.

To compute the rainfall intensity for any rainfall duration, it is recommended that a rainfall intensity versus rainfall duration curve be plotted on semilogarithmic paper. Because of the extremely conservative rainfall intensity values obtained for short durations, it is recommended that the minimum rainfall duration be 2.5 minutes. Rainfall depths should be extracted from the appropriate Hydrometeorological Report.

2.2 PMP COMPARISON STORMS

A comparison of estimates of the PMP with greatest observed rainfall and estimates of the 100-year events for areas both east and west of the 105° meridian was prepared (NWS, 1980). Information from 6500 precipitation reporting stations in the eastern U.S. and about 2100 stations in the west was used. Including storm durations of 6 to 72 hours, the study indicated that 177 separate storm events have been recorded in which the rainfall was greater than or equal to 50 percent of the PMP for stations east of the 105° meridian. Only 66 separate storm events were recorded west of the 105° meridian where rainfalls were greater than or equal to 50 percent of the PMP.

The National Weather Service also reported the number of storm events which met or exceeded the 100-year rainfall values and compared them with the regional PMP values (NWS, 1980). Table 2.2 summarizes these rainfall events for 6 and 24-hour storms occurring over a 10 square mile area. It is interesting to note that a storm has not been officially recorded west of the Continental Divide that exceeds 90% of the PMP value. However, it is evident that a number of storms approach the PMP values, thereby substantiating that the prescribed PMP values are not extremely conservative.

4.1.5.6 Gully Width

The width of the gully across the top of the gully at the point of maximum depth can be estimated from Figure 4.5. Having computed the maximum depth, D_{max}, and knowing the uniformity coefficient, C_u, the top width is estimated to be approximately 5.6 feet. However, the gully width will widen over time to where the gully side wall stands at an angle less than the angle of repose of the cover material.

4.2 EMBANKMENT AND SLOPE STABILIZATION USING RIPRAP

Rock riprap is one of the most economical materials that is commonly used to provide for cover and slope protection. Factors to consider when designing rock riprap are: (1) rock durability, density, size, shape, angularity, and angle of repose; (2) water velocity, depth, shear stress, and flow direction near the riprap; and (3) the slope of the embankment or cover to be protected. Through the proper sizing and placement of riprap on any impoundment cover, rill and gully erosion can be minimized to ensure long term stabilization.

The primary failure mechanism of concern is the removal of material from the impoundment due to shear forces developed by water flowing parallel and/or adjacent to the cover as described by Nelson et al. (1983). One purpose of the cover is to expedite the removal of precipitation and tributary waters away from the cover to minimize seepage and percolation. However, when surface waters are not properly managed, extreme erosion may result and endanger the impoundment stability. For example, slopes are often designed and constructed to develop sheet flow conditions. After many years of exposure, sheet and rill erosion, and localized settlement, the hydraulic conditions have significantly altered causing flows to merge or concentrate into drainage channels. The greater the concentration of flow into the drainage channels, the greater the erosion potential.

4.2.1 Zone Protection

The design requirements for placing riprap rock on a cover vary depending upon cover location. It is suggested that four areas exist on the cover in which different failure mechanisms can result from tributary drainage. The four areas or zones of concern are presented in Figure 4.6 and include:

1. Zone I: This zone is considered the toe-of-the-slope of the reclaimed impoundment. The riprap protecting the slope toe must be sized to stabilize the slope due to flooding in the major watersheds and dissipate energy as the flow transitions from the impoundment slope into the natural terrain. Zone I is considered a zone of frequent saturation.

2. Zone II: This is the area along the side slope which remains in the major watershed flood plain (PMF). The rock protection must resist not only the flow off the cover, but also floods. The

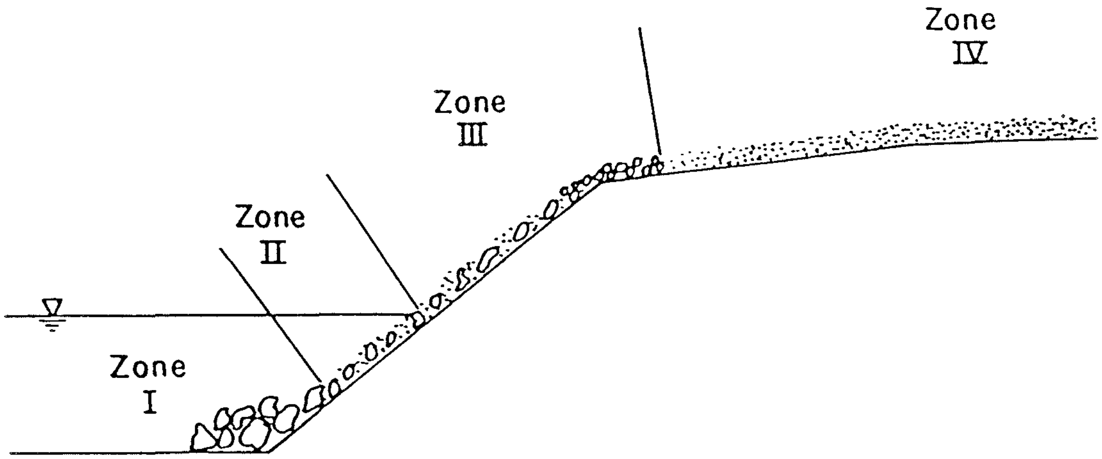

Fig. 4.6. Zones of a reclaimed impoundment requiring riprap protection.

riprap must serve as embankment protection similar to river and canal banks. Zone II is considered a zone of occasional saturation.

3. Zone III: Riprap should be designed to protect steep slopes and embankments from potential high overtopping velocities and excessive erosion. Flows in Zone III are derived from tributary drainage and direct runoff from the reclaimed site. Zone III is considered a seldom saturated zone.

4. Zone IV: Rock protection for Zone IV is generally designed for flows from mild slopes. Zone IV will usually be characterized by sheet flow with low flow velocities. Zone IV is considered a zone of seldom saturation.

Since the rock protection requirements are significantly different on various locations on the cover, it should be apparent that each riprap design procedure available was formulated to address a specific application. Since a single riprap design procedure does not necessarily meet all of the cover protection requirements, recommendations will be made indicating which zone(s) each riprap design procedure best addresses.

Because the frequency of wetting or saturation varies by zone, the durability requirements of the riprap may vary by zone. The concept of durability and oversizing will be addressed in Chapter 6 of this report.

4.2.2 Design Procedures

Presently, several methods are available to assist the designer in determining the appropriate rock size for protection of impoundment covers, embankments and unprotected slopes from the impact of drainage waters. Alternative riprap design methods summarized herein are

1. Safety Factors Method
2. The Stephenson Method
3. Corps of Engineers Method
4. The U.S. Bureau of Reclamation Method

These riprap design procedures are but examples of the many methods available.

4.2.2.1 Safety Factors Method

The Safety Factors Method (Richardson et al., 1975) for sizing rock riprap is quite versatile in that it allows the designer to evaluate rock stability from flow parallel to the cover and adjacent to the cover. The Safety Factors Method can be used by assuming a rock size and then calculating the safety factor (S.F.) or allowing the designer to determine a S.F. and then computing the corresponding rock size. If the S.F. is greater than unity, the riprap is considered safe from failure; if the S.F. is unity, the rock is at the condition of incipient motion; and if S.F. is less than unity, the riprap will fail.

where d_{50} is the mean rock size in feet. A graphical representation for determining n is presented in Figures 4.12 and 4.13. However, these values were developed for uniform flow condition over submerged riprap. When overtopping flows on steep slopes begin to cascade, n values will increase and may range from 0.07 to 0.09 or higher. (Abt and Ruff, 1985 and COE, 1970).

Table 4.2. Manning Coefficient, n.

Channel Material	Manning Coefficient, n
Fine sand, colloidal	0.020
Sandy loam, non-colloidal	0.020
Silt loam, non-colloidal	0.020
Alluvial silts, non-colloidal	0.020
Ordinary firm loam	0.020
Volcanic ash	0.020
Stiff clay, very colloidal	0.025
Alluvial silts, colloidal	0.025
Shales and hardpans	0.025
Fine gravel	0.020
Graded loam to cobbles, non-colloidal	0.030
Graded silts to cobbles, colloidal	0.030
Coarse gravel, non-colloidal	0.025
Cobbles and shingles	0.035

Source: Morris and Wiggert, 1972.

4.8 COVER EROSION RESISTANCE EVALUATION

The cover design should be evaluated to determine if the unprotected slopes(s) can withstand overland or sheet flow with a minimum of erosion. Based upon the site-specific cover and precipitation parameters, the design sheet flow velocity should be estimated. A comparison of the design flow velocity with the cover permissible flow velocity can be performed. Furthermore, the design velocity can be used to determine the sediment discharge using the Universal Soil Loss Equation (Chapter 5) and for sizing stone protection (Section 4.2).

The design velocity will usually be determined from the peak discharge generated from the Probable Maximum Flood (PMF). The PMF can be estimated by

(a) Using computer models, i.e., HEC-1 (COE, 1974), that are widely accepted by the engineering profession.

(b) Applying the Rational Method for tributary areas that are less than approximately one square mile in area.

The Rational formula is commonly expressed as

$$Q = CiA \tag{4.42}$$

where Q is the maximum or design discharge in cfs, C is a runoff coefficient dependent upon the characterization of the drainage basin, i is the rainfall intensity expressed in inches per hour and A is the tributary area expressed in acres. When a unit width approach is taken, the area A_W is the slope(s) length times the unit width. Therefore, Equation 4.42 would be presented as

$$q = CiA_W \tag{4.43}$$

for a unit width analysis.

4.8.1 Runoff Coefficient

The runoff coefficient, C, is related to the climatic conditions and type of terrain characteristic of the watershed including soil materials, permeability and storage potential. Values of the coefficient C are presented in Table 4.4 (Lindsley et al., 1958), Table 4.5 (Chow, 1964), and Table 4.6 (ASCE, 1970 and Seelye, 1960).

Table 4.4. Values of Coefficient C.

Type Area	Value of C
Flat cultivated land, open sandy soil	0.20
Rolling cultivated land, clay-loam soil	0.50
Hill land, forested, clay loam soil	0.50
Steep, impervious slope	0.95

Source: Lindsley, et al, 1958.

The selection of a coefficient value requires considerable judgment as it is a tangible aspect of using the rational formula. It is recommended that a conservative value of C be applied for PMF estimation since infiltration and storage comprise a low percentage of the runoff. Furthermore, the C values presented were derived for storms of 5-100 year frequencies. Therefore, less frequent, higher intensity storms will require the use of a higher C value (Chow, 1964). It is recommended that a runoff coefficient of 1.0 be used for PMF applications in very small watersheds since the effects of localized storage and infiltration will be small.

Table 4.5. Values of C for Use in Rational Formula.

Soil Type	Watershed Cover		
	Cultivated	Pasture	Woodlands
With above-average infiltration rates; usually sandy or gravelly	0.20	0.15	0.10
With average infiltration rates; no clay pans; loams and similar soils	0.40	0.35	0.30
With below-average infiltration rates; heavy clay soils or soils with a clay pan near the surface; shallow soils above impervious rock	0.50	0.45	0.40

Source: Chow, 1964.

4.8.2 Rainfall Intensity

In order to determine the rainfall intensity, i, the time of concentration, t, must be estimated. The time of concentration can be approximated by:

(a) Applying one of the many accepted empirical formulae such as

$$t_c = 0.00013 \frac{L^{0.77}}{S^{0.385}} \qquad (4.44)$$

where L is the length of the basin in feet measured along the watercourse from the upper end of the watercourse to the drainage basin outlet and S is the average slope of the basin. Time of concentration is expressed in hours. This procedure is not applicable to rock covered slopes. This expression was

Table 4.6. Values of runoff coefficient C.

Character of Surface	Runoff Coefficients	
	Range	Recommended
Pavement--asphalt or concrete	0.70-0.95	0.90
Gravel, from clean and loose to clayey and compact	0.25-0.70	0.50
Roofs	0.70-0.95	0.90
Lawns (irrigated) sandy soil		
Flat, 2 percent	0.05-0.15	0.10
Average, 2 to 7 percent	0.15-0.20	0.17
Steep, 7 percent or more	0.20-0.30	0.25
Lawns (irrigated) heavy soil		
Flat, 2 percent	0.13-0.17	0.15
Average, 2 to 7 percent	0.18-0.22	0.20
Steep, 7 percent	0.25-0.35	0.30
Pasture and non-irrigated lawns		
Sand		
Bare	0.15-0.50	0.30
Light vegetation	0.10-0.40	0.25
Loam		
Bare	0.20-0.60	0.40
Light vegetation	0.10-0.45	0.30
Clay		
Bare	0.30-0.75	0.50
Light vegetation	0.20-0.60	0.40
Composite areas		
Urban		
Single-family, 4-6 units/acre	0.25-0.50	0.40
Multi-family, >6 units/acre	0.50-0.75	0.60
Rural (mostly non-irrigated lawn area)		
<1/2 acre - 1 acre	0.20-0.50	0.35
1 acre - 3 acres	0.15-0.50	0.30
Industrial		
Light	0.50-0.80	0.65
Heavy	0.60-0.90	0.75
Business		
Downtown	0.70-0.95	0.85
Neighborhood	0.50-0.70	0.60
Parks	0.10-0.40	0.20

Source: ASCE, 1970 and Seelye, 1960.

designed for and applicable to small drainage basins (Kirpich, 1940).

(b) Using the Soil Conservation Service (SCS) Triangular Hydrograph Theory (DOI, 1977), the time of concentration is

$$t_c = \left(\frac{11.9\ L^3}{H}\right)^{0.385} \qquad (4.45)$$

0.385 — see USNRC (pg D-3) "Final Staff Technical Position Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites" (1990)

where L is the length (miles) of the longest watercourse from the point of interest to the tributary divide, H is the difference in elevation (feet) between the point of interest and the tributary divide. The time of concentration will be expressed in hours. The SCS procedure is most applicable to drainage basins of at least 10 square miles.

Once the rainfall duration or time of concentration is determined, the rainfall depth can be computed based on the PMP intensity values estimated in Section 2.1.2.

4.8.3 Tributary Area

The tributary area may be expressed in a unit width format for design of rock protection on an embankment. Therefore, the area is the length of the longest expected or measured water course multiplied by the unit width. This procedure is primarily applicable to Zones I, II, and III and is not applicable for drainage ditch design. It should be noted that a unit width approach to drainage and diversion ditch design is not effective. Ditch design requires an entire basin analysis in which a composite inflow hydrograph is determined and is routed along the channel. From the inflow hydrograph, water surface profiles (i.e., HEC-2) can be estimated to determine flow depth and velocities for riprap design (COE, 1982).

4.8.4 Sheet Flow Velocity

The design velocity for sheet flow on an embankment slope can be estimated by solving the Manning formula presented in Equation 4.39. It is assumed that the hydraulic radius, R, is approximately equal to the flow depth, y, and that the design discharge is equal to that estimated by the Rational Method. Therefore, the depth of flow is

$$y = \left[\frac{Qn}{1.486\ S^{1/2}}\right]^{3/5} \qquad (4.46)$$

where Q is the discharge, S is the slope, and n is the Manning coefficient.

Therefore, the design velocity can be estimated as

$$V_{Design} = Q/A \text{ (feet/sec)} \qquad (4.47)$$

where A is the cross-sectional area of flow.

4.9 FLOW CONCENTRATIONS

Despite the extensive efforts of the impoundment reclamation designer, reviewer, contractor and inspector, the topographic features of the cover will alter over time without continual maintenance (Powledge and Dodge, 1985). Cover modifications will result from differential settlement, collapsing soils, marginal quality control in cover placement, erosion, major hydrologic events and monitoring disturbance. Because of these unpredictable and generally uncontrollable events, tributary drainage areas evolve that were not originally designed or constructed. The result is that the peak discharge and volume of runoff exceed design levels and increase the erosion potential.

Abt and Ruff (1985) conducted a series of flume experiments on a 1V:5H prototype embankment protected by riprap with median rock sizes of 2 inches to 6 inches in diameter. It was observd that 2-4 inch diameter riprap were highly susceptible to sheet flows converging along the face of the embankment into channels. The discharge in the channel(s) was compared to the total discharge over the embankment by

$$CF = \frac{1}{1 - (Q_c - Q)} \qquad (4.48)$$

where CF is the concentration factor, Q_c is the discharge in the channel and Q is the total discharge over the embankment. The concentration factors ranged from 1.1 to 3.2 where flows were less than the failure discharge. These preliminary results indicate that riprap designed for sheet flow conditions may be subjected to flow channelizations that concentrate 3 times the discharge in a single location.

The peak discharge along a crest or at a design point is a function of the amount of precipitation, the tributary drainage area, the slope of the drainage basin, the basin contouring, the cover material and cover protection. Any modification in one or more of these parameters can impact the outlet peak discharge. The cover design must account for these potential changes in the form of a concentration or safety factor. Therefore, a flow concentration factor may be incorporated into the design process to adequately evaluate the soil resistance to erosion, to adequately select and evaluate alternative protective measures and to size riprap when warranted.

It is difficult to accurately predict the value of the flow concentration factor since limited information is currently available to substantiate design limits. However, it is reasonable to assume that values between 2 and 3 are attainable with only a slight evolutionary change in cover. Unless it can be shown that design procedures such as overbuilding can compensate for differential settlement, it is recommended that a conservative concentration factor be used until additional research can justify a more reasonable range of values.

To incorporate the flow concentration factor into the stone sizing procedure of any riprap design method, multiply the design peak discharge by the flow concentration factor. All subsequent computations, i.e., velocity and depth estimate, stone size determination, etc., will reflect the influence of the flow concentration.

4.10 PERMISSIBLE VELOCITIES

Evaluation of proposed reclamation alternatives should include an analysis of the critical erosion potential of the cover material. Erosion potential can be determined based upon the properties of the reclamation materials as well as the degree of compaction in which the material is placed. The permissible velocity approach consists of specifying a velocity criterion that will not erode the cover or channel and will prevent scour. A comparison of the actual or design flow velocities to the permissible velocities associated with overland flows, sheetflows or channel flows determines the erosion potential. When the design flow velocity meets or exceeds the permissible velocity, cover protection should be considered.

The permissible velocity values presented were developed from experiments performed primarily in canals and stream beds. Therefore, the following permissible velocities should provide a conservative estimate for evaluating the erosion resistance of the reclaimed covers over long term periods. In cases where a range of permissible velocities are presented, it is recommended that the lower velocity be used for determining erosion potential.

A series of permissible maximum canal velocities was developed by Fortier and Scobey (1926) and adapted by Lane (1955). The maximum permissible velocities presented in Table 4.7 are applicable to colloidal silts. These velocity values were developed for channels without sinuosity. Lane recommended a reduction of the velocities in Table 4.7 by 13 percent if the canal/channel is moderately sinuous. The maximum allowable velocities for sandy-based materials are given in Table 4.8. Table 4.9 provides limiting velocities for cohesive materials according to compactness for materials with less than 50 percent sand content. The Soil Conservation Service maximum permissible velocities (SCS, 1984) for well maintained grass covers are presented in Table 4.10.

It is important to recognize that limited information is available pertaining to permissible velocities on covers under sheet flow conditions.

Table 4.7. Maximum permissible velocities in erodible channels.

Channel Material	Water Transporting Colloidal Silts v (ft/sec)
Fine sand, colloidal	2.50
Sandy loam, non-colloidal	2.50
Silty loam, non-colloidal	3.00
Alluvial silts, non-colloidal	3.50
Firm loam	3.50
Volcanic ash	3.50
Stiff clay, colloidal	5.00
Alluvial silts, colloidal	5.00
Shales and hardpans	6.00
Fine gravel	5.00
Graded loam to cobbles, non-colloidal	5.00
Graded silts to cobble, colloidal	5.50
Coarse gravel, non-colloidal	6.00
Cobbles and shingles	5.50

Source: Lane 1955.

Table 4.8. Maximum allowable velocities in sand-based material.

Material	Velocity (ft/sec)
Very light sand of quicksand character	0.75 to 1.00
Very light loose sand	1.00 to 1.50
Coarse sand to light sandy soil	1.50 to 2.00
Sandy soil	2.00 to 2.50
Sandy loam	2.50 to 2.75
Average loam, alluvial soil, volcanic ash	2.75 to 3.00
Firm loam, clay loam	3.00 to 3.75
Stiff clay soil, gravel soil	4.00 to 5.00
Coarse gravel, cobbles and shingles	5.00 to 6.00
Conglomerate, cemented gravel, soft slate, tough hardpan, soft sedimentary rock	6.00 to 8.00

Source: Lane, 1955.

Therefore, the permissible velocities developed for channels is usually extended to overland flow situations. When design velocities reach or exceed those indicated in Tables 4.7 through 4.10, protection is warranted.

Table 4.9. Limiting Velocities in Cohesive Materials.

Principle Cohesive Material	Compactness of Bed: Loose Velocity (ft/sec)	Fairly Compact Velocity (ft/sec)	Compact Velocity (ft/sec)	Very Compact Velocity (ft/sec)
Sandy clay	1.48	2.95	4.26	5.90
Heavy clayey soils	1.31	2.79	4.10	5.58
Clays	1.15	2.62	3.94	5.41
Lean clayey soils	1.05	2.30	3.44	4.43

Source: Lane, 1955.

The materials presented in Tables 4.7 through 4.9 can be referenced to the Unified Soil Classification System as presented by Wagner (1957). An engineering analysis of the cover material can provide an approximation of the permissible velocities that the alternative cover materials may withstand without supplemental protection.

4.11 PERMISSIBLE VELOCITY EXAMPLE

A tailings disposal site located in the northwest corner of New Mexico has prepared a reclamation plan for review. The reclamation plan indicates that a 10 foot thick cap will be placed atop the tailings at a slope of 2.4% with a compaction of 95% of optimum. The cap will be graded as shown in Figure 4.14 and shall transition into side slopes of 1V:10H. It is proposed that the cap will be composed of a sandy clay with a coarse gravel cover. Along the crest, a 12 inch thick layer of riprap will be placed for at least 8 feet upslope and downslope of the crest to stabilize the transition. The riprap will have a median stone size of 6 inches. The gravel cover will have a median rock size of 1.5 inches. The design reviewer must verify that the gravel cover will resist the potential velocities that may result on the cap.

In order to assess the stabilization of the cap against erosion due to overland flow, information provided in Sections 4.6 through 4.10 of this report must be utilized. One alternative means of reviewing the design is presented in the following analysis.

4.11.1 Estimation of Peak Runoff

The peak runoff can be estimated using the Rational formula presented in Equation 4.43. The three components of the Rational formula that require consideration are: the runoff coefficient, C; the rainfall intensity, i; and the tributary area, A.

The runoff coefficient can be estimated by examining Tables 4.4 through 4.6. Since the cap will be composed of a compacted clay, the infiltration and localized storage will be low. The peak runoff is a direct function of the estimated localized PMF. Therefore, a reasonable C value is 1.0.

The rainfall intensity can be estimated by determining the 1-hr, 1-mi^2 local storm PMP value and adjusting the rainfall depth in accordance with the percentages presented in Table 2.1. For northwest New Mexico, the 1-hr, 1-mi^2 PMP is estimated to be 9.5 inches after the appropriate elevation and area adjustments are performed.

The time of concentration, t_c, should be estimated. Using Equation 4.44, the t_c can be estimated where the longest flow path is approximately 450 feet as

$$t_c = 0.00013 \frac{(450)^{0.77}}{(0.024)^{0.385}} \tag{4.49}$$

and

$$t_c = 0.06 \text{ hrs} = 3.62 \text{ minutes} \tag{4.50}$$

The rainfall depth for variable rainfall durations can be estimated using the values presented in Table 2.1 which are applicable to northwest New Mexico. Since the time of concentration is 3.6 minutes, the percent of the 1-hr PMP can be interpolated to be approximately 35 percent. The rainfall depth is computed using Equation 2.1 to be

$$\text{Rainfall depth} = (0.35) \times 9.5 \text{ inch} = 3.33 \text{ inches} \tag{4.51}$$

A conservative estimate of the rainfall intensity is determined by applying Equation 2.2.

$$i = 3.33 \text{ inches} \times \frac{60}{3.6} = 55.5 \text{ inches/hr} \qquad (4.52)$$

The tributary area, A, can be estimated using a unit width approach presented in Section 4.8. Since the longest flow path is 450 feet with a unit width of one foot, the tributary area is 450 square feet. The tributary area can be converted to acres by dividing by 43,560 square feet/acre resulting in an area of 0.0103 acres.

The peak sheet flow unit discharge at the transition can be computed by using the Rational formula presented in Equation 4.43.

$$q = (1.0)\ (55.5)\ (0.0103) = 0.57 \text{ cfs} \qquad (4.53)$$

4.11.2 Sheet Flow Velocity

The sheet flow design velocity can be estimated by first determining the depth of flow. The depth of flow, y, can be calculated using Equation 4.46. However, the Manning surface roughness coefficient, n, must be determined. From Equation 4.41, the Manning n value can be calculated as

$$n = 0.0395 (d_{50})^{1/6}$$

$$n = 0.0395\ (0.125)^{1/6} = 0.028 \qquad (4.54)$$

The depth of flow is then computed to be

$$y = \left[\frac{(0.57)\ 0.028}{1.486\ (0.024)^{1/2}}\right]^{3/5} = 0.202 \text{ feet} \qquad (4.55)$$

or

$$y = (0.202 \text{ ft})\ (12 \text{ in/ft}) = 2.42 \text{ inches} \qquad (4.56)$$

The design sheet flow velocity is calculated using Equation 4.47.

$$V = \frac{0.57}{(1.0)(0.20)} = 2.82 \text{ feet/sec} \qquad (4.57)$$

where 0.57 is the unit discharge, 1.0 is the width of flow in feet and 0.20 is the depth of flow in feet. It should be noted that the flow concentration factor was not incorporated into this computation.

4.11.3 Cover Permissible Velocity

The permissible velocity for the clay cap covered with gravel has been determined to be 5.0-6.0 feet/sec as presented in Table 4.8. Since the design sheet flow velocity was calculated to be 2.9 feet/sec, the cover should be able to withstand the design flow.

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Development of Riprap Design Criteria by Riprap Testing in Flumes: Phase I

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embankments, channel and unprotected slopes from the impact of flowing waters. Four riprap design procedures which will be referenced are:

1. Safety Factors Method (SF)
2. The Stephenson Method (STEPH)
3. The U.S. Army Corps of Engineers Method (COE)
4. The U.S. Bureau of Reclamation Method (USBR)

A summary of each method will be presented.

3.4.1 Safety Factors Method

The Safety Factors Method (Richardson et al., 1975) for sizing riprap allows the designer to evaluate rock stability from flow parallel to the cover and adjacent to the cover. The Safety Factors Method can be used by assuming a stone size and then calculating the safety factor (SF) or allowing the designer to determine a SF and then computing the corresponding stone size. If the SF is greater than unity, the riprap is considered safe from failure; if the SF is unity, the rock is at the condition of incipient motion; and if SF is less than unity, the riprap will fail.

The following equations are provided for riprap placed on a side slope or embankment where the flow has a non-horizontal (downslope) velocity vector. The safety factor, SF, is:

$$SF = \frac{\cos\theta \tan\phi}{\eta' \tan\phi + \sin\theta \cos\beta} \tag{3.5}$$

where

$$\eta' = \eta \left[\frac{[1 + \sin(\lambda + \beta)]}{2} \right] \tag{3.6}$$

$$\eta = \frac{21\ \tau_0}{(G_s - 1)\ \gamma\ D_{50}} \tag{3.7}$$

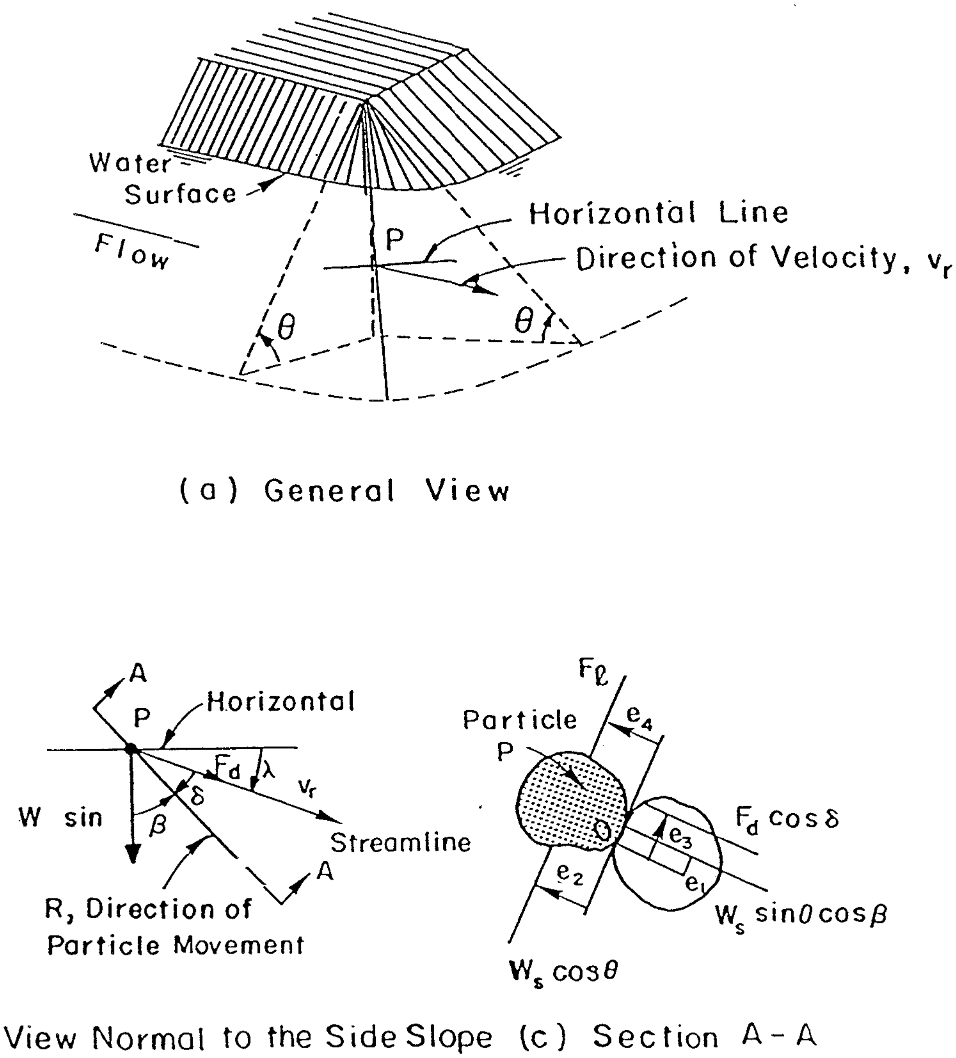
$$\tau_0 = \gamma\ DS \tag{3.8}$$

and

$$\beta = \tan^{-1} \left[\frac{\cos\lambda}{(2\ \sin\theta)/(\eta \tan\phi) + \sin\lambda} \right] \tag{3.9}$$

The angle, λ, is shown in Figure 3.1 and is the angle between a horizontal line and the velocity vector component measured in the plane of the side slope. The angle, θ, is the side slope angle shown in Figure 3.1 and β is the angle between the vector component of the weight, W_s, directed down the side slope and the direction of particle movement. The angle, ϕ, is the angle of repose of the riprap, τ_0 is the bed shear stress (Simons and Senturk, 1977), D_{50} is the representative stone size, G_s is the specific gravity of the rock, D is the depth of flow, γ is the specific weight of the liquid, S is the slope of the channel, and η' and η are stability numbers. In Figure 3.1, the forces F_l and F_d are the lift and drag forces, and the moment arms of the various forces are indicated by the value e_i as i = 1 through 4. Figure 3.2 illustrates the angle of repose for riprap material sizes.

Riprap is often placed along side slopes where the flow direction is close to horizontal or the angularity of the velocity component with the



(a) General View

(b) View Normal to the Side Slope (c) Section A - A

Fig. 3.1. Riprap stability conditions as described in the Safety Factors Method.

horizontal is small (i.e., $\lambda = 0$). For this case, the above equations reduce to:

$$\tan \beta = \frac{\eta \tan \phi}{2 \sin \theta} \tag{3.10}$$

and

$$\eta = \left[\frac{S_m^2 - (SF)^2}{(SF)\ (S_m^2)} \right] \cos \theta \tag{3.11}$$

where

$$S_m = \frac{\tan \phi}{\tan \theta} \tag{3.12}$$

The term S_m is the safety factor of the rock particles against rolling down the slope with no flow. The safety factor, SF, for horizontal flow may be expressed as:

$$SF = \frac{S_m}{2} [S_m^2 \eta^2 \sec^2 \theta + 4)^{0.5} - S_m \eta \sec \theta] \tag{3.13}$$

Riprap may also be placed on the cover or side slope. For a cover sloping in the downstream direction at an angle, α, with the horizontal, the equations reduce to:

$$SF = \frac{\cos \alpha \tan \phi}{\eta \tan \phi \sin \alpha} \tag{3.14}$$

Historic use of the Safety Factors Method has indicated that a minimum SF of 1.5 for non-PMF applications (i.e. 100-year events) provides a side slope with reliable stability and protection (Simons and Senturk, 1977). However, a SF of slightly greater than 1.0 is recommended for PMF or maximum credible flood circumstances. It is recommended that the riprap thickness be a minimum of 1.5 times the D_{50}. Also, a bedding or filter layer should underlay the rock riprap. The filter layer should minimally range from 6 inches to 12 inches in thickness. In cases where the Safety Factors Method is used to design riprap along embankments or slopes steeper than 4H:1V, it is recommended that the toe be firmly stabilized.

3.4.2 Stephenson Method

The Stephenson Method for sizing rockfill to stabilize slopes and embankments is an empirically derived procedure developed for emerging flows (Stephenson, 1979). The procedure is applicable to a relatively even layer of rockfill acting as a resistance to through and surface flow. It is ideally suited for the design and/or evaluation of embankment gradients and rockfill protection for flows parallel to the embankments, cover or slope.

The sizing of the stable stone or rock requires the designer to determine the maximum flow rate per unit width (q), the rockfill porosity (n_p), the acceleration of gravity (g), the relative density of the rock (G_s), the angle of the slope measured from the horizontal (θ), the angle of friction (ϕ), and the empirical factor (C).

The stone or rock size, D_{50}, is expressed by Stephenson as

$$D_{50} = \left[\frac{q(\tan\theta)^{7/6} n_p^{1/6}}{C\, g^{1/2}\, [1-n_p)(G_s-1)\cos\theta\,(\tan\phi - \tan\theta)]^{5/3}} \right]^{2/3} \qquad (3.15)$$

where the factor C varies from 0.22 for gravel and pebbles to 0.27 for crushed granite. The stone size calculated in Equation 3.15 is the representative diameter, D_{50}, at which rock movement is expected for unit discharge, q. The representative median stone diameter (D_{50}), is then multiplied by Oliviers' constant, K, to insure stability. Oliviers' constants are 1.2 for gravel and 1.8 for crushed rock. The rockfill layer should be well graded and at least two times the D_{50} in thickness. A bedding layer or filter should be placed under the rockfill.

The Stephenson Method does not account for uplift of the stones due to emerging flow. This procedure was developed for flow over and through rockfill on steep slopes. Therefore, it is recommended that the Stephenson Method be applied as an embankment stabilization for overflow or sheetflow conditions. Alternative riprap rockfill design procedures should be considered for toe and stream bank stabilization.

3.4.3 U.S. Army Corps of Engineers Method

The U.S. Army Corps of Engineers has developed perhaps the most comprehensive methods and procedures for sizing riprap revetment. Their criteria are based on extensive field experience and practice (COE, 1970 and

SECOND EDITION

ORIGIN OF SEDIMENTARY ROCKS

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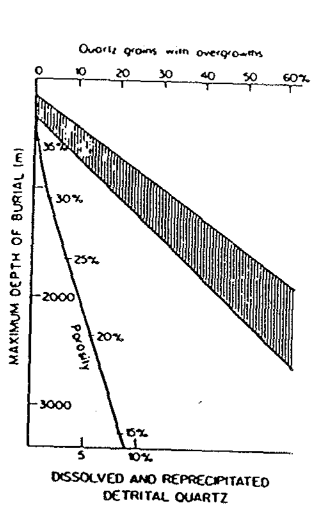


Fig. 12-8 Porosity, burial depth, and abundance of quartz overgrowths in quartz sandstones from the "Dogger beta" (Jurassic), West Germany. For example, at a depth of 1000 m the porosity is 31%, quartz overgrowths form 1% of the rock, and between 19% and 30% of the detrital quartz grains have overgrowths. (From Hans Füchtbauer, 1967, *Proc. 7th World Pet. Cong., Mexico City*, 2, 354. Used by permission of the Elsevier Scientific Pub. Co.)

by retarding pressure solution and the formation of quartz overgrowths. Fluid flow through sandstones may also enhance porosity by dissolving earlier-formed cements or detrital mineral grains.

12.4 PERMEABILITY

Permeability is a measure of the ease with which a fluid flows through a rock. It is defined by an empirical relationship first recognized by the French hydrologist Henri Darcy in 1856 and may be written

$$V = \frac{Q}{A} = k\frac{\Delta p}{\mu l}$$

where V = apparent velocity (cm/s)
Q = discharge (cm^3/s)
A = cross-sectional area (cm^2)
k = permeability (darcies = $cm^2 \times 10^{-8}$)
μ = fluid viscosity (centipoises, gm/cm s $\times 10^{-2}$)
l = distance of flow (cm)
p = pressure (dynes/cm^2); this term consists of both a fluid pressure term and a gravitational acceleration term.

Permeabilities to water of more than 500 darcies have been measured in modern river sands; in ancient rocks permeabilities to air range from a high of several darcies in coarser sandstones to a measured low of 10^{-11} darcy in a shale. The median permeability of petroleum reservoirs is on the order of 0.1 darcy (100 md).

Permeability is normally determined in the laboratory by sealing the side of the cylindrical rock core, removing any oil in the core with a solvent, and forcing air longitudinally through the core. Thus permeabilities ordinarily reported in core analysis refer to the permeability to dry air at atmospheric pressure. The permeability to freshwater, brine, or petroleum may be much less, depending on the mineral composition of the rock, particularly the amount and type of clay minerals it contains (see below). Unfortunately, the accuracy of core analysis for determining permeability is somewhat illusory. When a core is removed from the subsurface, all confining forces are removed and the rock matrix expands in all directions, partially changing the pore radii and fluid flow paths inside the core. Increases in permeability of more than 100% have been documented (Fatt and Davis, 1952). Presumably the percentage increase depends largely on the depth at which the core was taken and on the mineral composition of the core, particularly its content of clay and mica.

Subsurface measurements of permeability can be made by using semiempirical electric logging techniques, but errors of 100% are possible. A better method in use in petroliferous rocks is to determine the output of a well under a known pressure drawdown or to interpret pressure buildup data during a drill-stem test. The drill-stem test has the advantage that it represents the effective permeability of a large volume of rock under *in situ* conditions.

Depositional permeability is greatest in a direction either parallel to the bedding or at a small angle to it because of grain orientations, micaceous foliations produced during deposition of the sediment, and vertical changes in grain size within the rock unit. Johnson and Hughes (1948) examined 33 Devonian oil sands in New York and Pennsylvania and found variations in permeability averaging 30% in the plane of the bedding, with differences being less pronounced in sands of higher permeabilities. Griffiths (1949) observed that sand grains are normally imbricated at a low angle to the bedding and, therefore, planes parallel to the bedding are projections of sections through the individual grains on a plane that lies at varying angles to varying imbrications. Small variations in grain shape would result in large differences on the projection plane. He found greatest permeabilities in three cores at a low angle to the bedding and attributed the result to the existence of grain imbrication in the sandstones. Mast and Potter (1963) studied permeabilities in the bedding plane of 13 Carboniferous sandstones and concluded that variations in permeability as a result of fabric "are extremely small." Clearly it is difficult to generalize about directional permeability beyond the statement that it is least in a direction approximately normal to bedding.

In some units, however, jointing or microfaulting can increase permeability perpendicular to bedding by orders of magnitude (Nelson and Handin, 1977).

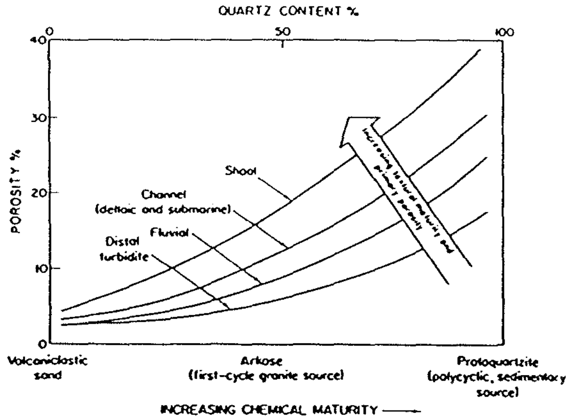


Fig. 12-6 Interrelationships among porosity, mineral composition, and environment of deposition of Jurassic sandstones in the North Sea area. (From R. C. Selley, 1978, *Jour. Geol. Soc.*, 135, 126. Used by permission of the Geological Society.)

in the sand and undercompaction of the mud (Sec. 5.12). The effect of clay mineralogy on compaction of muds can be traced primarily to the presence of smectites or interlayered smectite-illite clays. Smectitic clays contain more water than illitic or kaolinitic clays and resist compaction of the mud.

Burst (1969) has suggested that the compaction of clays proceeds in three main stages. In the first, pore-water and water interlayers beyond two are removed by the action of overburden pressure. At the time of deposition muds may have water contents on the order of 70 to 90%. After a few thousand feet of burial the mud retains only about 30% water by volume, of which 20 to 25% is interlayer water and 5 to 10% is residual pore water. In the second stage, pressure is relatively ineffective as a dehydrating agent. Dehydration proceeds by heating, which removes another 10 to 15% of the water. The second stage begins at temperatures close to 80°C and may be accompanied by diagenetic changes in clay mineralogy. Since this is also the temperature at which organic matter matures to petroleum (Sec. 9.2), is possible that explusion of water during the third stage of clay recrystallization also the cause of the "primary" migration of petroleum from source to reservoir rocks. The third stage of dehydration is also controlled by temperature but apparently is also very slow, requiring tens to hundreds of years to reach completion.

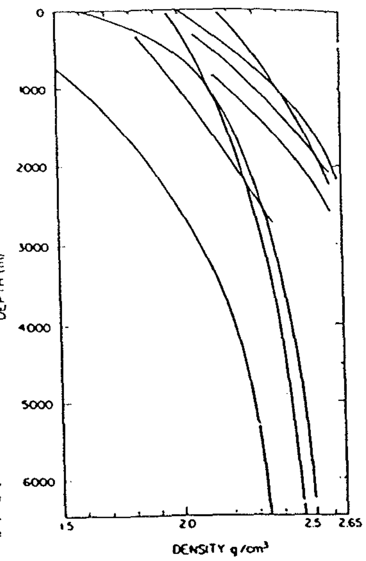


Fig. 12-7 Variation of the bulk density of mudrocks with depth in several sedimentary basins. (From H. H. Rieke, III, and G. V. Chilingar, 1974, *Compaction of Argillaceous Sediments*, Elsevier Pub. Co., p. 34. Used by permission of the Elsevier Scientific Pub. Co.)

Interlayer water is removed completely, leaving only a few percent of pore water in the mudrock.

Authigenesis

Authigenic minerals in sandstones are dominantly calcite and quartz cements but may also be clay minerals (Chap. 9). Authigenesis in both sands and muds is favored by increasing compaction, temperature, and salinity, all of which accompany increased depth of burial. The relationship between burial depth and the formation of secondary growths on detrital quartz grains is illustrated for some Mesozoic sandstones by Füchtbauer (1967) (Fig. 12-8). In some rocks, however, authigenesis may preserve rather then destroy porosity. Lumsden et al. (1971) found that authigenic chlorite coatings on detrital quartz grains in the Spiro and Foster Sands (Pennsylvanian, Oklahoma) preserve the bulk of depositional porosity

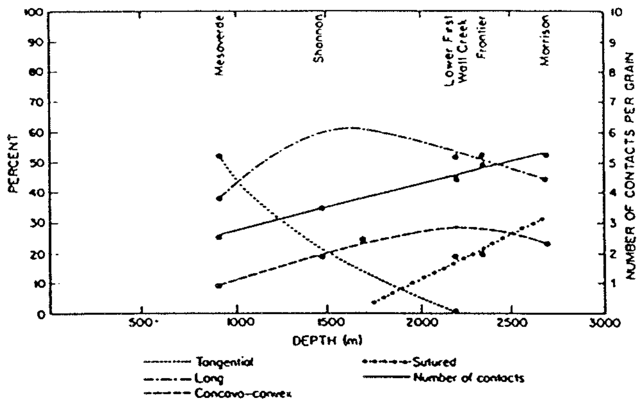


Fig. 12-4 Relationship between depth and type of grain-to-grain contact in thin sections of cores of Mesozoic sandstones in Wyoming. (From J. M. Taylor, 1950, *Amer. Assoc. Pet. Geol. Bull.*, 34, 715. Used by permission of the American Assoc. Petroleum Geologists.)

may have resulted simply from either an increase in percentage of elongate rock fragments with depth or an increase in clay content of the sandstones.

The presence of detrital clay in a sandstone has the same effect as the presence of ductile fragments but increases the rate of compaction. Mud has a very low bearing strength and noticeable compaction of clayey sandstones can occur at depths of only a few meters.

Increased compaction causes a decrease in primary porosity, a feature observed in several field studies. Data relating porosity to burial depth have been collected from large numbers of subsurface cores in different sedimentary basins (Fig. 12-5), and it was found that porosity can decrease either linearly or nonlinearly with depth and at greatly differing rates. Petrographic studies are needed to determine the causes of these differences. The interrelationships among porosity, textural maturity, and mineralogic composition are well illustrated by Selley (1978) in a study of the occurrence of oil in Jurassic sandstones in the North Sea area (Fig. 12-6). Volcaniclastic sands are easily altered chemically during diagenesis to produce fine-grained matrix. Nearly pure quartz sandstones suffer least from diagenetic effects. Arkoses occupy an intermediate position with respect to diagenetic effects. With respect to texture, the situation in the Jurassic rocks is equally clear, with shallow environments being most texturally mature, distal turbidites the least.

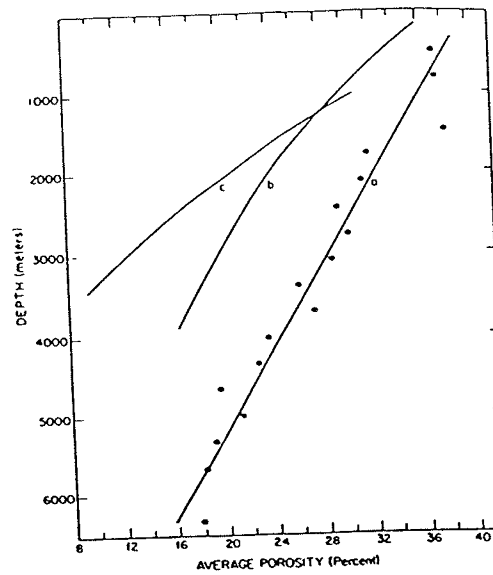


Fig. 12-5 Porosity vs. depth. (a) South Louisiana Tertiary sands; 17,367 samples. (From G. I. Atwater and E. E. Miller, 1965, unpub. ms.; data averaged for each 1000 ft. interval); (b) Great Valley Cretaceous and Tertiary sands; 165 reservoirs. (From D. L. Ziegler, and J. H. Spotts, 1978, *Amer. Assoc. Pet. Geol. Bull.*, 62, 814; (c) Cis-Caucasus, U.S.S.R.; 93 samples. (From B. K. Proshlyakov, 1960, trans. by Assoc. Tech. Serv., Inc., N.J., 1965, p. 3.)

The compaction of muds is considerably more complex than that of sandstones, as Meade (1966) has described. In the early stages, compaction may depend strongly on several factors in addition to depth of burial: grain size, rate of deposition, clay mineralogy, content of organic matter, and geochemical factors (Chapter 11). Variations in these parameters cause wide variations in the amount of compaction suffered by different muds at the same burial depth (Fig. 12-7). Coarser grain size correlates with increased quartz/clay ratio and hence reduced compaction. High rates of deposition can result in the formation of clay "seals" above sand units, which destroy vertical permeability and cause the formation of excess pore pressure

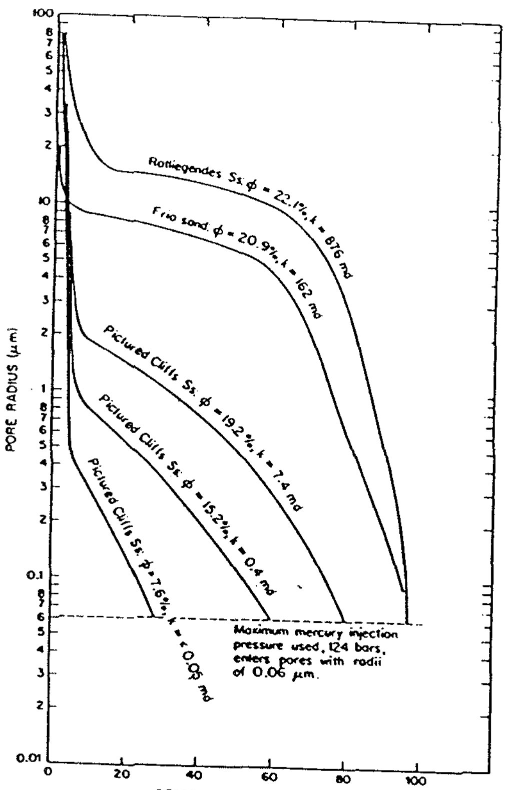


Fig. 12-3 Relationships among total porosity (ϕ), permeability (k), and pore radius of five sandstone cores (courtesy of Amoco Production Company). Total porosity determined by gas expansion. For the three relatively impermeable sandstones, the majority of the pore throat radii are less than 0.5 μm.

to 0.01 μm or less at a depth of 3000 m. These values are an order of magnitude smaller than those typical of sandstones (see Fig. 12-3).

The quantitative significance of the sorting of sand grains on porosity of a sandstone was studied experimentally by Beard and Weyl (1973) for gaussian distributions. Porosity was essentially independent of grain size but decreased sequentially as sorting decreased from 42.4% porosity in extremely well-sorted sands to 27.9% in very poorly sorted sands with no clay matrix. This result seems quite reasonable because smaller grains will lodge between the larger ones. Pryor (1973) found no significant change in the porosity of river, beach, and dune sands with change in standard deviation from 0.3ϕ to 1.6ϕ, but his core samples, unlike those in the Beard and Weyl study, were not homogeneous. Pryor's cores consisted of many thin, individually well-sorted laminae so that although porosity would be excellent, the sediment sorting determined in the laboratory might be good or poor for the core as a unit.

The porosity of a sandstone depends on postdepositional factors as well as those present at the time and site of deposition. As noted, the most important factors during deposition are clay content and the sorting of the sand fraction of the sediment. Of lesser importance are initial grain packing, sand mineralogy, mean grain size (assuming constant sorting), and grain angularity. Important postdepositional or diagenetic factors are degree of compaction and the formation of authigenic minerals.

Compaction

Upon burial, sands compact much less than mudrocks. The lesser compaction of sands results from two factors. First, the average sandstone is composed largely of quartz grains, and these grains are undeformable under most sedimentary conditions. Secondly, the finer particles that predominate in mudrocks are deposited with initially higher water contents and this water is quickly expelled. Many investigators have compacted quartz sands in the laboratory with the result that the thickness of the aggregate has decreased only 10 to 15% due to rearrangement of grains and chipping of grain corners.

The amount of compaction increases significantly with the proportion of ductile rock fragments in the detrital fraction of the sand. Such particles as shale, slate, phyllite, and schist deform easily at shallow depth, decreasing porosity (see below) and thinning the stratigraphic section. This decrease in porosity is noticeable in well logs and was first studied in thin sections of subsurface cores by Taylor (1950). She found that the proportions of the four different types of intergranular contacts changed with depth of burial (Fig. 12-4). Tangential contacts decreased rapidly in abundance with depth, whereas the other three types showed marked increases. Grains were being pushed close together as burial depth increased. Unfortunately, Taylor did not keep a close check on changes in mineral composition with depth; so we cannot be certain how much of the increased closeness of grains was due to plastic deformation of elongate ductile fragments and how much tance. Tortuosity in a sandstone is usually between 2 and 3; in loose sediment it is approximately one-half as large. The greater the tortuosity, the slower the flow of fluid through the pore system.

The physical principle on which the mercury injection method is based is that liquids forming contact angles on solid surfaces of more than 90° (i.e., nonwetting fluids) cannot penetrate into small pores unless the injection pressure exceeds the capillary pressure. The higher the injection pressure, the smaller the pores that can be penetrated by the liquid. In circular pores with radius r the surface tension σ acts along the perimeter of the circle with the force $-2\pi r\sigma$. The force counteracting the intrusion of the liquid parallel to the axis of the pore is $-2\pi r\sigma \cos \lambda$, where λ is the angle of contact. The force caused by the injection pressure p is $\pi r^2 p$. For equilibrium, we obtain

$$-2\pi r\sigma \cos \lambda = \pi r^2 p$$

or

$$r = -\frac{2\sigma \cos \lambda}{p}$$

The surface tension of mercury is 484.2 dynes/cm at 25°C, and the angle of contact of mercury on silicate mineral surfaces has been determined experimentally to approximate 141.3°. Using these values,

$$r = \frac{7.6}{p}$$

when pressure is measured in bars and pore radii in micrometers (Fig. 12-2). Using this relationship, mercury injection of a core yields the volume percentage of pore throats of any given size in the rock sample (Fig. 12-3).

The porosity of mudrocks varies over essentially the same range as in sandstones, from zero to about 40%, but the definition of porosity in a mudrock is not as clear-cut as in the coarser-grained rocks. Indeed, the definition and measurement of porosity in mudrocks present problems not encountered in sandstones. In a sandstone composed primarily of quartz and similar minerals, the boundary between pore space and grain is reasonably well defined. For example, if the pore space is filled with water, then this free or movable water represents the porosity. The proportion of adsorbed or bound water is usually negligible because the specific surface of such minerals as quartz is only 1 to 2 m^2/g of sediment. (Compare with clay minerals below.) In subsurface studies, logging methods that measure total hydrogen concentration, such as neutron logging, effectively measure the porosity. But mudrocks present a more complex problem. Many of the clay minerals contain water as part of their structure, and this water certainly should be considered part of the solid rather than part of the pore space. In addition, water adsorbed on the surface of the clay flakes normally is not free to move, and water may form a large percentage of the total water between clay flakes in mudrock. This situation occurs because the specific surface of clay minerals is very large, on the order of tens of square meters per gram. Within the space between the grains and their adsorbed water, however, there exists free water

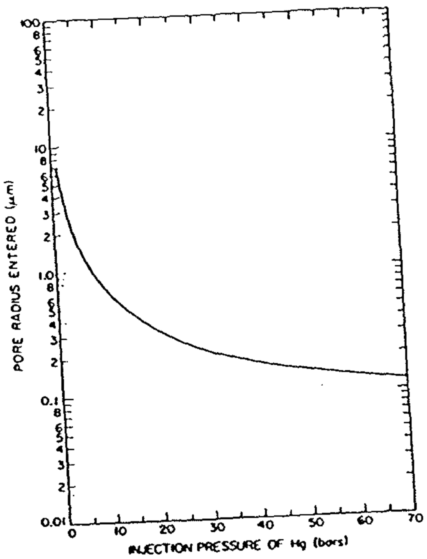


Fig. 12-2 Relationship between injection pressure of mercury into a core and the radii of pore throats that are penetrated.

capable of moving or being easily removed by compaction. Thus when we speak of mudrock porosity, we usually mean the percentage of the total volume of the rock that contains free or easily movable water. It is usually measured by mechanically compacting the rock and measuring the amount of fluid removed or the percentage of volume reduction. These methods are, at best, an approximation of the true pore volume because of the possibility of altering the water content of the clay flakes or the amount of adsorbed water during the analysis.

The critical differences in pore characteristics between sandstones and mudrocks are the sizes and shapes of the pores. Particularly in fissile mudrocks (shales), the clay mineral flakes that form 60% of the mineral grains are oriented in parallel and hence pore spaces are dominantly tabular. Furthermore, because flat flakes can be very closely packed, pore sizes are much smaller. Heling (1970) studied the fabric of Tertiary shales from the Rhinegraben that were buried to depths up to 3400 m. Pore radii decreased from an average of 0.04 μm at a depth of 100 m

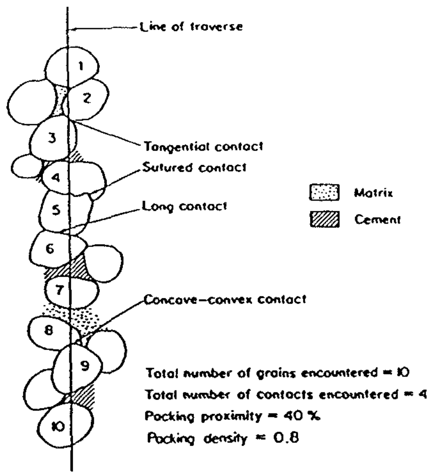


Fig. 12-1 Definition of grain contact types and packing proximity. (After J. M. Taylor, 1950, *Amer. Assoc. Pet. Geol. Bull.*, 34, p. 711, 712, and J. S. Kahn, 1956, *Jour. Geol.*, 64, p. 393).

grain volume; and effective porosity, the ratio of interconnected void volume to total rock volume. In detrital silicate rocks, effective porosity is usually only slightly less than total porosity.

Methods of Measurement

Cores of rocks used for porosity determination are normally cylinders one inch long and one inch in diameter. The porosity can be easily determined by gas expansion, using Boyle's law. Alternatively, the grain density can be assumed (2.65) and the porosity determined by weighing a sample saturated with a fluid of known density. These experimental methods are suitably accurate and are the standards for calibration of all other porosity-determining methods, such as point counts in rock thin sections or subsurface logging techniques. An important point to keep in mind, however, is that the porosity of 13 cm^3 of rock may not be representative of a rock unit millions of times larger in volume, particularly because field observations reveal that porosities can vary greatly over small distances with such factors as clay mineral or rock fragment content.

The use of subsurface logging techniques (sonic, density, neutron) can sometimes produce porosity values within 1% of the value obtained on the same rock in a core sample. The advantages of logging methods over core analysis for porosity determination lie in the much larger volume of rock "sampled," perhaps 100 times larger than the laboratory core, and in the fact that the measurement is made *in situ*, before overburden pressure is removed. In addition, there is the matter of cost. Electric logs are made of all wells, but cores are taken in relatively few.

In most sandstones the bulk of pore space has diameters less than the 30 μm thickness of a standard thin section and so is difficult or impossible to detect during examination of the slide unless special techniques are used. The usual technique is to vacuum-impregnate the rock slice with a colored epoxy before thin sectioning so that even extremely narrow pores that intersect the plane of the thin section become visible in uncrossed nicols. This technique, now standard in industry laboratories, also makes it possible to distinguish between pores produced by diagenetic dissolution of detrital grains and pseudopores produced by grain plucking during grinding of the thin section.

Pore Sizes, Geometry, and Measurement

Pores are irregularly shaped cavities in a rock; therefore any definition of their "size" is an approximation based on the measurement technique used to determine it. In some cases, it is possible to vacuum-impregnate a porous rock with either a molten plastic or metal and then dissolve the rock by using suitable reagents to produce a "negative image" of the rock—that is, its three-dimensional pore network (Swanson, 1979). This technique, although useful for some research purposes, is impractical as a standard method.

The distribution of pore sizes in a rock sample is determined generally by injection of mercury into the rock. The sizes of pores determined in this way are actually the sizes of the pore "throats" or narrow connections between large pores. It is the sizes of the throats that control the flow of fluid through rocks, whether the flow is of mercury during measurement of porosity or is water, petroleum, or natural gas in the subsurface. One deficiency of the mercury injection technique is that if a large pore, such as a vug, is entered by fluid through a narrow throat, the large vug will be included within the volume of pore space represented by the throat size. A second deficiency is that not all pores can be invaded by the mercury because they may be shielded by other smaller pores whose displacement pressure is not exceeded.

The individual pore may be tubular like a capillary tube; or it may be nodular and feather out into the bounding constrictions between nodules; or it may be a thin, intercrystalline tabular opening that is 50 to 100 times as wide as it is thick. The wall of the pore may be clean quartz, feldspar, or calcite; or it may be coated with clay mineral particles, platey accessory minerals, or rock fragments. The crookedness of the pore pattern, called the *tortuosity*, is the ratio between the distance between two points by way of the connected pores and the straight-line dis-

CHAPTER 12

POROSITY AND PERMEABILITY OF DETRITAL ROCKS

12.1 INTRODUCTION

The porosity and permeability of sandstones and mudrocks have been generally neglected by academic geologists. Most of our knowledge in this area comes from the petroleum industry as part of its effort to locate reserves of oil and gas. It is strange that few geologists outside of industry have investigated the porosities and permeabilities of detrital rocks, for these variables control most diagenetic processes in rocks. Without adequate permeability to water there can be little cementation of sandstones, diagenetic alteration of heavy minerals, conversion of smectite to illite, or the myriad of other processes that affect rock after burial. Pore space and permeability are basic aspects of rock fabric and should be studied as a normal part of a petrologic investigation.

12.2 FABRIC

The term *fabric* is reserved for "the manner of mutual arrangement in space of the components of a rock body and of the boundaries between these components" (*International Tectonics Dictionary*). It thus includes both the packing

and orientation of grains. Grain packing strongly affects both porosity and permeability and grain orientation affects the permeability (Sec. 12.4).

The least-studied aspect of fabric is *packing*, "the spacing or density pattern of mineral grains in a rock" (AGI Glossary). The meaning of packing and its distinction from other aspects of fabric, such as orientation, is most clearly seen for the case of a sediment composed of perfect spheres uniform in size. Even in this highly idealized case it has been shown that there are six different systematic ways of arranging the spheres so that each sphere is in contact with four or more adjacent spheres and there are no vacant positions. The arrangements vary from the "loosest" cubic packing with a porosity of 47.6% to the "tightest" rhombohedral packing with a porosity of 26.0%. The six regular packings do not exhaust the number of ways that spheres may, in fact, be packed because in nature an infinite number of combinations of the six and of "random" packings may also be developed.

Kahn (1956) devised two numerical measures for use in thin section studies.

1. The *packing density* is the ratio of the sum of the lengths of grain intercepts to the total length of the traverse across the thin section. It is a measure of the porosity of a cement-and matrix-free sand or of the "matrix-cement-free porosity" of a sandstone that has some matrix and cement.
2. The *packing proximity* is the ratio of the number of grain-to-grain contacts (encountered in a traverse across the thin section) to the total number of contacts of all kinds encountered in the same traverse (Fig. 12-1). If the grains have only small areas of contact with each other, most of the contacts observed in a thin section will be contacts between a grain and matrix or cement; so the packing proximity will be small. In a rock in which there has been compaction without the introduction of much cement, most of the grain contacts observed will be grain-to-grain contacts and the packing proximity will be large.

The type of contact between grains can also be studied in thin section. In the ideal case of packed spheres, the only observed contacts between grains would be tangential ones. But in the case of nonspherical grains or where compaction has taken place, three other types of contacts can be observed (Taylor, 1950). The four possible types of contacts are (a) tangential, (b) long—that is, a contact that appears as a straight line in the plane of section, (c) concavoconvex, and (d) sutured. The frequency of concavoconvex and sutured contacts relative to that of other types of contacts has been used as a measure of the intensity of compaction of sands.

12.3. POROSITY

Several terms are widely used to indicate the amount of pore space in a rock. The most common are porosity, the ratio of void volume to total rock volume (multiplied by 100 to form a percentage); void ratio, the ratio of pore volume to

APPENDIX G

Slope Stability

PURPOSE:

Stability Analysis of the Side Slopes of the Cover

The purpose of this calculation brief is to evaluate stability of the side slopes of the cover for the uranium tailings impoundments. The sides of the covers are sloped at 5H:1V. From the old drawings as published by UMETCO (section B-B), the side slope for Cell 4 is the tallest. Also, along the southern section of Cell 4, the ground elevation drops rapidly. Hence the side slopes of the cover located along the southern side of Cell 4 are assumed to be critical and considered for stability analysis.

METHODOLOGY:

Static and pseudostatic slope stability analyses have been performed for the slope geometry as shown in Figure 1. The limit equilibrium slope stability code GSLOPE, developed by MITRE Software Corporation has been used for these analyes. The Bishop's method of slices has been applied.

Geometry and Material Properties

Along the southern end of Cell 4, the topography drops at a rate of approximately 5.5% (Figure 2). The material properties as provided by Dames and Moore, 1978, have been used for these analyses. The material properties have been listed in Table 1, below.

Material No.	Type of Material	Unit weight, γ (pcf)	Cohesion, c (psf)	Angle of friction, ϕ (degrees)
1	Earthfill	123	0	30
2	Tailings	62.4	0	0
3	Dike	123	0	30
4	Foundation	120	0	28
5	Bedrock	130	10,000	45

Table 1: Material Properties

The surface of the bedrock has been determined from the bore-logs as supplied by Chen and Associates, 1978. But as this bedrock surface almost coincides with that of the foundation, assuming the bedrock layer to be about 10 ft. below the lowest point of the foundation surface, will give conservative results. Thus, for the stability analysis, the surface of competent bedrock has been assumed to be at an elevation of +5540 ft. above mean sea level (MSL).

Factor of Safety and Horizontal Acceleration required for analysis:
A factor of safety of 1.5 and 1.0 are respectively acceptable for static and pseudostatic analyses. Pseudostatic slope stability analysis has been performed for a maximum seismic coefficient of 0.1g.

RESULTS:

Results of the stability analyses have been presented in this calculation document.
Results for Static case: For static analysis, the maximum Factor of Safety calculated is 2.91 (>1.5).
Results for Pseudostatic case: For pseudostatic analysis, the maximum Factor of Safety calculated is 1.903 (>1.0) for a ground acceleration of 0.1g.

Hence the side slopes are stable.

REFERENCE:

a) Chen and Associates, Inc., 1978. Soil Property Study, Earth Lined Tailings Retention Cells, White Mesa Uranium Project, Blanding, Utah.

b) Dames and Moore, 1978. Site Selection and Design Study - Tailing Retention and Mill Facilities, White Mesa Uranium Project, January 17, 1978.

c) "GSLOPE Limit Equilibrium Slope Stability Analysis", Mitre Software Corporation, Alberta, Canada

RESULTS OF RUN BY "GSLOPE" ANALYSIS

Material	Unit Wt pcf	C psf	Phi deg	Piezo Surf.	Ru
Earthfill	123	0	30	0	0
Tailings	62.4	0	0	0	0
Dike	123	0	30	0	0
Foundation	120	0	28	0	0
Bedrock	130	10000	45	0	0

Titan Environmental - Bozeman MT

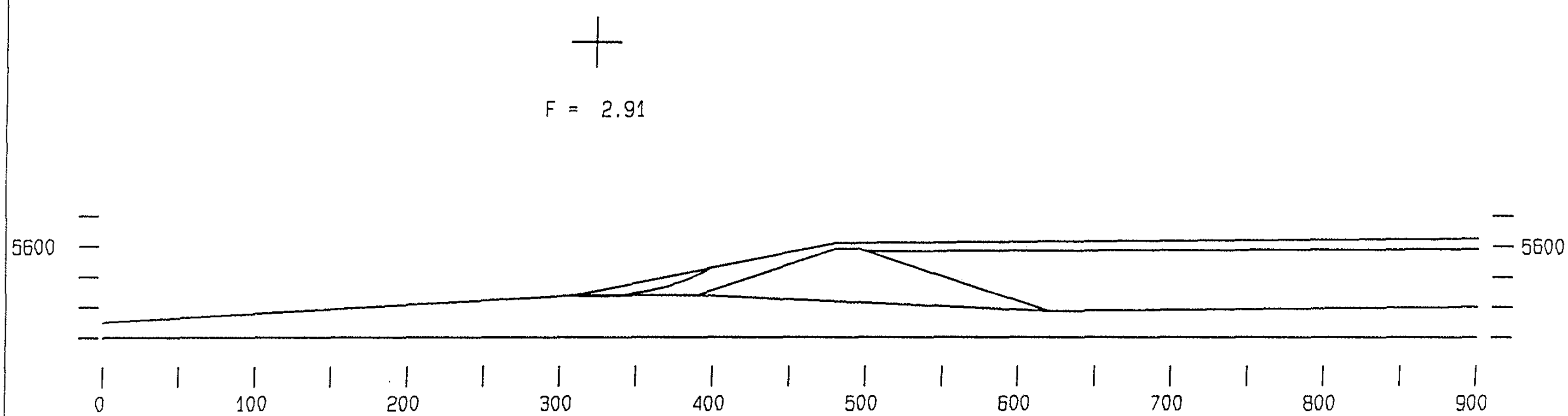
6111.001

EFN White Mesa Slope Stability

7/1996

Static Analysis

WHTMESA1.GSL



DATA FILE NAME..... C:\STABLITY\GSLOPE\WHTMESA1.GSL

Job No.	6111.001
Title	EFN White Mesa Slope Stability
Date	7/1996
Label A	Static Analysis
Label B	

Max Slice Width	10
Set Neg. Normals to zero	Y
No. of Materials	5
Seismic Acceleration	0
External Forces	0
Piezometric Surfaces	0
Unit Wt. of Pore Fluid	62.4

Material	Unit Wt	Cohesion	Friction Angle	Piezo Surface	Ru Value
# 1 -Earthfill	123	0	30	0	0
# 2 -Tailings	62.4	0	0	0	0
# 3 -Dike	123	0	30	0	0
# 4 -Foundation	120	0	28	0	0
# 5 -Bedrock	130	10000	45	0	0

Upper Surface of Material # 1 (Earthfill)

X-Coord	Y-Coord
0	5550.5
310	5568
480	5602
900	5605

Upper Surface of Material # 2 (Tailings)

X-Coord	Y-Coord
0	5550.5
310	5568
390	5568
480	5598
495	5598
500	5596.5
900	5598

Upper Surface of Material # 3 (Dike)

X-Coord	Y-Coord
0	5550.5
[illegible]	5568
390	5568
480	5598
495	5598

500	5596.5
620	5557.5
900	5560

Upper Surface of Material # 4 (Foundation)

X-Coord	Y-Coord
0	5550.5
310	5568
390	5568
620	5557.5
900	5560

Upper Surface of Material # 5 (Bedrock)

X-Coord	Y-Coord
0	5540
900	5540

There are no explicit external forces in the data set.

GSLOPE 3.26a

LIMIT EQUILIBRIUM SLOPE STABILITY ANALYSIS

Licensed by MITRE Software Corporation, Edmonton, Canada for use at:-

Titan Environmental - Bozeman MT

Results are for Bishop's Modified Method unless otherwise noted.

File C:\STABLITY\GSLOPE\WHTMESA1.GSL   Output dated 07-03-1996 at 11:55:05

Material	Unit Wt	Cohesion	Friction Angle	Piezo Surface	Ru Value
# 1 -Earthfill	123	0	30	0	0
# 2 -Tailings	62.4	0	0	0	0
# 3 -Dike	123	0	30	0	0
# 4 -Foundation	120	0	28	0	0
# 5 -Bedrock	130	10000	45	0	0

X-centre	Y-centre	Radius	Factor of Safety	Iterations	Slices	M Alpha Warnings
322.60	5732.50	165.50	2.9103	4	11	0
22.91	5732.50	165.50	2.9101	4	11	0
323.23	5732.50	165.50	2.9164	4	12	0
322.60	5733.13	166.13	2.9101	4	11	0
322.91	5733.13	166.13	2.9159	4	12	0
323.23	5733.13	166.13	2.9164	4	12	0
322.60	5733.75	166.75	2.9099	4	11	0
322.91	5733.75	166.75	2.9160	4	12	0
323.23	5733.75	166.75	2.9164	4	12	0

Minimum Bishop Factor of Safety this run:

322.60	5733.75	166.75	2.9099	4	11	0

Material	Unit Wt	C	Phi	Piezo	Ru
	pcf	psf	deg	Surf.	
Earthfill	123	0	30	0	0
Tailings	62.4	0	0	0	0
Dike	123	0	30	0	0
Foundation	120	0	28	0	0
Bedrock	130	10000	45	0	0

Seismic coefficient = .1

Titan Environmental - Bozeman MT

6111.001

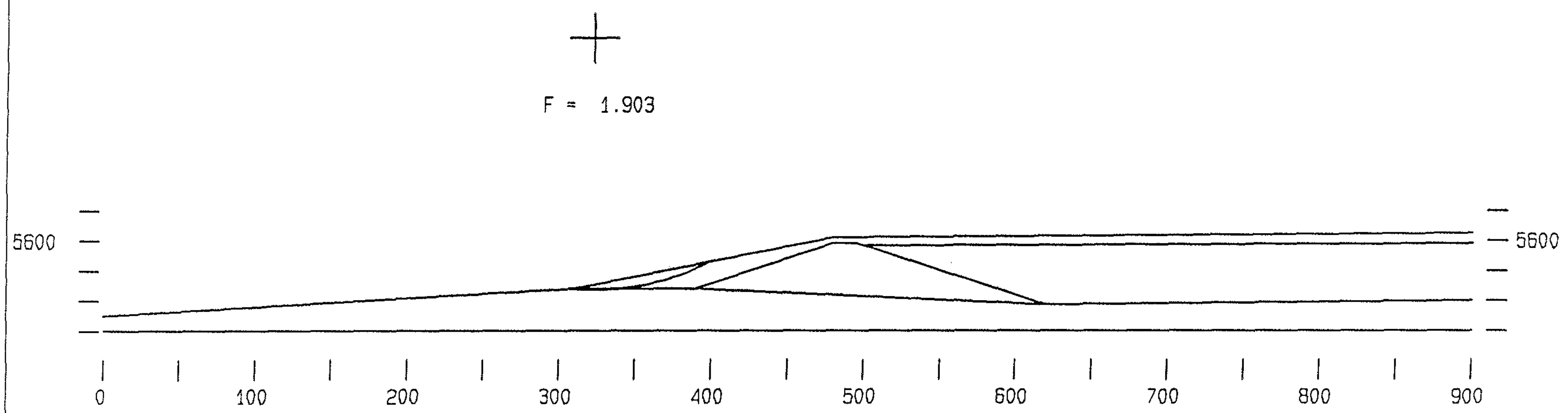
EFN White Mesa Slope Stability

7/1996

Pseudostatic Analysis

ground accln. = 0.1g

WHTMESA2.GSL



DATA FILE NAME..... C:\STABLITY\GSLOPE\WHTMESA2.GSL

J No.	6111.001
le	EFN White Mesa Slope Stability
Date	7/1996
Label A	Pseudostatic Analysis
Label B	ground accln. = 0.1g

Max Slice Width	10
Set Neg. Normals to zero	Y
No. of Materials	5
Seismic Acceleration	.1
External Forces	0
Piezometric Surfaces	0
Unit Wt. of Pore Fluid	62.4

Material	Unit Wt	Cohesion	Friction Angle	Piezo Surface	Ru Value
# 1 -Earthfill	123	0	30	0	0
# 2 -Tailings	62.4	0	0	0	0
# 3 -Dike	123	0	30	0	0
# 4 -Foundation	120	0	28	0	0
# 5 -Bedrock	130	10000	45	0	0

Upper Surface of Material # 1 (Earthfill)

X-Coord	Y-Coord
0	5550.5
310	5568
480	5602
900	5605

Upper Surface of Material # 2 (Tailings)

X-Coord	Y-Coord
0	5550.5
310	5568
390	5568
480	5598
495	5598
500	5596.5
900	5598

Upper Surface of Material # 3 (Dike)

X-Coord	Y-Coord
[illegible]	5550.5
[illegible]	5568
390	5568
480	5598
495	5598

500	5596.5
620	5557.5
900	5560

Upper Surface of Material # 4 (Foundation)

X-Coord	Y-Coord
0	5550.5
310	5568
390	5568
620	5557.5
900	5560

Upper Surface of Material # 5 (Bedrock)

X-Coord	Y-Coord
0	5540
900	5540

There are no explicit external forces in the data set.

GSLOPE 3.26a

LIMIT EQUILIBRIUM SLOPE STABILITY ANALYSIS

Licensed by MITRE Software Corporation, Edmonton, Canada for use at:-

Titan Environmental - Bozeman MT

Results are for Bishop's Modified Method unless otherwise noted.

File C:\STABLITY\GSLOPE\WHTMESA2.GSL Output dated 07-03-1996 at 12:14:06

Material	Unit Wt	Cohesion	Friction Angle	Piezo Surface	Ru Value
# 1 -Earthfill	123	0	30	0	0
# 2 -Tailings	62.4	0	0	0	0
# 3 -Dike	123	0	30	0	0
# 4 -Foundation	120	0	28	0	0
# 5 -Bedrock	130	10000	45	0	0

X-centre	Y-centre	Radius	Factor of Safety	Iterations	Slices	M Alpha Warnings
22.60	5732.50	165.50	1.9036	4	11	0
322.60	5732.50	166.13	1.9067	4	12	0
322.60	5732.50	164.88	1.9160	4	11	0
		MIN THIS CENTRE	1.903			
322.91	5732.50	165.50	1.9037	4	11	0
322.91	5732.50	166.13	1.9067	4	12	0
322.91	5732.50	164.88	1.9163	4	11	0
		MIN THIS CENTRE	1.903			
323.23	5732.50	165.50	1.9066	4	12	0
323.23	5732.50	166.13	1.9068	4	12	0
323.23	5732.50	164.88	1.9165	4	11	0
		MIN THIS CENTRE	1.906			
322.60	5733.13	166.13	1.9035	4	11	0
322.60	5733.13	166.75	1.9067	4	12	0
322.60	5733.13	165.50	1.9160	4	11	0
		MIN THIS CENTRE	1.903			
322.91	5733.13	166.13	1.9062	4	12	0
322.91	5733.13	166.75	1.9067	4	12	0
322.91	5733.13	165.50	1.9162	4	11	0
		MIN THIS CENTRE	1.906			

323.23	5733.13	166.13	1.9066	4	12	0
323.23	5733.13	166.75	1.9067	4	12	0
323.23	5733.13	165.50	1.9164	4	11	0
		MIN THIS CENTRE	1.906			
322.60	5733.75	166.75	1.9034	4	11	0
322.60	5733.75	167.38	1.9067	4	12	0
322.60	5733.75	166.13	1.9159	4	11	0
		MIN THIS CENTRE	1.903			
322.91	5733.75	166.75	1.9062	4	12	0
322.91	5733.75	167.38	1.9067	4	12	0
322.91	5733.75	166.13	1.9161	4	11	0
		MIN THIS CENTRE	1.906			
323.23	5733.75	166.75	1.9066	4	12	0
323.23	5733.75	167.38	1.9066	4	12	0
323.23	5733.75	166.13	1.9163	4	11	0
		MIN THIS CENTRE	1.906			

Minimum Bishop Factor of Safety this run:

322.60	5733.75	166.75	1.9034	4	11	0

PURPOSE:

Pseudostatic Slope Stability Analysis of the Side Slopes of the Cover for horizontal acceleration of 0.12g

The purpose of this calculation brief is to evaluate pseudostatic stability of the side slopes of the cover for the uranium tailings impoundments for a horizontal ground acceleration of 0.12g. The sides of the covers are sloped at 5H:1V. From the old drawings as published by UMETCO (section B-B), the side slope for Cell 4 is the tallest. Also, along the southern section of Cell 4, the ground elevation drops rapidly. Hence the side slopes of the cover located along the southern side of Cell 4 are assumed to be critical and considered for stability analysis.

METHODOLOGY:

Pseudostatic slope stability analyses have been performed for the slope geometry as shown in Figure 1. The limit equilibrium slope stability code GSLOPE, developed by MITRE Software Corporation has been used for these analyes. The Bishop's method of slices has been applied.

Geometry and Material Properties

Along the southern end of Cell 4, the topography drops at a rate of approximately 5.5% (Figure 2). The material properties as provided by Dames and Moore, 1978, have been used for these analyses. The material properties have been listed in Table 1, below.

Material No.	Type of Material	Unit weight, γ (pcf)	Cohesion, c (psf)	Angle of friction, ϕ (degrees)
1	Earthfill	123	0	30
2	Tailings	62.4	0	0
3	Dike	123	0	30
4	Foundation	120	0	28
5	Bedrock	130	10,000	45

Table 1: Material Properties

The surface of the bedrock has been determined from the bore-logs as supplied by Chen and Associates, 1978. But as this bedrock surface almost coincides with that of the foundation, assuming the bedrock layer to be about 10 ft. below the lowest point of the foundation surface, will give conservative results. Thus, for the stability analysis, the surface of competent bedrock has been assumed to be at an elevation of +5540 ft. above mean sea level (MSL).

Factor of Safety and Horizontal Acceleration required for analysis:

A factor of safety of 1.0 is acceptable for pseudostatic. Pseudostatic slope stability analysis has been performed for a maximum seismic coefficient of 0.12g as recommended by the Lawrence Livermore National Laboratory.

RESULTS:

Results for Pseudostatic case: For pseudostatic analysis, the maximum Factor of Safety calculated is 1.778 (>1.0) for a ground acceleration of 0.12g.

Hence the side slopes are stable.

REFERENCE:

a) Chen and Associates, Inc., 1978. Soil Property Study, Earth Lined Tailings Retention Cells, White Mesa Uranium Project, Blanding, Utah.

b) Dames and Moore, 1978. Site Selection and Design Study - Tailing Retention and Mill Facilities, White Mesa Uranium Project, January 17, 1978.

c) Report by "Lawrence Livermore Natioal Laboratory"

d) "GSLOPE Limit Equilibrium Slope Stability Analysis", Mitre Software Corporation, Alberta, Canada

Material	Unit Wt pcf	C psf	Phi deg	Piezo Surf.	Ru
Earthfill	123	0	30	0	0
Tailings	62.4	0	0	0	0
Dike	123	0	30	0	0
Foundation	120	0	28	0	0
Bedrock	130	10000	45	0	0

Seismic coefficient = .12

Titan Environmental - Bozeman MT

6111.001

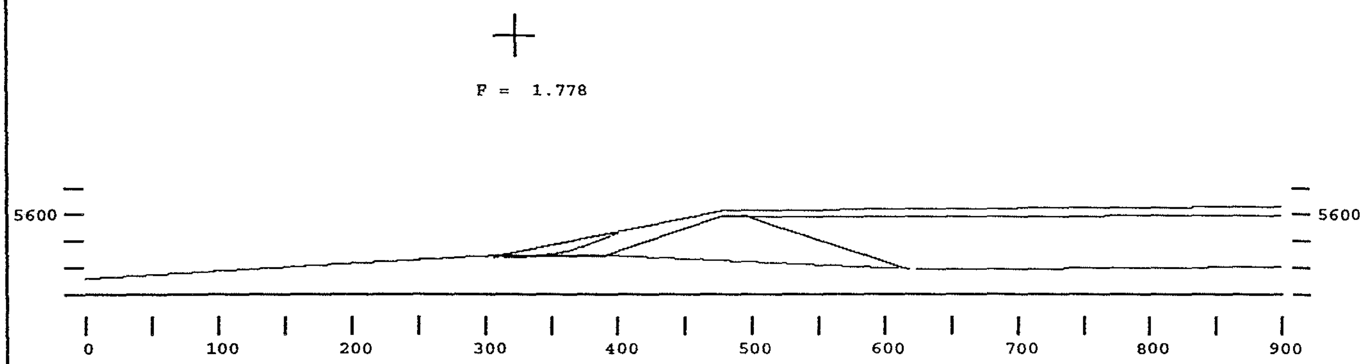
EFN White Mesa Slope Stability

7/1996

Pseudostatic Analysis

ground accln. = 0.12g

WHTMESA4.GSL



DATA FILE NAME..... C:\STABLITY\GSLOPE\....MESA4.GSL

Job No.	BA 9/96	6111.001
Title		EFN White Mesa Slope Stability
Date		7/1996
Label A		Pseudostatic Analysis
Label B		ground accln. = 0.12g

Max Slice Width	10
Set Neg. Normals to zero	Y
No. of Materials	5
Seismic Acceleration	.12
External Forces	0
Piezometric Surfaces	0
Unit Wt. of Pore Fluid	62.4

Material	Unit Wt	Cohesion	Friction Angle	Piezo Surface	Ru Value
# 1 -Earthfill	123	0	30	0	0
# 2 -Tailings	62.4	0	0	0	0
# 3 -Dike	123	0	30	0	0
# 4 -Foundation	120	0	28	0	0
# 5 -Bedrock	130	10000	45	0	0

U Surface of Material # 1 (Earthfill)

X-Coord	Y-Coord
0	5550.5
310	5568
480	5602
900	5605

Upper Surface of Material # 2 (Tailings)

X-Coord	Y-Coord
0	5550.5
310	5568
390	5568
480	5598
495	5598
500	5596.5
900	5598

Upper Surface of Material # 3 (Dike)

X-Coord	Y-Coord
0	5550.5
310	5568
390	5568
[illegible]	5598
[illegible]	5598
500	5596.5
620	5557.5
900	5560

Upper Surface of Material # 4 (Founda[illegible]n)

X-Coord	Y-Coord
0	5550.5
310	5568
390	5568
	5557.5
	5560

Upper Surface of Material # 5 (Bedrock)

X-Coord	Y-Coord
0	5540
900	5540

There are no explicit external forces in the data set.

PTA 9/9/96

BA 9/96

GSLOPE 3.26a

LIMIT EQUILIBRIUM SLOPE STABILITY ANALYSIS

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Titan Environmental - Bozeman MT

Results are for Bishop's Modified Method unless otherwise noted.

File C:\STABLITY\GSLOPE\WHTMESA4.GSL   Output dated 08-28-1996 at 13:09:05

Material	Unit Wt	Cohesion	Friction Angle	Piezo Surface	Ru Value
# 1 -Earthfill	123	0	30	0	0
# 2 -Tailings	62.4	0	0	0	0
# 3 -Dike	123	0	30	0	0
# 4 -Foundation	120	0	28	0	0
# 5 -Bedrock	130	10000	45	0	0

X-centre	Y-centre	Radius	Factor of Safety	Iterations	Slices	M Alpha Warnings
322.60	5732.50	165.50	1.7777	4	11	0
22.91	5732.50	165.50	1.7778	4	11	0
323.23	5732.50	165.50	1.7804	4	12	0
322.60	5733.13	166.13	1.7777	4	11	0
322.91	5733.13	166.13	1.7801	4	12	0
323.23	5733.13	166.13	1.7804	4	12	0
322.60	5733.75	166.75	1.7776	4	11	0
322.91	5733.75	166.75	1.7801	4	12	0
323.23	5733.75	166.75	1.7804	4	12	0

Minimum Bishop Factor of Safety this run:

322.60	5733.75	166.75	1.7776	4	11	0

FIGURES

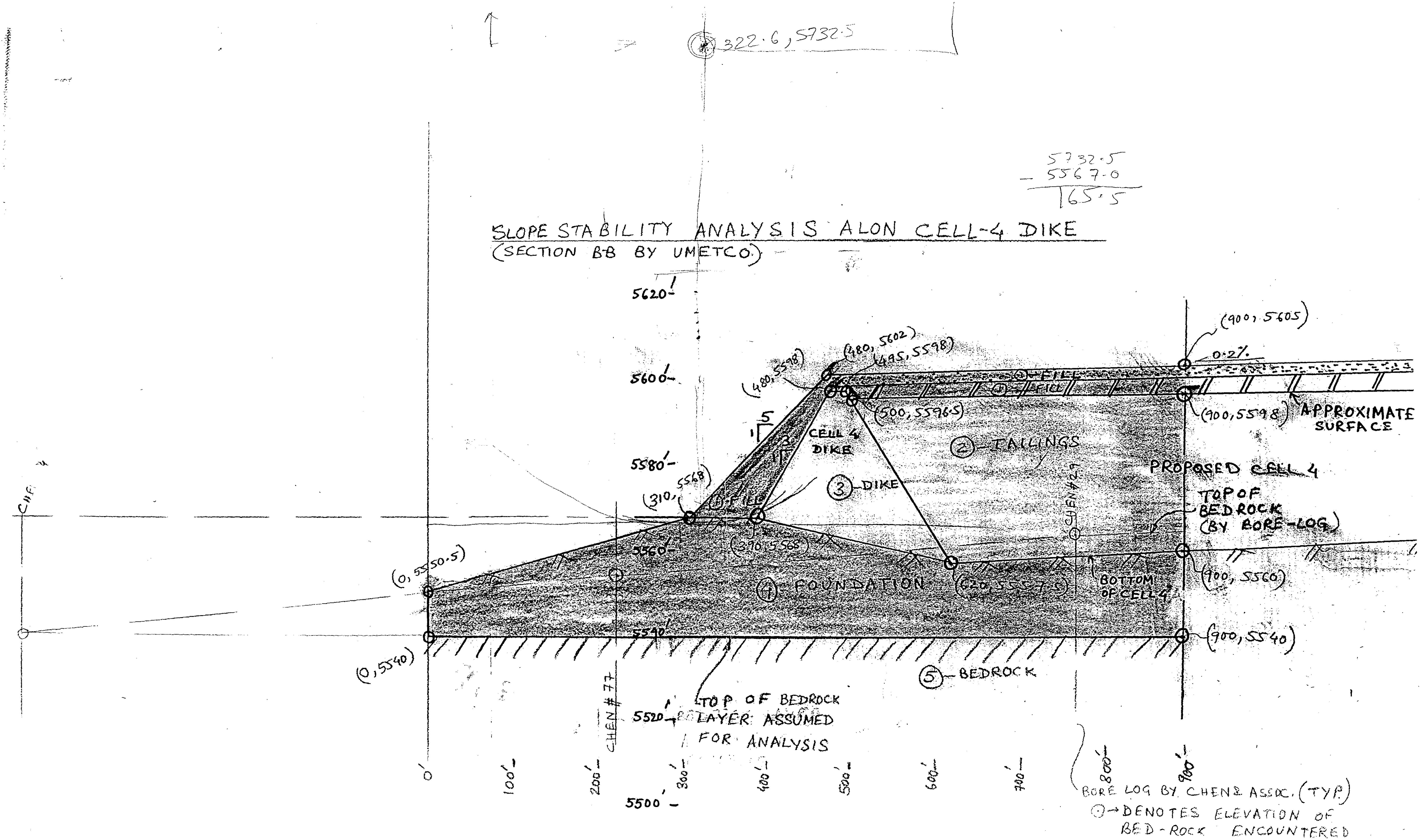
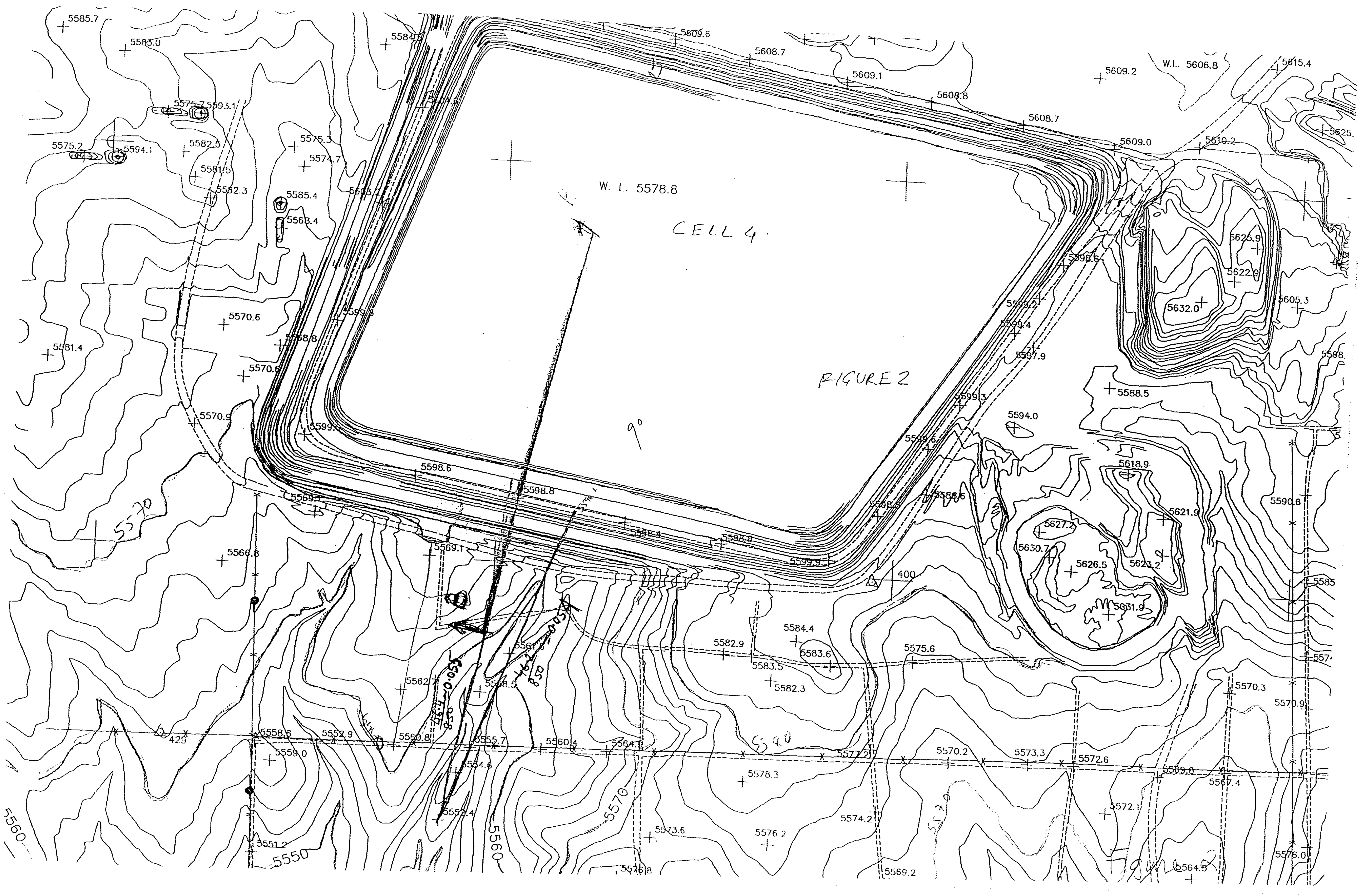


FIGURE 1

Figure 1


W. L. 5578.8
CELL 4.
FIGURE 2
W.L. 5606.8
5585.7
5583.0
5584.1
5609.6
5608.7
5609.1
5608.8
5608.7
5609.0
5610.2
5609.2
5615.4
5575.2
5594.1
5582.5
5575.3
5574.7
5581.5
5582.3
5585.4
5568.4
5603.2
5570.6
5568.8
5581.4
5570.9
5599.3
5598.6
5598.8
5598.4
5599.9
5598.6
5599.2
5599.4
5597.9
5599.3
5599.6
5594.0
5588.5
5625.9
5622.9
5632.0
5605.3
5618.9
5621.9
5627.2
5630.7
5626.5
5623.2
5590.6
5566.8
5569.1
400
5584.4
5582.9
5583.6
5583.5
5582.3
5575.6
5570.3
5570.9
429
5558.6
5552.9
5560.8
5555.7
5560.4
5564.9
5559.0
5554.6
5552.4
5578.3
5570.2
5573.3
5572.6
5567.4
5572.1
5574.2
5573.6
5576.2
5551.2
5569.2
5564.5
5576.0
5570
5560
5550
5580

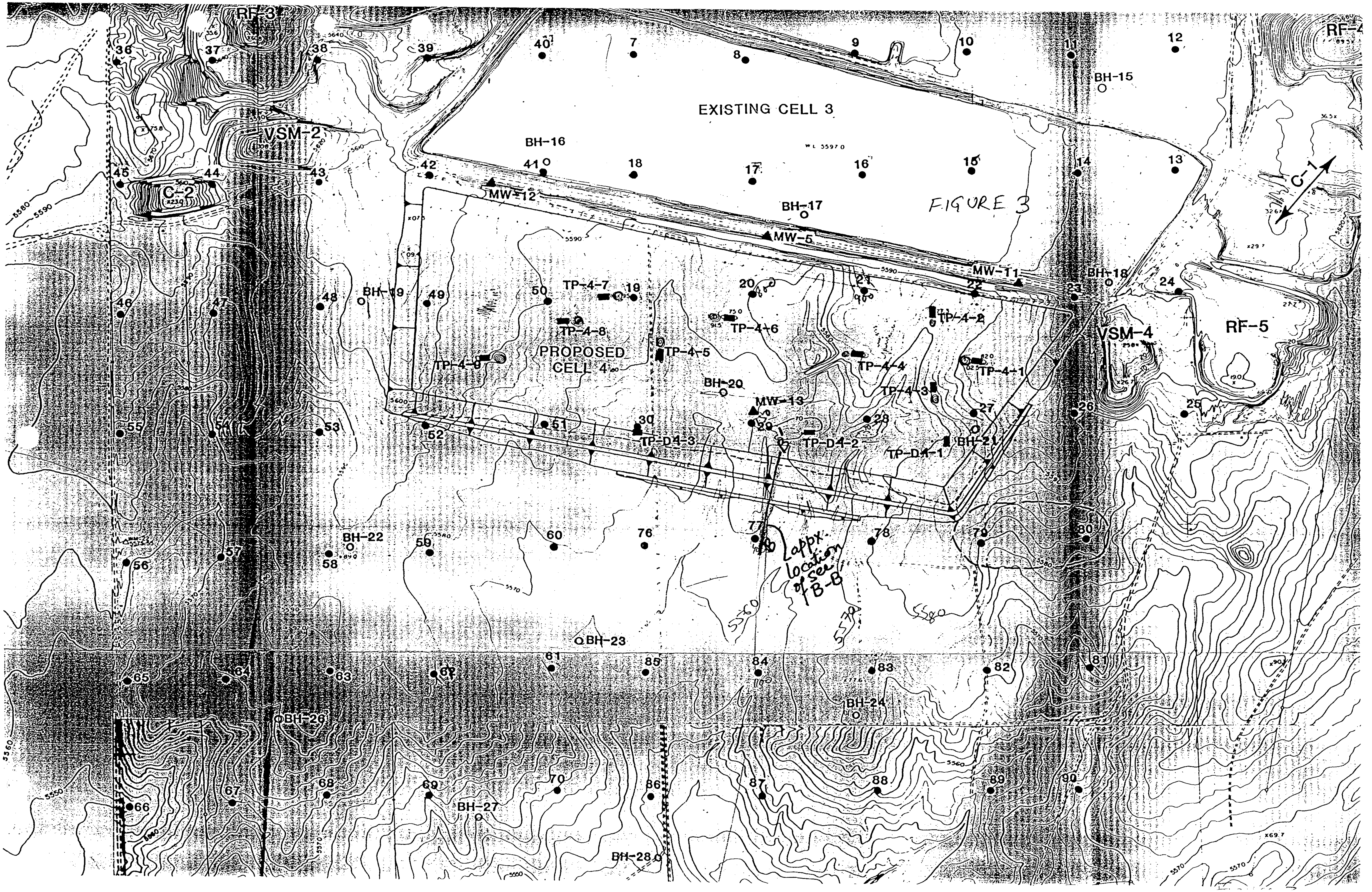


FIGURE 3
EXISTING CELL 3
PROPOSED CELL 4
RF-3
RF-4
RF-5
VSM-2
VSM-4
C-2
C-1
BH-15
BH-16
BH-17
BH-18
BH-19
BH-20
BH-21
BH-22
BH-23
BH-24
BH-26
BH-27
BH-28
MW-5
MW-11
MW-12
MW-13
TP-4-1
TP-4-2
TP-4-3
TP-4-4
TP-4-5
TP-4-6
TP-4-7
TP-4-8
TP-4-9
TP-D4-1
TP-D4-2
TP-D4-3
appx. location of sec. B-B

APPENDIX

chen and associates, inc.
CONSULTING ENGINEERS

SOIL & FOUNDATION ENGINEERING
96 S. ZUNI • DENVER, COLORADO 80223 • 303/744-7105
1924 EAST FIRST STREET • CASPER, WYOMING 82601 • 307/234-2126

SECTION 2

Extracted Data From

SOIL PROPERTY STUDY
EARTH LINED TAILINGS RETENTION CELLS
WHITE MESA URANIUM PROJECT
BLANDING, UTAH

Prepared for:

ENERGY FUELS NUCLEAR, INC.

PARK CENTRAL
1515 ARAPAHOE STREET
DENVER, COLORADO 80202

Job No. 16,406

July 18, 1978

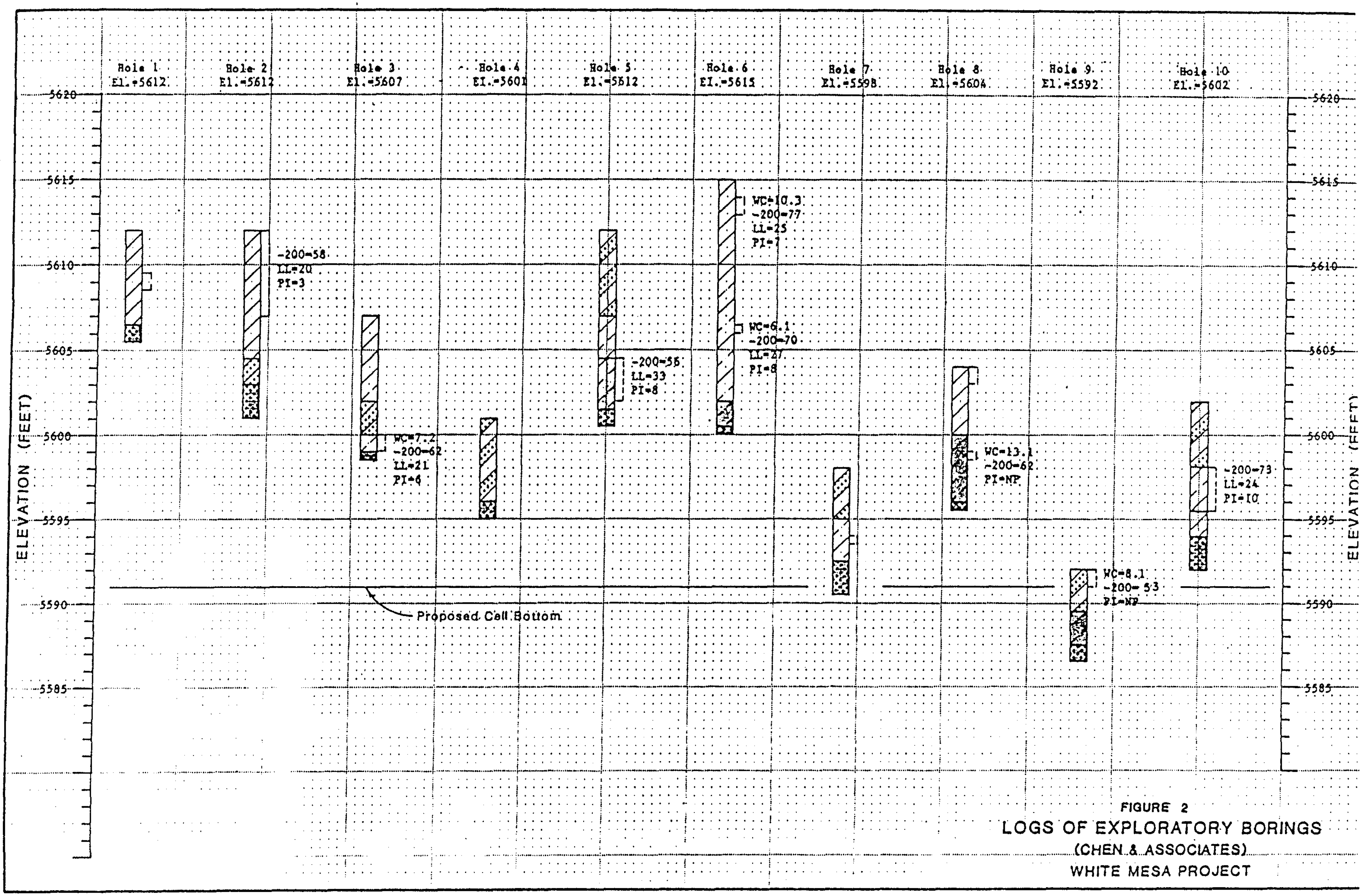


FIGURE 2
LOGS OF EXPLORATORY BORINGS
(CHEN & ASSOCIATES)
WHITE MESA PROJECT

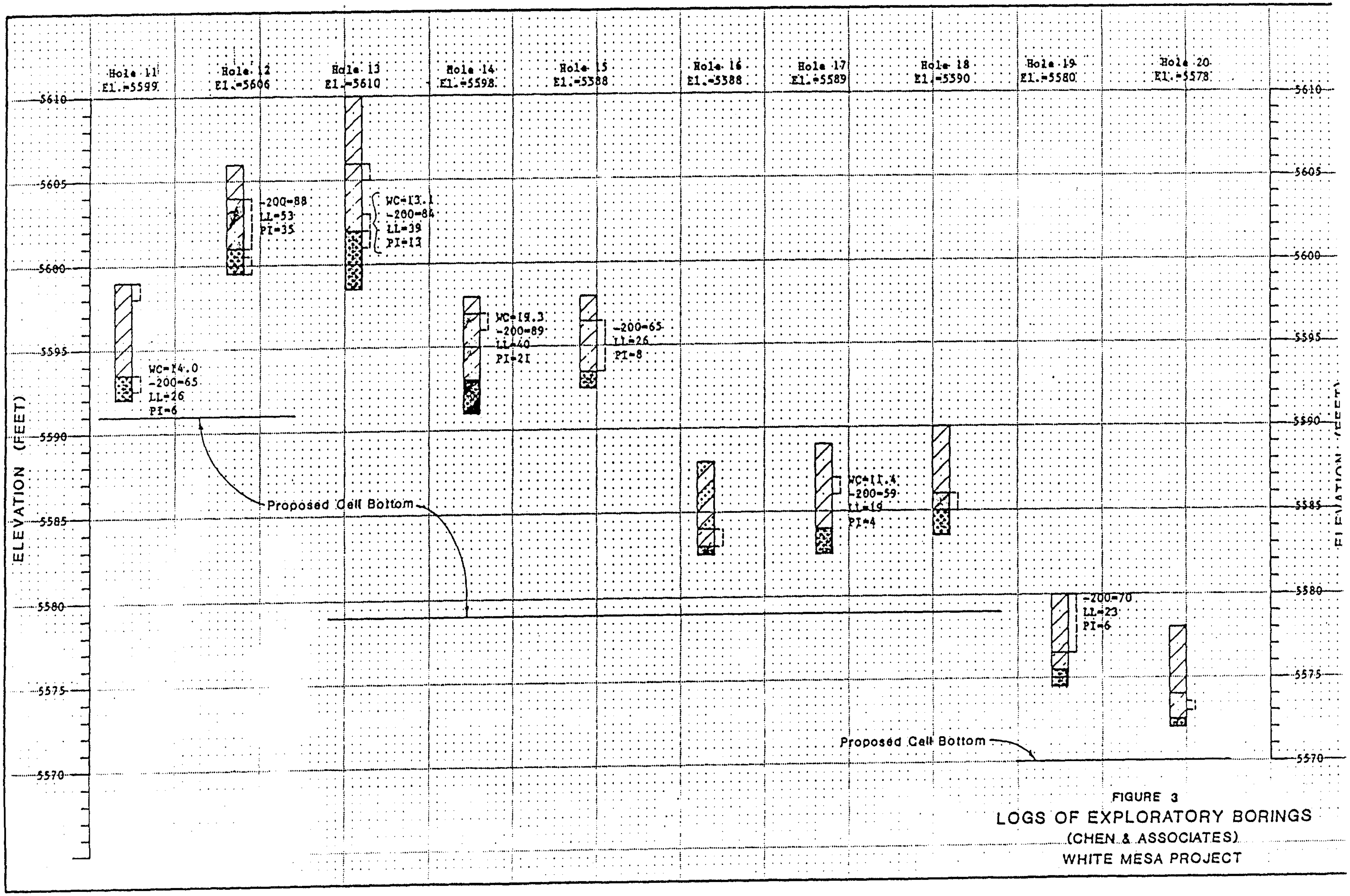


FIGURE 3
LOGS OF EXPLORATORY BORINGS
(CHEN & ASSOCIATES)
WHITE MESA PROJECT

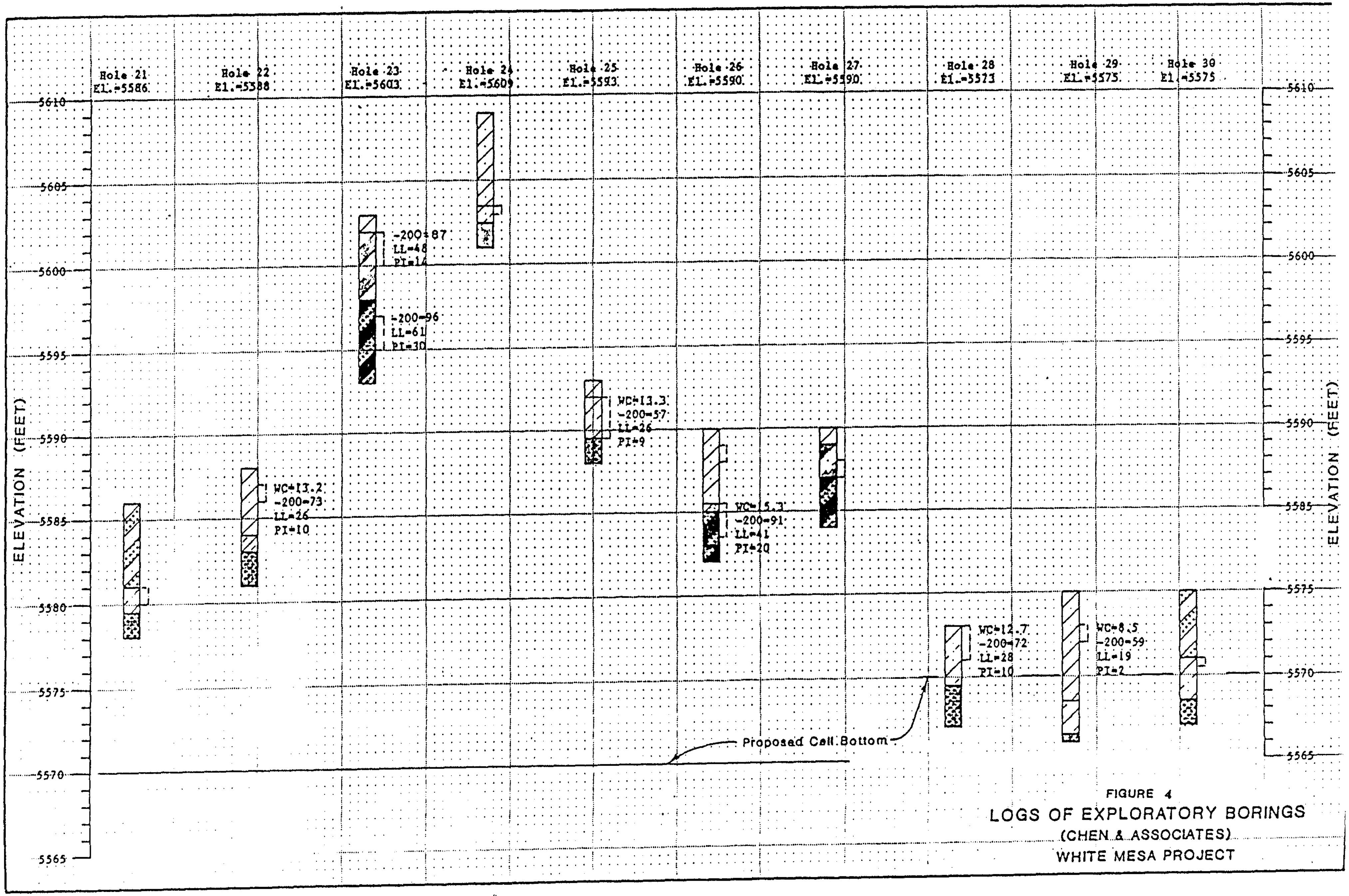


FIGURE 4

LOGS OF EXPLORATORY BORINGS

(CHEN & ASSOCIATES)

WHITE MESA PROJECT

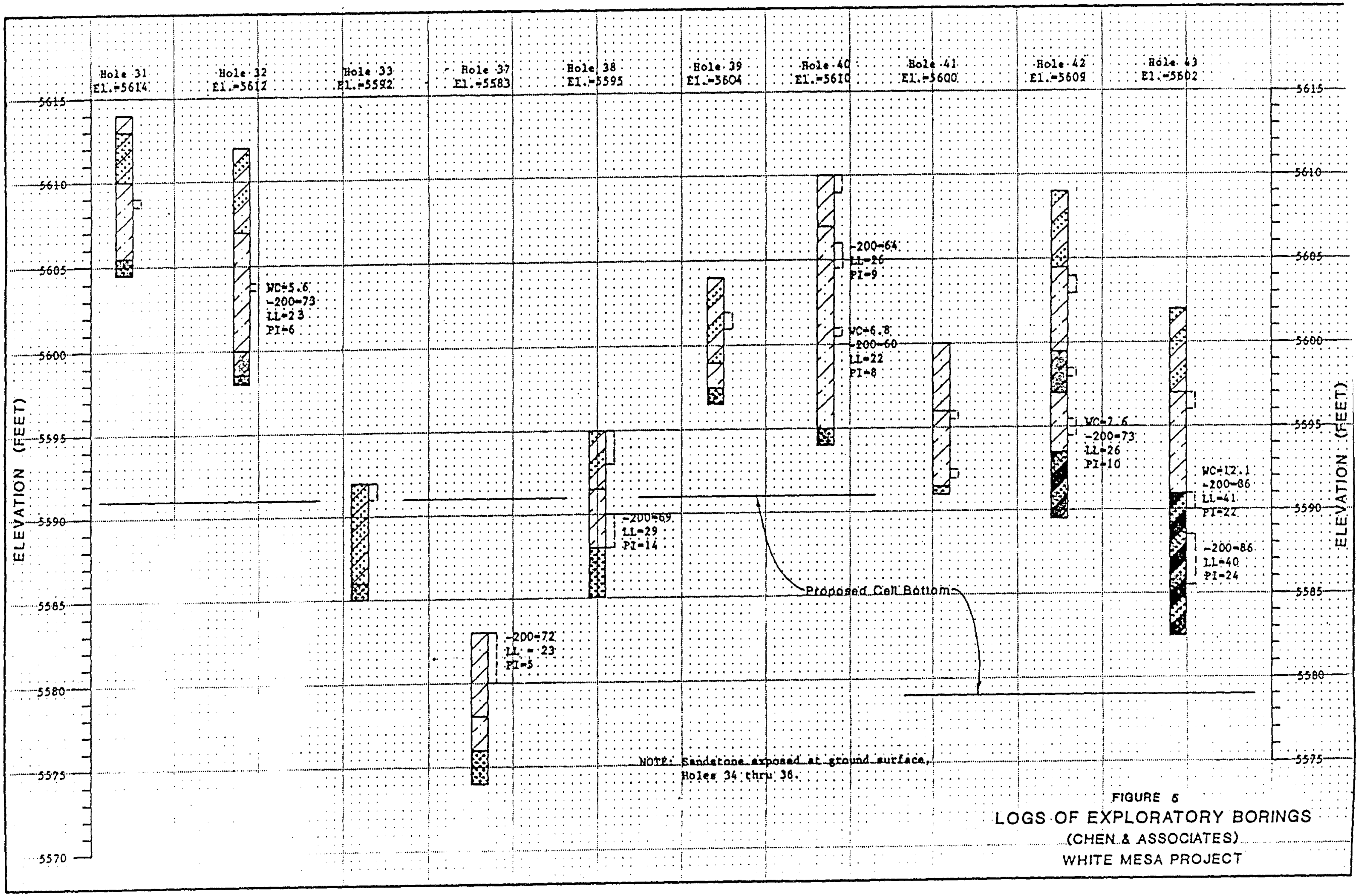


FIGURE 5
LOGS OF EXPLORATORY BORINGS
(CHEN & ASSOCIATES)
WHITE MESA PROJECT

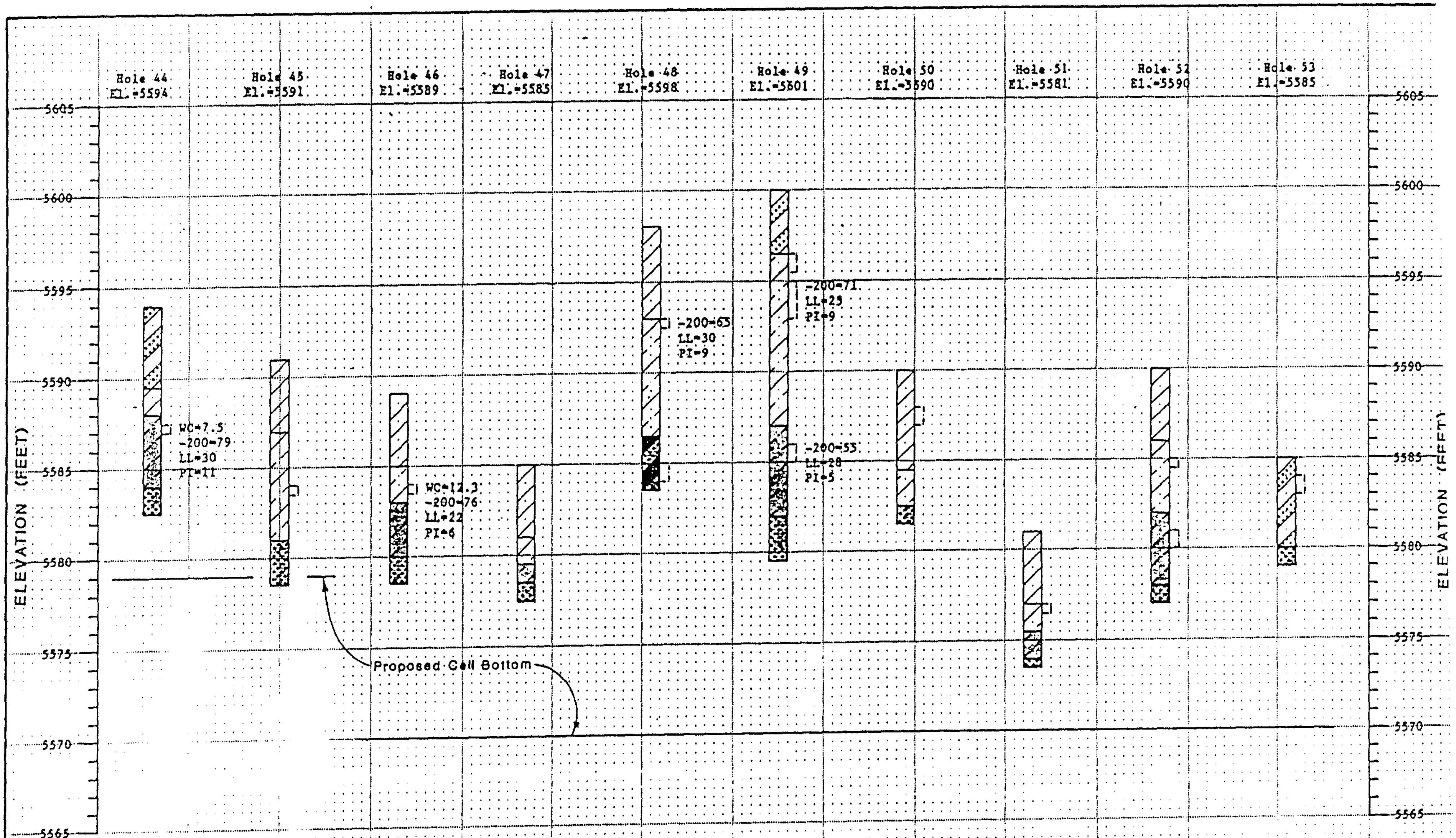


FIGURE 6

LOGS OF EXPLORATORY BORINGS

(CHEN & ASSOCIATES)

WHITE MESA PROJECT

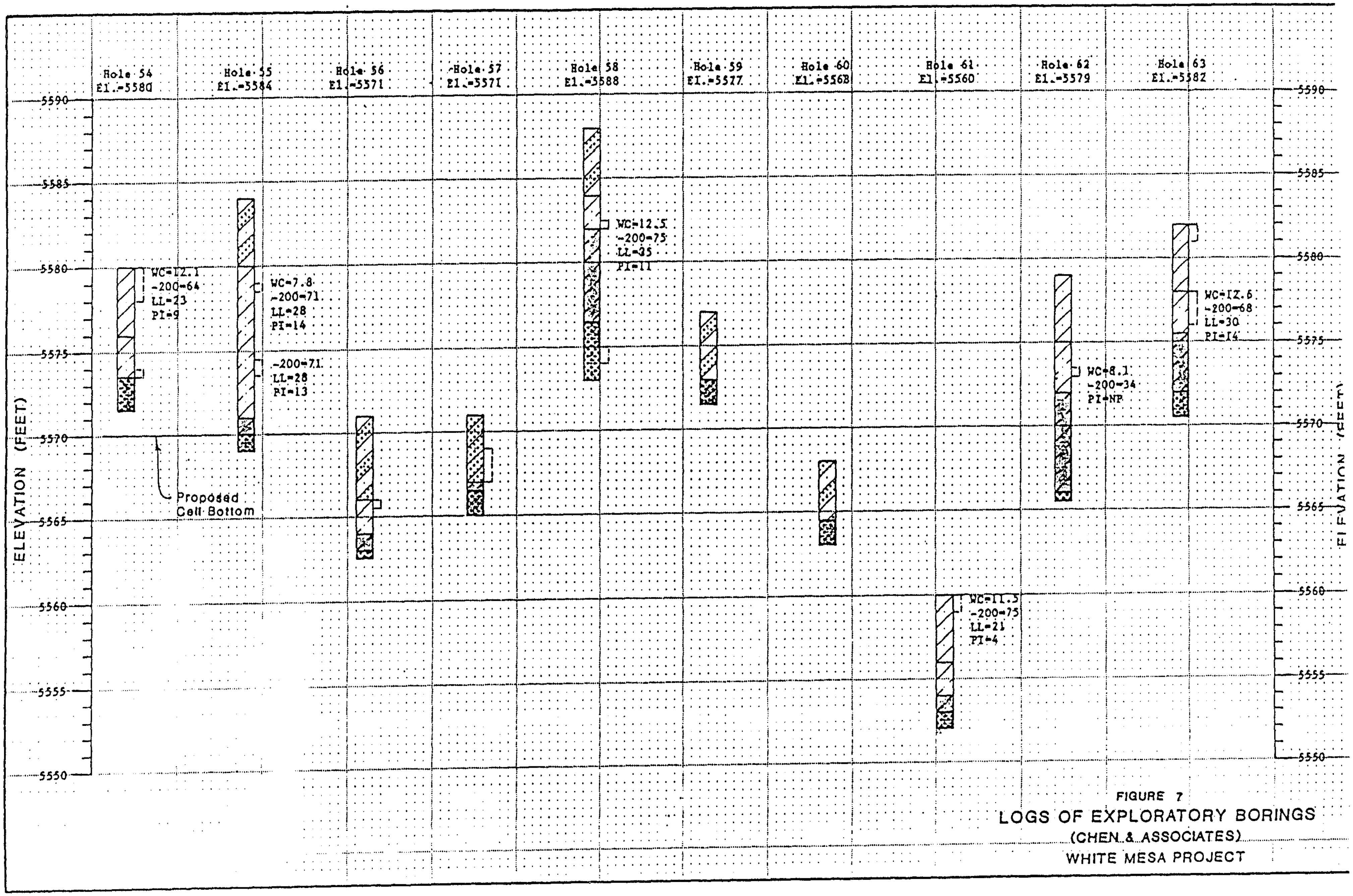


FIGURE 7

LOGS OF EXPLORATORY BORINGS

(CHEN & ASSOCIATES)

WHITE MESA PROJECT

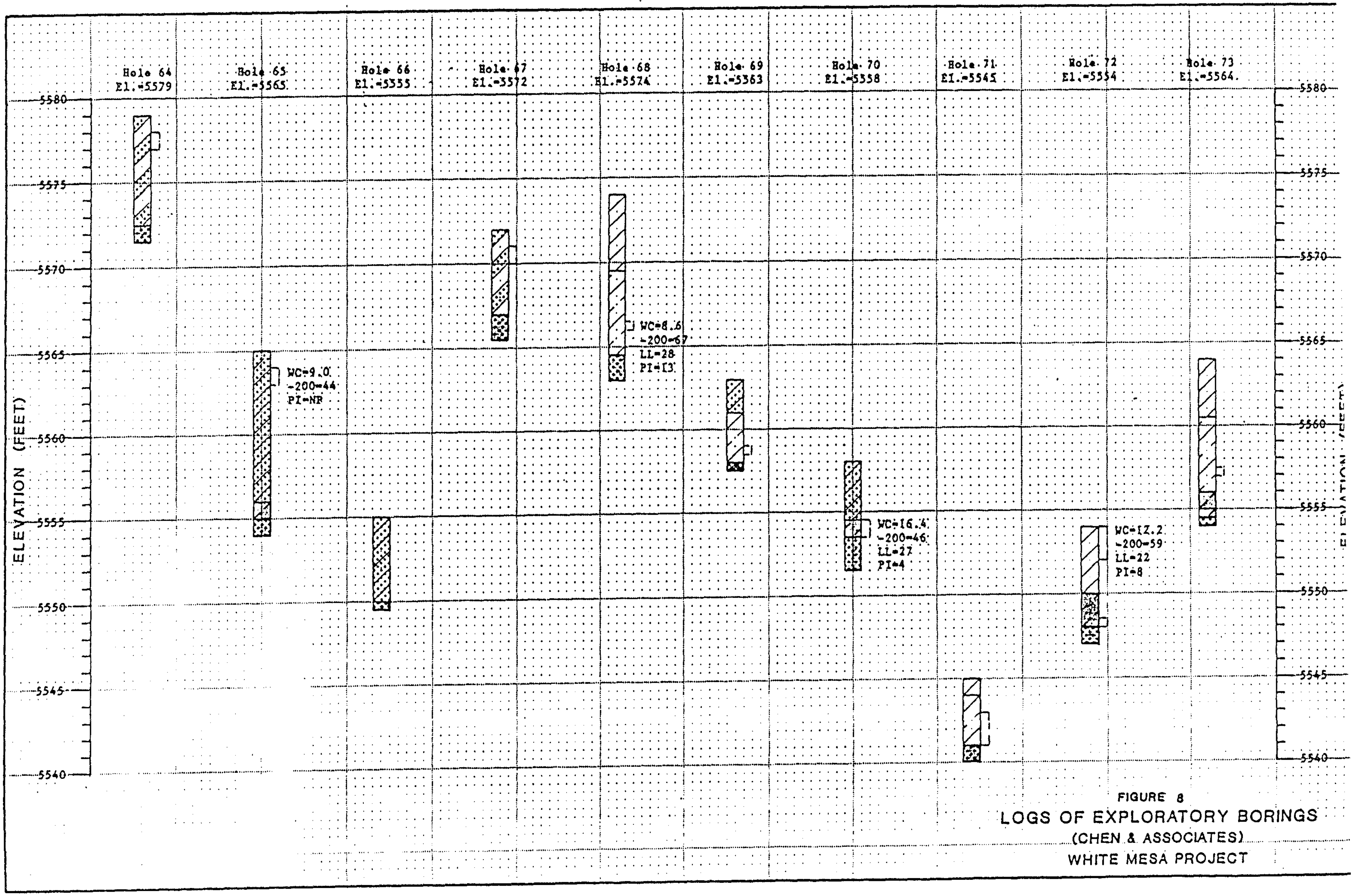
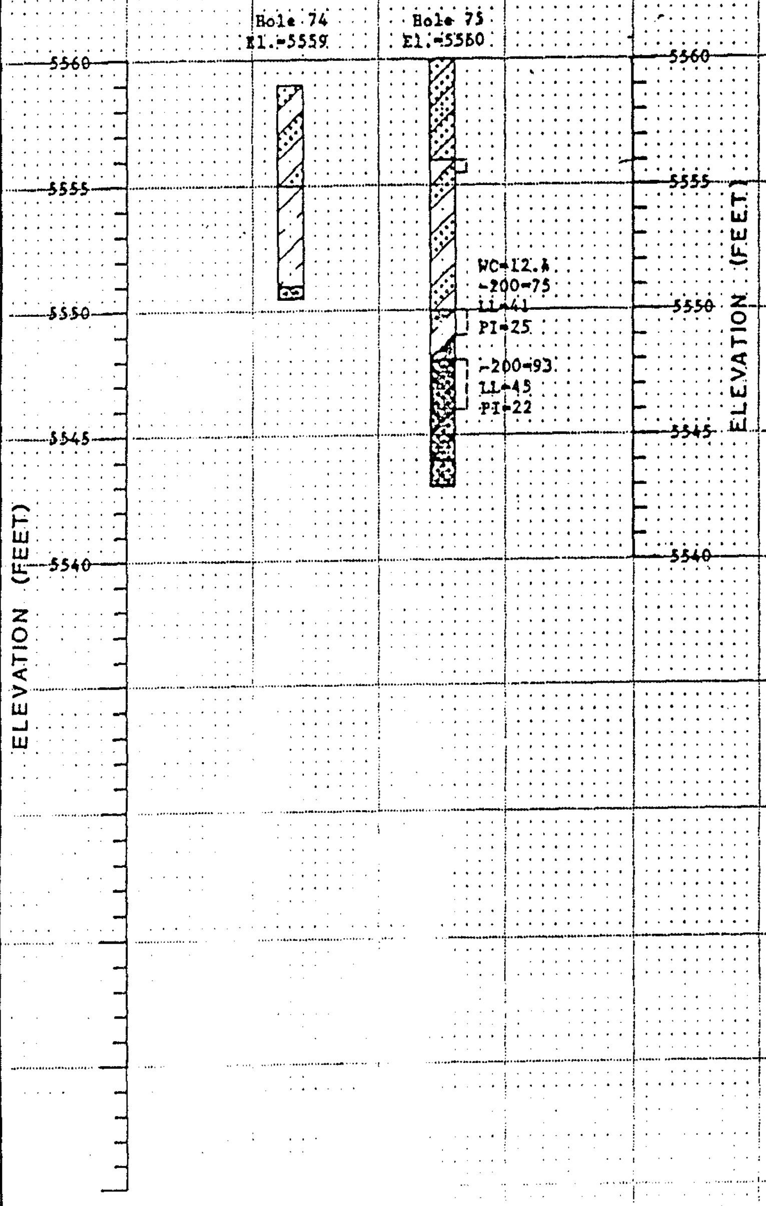


FIGURE 8
LOGS OF EXPLORATORY BORINGS
(CHEN & ASSOCIATES)
WHITE MESA PROJECT



Legend:

Sand (SM), silty, fine to medium grained, approximately 40-50% silt, slightly moist to moist, reddish brown.

Sand, silty to sandy silt (SM-ML), fine to medium grained, approximately 50-60% silt, slightly moist to moist, reddish brown.

Silt (ML), sandy, approximately 60-70% silt, fine to medium sand size, slightly calcareous with depth, slightly moist to moist, reddish brown to light brown.

Clay, silty to sandy silt (CL-ML), approximately 60-75% low to non-plastic fines, fine to medium sand size, slightly to moderately calcareous with depth, slightly moist, light brown.

Clay (CL), highly calcareous, sandy to silty, approximately 50-75% low plasticity fines, scattered very hard lenses/layer, dry to slightly moist, light tan to white.

Weathered claystone (CL-CH), approximately 90% medium to high plasticity fines, moist, gray-brown.

Claystone, bedrock, slightly moist, greenish gray.

Claystone-sandstone bedrock, lightly cemented, roughly stratified, fine to medium grained, greenish gray.

Sandstone bedrock, well cemented with depth, fine to medium grained, tan to gray.

Disturbed auger sample.

NOTES:

(1) Test holes were drilling on May 17 and 18, 1978 with a 12-inch, single-flight, power auger.
(2) Elevations are approximate and taken from contours shown on Fig. 1.
(3) No free water was found in test holes at the time of drilling.
(4) WC = Water Content (%);
-200 = Percent Passing No. 200 Sieve;
LL = Liquid Limit (%);
PI = Plasticity Index (%)
NP = Non-Plastic.

FIGURE 9
LOGS OF EXPLORATORY BORINGS
(CHEN & ASSOCIATES)
WHITE MESA PROJECT

SECTION 4

Extracted Data From

REPORT
SITE SELECTION AND DESIGN STUDY
TAILING RETENTION AND MILL FACILITIES
WHITE MESA URANIUM PROJECT
BLANDING, UTAH
FOR ENERGY FUELS NUCLEAR, INC.

Dames and Moore

January 17, 1978

09973-015-14

3.8 Stability

3.8.1 Slope Stability

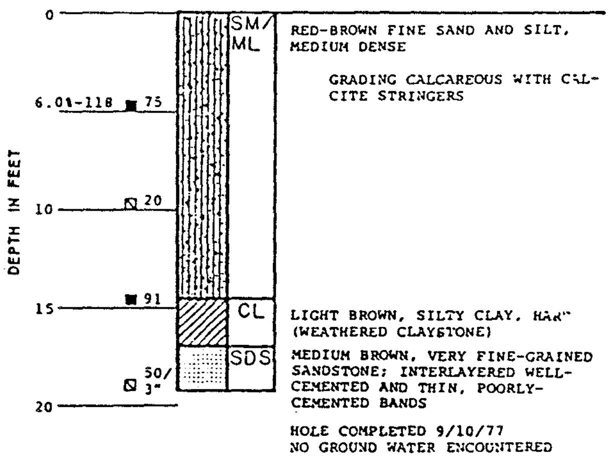
The external dikes formed by cover placement on Cell 2 will be extended to a reclaimed slope of 5(H) to 1(V) but may exist on an interim basis as 3(H) to 1(V) slopes until final reclamation. A stability analysis was performed using the 3(H) to 1(V) slopes. The maximum section of the dike will have a 15-foot wide berm at its base. The soil strength parameters used in the analysis are those developed by Dames & Moore (1978a) and are as follows:

Soil Parameters
for
Slope Stability Analysis

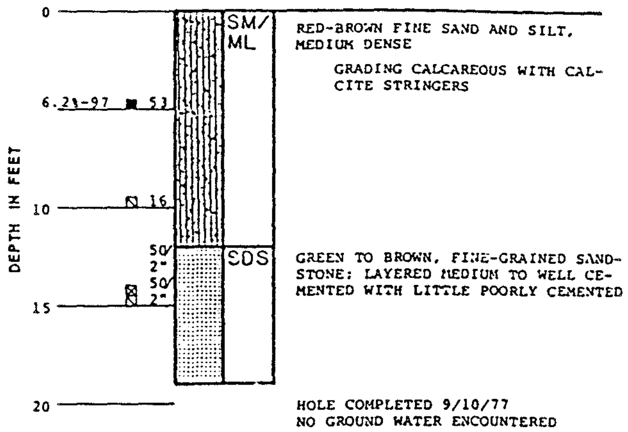
Section	Density (Pcf)	(Degrees)	C (psf)
Embankment	123	30	0
Tailings	62.4	0	0
Foundation Soils	120	28	0
Bedrock	130	45	10,000

From UMETCO, 1988

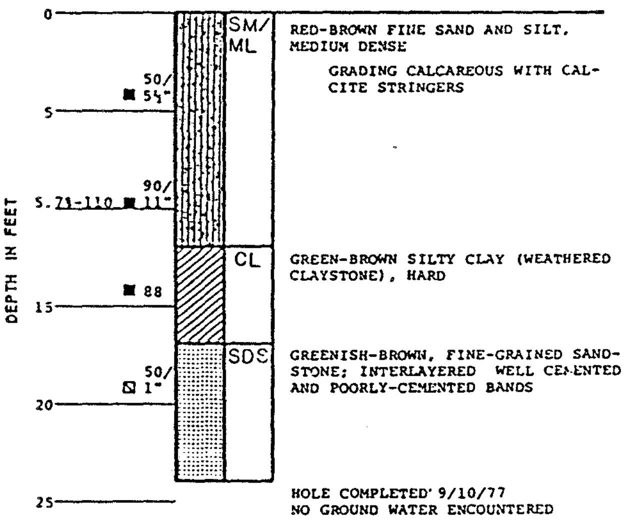
BORING NO. 1
EL. 5629.0 FT.



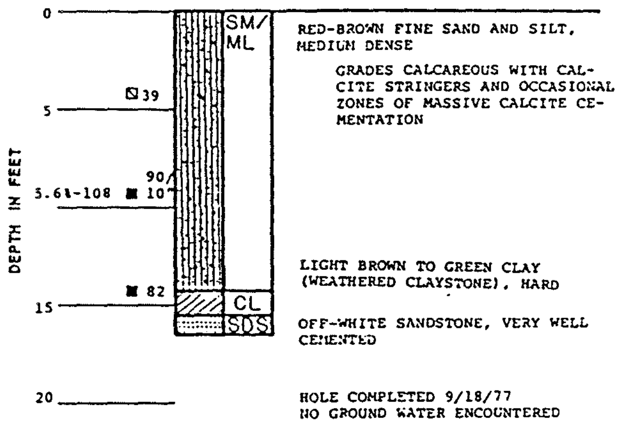
BORING NO. 5
EL. 5632.9 FT.



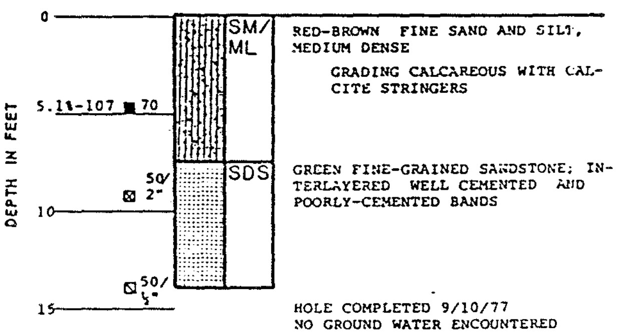
BORING NO. 2
EL. 5634.3 FT.



BORING NO. 6
EL. 5633.5 FT.



BORING NO. 4
EL. 5623.2 FT.



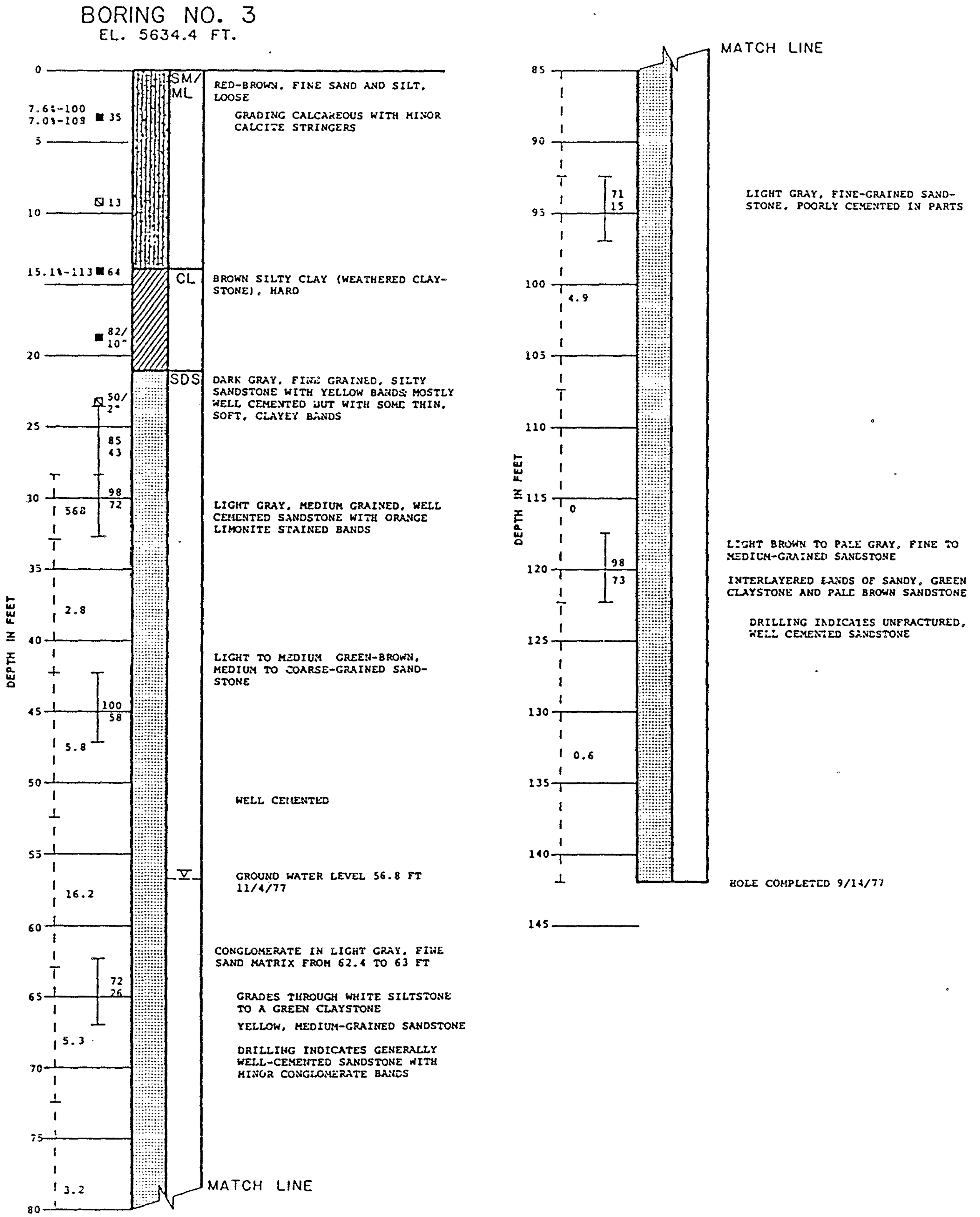
KEY

A-B ■ C	INDICATES DEPTH AT WHICH UNDISTURBED SAMPLE WAS EXTRACTED USING DAMES & MOORE SAMPLER
⊠ C	INDICATES DEPTH AT WHICH DISTURBED SAMPLE WAS EXTRACTED USING DAMES & MOORE SAMPLER
□ C	INDICATES SAMPLE ATTEMPT WITH NO RECOVERY
⊠ C	INDICATES DEPTH AT WHICH DISTURBED SAMPLE WAS EXTRACTED USING STANDARD PENETRATION TEST SAMPLER
A	FIELD MOISTURE EXPRESSED AS A PERCENTAGE OF THE DRY WEIGHT OF SOIL
B	DRY DENSITY EXPRESSED IN LBS/CU FT
C	BLOWS/FT OF PENETRATION USING A 140-LB HAMMER DROPPING 30 INCHES
[D E	INDICATES NC CORE RUN
D	PERCENT OF CORE RECOVERY
E	RQD*
I F	INDICATES PACKER TEST SECTION
F	PERMEABILITY MEASURED BY SINGLE PACKER TEST IN FT/YR
NA	NOT APPLICABLE (USED FOR RQD IN CLAYS OR MECHANICALLY FRACTURED ZONES)
NOTE:	ELEVATIONS PROVIDED BY ENERGY FUELS NUCLEAR, INC.

* ROCK QUALITY DESIGNATION -- PERCENTAGE OF CORE RECOVERED IN LENGTHS GREATER THAN 4 INCHES

LOG OF BORINGS

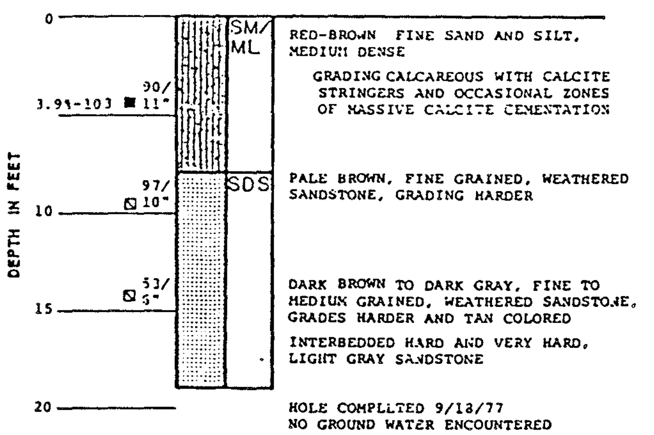
DAMES & MOORE



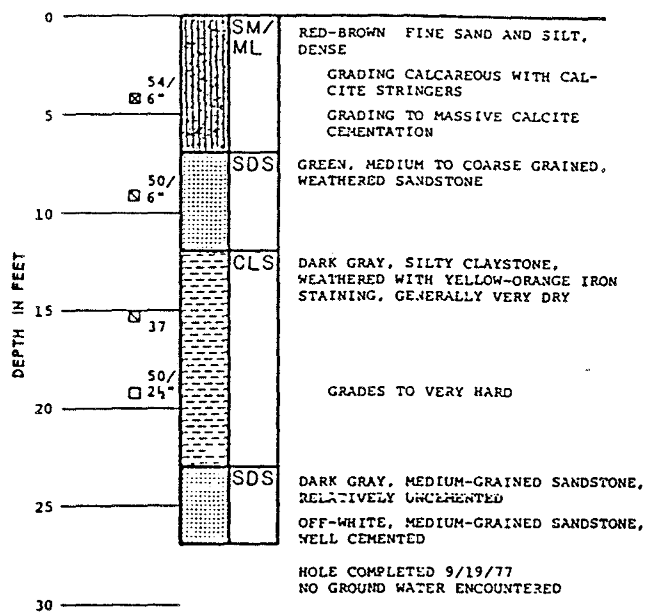
LOG OF BORINGS

DAMES & MOORE

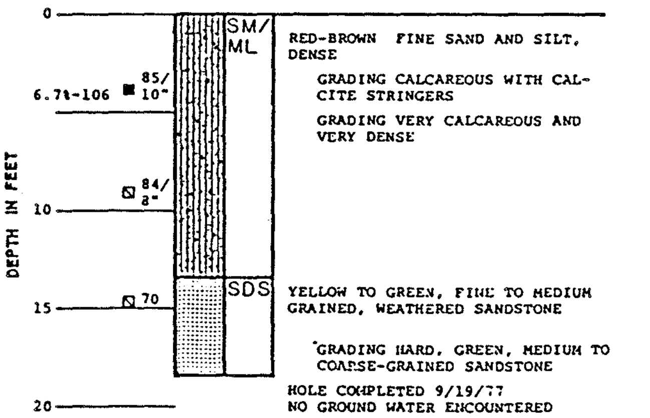
BORING NO. 7
EL. 5656.9 FT.



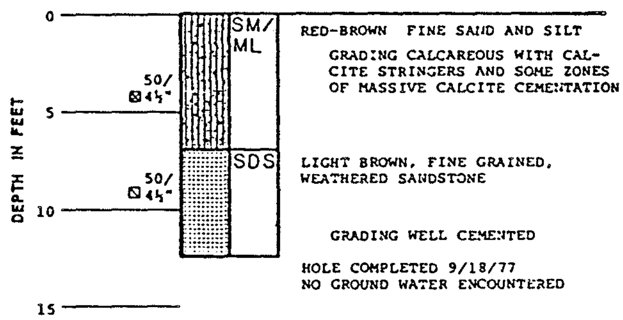
BORING NO. 8
EL. 5668.4 FT.



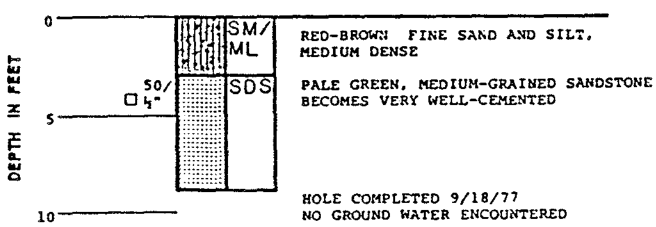
BORING NO. 10
EL. 5690.9 FT.



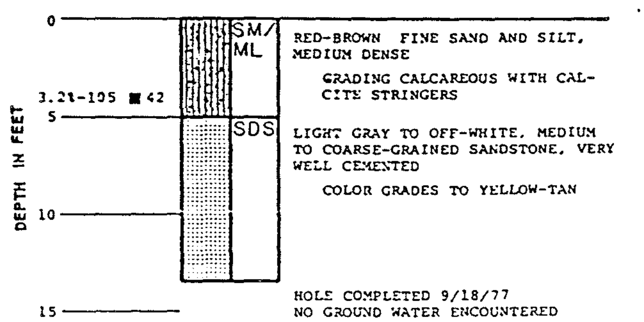
BORING NO. 11
EL. 5677.8 FT.



BORING NO. 13
EL. 5602.4 FT.

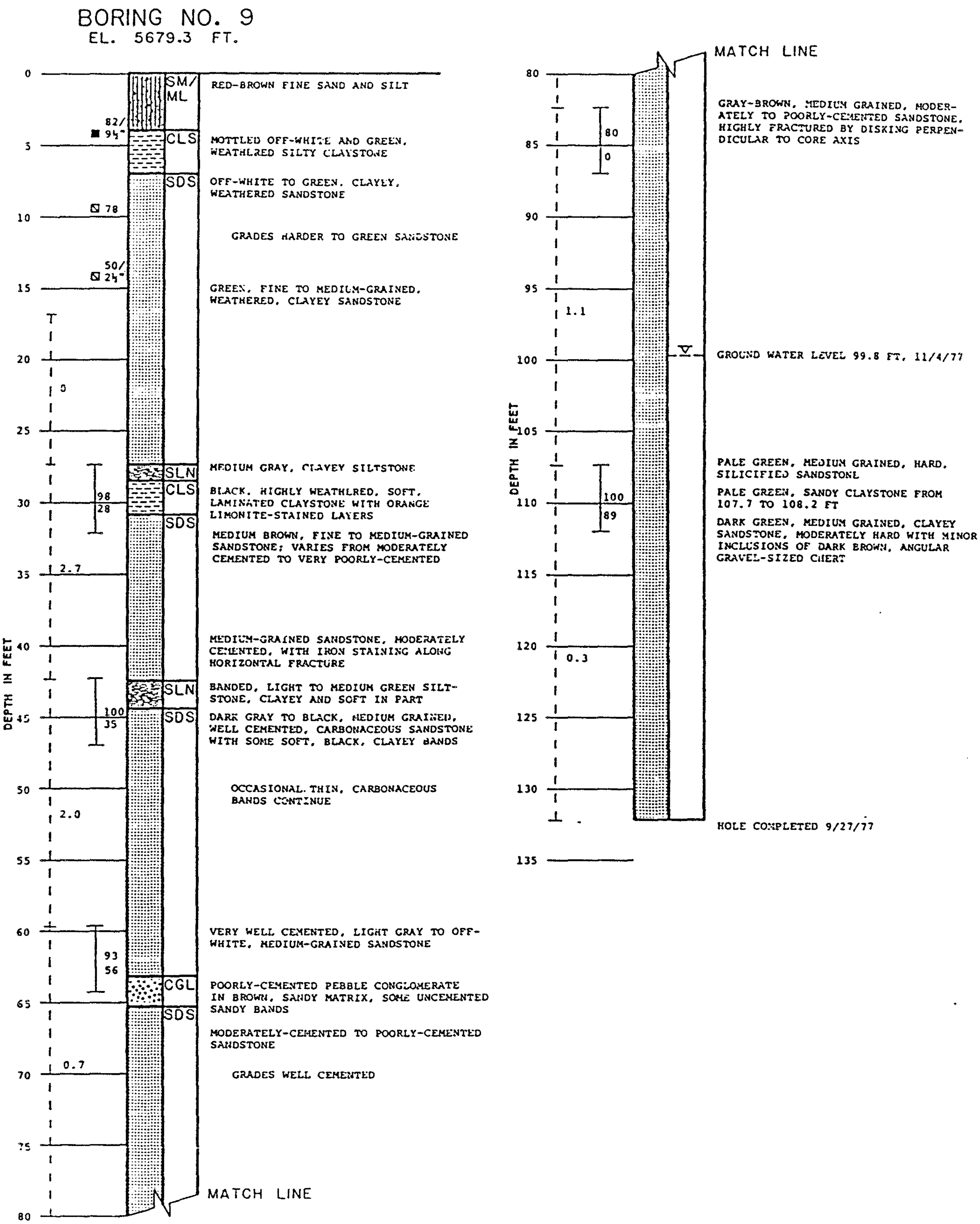


BORING NO. 14
EL. 5597.5 FT.



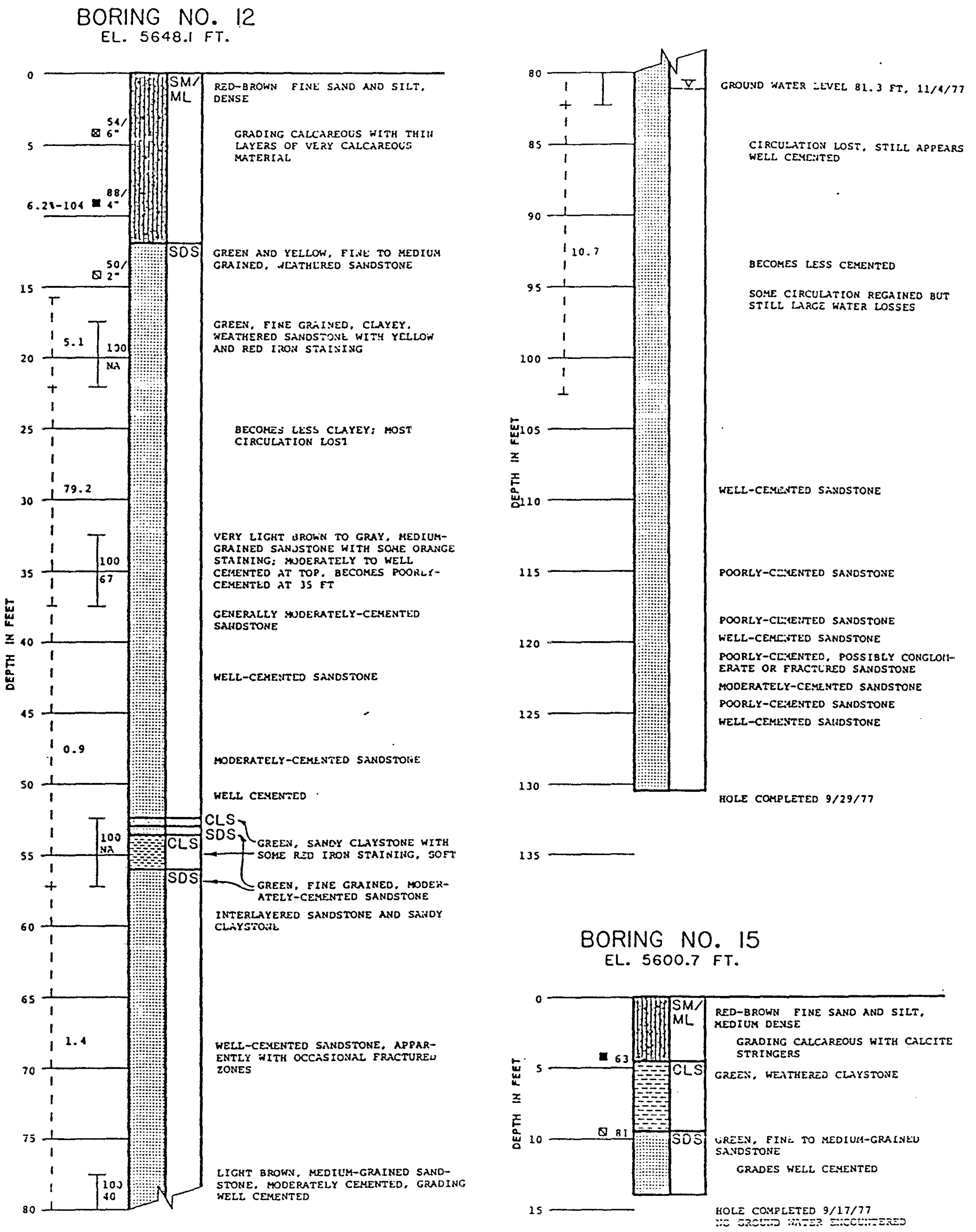
LOG OF BORINGS

DAMES & MOORE



LOG OF BORINGS

DAMES & MOORE



LOG OF BORINGS

DAMES & MOORE

BORING NO. 16
EL. 5597.5 FT.

DEPTH IN FEET: 0, 10, 15, 20

- 0 — SM/ML — RED-BROWN FINE SAND AND SILT, MEDIUM DENSE
  - GRADING CALCAREOUS WITH CALCITE STRINGERS
  - 6.3%-104 ■ 90/11"
  - GRADES DENSE
  - ◪ 79
- 10 — SDS — PALE GREEN TO WHITE, FINE TO COARSE-GRAINED SANDSTONE, ALTERNATING WELL-CEMENTED AND POORLY-CEMENTED BANDS
  - ◪ 50/2½"
  - BECOMES CONTINUOUSLY WELL-CEMENTED

HOLE COMPLETED 9/10/77
NO GROUND WATER ENCOUNTERED

BORING NO. 17
EL. 5582.0 FT.

DEPTH IN FEET: 0, 10, 15

- 0 — SM/ML — RED-BROWN FINE SAND AND SILT
  - GRADING CALCAREOUS WITH CALCITE STRINGERS AND INCLUSIONS
  - 5.5%-105 ■ 76
- SDS — GREEN, FINE TO MEDIUM-GRAINED SANDSTONE, INITIALLY WEATHERED, GRADING WELL CEMENTED
  - ◪ 50/1½"
  - LAYERED POORLY-CEMENTED AND WELL-CEMENTED, POSSIBLY SOME CLAYSTONE LAYERS
  - LAYERED WELL-CEMENTED AND VERY WELL-CEMENTED

HOLE COMPLETED 9/17/77
NO GROUND WATER ENCOUNTERED

BORING NO. 18
EL. 5608.5 FT.

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30

- 0 — SM/ML — RED-BROWN FINE SAND AND SILT, MEDIUM DENSE
  - GRADING CALCAREOUS WITH CALCITE STRINGERS
  - ■ 93/11"
- 5 — SDS — OFF-WHITE, POORLY CEMENTED, WEATHERED SANDSTONE WITH LAYERS OF WEATHERED CLAYSTONE
  - ◪ 19
  - GREEN SANDSTONE
  - ⊠ 50/5"
- CLS — GREEN, WEATHERED CLAYSTONE WITH ORANGE IRON STAINING
  - ◪ 86/11½"
  - ◪ 50/4"
  - □ 50/0"

HOLE COMPLETED 9/17/77
NO GROUND WATER ENCOUNTERED

BORING NO. 21
EL. 5584.5 FT.

DEPTH IN FEET: 0, 5, 10, 15

- 0 — SM/ML — RED-BROWN FINE SAND AND SILT, LOOSE TO MEDIUM DENSE
- CLS — GREEN CLAY WITH SOME GYPSUM CRYSTALS, (WEATHERED CLAYSTONE) STIFF TO VERY STIFF
  - ■ 52
- SDS — GREEN, FINE GRAINED, WEATHERED SANDSTONE
  - ◪ 86/6½"
  - BECOMES WELL-CEMENTED

HOLE COMPLETED 9/17/77
NO GROUND WATER ENCOUNTERED

BORING NO. 20
EL. 5570.4 FT.

DEPTH IN FEET: 0, 5, 10

- 0 — SM/ML — RED-BROWN FINE SAND AND SILT, LOOSE TO MEDIUM DENSE
  - ■ 80
- 5 — SDS — LIGHT BROWN, FINE TO MEDIUM-GRAINED SANDSTONE, GRADING WELL-CEMENTED
  - □ 50/0"

HOLE COMPLETED 9/17/77
NO GROUND WATER ENCOUNTERED

BORING NO. 22
EL. 5585.3 FT.

DEPTH IN FEET: 0, 10, 15, 20, 25

- 0 — SM/ML — RED-BROWN FINE SAND AND SILT
  - GRADING CALCAREOUS WITH CALCITE STRINGERS
  - 12.5%-118 ■ 73/10½"
  - GRADES CLAYIER
  - ◪ 60/6"
- CL — LIGHT BROWN TO OFF-WHITE, SILTY CLAY
  - ⊠ 50/4"
- SDS — GREEN, FINE GRAINED, WEATHERED SANDSTONE WITH HIGH CLAY CONTENT, POORLY-CEMENTED
  - ◪ 55/6"
  - BECOMES WELL-CEMENTED

HOLE COMPLETED 9/17/77
NO GROUND WATER ENCOUNTERED

LOG OF BORINGS

DAMES & MOORE

BORING NO. 19

EL. 5600.3 FT.

DEPTH IN FEET

0 — SM/ML — RED-BROWN FINE SAND AND SILT, MEDIUM DENSE

GRADING CALCAREOUS WTIH CALCITE STRINGERS

12.41-92 ■ 93/11"

5 — GRADES VERY CALCAREOUS AND VERY DENSE

10 — 10 — BECOMES VERY LOOSE, POSSIBLY WITH VOIDS

BECOMES DENSE

95/9"

15

SDS — GREEN, FINE TO MEDIUM-GRAINED SANDSTONE, WEATHERED, WITH SOME ORANGE AND YELLOW IRON STAINING

85/9½"

20

50/4½"

25 — GRAY-GREEN, FINE TO MEDIUM GRAINED, WEATHERED, CLAYEY SANDSTONE WITH ORANGE AND YELLOW IRON STAINING

98 / 71

BECOMES LESS WEATHERED WITH LESS CLAY, PREDOMINANTLY GRAY WITH ORANGE IRON STAINING, MODERATELY CEMENTED, MEDIUM GRAINED

30

7.0

35 — BROWN-YELLOW, COARSE-GRAINED SANDSTONE

CGL — FINE GRAVEL CONGLOMERATE WITH CONSIDERABLE COARSE-GRAINED SAND AND CALCAREOUS MATRIX

SDS

85 / 8

40 — BROWN TO YELLOW, COARSE-GRAINED SANDSTONE WITH CONSIDERABLE NEAR HORIZONTAL FRACTURING AND SOME ORANGE IRON STAINING, MODERATELY CEMENTED

943

45

50 — WATER RETURN COMPLETELY LOST

LIGHT GRAY, MEDIUM TO COARSE-GRAINED SANDSTONE; HIGHLY FRACTURED ALONG HORIZONTAL BEDDING, CONSIDERABLE LIMONITE STAINING ALONG BEDDING FRACTURES; MODERATELY CEMENTED TO UNCEMENTED, CORE LOSSES ASSUMED DUE TO WASHING AWAY OF UNCEMENTED ZONES

78 / 0

55

60 — LIMITED WATER RETURN

65 — BECOMES VERY UNCEMENTED, WATER RETURN LOST

70 — HOLE LOST AT 72 FT; HOLE 19A DRILLED 15 FT SOUTH OF HOLE 19; NO WATER RETURN OBTAINED; NO SAMPLING POSSIBLE; HOLE LOGGED FROM DRILLING PROCESS

75 — VERY WELL-CEMENTED SANDSTONE (72 FT)

MODERATELY-CEMENTED SANDSTONE (73 FT)

80 — MODERATELY WELL-CEMENTED CONGLOMERATE OR FRACTURED SANDSTONE GRADING BETTER CEMENTED

85 — GRADING LESS CEMENTED

VERY POORLY-CEMENTED SANDSTONE

MODERATELY-CEMENTED CLAYSTONE

90 — POORLY-CEMENTED SANDSTONE WITH MINOR HARD LENSES

MODERATELY-CEMENTED SANDSTONE

GRADES LESS CEMENTED

95 — APPEARS CLAYEY

MODERATELY-CEMENTED SANDSTONE

100

105

110 — GROUND WATER LEVEL 110 FT, 11/4/77

POORLY-CEMENTED SANDSTONE WITH OCCASIONAL BANDS OF GRAVEL OR CONGLOMERATE

115

VERY WELL-CEMENTED SANDSTONE

VERY POORLY-CEMENTED SANDSTONE

VERY WELL-CEMENTED SANDSTONE

120

125 — BECOMES LESS CEMENTED AND CLAYEY

HOLE COMPLETED 9/25/77

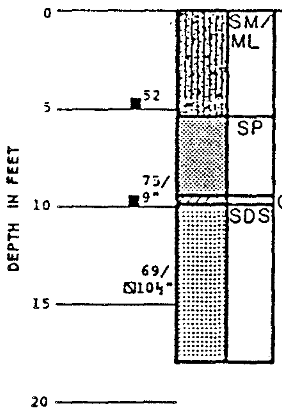
130

LOG OF BORINGS

DAMES & MOORE

LOG OF BORINGS

BORING NO. 23
EL. 5555.9 FT.



RED-BROWN FINE SAND AND SILT, LOOSE TO MEDIUM DENSE
GRADING CALCAREOUS WITH CALCITE STRINGERS
GRADES MEDIUM-GRAINED
MOTTLED COLORS FROM RED TO WHITE AND YELLOW

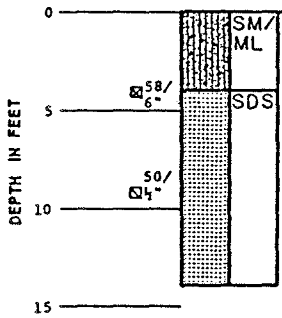
YELLOW TO LIGHT BROWN, MEDIUM TO COARSE-GRAINED SAND (WEATHERED SANDSTONE)

GREEN TO WHITE MOTTLED CLAY (WEATHERED CLAYSTONE)

OFF-WHITE TO YELLOW BROWN, MEDIUM TO COARSE-GRAINED, POORLY CEMENTED SANDSTONE, GRADES WELL CEMENTED

HOLE COMPLETED 9/10/77
NO GROUND WATER ENCOUNTERED

BORING NO. 24
EL. 5573.4 FT



RED-BROWN FINE SAND AND SILT, LOOSE TO MEDIUM DENSE
GRADING CALCAREOUS WITH CALCITE STRINGERS

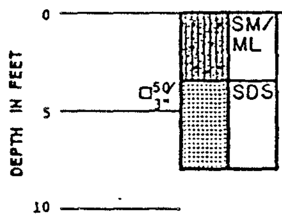
OFF-WHITE, FINE GRAINED, WEATHERED SANDSTONE, GRADES WELL-CEMENTED

OFF-WHITE, FINE TO MEDIUM GRAINED, MODERATELY WELL-CEMENTED SANDSTONE

LIGHT BROWN, FINE TO MEDIUM GRAINED, WELL-CEMENTED SANDSTONE

HOLE COMPLETED 9/17/77
NO GROUND WATER ENCOUNTERED

BORING NO. 26
EL. 5578.3 FT.

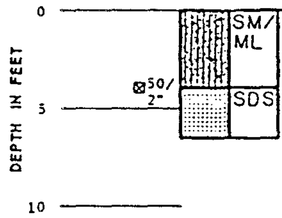


RED-BROWN FINE SAND AND SILT, LOOSE TO MEDIUM DENSE
GRADING CALCAREOUS WITH CALCITE STRINGERS

OFF-WHITE, FINE TO MEDIUM-GRAINED SANDSTONE, WEATHERED, GRADING WELL-CEMENTED
VERY WELL CEMENTED

HOLE COMPLETED 9/17/77
NO GROUND WATER ENCOUNTERED

BORING NO. 27
EL. 5555.0 FT.

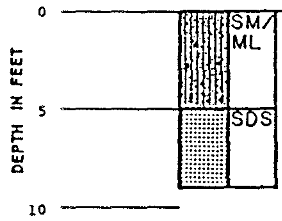


RED-BROWN FINE SAND AND SILT, LOOSE TO MEDIUM DENSE
GRADING CALCAREOUS WITH CALCITE STRINGERS

GREENISH, FINE TO MEDIUM-GRAINED SANDSTONE, VERY WELL-CEMENTED

HOLE COMPLETED 9/17/77
NO GROUND WATER ENCOUNTERED

BORING NO. 29
EL. 5655.0 FT. (APPROX)



RED-BROWN FINE SAND AND SILT, LOOSE
GRADES MEDIUM DENSE
GRADING CALCAREOUS

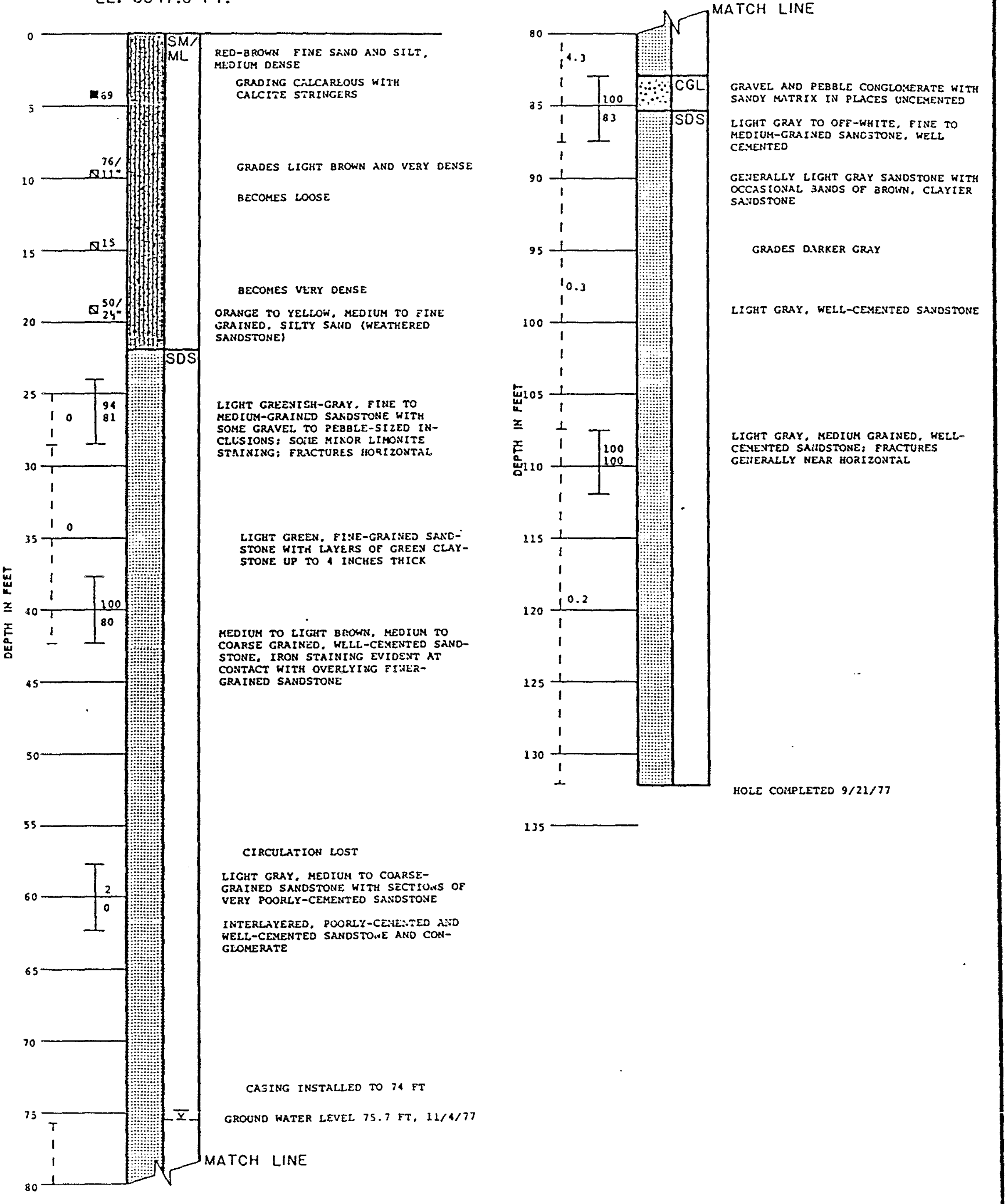
WHITE TO SLIGHTLY TAN SANDSTONE
BECOMES WELL-CEMENTED

HOLE COMPLETED 9/30/77
NO GROUND WATER ENCOUNTERED

DAMES & MOORE

BORING NO. 28

EL. 5547.6 FT.

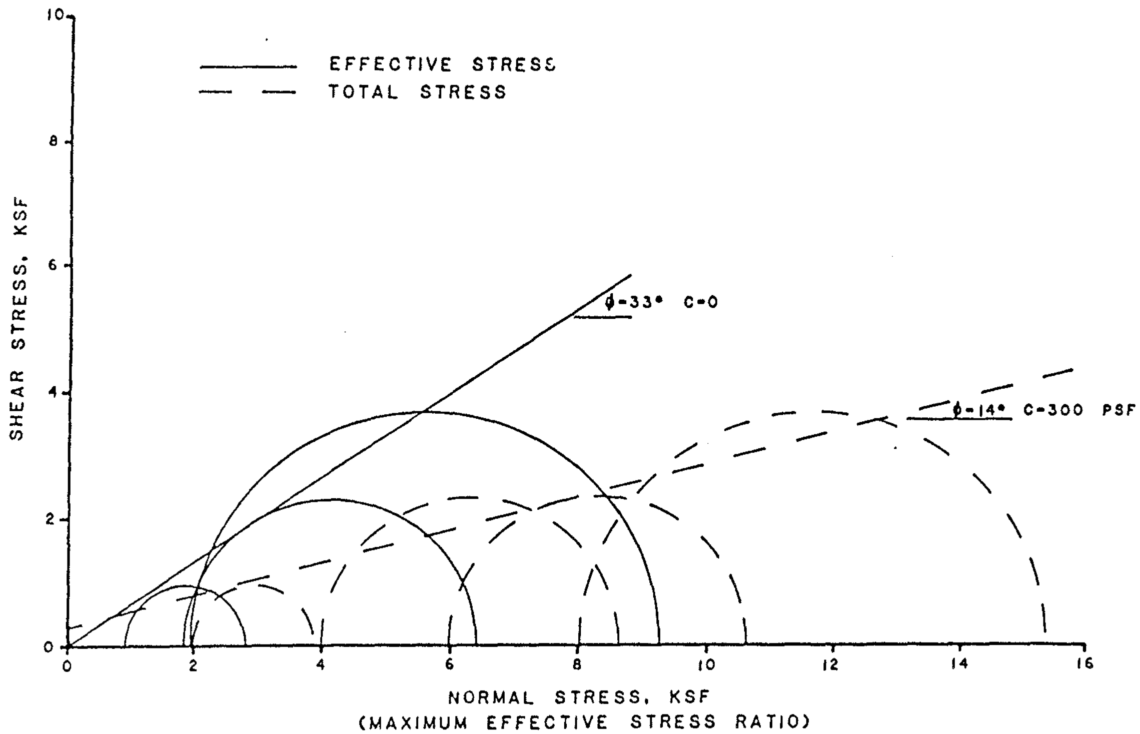


LOG OF BORINGS

DAMES & MOORE

PLATE A-11

TRIAXIAL COMPRESSION TESTS ON SILTY FINE SAND COMPACTED TO 95% OF AASHTO T-99 MAXIMUM DRY DENSITY



KEY	①		②		③		④	
BORING	19A		19A		19A		19A	
SAMPLE	1		2		3		4	
DEPTH (FEET)	Bulk		Bulk		Bulk		Bulk	
INITIAL w, %	13.3		13.2		13.3		13.1	
INITIAL γ_d, PCF	111.1		111.2		111.1		111.3	
INITIAL e_o	0.529		0.527		0.528		0.526	
INITIAL S %	68 %		68 %		68 %		67 %	
FINAL w, %	18.2		17.4		16.7		16.1	
FINAL γ_d, PCF	114.7		117.1		117.0		120.5	
FINAL e_f	0.481		0.450		0.451		0.409	
FINAL S %	100 %		100 %		100 %		100 %	
BACK PRESSURE (PSI)	86.1		72.2		165		145	
STRAIN RATE (INCHES / MINUTE)	.000833		.000833		.000833		.000800	
STRESS CONDITION	PEAK $\sigma_1-\sigma_3$	MAX. $\bar\sigma_1/\bar\sigma_3$	PEAK $\sigma_1-\sigma_3$	MAX. $\bar\sigma_1/\bar\sigma_3$	PEAK $\sigma_1-\sigma_3$	MAX. $\bar\sigma_1/\bar\sigma_3$	PEAK $\sigma_1-\sigma_3$	MAX. $\bar\sigma_1/\bar\sigma_3$
TOTAL STRESS ϵ, %	13.49	5.56	20.00	10.98	17.69	8.51	20.00	5.40
TOTAL STRESS TIME TO FAIL (MIN.)	960	396	1421	780	1261	[illegible]	1424	438
TOTAL STRESS σ_3, KSF	2.00	2.00	4.00	4.00	6.00	[illegible]	8.00	8.00
TOTAL STRESS $\sigma_1-\sigma_3$	2.48	1.88	5.68	4.59	5.12	4.57	11.68	7.37
TOTAL STRESS σ_1, KSF	4.48	3.88	9.68	8.59	11.12	10.57	19.68	15.37
TOTAL STRESS $\frac{1}{2}(\sigma_1-\sigma_3)$	1.24	0.94	2.84	2.29	2.53	2.29	5.84	3.63
TOTAL STRESS $\frac{1}{2}(\sigma_1+\sigma_3)$	3.24	2.94	6.84	6.30	8.59	8.28	13.84	11.69
TOTAL STRESS u, KSF	0.72	1.07	1.61	2.19	3.84	4.15	4.33	6.09
TOTAL STRESS A, $u/(\sigma_1-\sigma_3)$	0.29	0.57	0.28	0.48	0.75	0.91	0.37	0.83
EFFECTIVE STRESS ϵ, %	13.49	5.56	20.00	10.98	17.69	8.51	20.00	5.40
EFFECTIVE STRESS TIME TO FAIL (MIN.)	960	396	1421	780	1261	[illegible]	1424	438
EFFECTIVE STRESS $\bar\sigma_3$, KSF	1.28	0.93	2.39	1.81	2.16	1.85	3.67	1.91
EFFECTIVE STRESS $\bar\sigma_1-\bar\sigma_3$	2.48	1.88	5.68	4.59	5.12	4.57	11.68	7.37
EFFECTIVE STRESS $\bar\sigma_1$, KSF	3.76	2.81	8.07	6.40	7.28	6.42	15.35	9.28
EFFECTIVE STRESS $\frac{1}{2}(\bar\sigma_1-\bar\sigma_3)$	1.24	0.94	2.84	2.29	2.53	2.29	5.84	3.68
EFFECTIVE STRESS $\frac{1}{2}(\bar\sigma_1+\bar\sigma_3)$	2.52	1.87	5.23	4.11	4.75	4.13	9.51	[illegible]
EFFECTIVE STRESS u, KSF	0.72	1.07	1.61	2.19	3.84	4.15	4.33	6.09
EFFECTIVE STRESS A, $u/(\bar\sigma_1-\bar\sigma_3)$	0.29	0.57	0.28	0.48	0.75	[illegible]	0.37	0.83
EFFECTIVE STRESS $\bar\sigma_1/\bar\sigma_3$	2.94	3.01	3.38	[illegible]	3.38	[illegible]	4.19	4.86

TRIAXIAL COMPRESSION TEST REPORT

TYPE OF TEST CONSOLIDATED - UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE MEASUREMENT

TYPE MATERIAL COMPACTED CORE

SAMPLE DESCRIPTION

CLASSIFICATION REDDISH - BROWN CLAYEY SILT

LIQUID LIMIT - PLASTIC LIMIT - SPECIFIC GRAVITY, G_s 2.70 (All)

PROJECT ENERGY FUELS

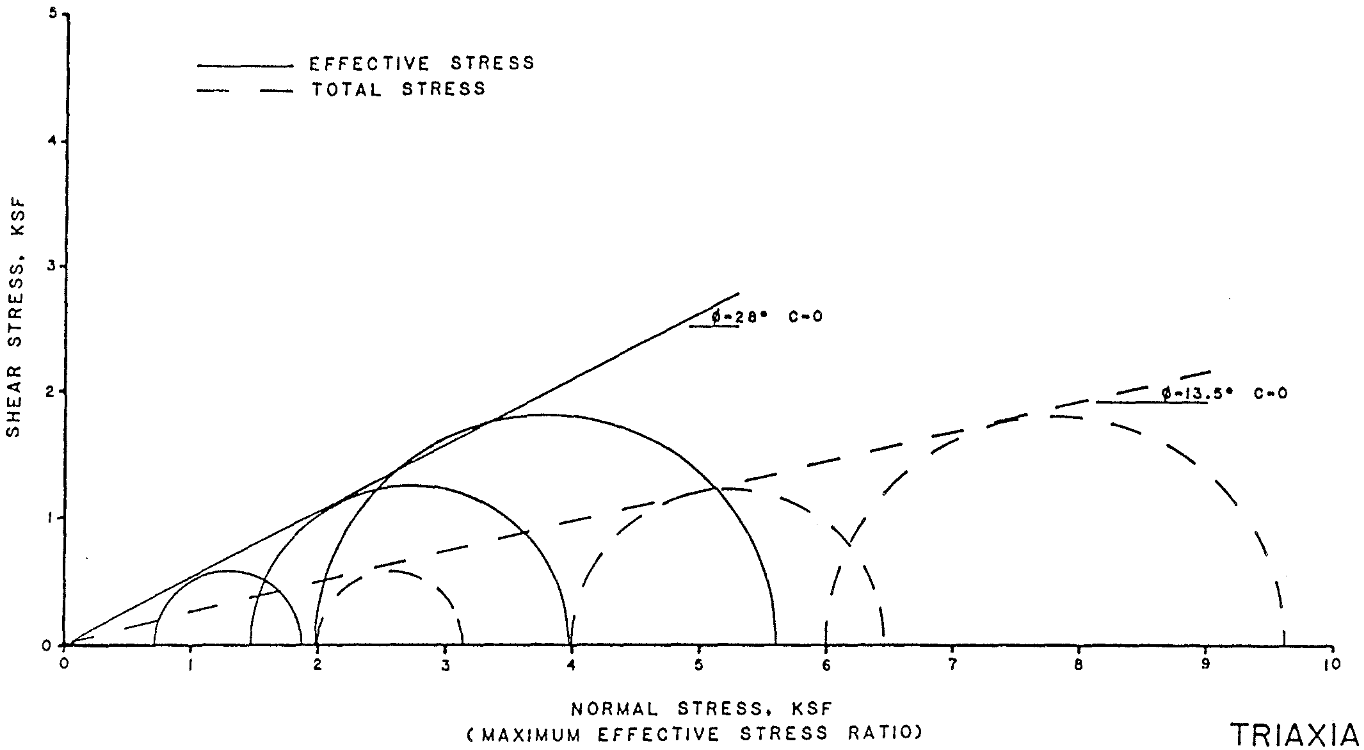
LOCATION DENVER

JOB NO. 9973-015-14 PREPARED BY RH , 10/27/77

CHECKED BY RH , 10/27/77

PLATE B-11

MULTI PHASE TRIAXIAL COMPRESSION TESTS ON SILTY FINE SAND AT NATURAL DENSITY



KEY		①		②		③
BORING		14		14		14
SAMPLE		1		1		1
DEPTH (FEET)		4'		4'		4'
INITIAL	w, %	3.2		19.7		17.7
	γ_d, PCF	104.7		108.6		112.6
	e_o	.5803		.5227		.4693
	B	.15		1.0		1.0
FINAL	w, %	19.7		17.7		17.6
	γ_d, PCF	108.6		112.6		113.7
	e_f	.5227		.4693		.4542
	B	1.0		1.0		1.0
BACK PRESSURE (PSI)						
STRAIN RATE (INCHES / MINUTE)						
STRESS CONDITION		PEAK $\sigma_1-\sigma_3$	MAX $\bar{\sigma}_1/\bar{\sigma}_3$	PEAK $\sigma_1-\sigma_3$	MAX $\bar{\sigma}_1/\bar{\sigma}_3$	PEAK $\sigma_1-\sigma_3$	MAX $\bar{\sigma}_1/\bar{\sigma}_3$
TOTAL STRESS	ϵ, %	1.5	2.5	1.0	1.5	1.0	2.0
	TIME TO FAIL (MIN.)	15	25	10	15	10	19
	σ_3, PSF	2000	2000	4000	4000	6000	6000
	$\sigma_1-\sigma_3$	1171	1160	2484	2467	3764	3628
	σ_1, PSF	3171	3160	6484	6467	9764	9624
	$\frac{1}{2}(\sigma_1-\sigma_3)$	585	580	1242	1234	1882	1814
	$\frac{1}{2}(\sigma_1+\sigma_3)$	2585	2580	5242	5234	7882	7812
	u, PSF	1166	1282	2318	2506	3442	4018
	A, $u/(\sigma_1-\sigma_3)$	996	1.11	.933	1.02	.914	1.11
EFFECTIVE STRESS	ϵ, %	1.5	2.5	1.0	1.5	1.0	2.0
	TIME TO FAIL (MIN.)	15	25	10	1500	10	19
	$\bar{\sigma}_3$, PSF	834	718	1682	1494	2558	1982
	$\bar{\sigma}_1-\bar{\sigma}_3$	1171	1160	2484	2467	3754	3628
	$\bar{\sigma}_1$, PSF	2005	1878	4166	3961	6322	5610
	$\frac{1}{2}(\bar{\sigma}_1-\bar{\sigma}_3)$	585	580	1242	1234	1882	1814
	$\frac{1}{2}(\bar{\sigma}_1+\bar{\sigma}_3)$	1420	1298	2924	2728	4440	3796
	u, PSF	1166	1282	2318	2506	3442	4018
	A, $u/(\bar{\sigma}_1-\bar{\sigma}_3)$	.956	1.11	.933	1.02	.914	1.11
	$\bar{\sigma}_1/\bar{\sigma}_3$	2.40	2.62	2.48	2.65	2.47	2.83

TRIAXIAL COMPRESSION TEST REPORT

TYPE OF TEST: Tx - CU - PP

TYPE MATERIAL: Brn Silt & F. Sand

SAMPLE DESCRIPTION

CLASSIFICATION: SM / ML

LIQUID LIMIT: N/A PLASTIC LIMIT: N/A SPECIFIC GRAVITY, G_s: 2.65 assumed

PROJECT: Energy Fuels

LOCATION: Blanding UT.

JOB NO. 09973-015-14 PREPARED BY: LWC, 11/21/77

CHECKED BY: ____, / /

APPENDIX H

Material Quantities

TITAN Environmental

By TAM Date 7/5/96 Subject EFN - White Mesa Page 1 of 8
Chkd By KEJ Date 8/14/96 Tailings Cover Material Volume Calc. Proj No 6111-001

Purpose: To determine the volume of riprap, clay, and random fill materials required to construct the uranium mill tailings cover at White Mesa Mill in Blanding, Utah.

Material volumes were calculated for two construction options:

- An integrated soil cover over Disposal Cells 2, 3, and 4A, and
- A cover over Cells 2 and 3, where Cell 4A tailings are excavated and placed in Cell 3.

Method: Standard geometric equations, as shown below, were used to determine the required material volumes.

Volume of a rectangle	= base * height * length
Volume of a trapezoid	= 1/2 * height *($base_1$ + $base_2$)

Surface area calculations for the tops of Cells 2, 3, and 4A are shown in Figure 1, and material volumes are calculated in Table 1.

The method for calculating material volumes on the side slopes is shown in Figure 2. The 5H:1V slopes have been divided into several zones which are indicated on Figure 1. The slopes have been categorized based on the average height they attain over a certain length. The height of the cover above the ground surface, along each side, was estimated using the cross sections in Figures 3 - 5. Calculations are presented in Table 2.

Assumptions:

- Random fill will be used to fill the existing freeboard space between the tailings and clay layer of the cover and bring the tailings pile elevations up to the berm elevations. This will create a smooth surface with a slope matching that of the cover. The random fill thickness between the clay and tailings surface will be a minimum of three feet. This random fill volume was not calculated due to the lack of information of the current topography in the tailings piles.

- The 0.2 percent slope on the tailings piles will be created using random fill materials beneath the clay layer of the cover. Cover materials will consist of one foot of clay under two feet of random fill . The top, riprap layer will consist of a minimum three inches on the top of the cover, and one foot on the side slopes.

Results:

Option 1: (Cover on Cells 2, 3, and 4A):

Total volume (Clay):	**=9,857,221 ft3**	**=365,082 yd3**
Total volume (Random fill):	**=19,918,351 ft3**	**=737,717 yd3**
Total volume (Riprap - top cover):	**=2,234,563 ft3**	**=82,762 yd3**
Total volume (Riprap - side slopes):	**=1,122,881 ft3**	**=41,588 yd3**

Option 2: (Cover on Cells 2 and 3):

Total volume (Clay):	**=7,816,884 ft3**	**=289,514 yd3**
Total volume (Random fill):	**=15,804,024 ft3**	**=585,334 yd3**
Total volume (Riprap - top cover):	**=1,754,563 ft3**	**=64,984 yd3**
Total volume (Riprap - side slopes):	**=968,890 ft3**	**=35,885 yd3**

TABLE 1
Volume of materials for top of cover:

Cell #	surface area ft^2				Th (riprap) inches	Th (fill) feet	Th (clay) feet					V (riprap)[1] ft.^3	V(fill)[1] ft.^3	V(clay)[1] ft.^3
2	3237500				3	2	1					809375	6475000	3237500
3	3780750				3	2	1					945188	7561500	3780750
4A	1920000				3	2	1					480000	3840000	1920000
Option 1 Total (Cells 2,3,and 4A):												**2234563**	**17876500**	**8938250**
Option 2 Total (Cells 2 and 3):												**1754563**	**14036500**	**7018250**

TABLE 2
Volume of materials for side slopes:

Slope #	total h ft.	h (riprap) ft.	h (fill) ft.	h (clay) ft.	L' (riprap) ft.	L' (fill) ft.	L' (clay) ft.	Length ft.	Th (riprap) feet	Th (fill) feet	Th (clay) feet	V(riprap)[2] ft.^3	V(fill)[2] ft.^3	V(clay)[2] ft.^3
1	16	15.5	14.0	12.5	79.0	71.4	63.7	3500	1	2	1	276622	499704	223082
2	6	5.5	4.0	2.5	28.0	20.4	12.7	500	1	2	1	14022	20396	6374
3	6	5.5	4.0	2.5	28.0	20.4	12.7	1180	1	2	1	33093	48135	15042
4	20	19.5	18.0	16.5	99.4	91.8	84.1	1900	1	2	1	188919	348773	159854
5	43	42.5	41.0	39.5	216.7	209.1	201.4	1750	1	2	1	379240	731709	352470
6	10	9.5	8.0	6.5	48.4	40.8	33.1	950	1	2	1	46019	77505	31486
7	5	4.5	3.0	1.5	22.9	15.3	7.6	1350	1	2	1	30977	41302	10326
8	27	26.5	25.0	23.5	135.1	127.5	119.8	1200	1	2	1	162149	305941	143792
9	35	34.5	33.0	31.5	175.9	168.3	160.6	1450	1	2	1	255078	487976	232898
10	18	17.5	16.0	14.5	89.2	81.6	73.9	1300	1	2	1	116003	212119	96117
Option 1 Total (Slopes 1, 2, 3, 4, 6, 7, 8, 9, and 10):												1122881	2041851	918971
Option 2 Total (Slopes 1, 2, 3, 4, 5, 6, and 7):												968890	1767524	798634

TABLE 3
Total Material Volumes for the Cover

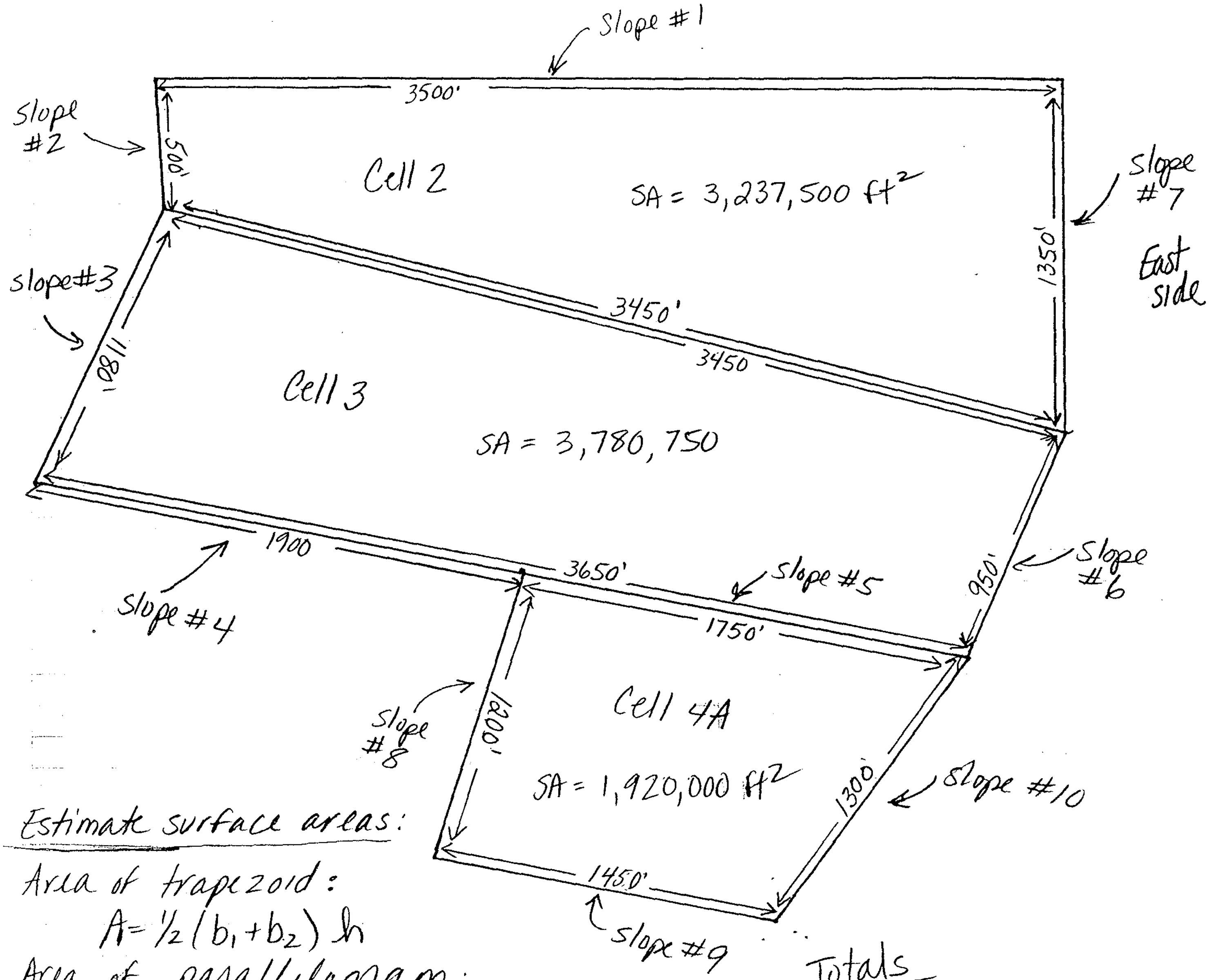
Option 1:			
	riprap (top of cover)	2234563 ft^3	82762 yd^3
	riprap (side slopes)	1122881 ft^3	41588 yd^3
	random fill	19918351 ft^3	737717 yd^3
	clay	9857221 ft^3	365082 yd^3
Option 2:			
	riprap (top of cover)	1754563 ft^3	64984 yd^3
	riprap (side slopes)	968890 ft^3	35885 yd^3
	random fill	15804024 ft^3	585334 yd^3
	clay	7816884 ft^3	289514 yd^3

Notes:
Riprap on top and sides of cover are of different dimensions, and are therefore caluculated separately.
Total h = the average height along the slope length.
Th = Thickness of the layer of material.
V = Total volume of the material
L' = Length of the layer down the side slope. Calculated as (h(material)) / (cos 78.7). The slope is 5H:1V.
Length = Horizontal length of the side slope.

(1) Volume calculated as (surface area) x (layer thickness).
(2) Volume calculated as (L' x Th x Length).

Surface Areas of Cells

AERIAL VIEW



Estimate surface areas:

Area of trapezoid:

$A = \frac{1}{2}(b_1 + b_2)h$

Area of parallelogram:

$A = bh$

Cell #2

$A = \frac{1}{2}(1350' + 500') \times 3500' = 3,237,500 \text{ ft}^2$

Cell #3

$A = (3550 \times 1065) = 3,780,750 \text{ ft}^2$

Cell #4A

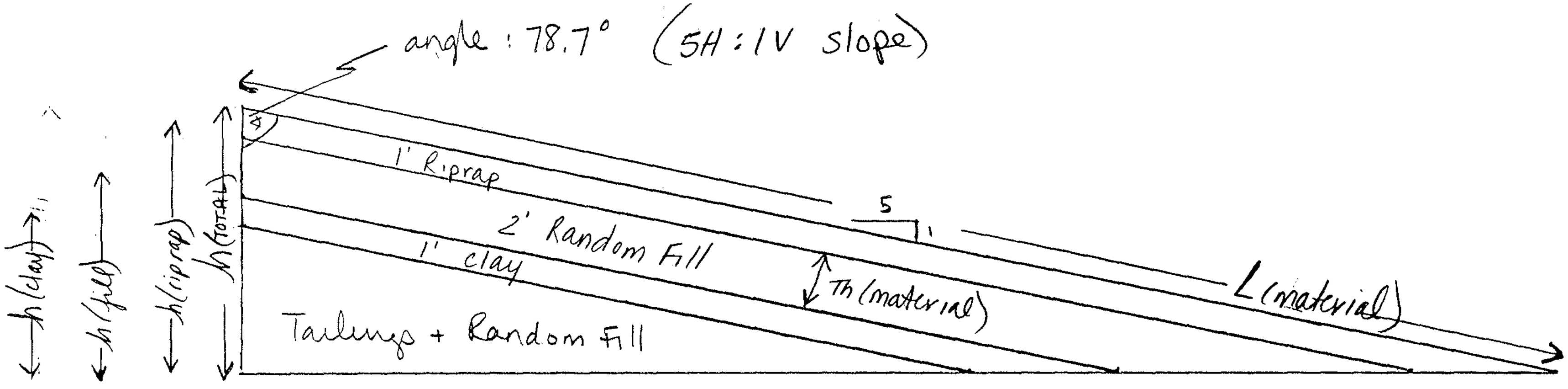
$A = \frac{1}{2}(1450 + 1750) \times 1200 = 1,920,000 \text{ ft}^2$

Totals

1) Option #1
   Cells 2, 3, 4A:
   8,938,250
2) Option #2
   Cells 2, 3:
   7,018,250 ft²

Figure 1

Volumes of Materials along side slopes



L = length of material layer down side slope

$$\cos \measuredangle = \frac{h\,(\text{material})}{L\,(\text{material})}$$

$$L\,(\text{material}) = \frac{h\,(\text{material})}{\cos 78.7}$$

$$V\,(\text{material}) = L\,(\text{material}) \times Th\,(\text{material}) \times \text{Length (from aerial view)}$$

Example: For $h_{\text{TOTAL}} = 16$ ft. (slope #1)

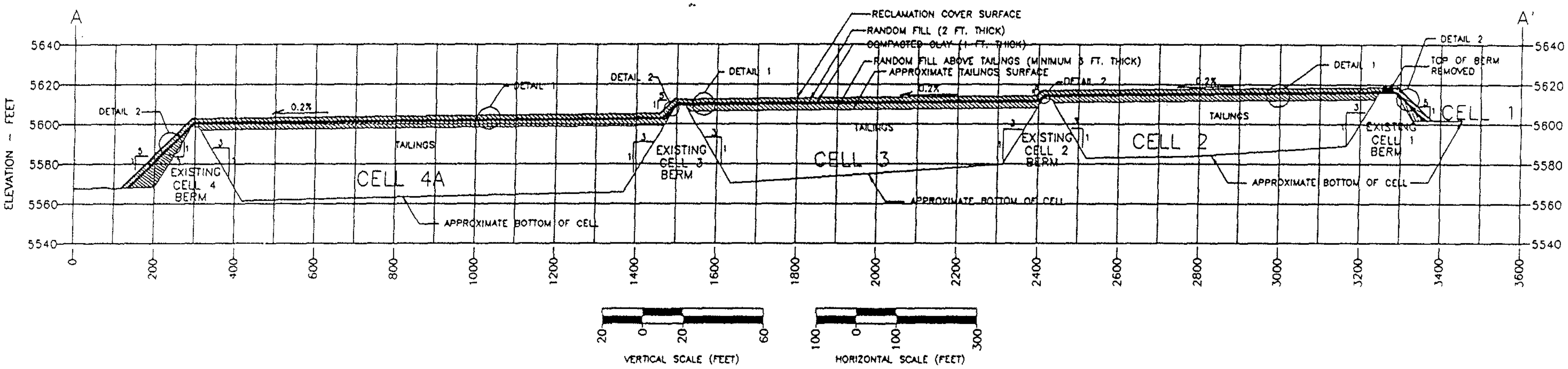
$h_{\text{riprap}} = 16$ ft. − 0.5 ft. = 15.5 ft.

$$L_{\text{riprap}} = \frac{15.5 \text{ ft}}{\cos 78.7} = 79.0 \text{ ft.}$$

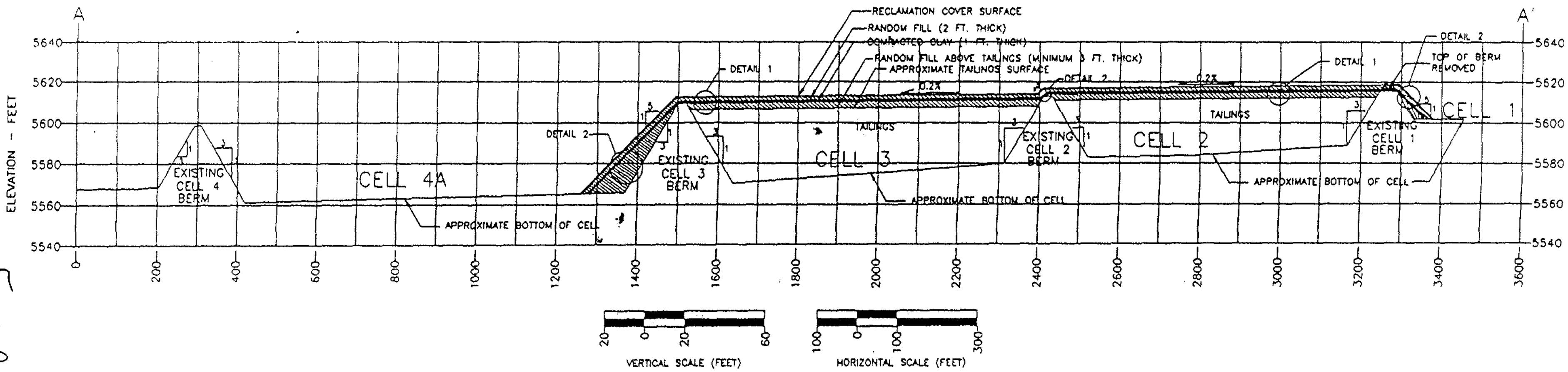
$$V_{\text{riprap}} = (79.0')(1.0')(3500') = \underline{276{,}500 \text{ ft}^3}$$

Figure 2

Figure 2



SECTION A–A' (WITH COVER ON CELLS 2, 3 & 4A)



SECTION A–A' (WITH COVER ON CELLS 2 & 3)

Figure 4

1 of 2

Figure 4

ATTACHMENT E.2

TECHNICAL SPECIFICATIONS FOR EXISTING COVER DESIGN

(from approved Reclamation Plan Revision 3.2b)

Denison Mines (USA) Corp.
1050 17th Street, Suite 950
Denver, CO 80265
USA

Tel : 303 628-7798
Fax : 303 389-4125

www.denisonmines.com

Attachment A
White Mesa Mill Reclamation Plan
Revision 3.2.B

Plans and Specifications

for

Reclamation

of the

White Mesa Mill and Tailings Management System

January 2011

State of Utah11e.(2) Byproduct Material License # UT1900479

ATTACHMENT A

PLANS AND SPECIFICATIONS

FOR

RECLAMATION

OF

WHITE MESA FACILITIES

BLANDING, UTAH

PREPARED BY

DENISON MINES (USA) CORP.

INDEPENDENCE PLAZA

1050 17TH STREET, SUITE 950

DENVER, CO 80265

January 2011 Revision 3.2.B

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1.0 GENERAL

The specifications presented in this section cover the reclamation of the Mill facilities.

2.0 CELL 1 RECLAMATION

2.1 Scope

The reclamation of Cell 1 (previously referred to as Cell 1-I) consists of evaporating the cell to dryness, removing raffinate crystals, synthetic liner and any contaminated soils, and constructing a clay lined area adjacent to and parallel with the existing Cell 1 dike for permanent disposal of contaminated material and debris from the Mill site decommissioning, referred to as the Cell 1 Tailings Area. A sedimentation basin will then be constructed and a drainage channel provided.

2.2 Removal of Contaminated Materials

2.2.1 Raffinate Crystals

Raffinate crystals will be removed from Cell 1 and transported to the tailings cells. It is anticipated that the crystals will have a consistency similar to a granular material when brought to the cells, with large crystal masses being broken down for transport. Placement of the crystals will be performed as a granular fill, with care being taken to avoid nesting of large sized material. Voids around large material will be filled with finer material or the crystal mass broken down by the placing equipment. Actual placement procedures will be evaluated by the QC officer during construction as crystal materials are brought and placed in the cells.

2.2.2 Synthetic Liner

The PVC liner will be cut up, folded (when necessary), removed from Cell 1, and transported to the tailings cells. The liner material will be spread as flat as practical over the designated area. After placement, the liner will be covered as soon as possible with at least one foot of soil, crystals or other materials for protection against wind, as approved by the QC officer.

2.2.3 Contaminated Soils

The extent of contamination of the Mill site will be determined by a scintillometer survey. If necessary, a correlation between scintillometer readings and U-nat/Radium-226 concentrations will be developed. Scintillometer readings can then be used to define cleanup areas and to monitor the cleanup. Soil sampling will be conducted to confirm that the cleanup results in a concentration of Radium-226 averaged over any area of 100 square meters that does not exceed the background level by more than:

- 5 pCi/g averaged over the first 15 cm of soils below the surface, and
- 15 pCi/g averaged over a 15 cm thick layer of soils more than 15 cm below the surface

Where surveys indicate the above criteria have not been achieved, the soil will be removed to meet the criteria. Soil removed from Cell 1 will be excavated and transported to the tailings cells. Placement and compaction will be in accordance with Section 4.0 of these Plans and Specifications.

2.3 Cell 1 Tailings Area

2.3.1 General

A clay lined area will be constructed adjacent to and parallel with the existing Cell 1 dike for permanent disposal of contaminated material and debris from the Mill site decommissioning (the Cell 1 Tailings Area). The area will be lined with 12 inches of clay prior to placement of contaminated materials and installation of the final reclamation cap.

2.3.2 Materials

Clays will have at least 40 percent passing the No. 200 sieve. The minimum liquid limit of these soils will be 25 and the plasticity index will be 15 or greater. These soils will classify as CL, SC or CH materials under the Unified Soil Classification System.

2.3.3 Borrow Sources

Clay will be obtaned from suitable materials stockpiled on site during cell construction or will be imported from borrow areas located in Section 16, T38S, R22E, SLM.

2.4 Liner Construction

2.4.1 General

Placement of clay liner materials will be based on a schedule determined by the availability of contaminated materials removed from the Mill decommissioning area in order to maintain optimum moisture content of the clay liner prior to placing of contaminated materials

2.4.2 Placement and Compaction

2.4.2.1 Methods

Placement of fill will be monitored by a qualified individual with the authority to stop work and reject material being placed. The full 12 inches of the clay liner fill will be compacted to 95% maximum dry density per ASTM D 698.

In all layers of the clay liner will be such that the liner will, as far as practicable, be free of lenses, pockets, streaks or layers of material differing substantially in texture, gradation or moisture content from the surrounding material. Oversized material will be controlled through selective excavation of stockpiled material, observation of placement by a qualified individual with authority to stop work and reject material being placed and by culling oversized material from the fill.

If the moisture content of any layer of clay liner is outside of the Allowable Placement Moisture Content specified in Table A-5.3.2.1-1, it will be moistened and/or reworked with a harrow, scarifier, or other suitable equipment to a sufficient depth to provide relatively uniform moisture content and a satisfactory bonding surface before the next succeeding layer of clay material is placed. If the compacted surface of any layer of clay liner material is too wet, due to precipitation, for proper compaction of the earthfill material to be placed thereon, it will be reworked with harrow, scarifier or other suitable equipment to reduce the moisture content to the required level shown in Table A-5.3.2.1-1. It will then be recompacted to the earthfill requirements.

No clay material will be placed when either the materials, or the underlying material, is frozen or when ambient temperatures do not permit the placement or compaction of the materials to the specified density, without developing frost lenses in the fill.

2.4.2.2 Moisture and Density Control

As far as practicable, the materials will be brought to the proper moisture content before placement, or moisture will be added to the material by sprinkling on the fill. Each layer of the fill will be conditioned so that the moisture content is uniform throughout the layer prior to and during compaction. The moisture content of the compacted liner material will be within the limits of standard optimum moisture content as shown in Table A-5.3.2.1-1. Material that is too dry or too wet to permit bonding of layers during compaction will be rejected and will be reworked until the moisture content is within the specified limits. Reworking may include removal, re-harrowing, reconditioning, rerolling, or combinations of these procedures.

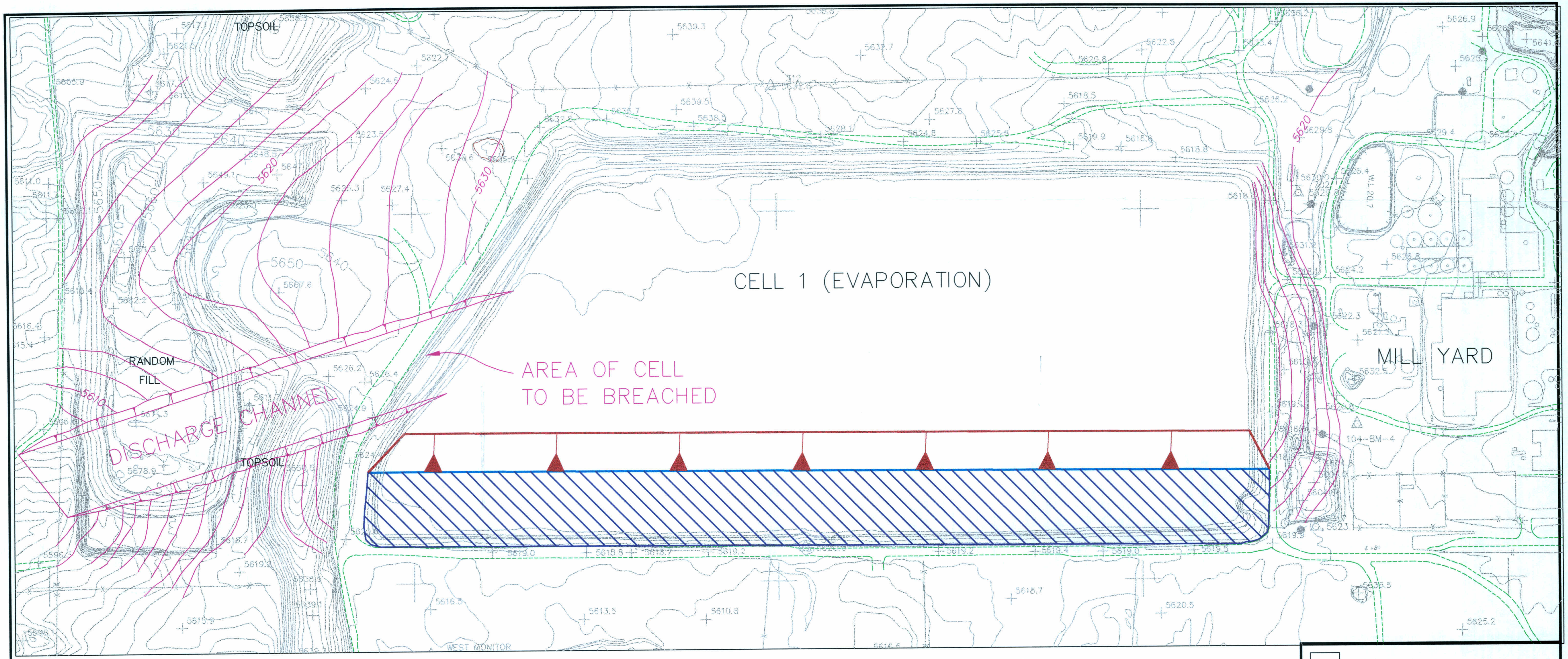
Density control of compacted clay will be such that the compacted material represented by samples having a dry density less than the values shown in Table A-5.3.2.1-1 will be rejected. Such rejected material will be reworked as necessary and rerolled until a dry density equal to or greater than the percent of its standard Proctor maximum density shown in Table A-5.3.2.1-1.

To determine that the moisture content and dry density requirements of the compacted liner material are being met, field and laboratory tests will be made at specified intervals taken from the compacted fills as specified in Section 7.4, "Frequency of Quality Control Tests."

2.5 Sedimentation Basin

Cell 1 will then be breached and constructed as a sedimentation basin. All runoff from the Mill area and immediately north of the cell will be routed into the sedimentation basin and will discharge onto the natural ground via the channel located at the southwest corner of the basin. The channel is designed to accommodate the PMF flood.

A sedimentation basin will be constructed in Cell 1 as shown in Figure A-2.2.4-1. Grading will be performed to promote drainage and proper functioning of the basin. The drainage channel out of the sedimentation basin will be constructed to the lines and grades as shown.



100 50 0 100 200
SCALE IN FEET

REVISIONS	
Date	By
6-30-00	DLS

Sedimentation Basin Detail
Figure A-2.2.4-1

Scale: 1" = 200'	Date: Jan., 1999	Cell1rec
Author:	Drafted By: D. L. Sledd	

3.0 MILL DECOMMISSIONING

The following subsections detail decommissioning plans for the Mill buildings and equipment; the Mill site; and windblown contamination.

3.1 Mill

The uranium and vanadium processing areas of the Mill, including all equipment, structures and support facilities, will be decommissioned and disposed of in tailings or buried on site as appropriate. All equipment, including tankage and piping, agitation equipment, process control instrumentation and switchgear, and contaminated structures will be cut up, removed and buried in tailings prior to final cover placement. Concrete structures and foundations will be demolished and removed or covered with soil as appropriate. These decommissioned areas would include, but not be limited to the following:

- Coarse ore bin and associated equipment, conveyors and structures.
- Grind circuit including semi-autogeneous grind (SAG) Mill, screens, pumps and cyclones.
- The three preleach tanks to the east of the Mill building, including all tankage, agitation equipment, pumps and piping.
- The seven leach tanks inside the main Mill building, including all agitation equipment, pumps and piping.
- The counter-current decantation (CCD) circuit including all thickeners and equipment, pumps and piping.
- Uranium precipitation circuit, including all thickeners, pumps and piping.

- The two yellow cake dryers and all mechanical and electrical support equipment, including uranium packaging equipment.
- The clarifiers to the west of the Mill building including the preleach thickener (PLT) and claricone.
- The boiler and all ancillary equipment and buildings.
- The entire vanadium precipitation, drying and fusion circuit.
- All external tankage not included in the previous list including reagent tanks for the storage of acid, ammonia, kerosene, water, dry chemicals, etc. and the vanadium oxidation circuit.
- The uranium and vanadium solvent extraction (SX) circuit including all SX and reagent tankage, mixers and settlers, pumps and piping.
- The SX building.
- The Mill building.
- The Alternate Feed processing circuit
- Decontamination pads
- The office building.
- The shop and warehouse building.
- The sample plant building.
- The Reagent storage building.

The sequence of demolition would proceed so as to allow the maximum use of support areas of the facility such as the office and shop areas. It is anticipated that all major structures and large equipment will be demolished with the use of hydraulic shears. These will speed the process, provide proper sizing of the materials to be placed in tailings, and reduce exposure to radiation and other safety hazards during the demolition. Any uncontaminated or decontaminated equipment to be considered for salvage will be released in accordance with the terms of License

Condition 9.10. As with the equipment for disposal, any contaminated soils from the Mill area will be disposed of in the tailings facilities in accordance with Section 4.0 of the Specifications.

3.2 Mill Site

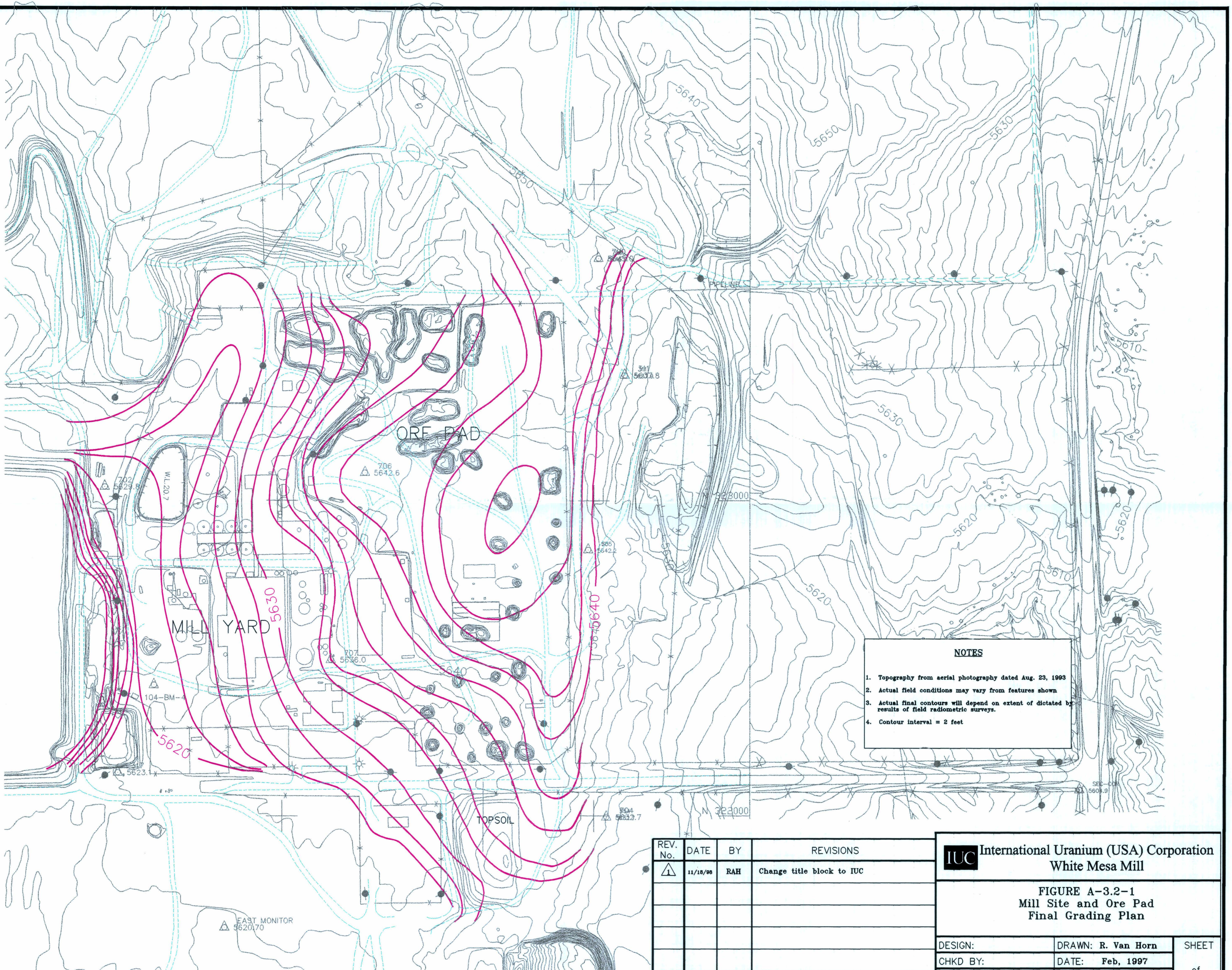
Contaminated areas on the Mill site will be primarily superficial and include the ore storage area and surface contamination of some roads. All ore and alternate feed materials will have been previously removed from the ore stockpile area. All contaminated materials will be excavated and be disposed in one of the tailings cells in accordance with Section 4.0 of these Plans and Specifications. The depth of excavation will vary depending on the extent of contamination and will be based on the criteria in Section 2.2.3 of these Plans and Specifications. All other 11e.(2) byproduct materials will be disposed of in the tailings cells.

All ancillary contaminated materials including pipelines will be removed and will be disposed of by disposal in the tailing cells in accordance with Section 4.0 of these Plans and Specifications.

Disturbed areas will be covered, graded and vegetated as required. The proposed grading plan for the Mill site and ancillary areas is shown on Figure A-3.2-1.

3.3 Windblown Contamination

Windblown contamination is defined as Mill derived contaminants dispersed by the wind to surrounding areas. The potential areas affected by windblown contamination will be surveyed using scintillometers taking into account historical operational data from the Semi-annual Effluent Reports and other guidance such as prevailing wind direction and historical background data. Areas covered by the existing Mill facilities and ore storage pad, the tailings cells and adjacent stockpiles of random fill, clay and topsoil, will be excluded from the survey. Materials from these areas will be removed in conjunction with final reclamation and decommissioning of the Mill and tailings cells.



NOTES

1. Topography from aerial photography dated Aug. 23, 1993
2. Actual field conditions may vary from features shown
3. Actual final contours will depend on extent of dictated by results of field radiometric surveys.
4. Contour interval = 2 feet

REV. No.	DATE	BY	REVISIONS
1	11/18/98	RAH	Change title block to IUC

IUC International Uranium (USA) Corporation
White Mesa Mill

FIGURE A-3.2-1
Mill Site and Ore Pad
Final Grading Plan

DESIGN:	DRAWN: R. Van Horn	SHEET
CHKD BY:	DATE: Feb, 1997	of
APP:	SCALE: 1" = 200'	

3.3.1 Guidance

The necessity for remedial actions will be based upon an evaluation prepared by Denison, and approved by the Executive Secretary, of the potential health hazard presented by any windblown materials identified. The assessment will be based upon analysis of all pertinent radiometric and past land use information and will consider the feasibility, cost-effectiveness, and environmental impact of the proposed remedial activities and final land use. All methods utilized will be consistent with the guidance contained in NUREG-5849: "Manual for Conducting Radiological Surveys in Support of License Termination."

3.3.2 General Methodology

The facility currently monitors soils for the presence of Ra-226, Th-230 and natural uranium, such results being presented in the second semi-annual effluent report for each year. Guideline values for these materials will be determined and will form the basis for the cleanup of the Mill site and surrounding areas. For purposes of determining possible windblown contamination, areas used for processing of uranium ores as well as the tailings and evaporative facilities will be excluded from the initial scoping survey, due to their proximity to the uranium recovery operations. Those areas include:

- The Mill building, including CCD, Pre-Leach Thickener area, uranium drying and packaging, clarifying, and preleach.
- The SX building, including reagent storage immediately to the east of the SX building.
- The alternate feed circuit.
- The ore pad and ore feed areas.
- Tailings Cells No. 2, 3, 4A, and 4B.
- Evaporation Cell No. 1.

The remaining areas of the Mill will be divided up into two areas for purposes of windblown determinations:

- The restricted area, less the above areas; and,
- A halo around the restricted area.

Areas within the restricted area, as shown on Figure 3.2-1 will be initially surveyed on a 30 x 30 meter grid as described below in Section 3.3.3. The halo around the suspected area of contamination will also be initially surveyed on a 50 x 50 meter grid using methodologies described below in Section 3.3.3. Any areas which are found to have elevated activity levels will be further evaluated as described in Sections 3.3.4 and 3.3.5. Initial surveys of the areas surrounding the Mill and tailings area have indicated potential windblown contamination only to the north and east of the Mill ore storage area, and to the southwest of Cell 3, as indicated on Figure 3.2-1.

3.3.3 Scoping Survey

Areas contaminated through process activities or windblown contamination from the tailings areas will be remediated to meet applicable cleanup criteria for Ra-226, Th-230 and natural uranium. Contaminated areas will be remediated such that the residual radionuclides remaining on the site, that are distinguishable from background, will not result in a dose that is greater than that which would result from the radium soil standard (5 pCi/gram above background).

Soil cleanup verification will be accomplished by use of several calibrated beta/gamma instruments. Multiple instruments will be maintained and calibrated to ensure availability during Remediation efforts.

Initial soil samples will be chemically analyzed to determine on-site correlation between the gamma readings and the concentration of radium, thorium and uranium, in the samples. Samples will be taken from areas known to be contaminated with only processed uranium materials (i.e. tailings sand and windblown contamination) and areas in which it is suspected that unprocessed uranium materials (i.e. ore pad and windblown areas downwind of the ore pad) are present. The actual number of samples used will depend on the correlation of the results between gamma readings and the Ra-226 concentration. A minimum of 35 samples of windblown tailings material, and 15 samples of unprocessed ore materials is proposed. Adequate samples will be taken to ensure that graphs can be developed to adequately project the linear regression lines and the calculated upper and lower 95 percent confidence levels for each of the instruments. The 95 percent confidence limit will be used for the guideline value for correlation between gamma readings and radium concentration. Because the unprocessed materials are expected to have proportionally higher values of uranium in relation to the radium and thorium content, the correlation to the beta/gamma readings are expected to be different than readings from areas known to be contaminated with only processed materials. Areas expected to have contamination from both processed and unprocessed materials will be evaluated on the more conservative correlation, or will be cleaned to the radium standard which should ensure that the uranium is removed.

Radium concentration in the samples should range from 25% of the guideline value (5 pCi/gram above background) for the area of interest, through the anticipated upper range of radium contamination. Background radium concentrations have been gathered over a 16 year period at sample station BHV-3 located upwind and 5 miles west of the Mill. The radium background concentration from this sampling is 0.93 pCi/gram. This value will be used as an interim value for the background concentration. Prior to initiating cleanup of windblown contamination, a systematic soil sampling program will be conducted in an area within 3 miles of the site, in geologically similar areas with soil types and soil chemistry similar to the areas to be cleaned, to determine the average background radium concentration, or concentrations, to be ultimately used for the cleanup.

An initial scoping survey for windblown contamination will be conducted based on analysis of all pertinent radiometric and past land use information. The survey will be conducted using calibrated beta/gamma instruments on a 30 meter by 30 meter grid. Additional surveys will be conducted in a halo, or buffer zone, around the projected impact area. The survey in the buffer area will be conducted on a 50 meter by 50 meter grid. Grids where no readings exceed 75% of the guideline value (5 pCi/gram above background) will be classified as unaffected, and will not require remediation.

The survey will be conducted by walking a path within the grid as shown in Figure A-3.3-1. These paths will be designed so that a minimum of 10% of the area within the grid sidelines will be scanned, using an average coverage area for the instrument of one (1) meter wide. The instrument will be swung from side to side at an elevation of six (6) inches above ground level, with the rate of coverage maintained within the recommended duration specified by the specific instrument manufacturer. In no case will the scanning rate be greater than the rate of 0.5 meters per second (m/sec) specified in NUREG/CR-5849 (NRC, 1992).

3.3.4 Characterization and Remediation Control Surveys

After the entire subarea has been classified as affected or unaffected, the affected areas will be further scanned to identify areas of elevated activity requiring cleanup. Such areas will be flagged and sufficient soils removed to, at a minimum, meet activity criteria. Following such remediation, the area will be scanned again to ensure compliance with activity criteria. A calibrated beta/gamma instrument capable of detecting activity levels of less than or equal to 25 percent of the guideline values will be used to scan all the areas of interest.

3.3.5 Final Survey

After removal of contamination, final surveys will be taken over remediated areas. Final surveys will be calculated and documented within specific 10 meter by 10 meter grids with sample point locations as shown in Figure A-3.3.2. Soil samples from 10% of the surveyed grids will be chemically analyzed to confirm the initial correlation factors utilized and confirm the success of cleanup effort for radium, thorium and uranium. Ten (10) percent of the samples chemically analyzed will be split, with a duplicate sent to an off site laboratory. Spikes and blanks, equal in number to 10 percent of the samples that are chemically analyzed, will be processed with the samples.

3.3.6 Employee Health and Safety

Programs currently in place for monitoring of exposures to employees will remain in effect throughout the time period during which tailings cell reclamation, Mill decommissioning and clean up of windblown contamination are conducted. This will include personal monitoring (film badges/TLD's) and the ongoing bioassay program. Access control will be maintained at the Restricted Area boundary to ensure employees and equipment are released from the site in accordance with the current License conditions. In general, no changes to the existing programs are expected and reclamation activities are not expected to increase exposure potential beyond the current levels.

3.3.7 Environment Monitoring

Existing environmental monitoring programs will continue during the time period in which reclamation and decommissioning is conducted. This includes monitoring of surface and groundwater, airborne particulates, radon, soils and vegetation, according to the existing License conditions. In general, no changes to the existing programs are expected and reclamation activities are not expected to increase exposure potential beyond the current levels.

3.3.8 Quality Assurance

At least six (6) months prior to beginning of decommission activities, a detailed Quality Assurance Plan will be submitted for Executive Secretary approval. The Plan will be in accordance with NRC Regulatory Guide 4.15, Quality Assurance for Radiological Monitoring Programs. In general, the Plan will detail Denison's organizational structure and responsibilities, qualifications of personnel, operating procedures and instructions, record keeping and document control, and quality control in the sampling procedure and outside laboratory. The Plan will adopt the existing quality assurance/quality control procedures utilized in compliance with the existing License.

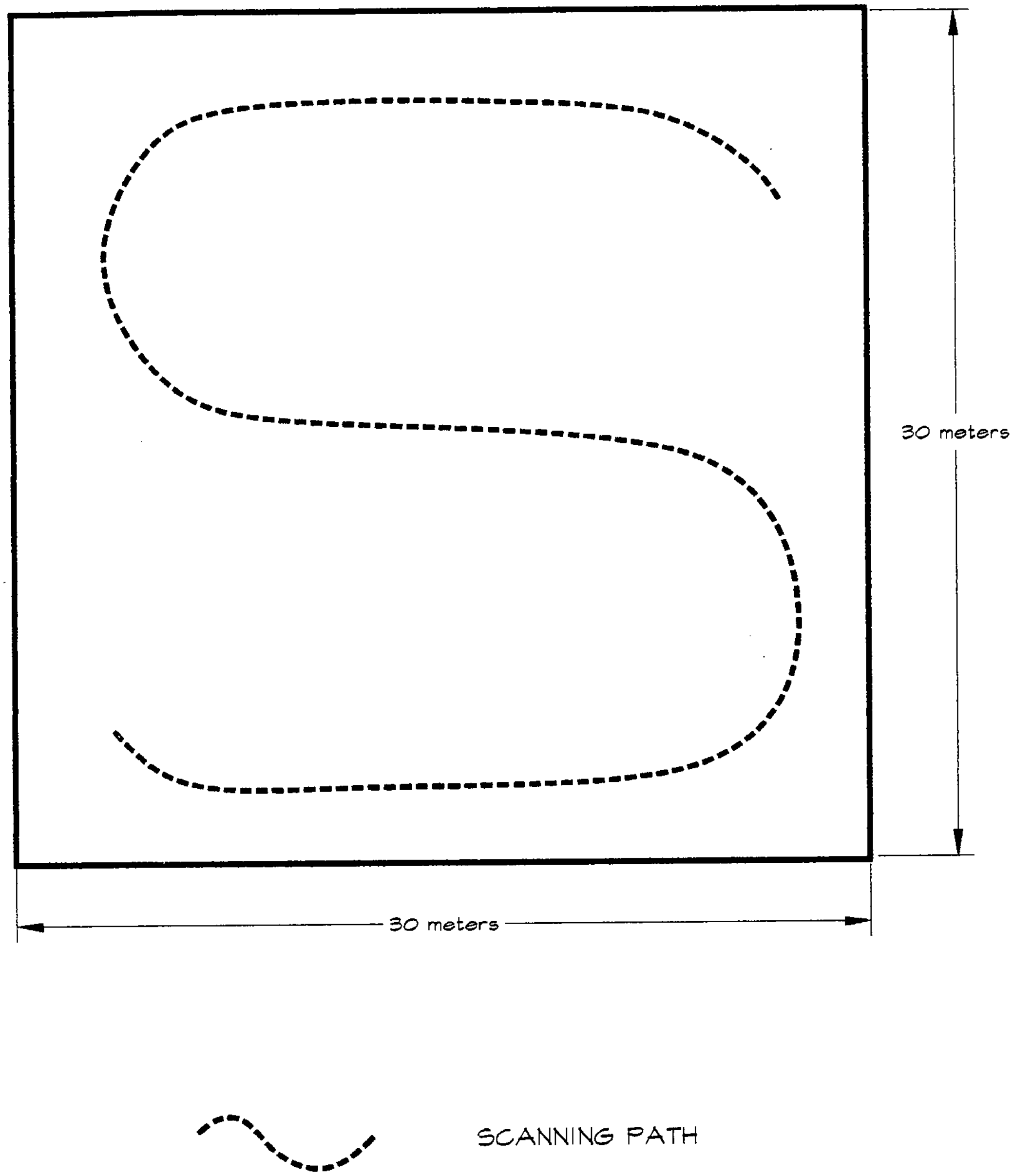


FIGURE A-3.3-1
TYPICAL SCANNING PATH
SCOPING SURVEY

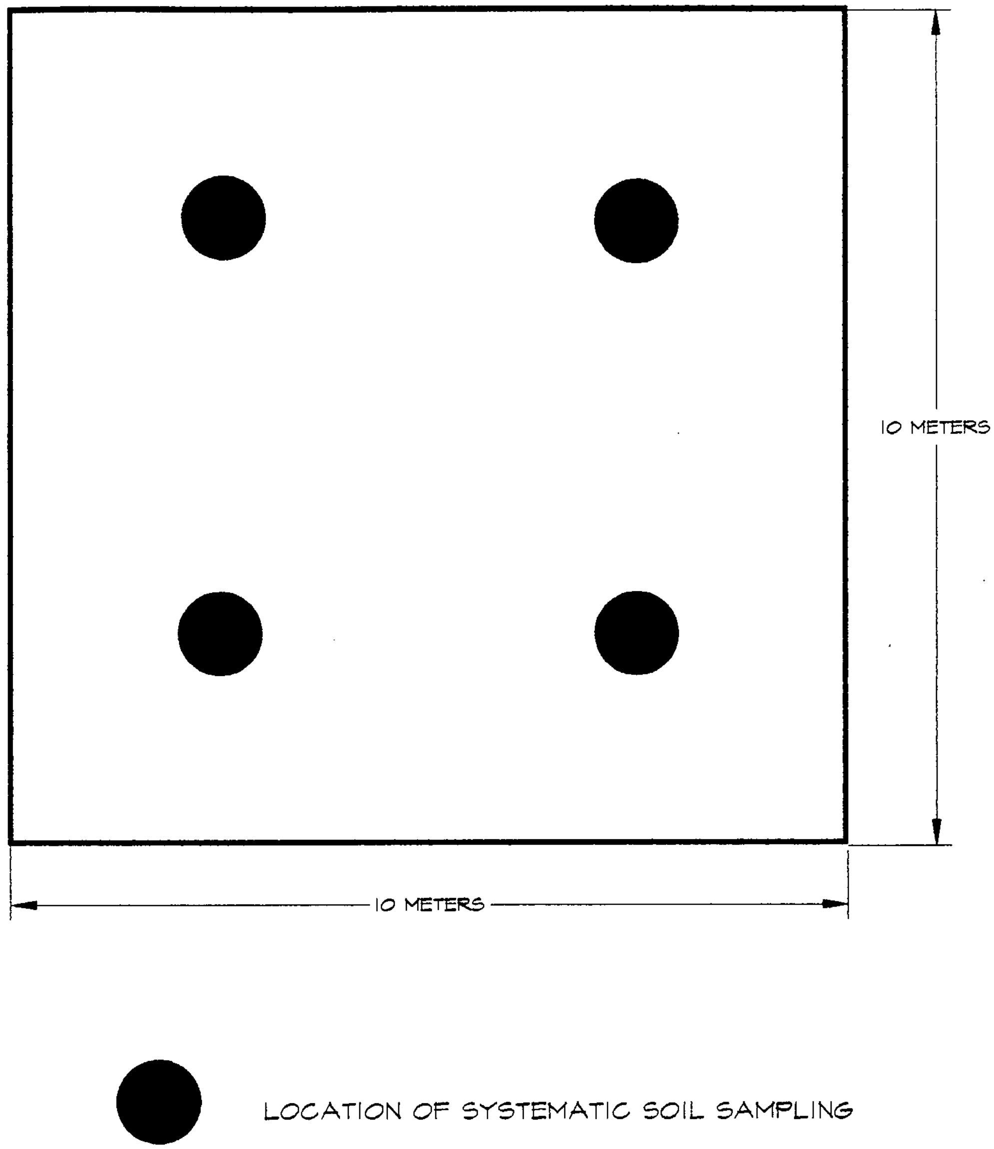


FIGURE A-3.3-2
STANDARD SAMPLING PATTERN FOR
SYSTEMATIC SURVEY OF SOIL

4.0 PLACEMENT METHODS

4.1 Scrap and Debris

The scrap and debris will have a maximum dimension of 20 feet and a maximum volume of 30 cubic feet. Scrap exceeding these limits will be reduced to within the acceptable limits by breaking, cutting or other approved methods. Empty drums, tanks or other objects having a hollow volume greater than five cubic feet will be reduced in volume by at least 70 percent. If volume reduction is not feasible, openings will be made in the object to allow soils, tailings and/or other approved materials to enter the object at the time of covering on the tailings cells. The scrap, after having been reduced in dimension and volume, if required, will be placed on the tailings cells as directed by the QC officer.

Any scrap placed will be spread across the top of the tailings cells to avoid nesting and to reduce the volume of voids present in the disposed mass. Stockpiled soils, contaminated soils, tailings and/or other approved materials will be placed over and into the scrap in sufficient amount to fill the voids between the large pieces and the volume within the hollow pieces to form a coherent mass. It is recognized that some voids will remain because of the scrap volume reduction specified, and because of practical limitations of these procedures. Reasonable effort will be made to fill the voids. The approval of the Site Manager or a designated representative will be required for the use of materials other than stockpiled soils, contaminated soils or tailings for the purpose of filling voids.

4.2 Contaminated Soils and Raffinate Crystals

The various materials will not be concentrated in thick deposits on top of the tailings, but will be spread over the working surface as much as possible to provide relatively uniform settlement and consolidation characteristics of the cleanup materials.

4.3 Compaction Requirements

The scrap, contaminated soils and other materials for the first lift will be placed over the existing tailings surface to a depth of up to four feet thick in a bridging lift to allow access for placing and compacting equipment. The first lift will be compacted by the tracking of heavy equipment, such as a Caterpillar D6 Dozer (or equivalent), at least four times prior to the placement of a subsequent lift. Subsequent layers will not exceed two feet and will be compacted to the same requirements.

During construction, the compaction requirements for the crystals will be reevaluated based on field conditions and modified by the Site Manager or a designated representative, with the agreement of the Executive Secretary.

The contaminated soils and other cleanup materials after the bridging lift will be compacted to at least 80 percent of standard Proctor maximum density (ASTM D-698).

5.0 RECLAMATION CAP - CELLS 1, 2, 3, 4A AND 4B

5.1 Earth Cover

A multi-layered earthen cover will be placed over tailings Cells 2, 3, 4A and 4B and a portion of Cell 1 used for disposal of contaminated materials (the Cell1 Tailings Area). The general grading plan is shown on Drawing A-5.1-1. Reclamation cover cross-sections are shown on Drawings A-5.1-2 and A-5.1-3.

5.2 Materials

5.2.1 Physical Properties

The physical properties of materials for use as cover soils will meet the following:

Random Fill (Platform Fill and Frost Barrier)
These materials will be mixtures of clayey sands and silts with random amounts of gravel and rock size material. In the initial bridging lift of the platform fill, rock sizes of up to 2/3 of the thickness of the lift will be allowed. On all other random fill lifts, rock sizes will be limited to 2/3 of the lift thickness, with at least 30 percent of the material finer than 40 sieve. For that portion passing the No. 40 sieve, these soils will classify as CL, SC, MC or SM materials under the Unified Soil Classification System. Oversized material will be controlled through selective excavation at the stockpiles and through the utilization of a grader, bulldozer or backhoe to cull oversize from the fill.

Clay Layer Materials

Clays will have at least 40 percent passing the No. 200 sieve. The minimum liquid limit of these soils will be 25 and the plasticity index will be 15 or greater. These soils will classify as CL, SC or CH materials under the Unified Soil Classification System.

LEGEND

5582.6	EXISTING SPOT ELEVATION
5612	ELEVATION OF TOP OF COVER
5612	ELEVATION OF TOP OF COVER CELL 4B
~5560~	EXISTING GROUND CONTOUR

NOTES

1. THE COVER WILL MEET THE GROUND WITH A DOWNWARD SIDE SLOPE OF 5H:1V.
2. ELEVATION OF THE BERMS SHOULD BE ADJUSTED TO MATCH WITH THOSE OF THE COVER.
3. A PORTION OF CELL 1-I WILL BE USED FOR PERMENANT STORAGE OF CONTAMINATED MATERIALS UPON FINAL SITE DECOMMISSIONING. (3)
4. TOPOGRAPHY BY KLH ENGINEERING FROM AERIAL PHOTOGRAPHY DATED AUGUST 23, 1993. CONTOUR INTERVAL IS 2 FT.
5. SEE FIGURES A-5.1-2 AND A-5.1-3 FOR CROSS SECTIONS AND DETAILS.
6. EXISTING GROUND SURFACES SHALL BE REGRADED TO CONSTRUCT THE COVER WITH A FINAL SURFACE THAT IS CONSISTENT WITH THE RECLAMATION COVER GRADING PLAN.

SCALE 200 0 200 400 FEET

After Titan Environmental, 1996

REV. No.	DATE	BY	REVISIONS
1	11/18/98	RAH	Add rock apron at toe of slopes, increase width of breach in Cell 4A dike & change to IUC title block
2	4/5/99	RAH	Add section lines through the breach in Cell 4A dike & change to IUC title block
3	6/30/00	DLS	Add Cell 1-I Disposal Area
4	3/25/08	dmf	Add Cell 4A Reclamation Cap
5	2/10/10	DLS	Add detail reference
6	6/16/10	dmf	Add Cell 4B Reclamation Cap
7	1/13/11	bm	Revision Update

Denison Mines (USA) Corp.

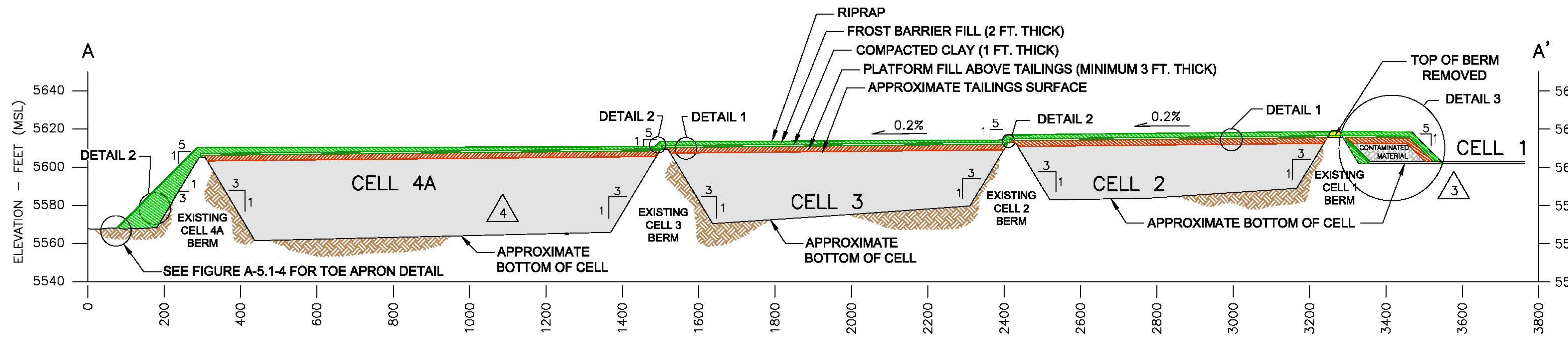
Project: WHITE MESA MILL

County: San Juan State: Utah

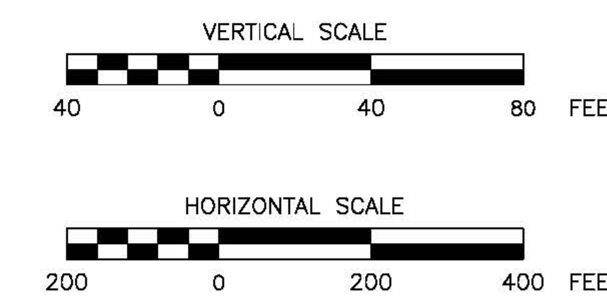
FIGURE A-5.1-1
RECLAMATION COVER GRADING PLAN
RECLAMATION PLAN REV. 3.2.B

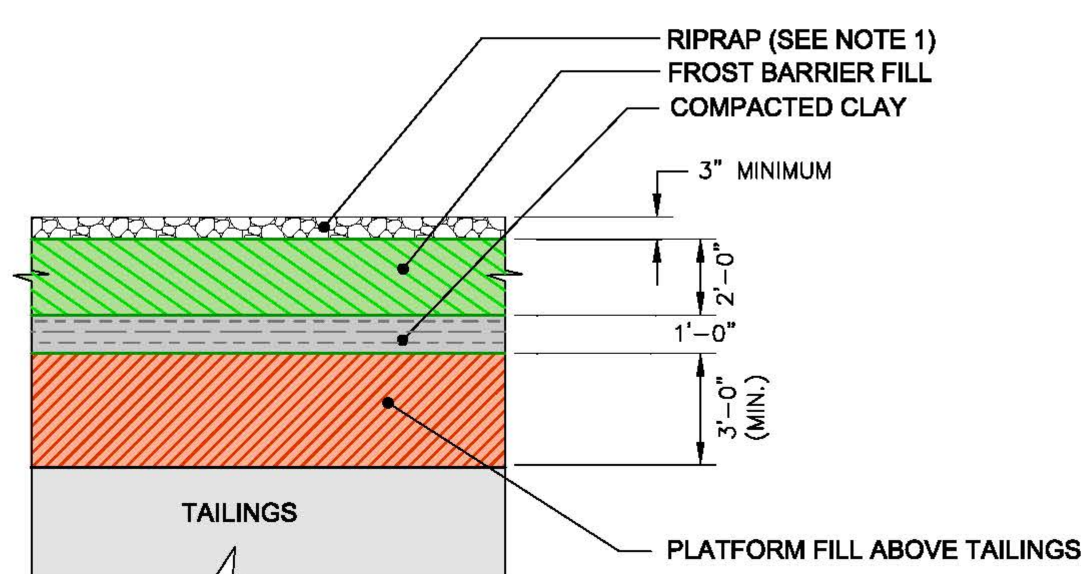
Date: March, 2010 Design: Drafted By: D.Sledd

W:\USA\Utah\Mill\dwgs\Reclamation Plans\RecPlan 3.2B\ Figure A-5.1-1_Reclamation Covers_Grading Plan.dwg 01/14/2011 bmunkhbaatar DN



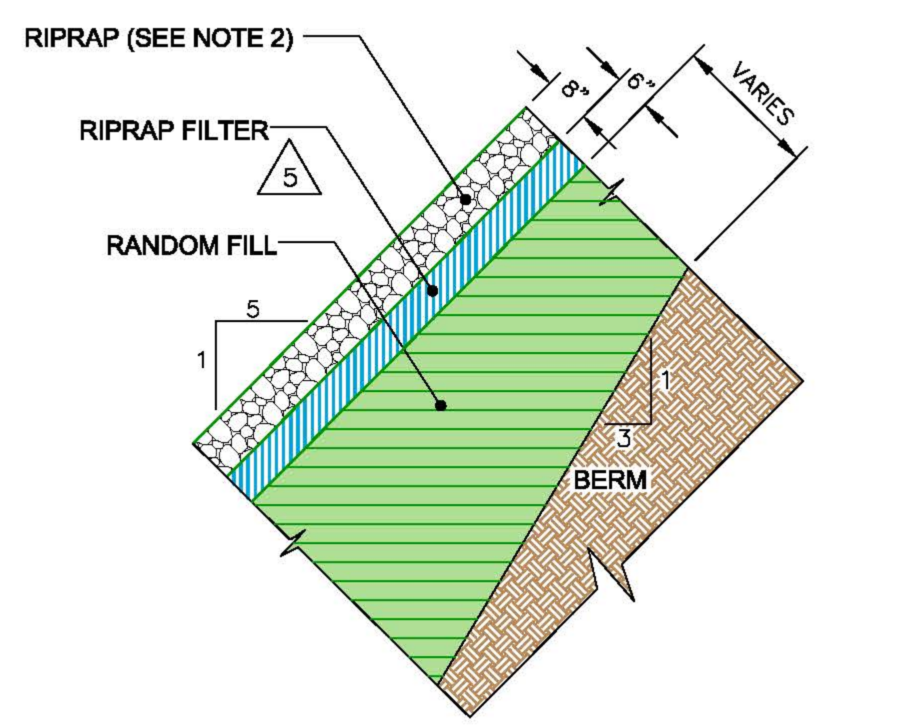
SECTION A–A' (WITH COVER ON CELLS 2, 3 & 4A)





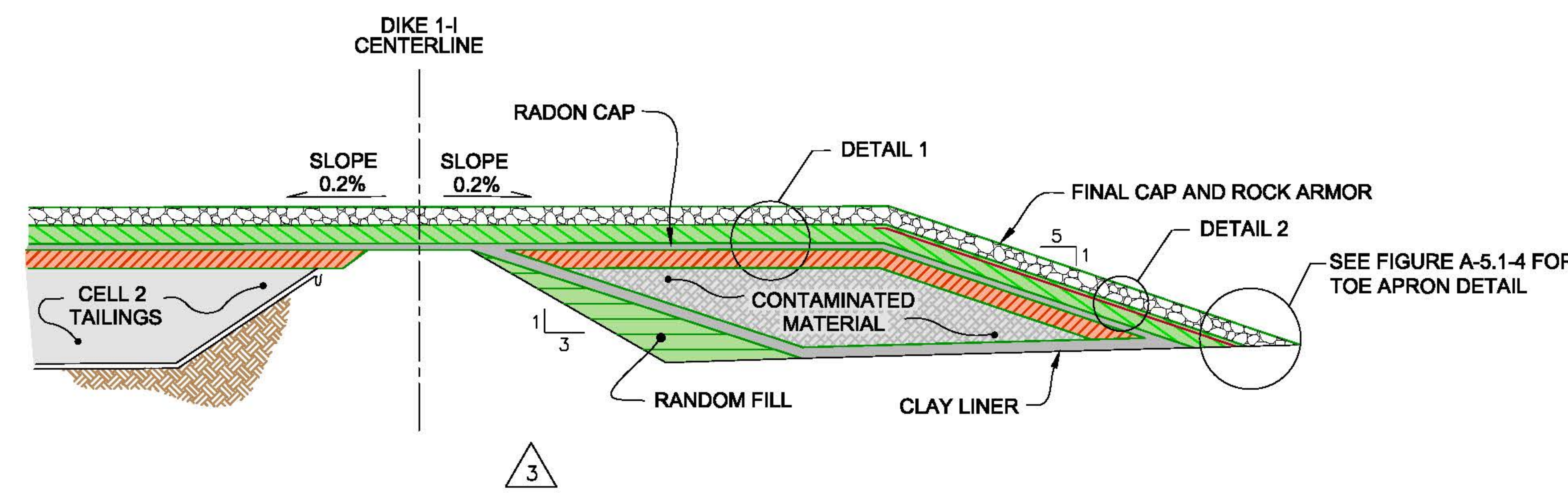
DETAIL 1: COVER DETAIL FOR POND SURFACE AREAS

(NOT TO SCALE)



DETAIL 2: COVER DETAIL FOR SIDE SLOPES

(NOT TO SCALE)



DETAIL 3: COVER DETAIL FOR CELL 1 CONTAMINATED MATERIAL

(NOT TO SCALE)

NOTES:

1. RIPRAP PLACED ON THE TOP OF COVER WILL CONSIST OF ROCK WITH D50 MINIMUM OF 0.34 INCHES.
2. RIPRAP PLACED ON THE SIDE SLOPES OF COVER WILL CONSIST OF ROCK WITH D50 MINIMUM OF 3.5 INCHES.
3. RIPRAP FILTER PLACED ON THE SIDE SLOPES OF COVER WILL CONSISTS OF MEDIUM SAND
4. POND BOTTOM ELEVATIONS INFERRED FROM 'CELL 4 PHASE A AND PHASE B PLAN', WESTERN ENGINEERS INC., (JANUARY 17, 1989).
5. SEE FIGURES 1 AND 2 FOR CROSS SECTION LOCATIONS.
6. EXISTING GROUND SURFACES SHALL BE REGRADED TO CONSTRUCT THE COVER WITH A FINAL SURFACE THAT IS CONSISTENT WITH THE RECLAMATION COVER GRADING PLAN.

REV. No.	DATE	BY	REVISIONS
1	11/18/98	RAH	Delete clay layer from exterior side slopes, change layer names, & change title block
2	5/26/98	RAH	Add Rock apron at toe of 5:1 slope
3	6/26/00	DLS	Add Cell 1-I Disposal Area
4	7/08/08	dmf	Add Cell 4A Cover
5	2/10/10	DLS	Add riprap filter and detail references
	12/17/10	BM	Add riprap filter and detail references update
	01/13/11	BM	Change figure number, revision update

Denison Mines (USA) Corp.

Project: WHITE MESA MILL

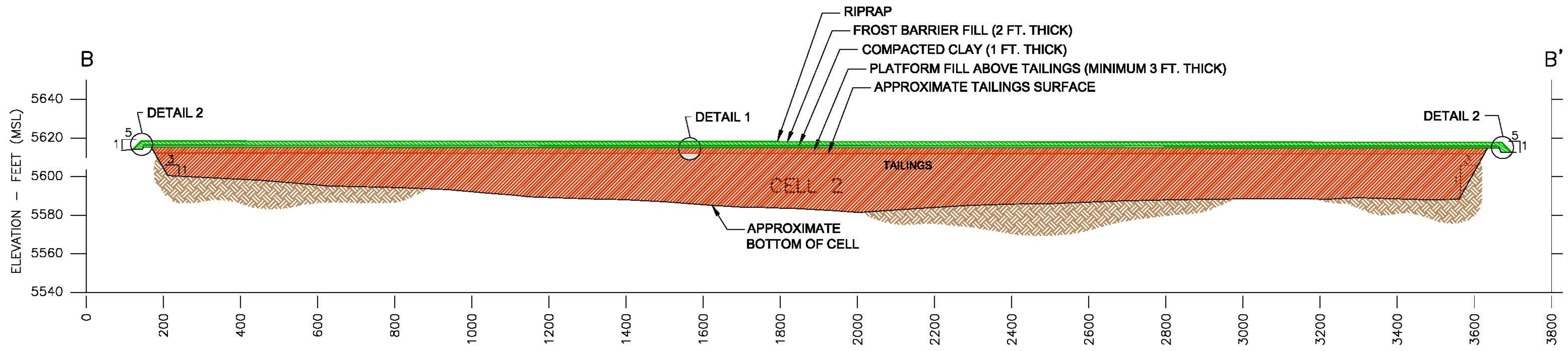
County: San Juan | State: Utah

FIGURE A-5.1-2

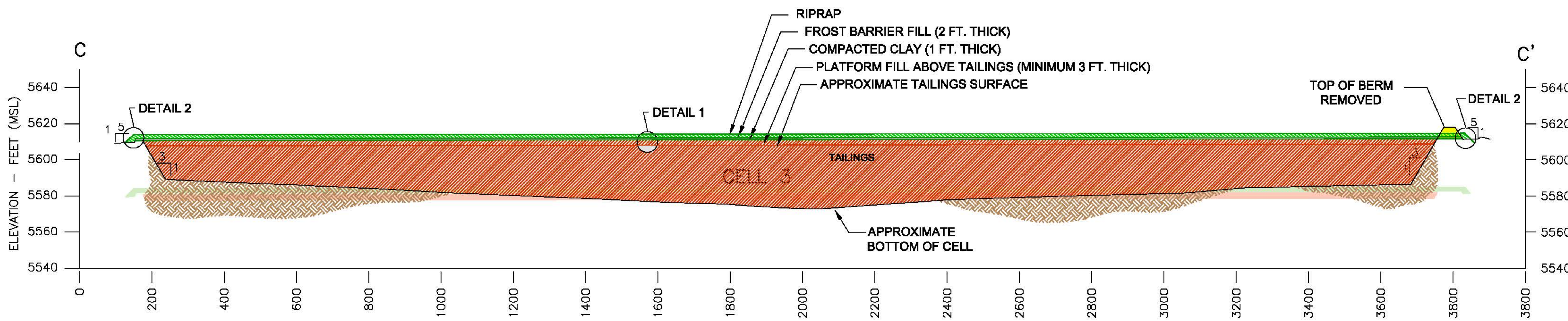
RECLAMATION COVER DETAILS & CROSS SECTION

RECLAMATION PLAN REVISION 3.2.B

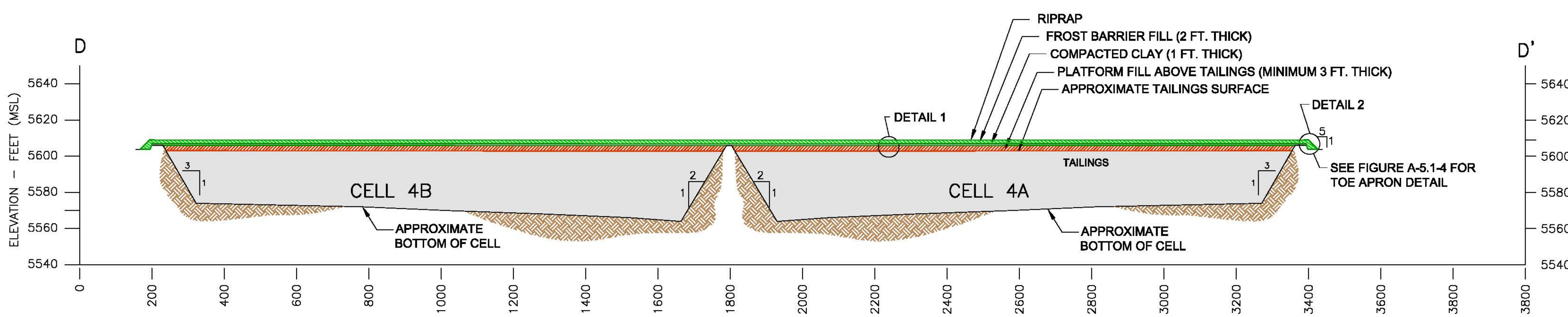
Date: March, 2010 | Design: | Drafted By: D.Stedd

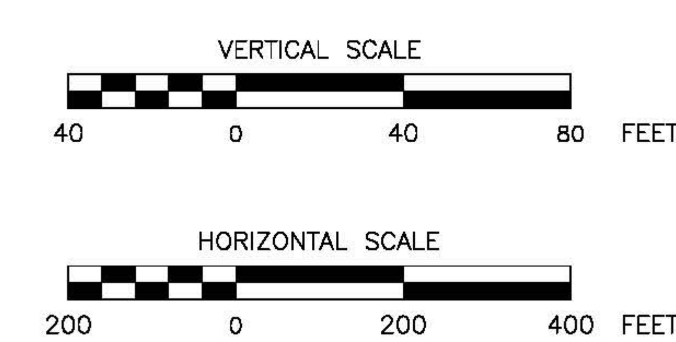


SECTION B–B'



SECTION C–C'





3 SECTION D–D' 2

REV. No.	DATE	BY	REVISIONS
1	11/19/98	RAH	Delete clay layer from exterior side slopes, change layer names, & change title block
2	7/11/08	dmf	Add section D–D'
	2/10/10	DLS	Add detail reference on section D–D'
	12/17/10	BM	Revision date update
3	01/13/11	BM	Add CELL 4B on section D–D'

Denison Mines (USA) Corp.

DENISON MINES

Project: WHITE MESA MILL

County: San Juan State: Utah

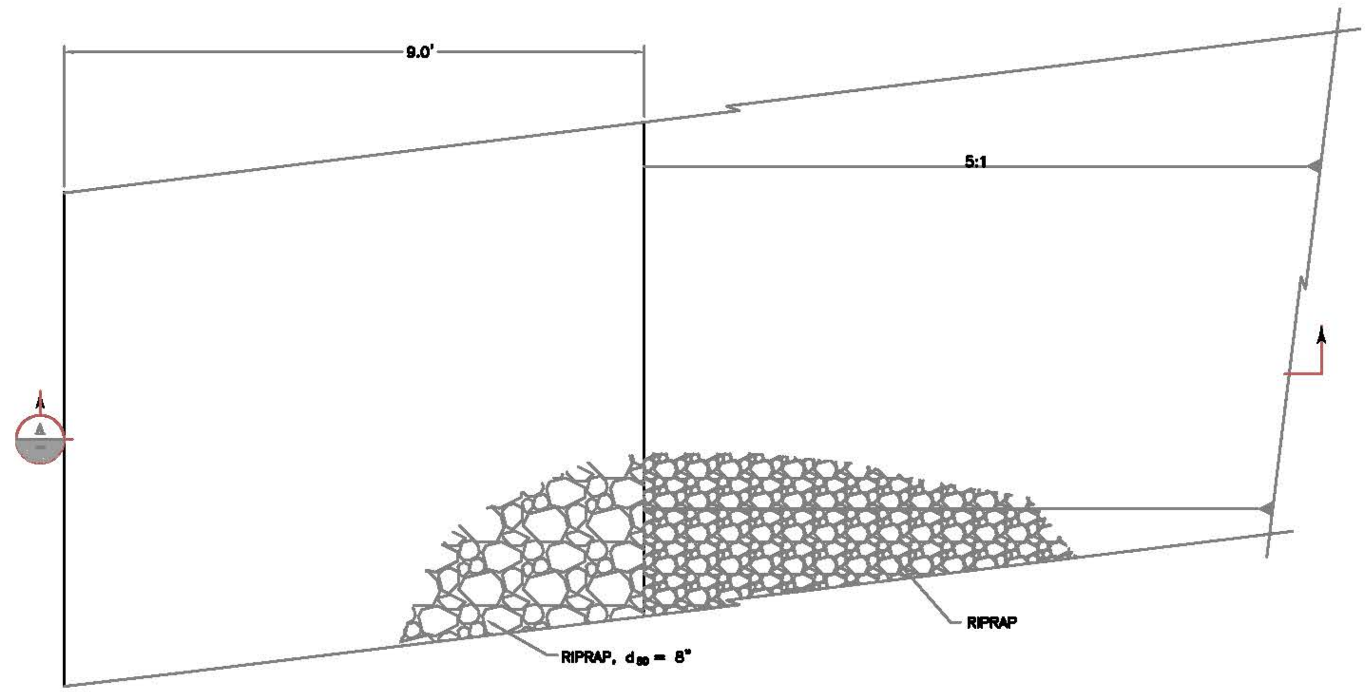
FIGURE A-5.1-3

RECLAMATION COVER AND CROSS SECTIONS

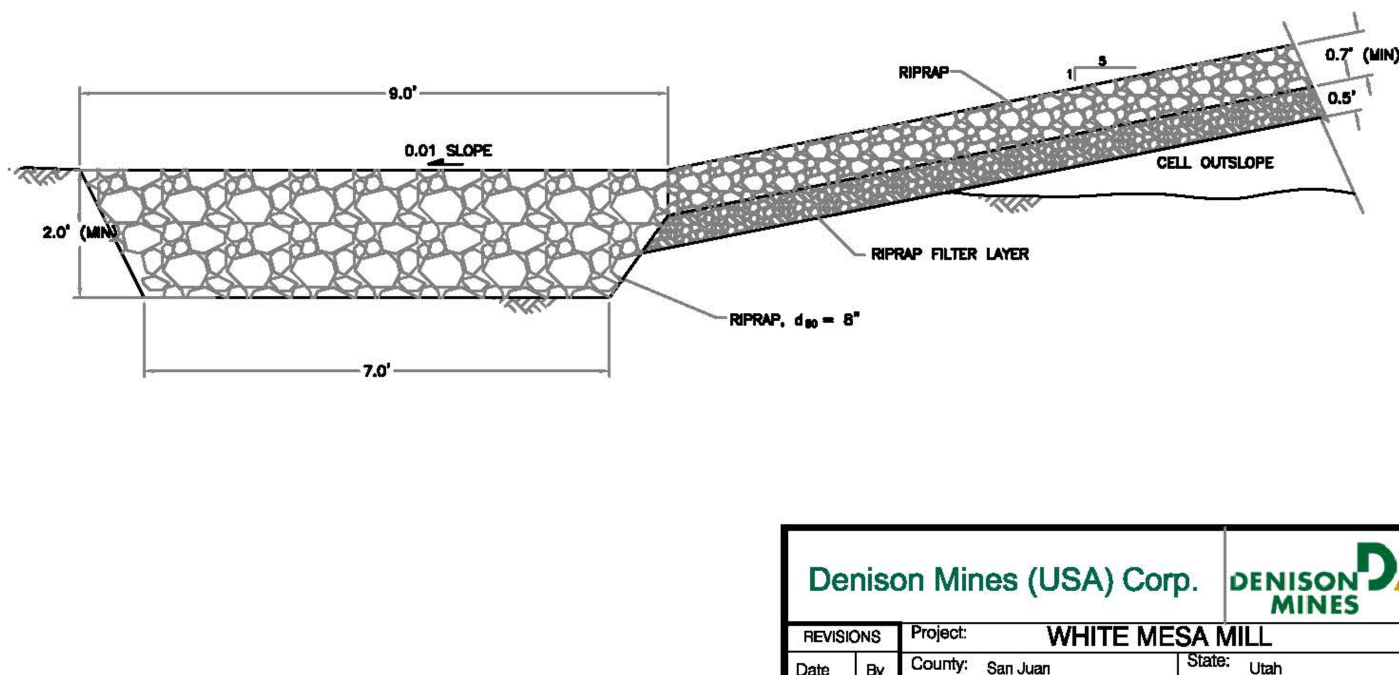
RECLAMATION PLAN REVISION 3.2.B

Date: March, 2010 Design: Drafted By: D.Sledd

W:\USA\Utah\Mill\dwgs\Reclamation Plans\RecPlan 3.2B\ Figure A-5.1-3_ Reclamation Cover_Cross Sections BCD.dwg 01/14/2011 bmunkhbaatar DN



PLAN
NTS



W:\USA\Utah\Mill\dwgs\Reclamation Plans\RecPlan 3.2B\Figure A-5.1-4.toepad.dwg Figure 13/01/2011 bmunkhbaatar

Denison Mines (USA) Corp.

REVISIONS		Project: WHITE MESA MILL	
Date	By	County: San Juan	State: Utah
2-22-10	DLS	Location:	
12-17-10	BM	**FIGURE A-5.1-4**	
01-13-10	BM	Rock Apron at Base of Toe Cell Outslopes	
		RECLAMATION PLAN REVISION 3.2.B	

Scale: N/A	Date: 4/2/99	Drafted By: RAH

5.2.2 Borrow Sources

The sources for soils for the cover materials are as follows:

1. Random Fill (Platform and Frost Barrier) - stockpiles from previous cell construction activities currently located to the east and west of the tailing facilities.

2. Clay - will be from suitable materials stockpiled on site during cell construction or will be imported from borrow areas located in Section 16, T38S, R22E, SLM.

3. Rock Armor - will be produced through screening of alluvial gravels located in deposits 1 mile north of Blanding, Utah; 7 miles north of the Mill site.

5.3 Cover Construction

5.3.1 General

Placement of cover materials will be based on a schedule determined by analysis of settlement data, piezometer data and equipment mobility considerations. Settlement plates and piezometers will be installed and monitored in accordance with Section 5.4 of these Plans and Specifications.

5.3.2 Placement and Compaction

5.3.2.1 Methods

Platform Fill

An initial lift of 3 to 4 feet of random fill will be placed over the tailings surface to form a stable working platform for subsequent controlled fill placement. This initial lift will be placed by pushing random fill material or contaminated materials across the tailings in increments, slowly enough that_the underlying tailings are displaced as little as possible. Compaction of the initial lift will be limited to what the weight of the placement equipment provides. The maximum rock size, as far as practicable, in the initial lift is 2/3 of the lift thickness. Placement of fill will be monitored by a qualified individual with the authority to stop work and reject material being placed. The top surface (top 1.0 feet) of the platform fill will be compacted to 90% maximum dry density per ASTM D 698.

Frost Barrier Fill

Frost barrier fill will be placed above the clay cover in 12- inch lifts, with particle size limited to 2/3 of the lift thickness. Frost barrier material will come from the excavation of random fill stockpiles, If oversized material is observed during the excavation of fill material it will be removed as far as practicable before it is placed in the fill.

In all layers of the cover the distribution and gradation of the materials throughout each fill layer will be such that the fill will, as far as practicable, be free of lenses, pockets, streaks or layers of material differing substantially in texture, gradation or moisture content from the surrounding material. Nesting of oversized material will be controlled through selective excavation of stockpiled material, observation of placement by a qualified individual with authority to stop work and reject material being placed and by culling oversized material from the fill utilizing a grader. Successive loads of material will be placed on the fill so as to produce the best practical distribution of material.

If the compacted surface of any layer of fill is too dry or smooth to bond properly with the layer of material to be placed thereon, it will be moistened and/or reworked with a harrow, scarifier, or other suitable equipment to a sufficient depth to provide relatively uniform moisture content and a satisfactory bonding surface before the next succeeding layer of earthfill is placed. If the compacted surface of any layer of earthfill in-place is too wet, due to precipitation, for proper compaction of the earthfill material to be placed thereon, it will be reworked with harrow, scarifier or other suitable equipment to reduce the moisture content to the required level shown in Table 5.3.2.1-1. It will then be recompacted to the earthfill requirements.

No material will be placed when either the materials, or the underlying material, is frozen or when ambient temperatures do not permit the placement or compaction of the materials to the specified density, without developing frost lenses in the fill.

5.3.2.2 Moisture and Density Control

As far as practicable, the materials will be brought to the proper moisture content before placement on tailings, or moisture will be added to the material by sprinkling on the earthfill. Each layer of the fill will be conditioned so that the moisture content is uniform throughout the layer prior to and during compaction. The moisture content of the compacted fill will be within the limits of standard optimum moisture content as shown in Table 5.3.2.1-1. Material that is too dry or too wet to permit bonding of layers during compaction will be rejected and will be reworked until the moisture content is within the specified limits. Reworking may include removal, re-harrowing, reconditioning, rerolling, or combinations of these procedures.

Density control of compacted soil will be such that the compacted material represented by samples having a dry density less than the values shown in Table 5.3.2.1-1 will be rejected. Such rejected material will be reworked as necessary and rerolled until a dry density equal to or greater than the percent of its standard Proctor maximum density shown in Table 5.3.2.1-1.

To determine that the moisture content and dry density requirements of the compacted fill are being met, field and laboratory tests will be made at specified intervals taken from the compacted fills as specified in Section 7.4, "Frequency of Quality Control Tests."

5.4 Monitoring Cover Settlement

5.4.1 Temporary Settlement Plates

5.4.1.1 General

Temporary settlement plates will be installed in the tailings Cells. At the time of cell closure, a monitoring program will be proposed to the Executive Secretary. Data collected will be analyzed and the reclamation techniques and schedule adjusted accordingly.

5.4.1.2 Installation

At the time of cell closure or during the placement of interim cover temporary settlement plates will be installed. These temporary settlement plates will consist of a corrosion resistant steel plate 1/4 inch thick and two foot square to which a one inch diameter corrosion resistant monitor pipe has been welded. The one inch monitor pipe will be surrounded by a three inch diameter guard pipe which will not be attached to the base plate.

The installation will consist of leveling an area on the existing surface of the tailings, and placing the base plate directly on the tailings. A minimum three feet of initial soil or tailings cover will be placed on the base plate for a minimum radial distance of five feet from the pipe.

5.4.1.3 Monitoring Settlement Plates

Monitoring of settlement plates will be in accordance with the program submitted to and approved by the DRC. Settlement observations will be made in accordance with Quality Control Procedure QC-16-WM, "Monitoring of Temporary Settlement Plates."

TABLE A-5.3.2.1-1

Placement and Compaction Criteria
Reclamation Cover Materials

Cover Layer	Maximum Lift Thickness	Per Cent Compaction	Allowable Placement Moisture Content from Optimum Moisture Content
Platform Fill	3 Feet Bridging Lift*	80	
	1 Foot	90	± 2
Clay Layer	1 Foot	95	0 to + 3
Frost Barrier	2 Feet	95	± 2
Riprap			
Top of Tails	6 Inches		
Slope	8 Inches		

Note:
* Compaction of the bridging lift is dependent on stability of fill and equipment used
Percent Compaction is based on standard Proctor dry density (ASTM D-698).

Optimum moisture content of a soil will be determined by ASTM D-2216 or D-4643 methods.

6.0 ROCK PROTECTION

6.1 General

The side slopes of the reclaimed cover will be protected by rock surfacing. Drawings 5.1-1, 5.1-2, and 5.1-3 show the location of rock protection with the size, thickness and gradation requirements for the various side slopes.

A riprap layer was designed for erosion protection of the tailings soil cover. According to NRC guidance, the design must be adequate to protect the soil/tailings against exposure and erosion for 200 to 1,000 years (NRC, 1990). Currently, there is no standard industry practice for stabilizing tailings for 1,000 years. However, by treating the embankment slopes as wide channels, the hydraulic design principles and practices associated with channel design were used to design stable slopes that will not erode. Thus, a conservative design based on NRC guidelines was developed. Engineering details and calculations are summarized in the Tailings Cover Design report (Appendix D).

Riprap cover specifications for the top and side slopes were determined separately as the side slopes are much steeper than the slope of the top of the cover. The size and thickness of the riprap on the top of the cover was calculated using the Safety Factor Method (NUREG/CR-4651, 1987), while the Stephenson Method (NUREG/CR-4651, 1987) was used for the side slopes. These methodologies were chosen based on NRC recommendations (1990).

By the Safety Factor Method, riprap dimensions for the top slope were calculated in order to achieve a slope "safety factor" of 1.1. For the top of the soil cover, with a slope of 0.2 percent, the Safety Factor Method indicated a median diameter (D_{50}) riprap of 0.28 inches is required to stabilize the top slope. However, this dimension must be modified based on the long-term durability of the specific rock type to be used in construction. The suitability of rock to be used as a protective cover has been assessed by laboratory tests to determine the physical characteristics of the rocks. The gravels sourced from pits located north of Blanding require an oversizing factor of 9.35%. Therefore, riprap created from this source should have a D_{50} size of at least 0.306 inches and should have an overall layer thickness of at least three inches on the top of the cover. From a practical construction standpoint the minimum rock layer thickness may be up to six (6) inches.

Riprap dimensions for the side slopes were calculated using Stephenson Method equations. The side slopes of the cover are designed at 5H:1V. At this slope, Stephenson's Method indicated the unmodified riprap D_{50} of 3.24 inches is required. Again assuming that the gravel from north of Blanding will be used, the modified D_{50} size of the riprap should be at least 3.54 inches with an overall layer thickness of at least 8 inches.

Riprap bedding should be placed between the random fill and the riprap on the side slopes. The bedding should consist of medium sand, and should be placed with a minimum layer thickness of 6 inches.

6.2 Materials

Materials utilized for riprap applications will meet the following specifications:

Material	D_{50} Size	D_{100} Size	Layer Thickness
Top Surface Riprap	0.3"	0.6"	6"
Slope Surface Bedding	No. 40 Sieve	3”	6”
Slope Surface Riprap	3.5"	7"	8"
Toe Apron Riprap	6.4"	12"	24"

Riprap will be supplied to the project from gravel sources located north of the project site. Riprap will be a screened product.

Riprap quality will be evaluated by methods presented in NUREG/1623 Design of Erosion Protection for Long-Term Stabilization Size adjustment will be made in the riprap for materials not meeting the quality criteria.

6.3 Placement

Riprap and bedding material will be hauled to the reclaimed surfaces and placed on the surfaces using belly dump highway trucks and road graders. Riprap and bedding will be dumped by trucks in windrows and the grader will spread the riprap in a manner to minimize segregation of the material. Depth of placement will be controlled through the establishment of grade stakes placed on a 200 x 200 foot grid on the top of the cells and by a 100 x 100 foot grid on the cell slopes. Physical checks of riprap and bedding depth will be accomplished through the use of hand dug test pits at the center of each grid in addition to monitoring the depth indicated on the grade stakes. Placement of the riprap and bedding will avoid accumulation of riprap or bedding sizes less than the minimum D_{50} size and nesting of the larger sized rock. The riprap and bedding layer will be compacted by at least two passes by a D-7 Dozer (or equivalent) in order to key the rock for stability.

7.0 QUALITY CONTROL/QUALITY ASSURANCE

7.1 Quality Plan

A Quality Plan has been developed for construction activities at the Mill. The Quality Plan includes the following:

1. QC/QA Definitions, Methodology and Activities.

2. Organizational Structure.
3. Surveys, Inspections, Sampling and Testing.
4. Changes and Corrective Actions.
5. Documentation Requirements.
6. Quality Control Procedures.

7.2 Implementation

The Quality Plan will be implemented upon initiation of reclamation work.

7.3 Quality Control Procedures

Quality control procedures have been developed for reclamation and are presented in Attachment B of this Reclamation Plan. Procedures will be used for all testing, sampling and inspection functions.

7.4 Frequency of Quality Control Tests

The frequency of the quality control tests for earthwork will be as follows:

1. The frequency of the field density and moisture tests will be not less than one test per 1,000 cubic yards (CY) of compacted contaminated material placed and one test per 500 CY of compacted random fill, radon barrier or frost barrier. A minimum of two tests will be taken for each day that an applicable amount of fill is placed in excess of 150 CY. A minimum of one test per lift and at least one test for every full shift of compaction operations will be taken.

   Field density/moisture tests will be performed utilizing a nuclear density gauge (ASTM D-2922 density and ASTM D-3017 moisture content). Correlation tests will be

performed at a rate of one for every five nuclear gauge tests for compacted contaminated materials (one
per 2,500 CY placed) and one for every ten nuclear gauge tests for other compacted materials (one per 5,000 CY of material placed). Correlation tests will be sand cone tests (ASTM D-1556) for density determination and oven drying method (ASTM D-2216) for moisture determination.

2. Gradation and classification testing will be performed at a minimum of one test per 2,000 CY of upper platform fill and frost barrier placed. A minimum of one test will be performed for each 1,000 CY of radon barrier material placed. For all materials other than random fill and contaminated materials, at least one gradation test will be run for each day of significant material placement (in excess of 150 CY).

3. Atterberg limits will be determined on materials being placed as radon barrier. Radon barrier material will be tested at a rate of at least once each day of significant material placement (in excess of 150 CY). Samples should be randomly selected.

4. Prior to the start of field compaction operations, appropriate laboratory compaction curves will be obtained for the range of materials to be placed. During construction, one point Proctor tests will be performed at a frequency of one test per every five field density tests (one test per 2,500 CY placed). Laboratory compaction curves (based on complete Proctor tests) will be obtained at a frequency of approximately one for every 10 to 15 field density tests (one lab Proctor test per 5,000 CY to 7,500 CY placed), depending on the variability of materials being placed.

5. For riprap and bedding materials, each load of material will be visually checked against standard piles for gradation prior to transport to the tailings piles.

Prior to delivery of any riprap materials to the site rock durability tests will be performed for each gradation to be used. Test series for riprap durability will include specific gravity, absorption, sodium soundness and LA abrasion. During construction
gradations will be performed for each type of riprap and bedding when approximately one-third (1/3) and two-thirds (2/3) of the total volume of each type have been produced or delivered. In addition, test series for rock durability will be performed on any riprap material at this same time. For any type of riprap where the volume is greater than 30,000 CY, a test series and gradations will be performed for each additional 10,000 CY of riprap produced or delivered.

Energy Fuels Resources (USA) Inc.

WHITE MESA MILL

Updated Tailings Cover Design Report

December2016

MWH®
BUILDING A BETTER WORLD

3665 JFK Parkway
Suite 206
Fort Collins, CO USA

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1.0 INTRODUCTION

This report presents the design of a monolithic evapotranspiration (ET) cover for the tailings management cells at the Energy Fuels Resources (USA) Inc. (EFRI) White Mesa Uranium Mill (Mill). The Mill is located approximately 6 miles south of Blanding, in San Juan County, Utah. The Mill site includes a conventional acid leach process mill, associated support facilities, and lined tailings management cells. The tailings management cells are located south of the Mill and comprise the following:

- Cell 1 – 55 acres, used for the evaporation of process solutions
- Cell 2 – 65 acres, used for storage of barren tailings sands (which has been filled with tailings sands and covered with a minimum of approximately 3 feet of interim cover across the cell)
- Cell 3 – 70 acres, used for storage of barren tailings sands (which have been partially covered with a minimum of approximately 3 feet interim cover across the majority of the cell, except the center of the cell which is currently receiving mill waste)
- Cell 4A – 40 acres, used for storage of barren tailings sands and evaporation of process solutions
- Cell 4B – 40 acres, currently being used for evaporation of process solutions

The cover design in this report has been written assuming tailings management Cells 2, 3, 4A, and 4B receive tailings to the maximum permitted tailings elevations. Cell 2 is full and partially reclaimed. Cell 3 was used for tailings storage, but is currently only receiving mill waste. Cell 3 is partially full and partially reclaimed. Cell 4A is the only cell currently receiving tailings and is partially full. Cell 4B is used for evaporation of process solutions and has not been used for storage of tailings. The tailings cover design assumes Cell 4B will be used for future tailings storage.

1.1 Scope of Report

A previous “Tailings Cover Design” report for the White Mesa Mill was prepared by Titan Environmental Corporation (Titan, 1996), and presented design criteria for a multi-layered cover system. This design report was included as Appendix D of the Reclamation Plan, Revision 4.0 (Denison, 2009) and previous versions of the Reclamation Plan.

An Updated Tailings Cover Design Report (MWH, 2011) was prepared to replace the Titan (1996) report as Appendix D to the Reclamation Plan, Revision 5.0 (Denison, 2011). The 2011 report provided design criteria for a proposed monolithic ET cover system for all the tailings management cells. This report is an update to the 2011 report and is provided as Appendix A to Reclamation Plan, Revision 5.1. The revised report includes subsequent cover design updates provided in EFRI responses to interrogatories and review comments (Denison, 2012; EFRI, 2012a; EFRI, 2015a) from Utah Department of Environmental Quality (UDEQ), Division of Waste Management and Radiation Control (DWMRC) on Reclamation Plan, Revision 5. Prior to 2015, the DWMRC was two separate divisions of UDEQ, the Division of Radiation Control and the Division of Solid and Hazardous Waste.

This report provides detailed summaries and results of the analyses conducted to evaluate the long-term stability of the tailings reclamation cover including evaluations of freeze/thaw, radon attenuation, biointrusion, infiltration, slope stability, settlement, liquefaction, erosional stability, and dewatering. This report also presents plans for final cover verification, vegetation, and long-term settlement monitoring.

1.2 Updates from 1996 Cover Design

The cover system presented in Titan (1996) was 6 feet thick, and consisted of random fill and clay, compacted to 95 percent of maximum dry density. The cover system consisted of the following materials, outlined below by individual layers and thicknesses from top to bottom:

- 3 in (7.6 cm) Erosion Protection Layer (gravel)
- 2 ft (61 cm) Radon Attenuation Layer (random fill)
- 1 ft (30.5) Radon Attenuation Layer (compacted clay)
- Minimum 3 ft (91.4 cm) Radon Attenuation and Grading Layer (random fill)

This cover design was presented in the Reclamation Plan, Revision 4.0 (Denison, 2009) for Cells 1, 2, 3, and 4A. Titan (1996) analyzed the proposed cover with respect to radon flux attenuation, infiltration, effects of free/thaw, erosion protection, and static and pseudostatic slope stability.

A conceptual ET cover design was proposed by EFRI for the White Mesa Mill disposal cells in the Infiltration and Contaminant Transport Modeling (ICTM) reports (MWH 2007 and 2010) submitted to the DWMRC to fulfill the White Mesa Mill's Ground Water Discharge Permit No. UGW370004. It was intended that the final design of the tailings cover would be completed as part of an updated tailings cover design report.

EFRI stated their intent to submit an ET cover design as part of their license renewal in a meeting with DWMRC on October 5, 2010 after review of the DWMRC Reclamation Plan, Version 4.0 Interrogatories – Round 1 (DRC, 2010). The proposed conceptual ET cover design was provided to DWMRC on October 7, 2010 and was essentially the same as presented in the 2010 ICTM report (MWH, 2010). The ET cover proposed and evaluated as described in this Updated Tailings Design Report (9.5 to 10.5 feet thick) is shown in Figure 1-1 and consists of the following materials outlined below by individual layers and thicknesses from top to bottom:

- Layer 4 - 0.5 ft (15 cm) thick Erosion Protection Layer (gravel-admixture or topsoil)
- Layer 3 - 3.5 ft (107 cm) thick Growth Medium Layer acting as a Water Storage/Biointrusion/Frost Protection/Secondary Radon Attenuation Layer (loam to sandy clay)
- Layer 2 – 3.0 to 4.0 ft (91 to 122 cm) thick Compacted Cover acting as the Primary Radon Attenuation Layer (highly compacted loam to sandy clay)
- Layer 1 - 2.5 ft (76 cm) thick (minimum) Interim Fill Layer acting as a Secondary Radon Attenuation and Grading Layer (loam to sandy clay)

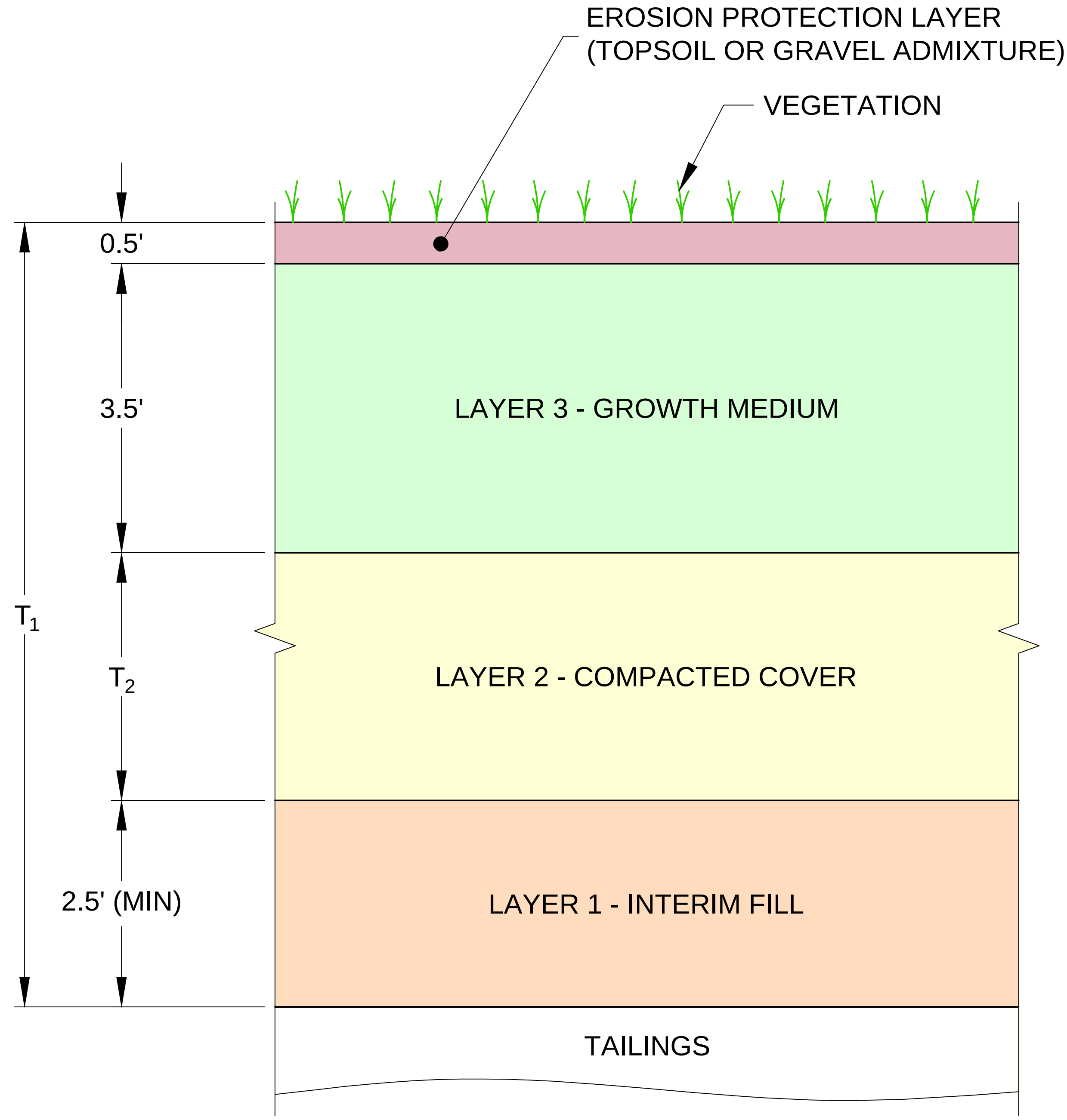
The loam to sandy clay soil is the same material referred to in Titan (1996) as random/platform fill. This material is stockpiled at the site.

This Updated Tailings Design Report provides the results of additional laboratory testing and analyses for the monolithic ET cover design, including radon flux attenuation, infiltration, effects of freeze/thaw, erosion protection, and static and pseudostatic slope stability. This report also presents analyses not performed for the Titan (1996) design, including biointrusion, tailings dewatering, liquefaction, and settlement.

1.3 Limitations

The analyses presented in this report use information from reports prepared by others that have been provided by EFRI, and MWH's experience with the White Mesa Mill site and other similar uranium mill sites. The analyses are limited by the information available but are supplemented by MWH's experience with the White Mesa Mill and other similar uranium mill sites. In the event that there are any changes in the nature, design, or characteristics of the project, or if additional data are obtained, conclusions and recommendations contained in the report will need to be re-evaluated by MWH in light of the proposed changes or additional information obtained.

MWH warrants that services were performed within the limits prescribed by EFRI with the usual thoroughness and competence of the engineering profession. No other warranty or representation, either expressed or implied, is included or intended in our technical documents.



COVER THICKNESS TABLE

CELL	COVER (T_1)	RADON ATTENUATION LAYER (T_2)
1	9.5'	3.0'
2	10.5'	4.0'
3	10.0'	3.5'
4A & 4B	9.5'	3.0'

ENERGY FUELS

PROJECT: WHITE MESA MILL TAILINGS RECLAMATION

TITLE: ET COVER PROFILE

MWH

DATE: AUG 2016

FIGURE 1-1

FILE NAME: 1009740 WM ET COVR

2.0 SITE CONDITIONS

2.1 Location

The White Mesa Uranium Mill is located in San Juan County in southeastern Utah, approximately 6 miles south of Blanding, Utah. The site is located on White Mesa, a flat area bounded on the east by Corral Canyon, to the west by Westwater Creek and to the south by Cottonwood Canyon. A site location map is shown on Figure 2-1. The Mill is located at an elevation of approximately 5,600 ft above mean sea level. The EFRI facilities consist of a uranium processing mill and five lined tailings management cells located within an approximately 686-acre restricted area. Total land holdings are approximately 5,415 acres (Denison, 2011).

2.2 Climate and Vegetation

2.2.1 Climate

The regional climate of the Blanding area is semiarid with an average annual precipitation of 13.3 inches (Denison, 2011). Most precipitation is in the form of rain, with snowfall accounting for about one quarter of the annual total precipitation. There are two separate rainfall seasons in the region, a late summer season when monsoonal moisture from the Gulf of Mexico produces thunderstorms, and a second during the winter season related to fronts from the Pacific. The average annual Class A pan evaporation is 68 inches, with the largest monthly evaporation rate typically occurring in July (Denison, 2011).

The mean annual temperature for Blanding, Utah is 52°F, based on the period of 1971-2000. January is typically the coldest month, with a mean monthly temperature of about 30°F. July is generally the warmest month, with a mean monthly temperature of 76°F. Daily ranges in temperatures are typically large.

As an element of the pre-construction baseline study and ongoing monitoring programs, the Mill operates an onsite meteorological station, which became operational in early 1977 and continues to operate. Additional information on climatic conditions is presented in the Reclamation Plan, Revision 5.1.

2.2.2 Vegetation

As described in Denison (2011), the natural vegetation near the site is characterized by pinyon-juniper woodland intergrading with big sagebrush (*Artemisia tridentata*) communities. The understory of this community, which is usually quite open, is composed of grasses, forbs, and shrubs that are also found in the big sagebrush communities. Based on work completed by Dames & Moore in the 1978 Environmental Report (Dames & Moore, 1978), no designated or proposed endangered plant species occur on or near the Mill site. A complete discussion of flora and fauna present in the vicinity of the Mill site is provided in Dames & Moore (1978).

In June 2012, the area surrounding the Mill site was surveyed for plant composition to supplement data presented in Dames & Moore (1978). Survey results confirmed that two principal plant community types in the vicinity of the Mill site. These plant communities are Big Sagebrush shrubland and Juniper woodland. In addition to these two principal plant community types, there are a number of disturbed areas in different stages of successional development. These areas reflect past disturbances such as sagebrush removal (chaining and plowing) and seeding and intense grazing, as evidenced by a complete lack of any understory species in some areas. The vegetation survey conducted in 2012 provides information of species that exist on the Mill site and their relative importance in terms of plant cover. All areas surveyed in 2012 show that big sagebrush (*Artemisia tridentata*) is the dominant species and subdominants are either broom snakeweed (*Gutierrezia sarothroae*) or galleta (*Hilaria jamesii*). Additional discussion on this survey is provided in Appendix D.

2.3 Geology and Seismicity

The White Mesa Mill is located within the Blanding Basin of the Colorado Plateau physiographic province in southeastern Utah. The site is underlain by unconsolidated alluvium overlying sedimentary bedrock, consisting primarily of sandstone and shale. The unconsolidated deposits are primarily eolian silt and sand and range from 1 to 30 ft thick (these deposits have been removed where the tailings cells are located). The bedrock underlying the site is relatively undeformed, with horizontally oriented bedding (generally dips are less than 3 degrees). Cretaceous Dakota Sandstone and Burro Canyon Formation are at or near the surface at the site; these sandstone units have a combined thickness of 100 to 140 ft at the site. Beneath the Burro Canyon Formation is the Jurassic Morrison Formation, which is primarily shale. The Brushy Basin Member is the uppermost member of the Morrison Formation and is composed primarily of bentonitic mudstones, siltstones, and claystones. Beneath the Brushy Basin Member are the Westwater Canyon, Recapture, and Salt Wash members of the Morrison Formation. Beneath the Morrison Formation lies the Middle to Late Jurassic San Rafael group, and the Late Triassic to Jurassic Glen Canyon Group. Additional details of the geologic setting are included in the Reclamation Plan, Revision 5.1.

The seismicity of the Colorado Plateau is characterized as small to moderate magnitude with a low to moderate rate of widely-distributed earthquakes (Wong and Humphrey, 1989). The Mill area is located within a relatively tectonically stable portion of the Colorado Plateau, characterized by relatively sparse concentrations of earthquake events. Most of the larger seismic events in the Colorado Plateau have occurred along its margins rather than in the interior central region. Based on the region's seismic history, the probability of a major damaging earthquake occurring at or near the Mill site is low. Additional information on the seismotectonics of the Mill site and vicinity is provided in the Reclamation Plan, Revision 5.1.

Several site-specific seismic studies have been performed for the Mill site (UMETCO, 1988; Tetra Tech, 2006; Tetra Tech, 2010, MWH, 2015b). The most recent study (MWH, 2015b) was performed to provide additional information for design of the tailings reclamation cover system. This study concluded that the maximum horizontal acceleration value at the Mill site for a seismic event associated with an average return period of 10,000 years is 0.15g. Based on this maximum horizontal acceleration, a pseudo-static coefficient of 0.10g was used for seismic stability analyses of the reclaimed tailings impoundments (presented in Appendix E).

2.4 Hydrogeology

Groundwater beneath the site is first encountered as a perched zone within the Burro Canyon Formation. The low-permeability Brushy Basin Member of the Morrison Formation acts as an aquitard and forms the base of this perched zone. The saturated thickness of the perched zone ranges from less than 5 ft to as much as 82 ft beneath the site, assuming the base of the Burro Canyon Formation is the base of the perched zone. The water table of the perched zone was 13 to 116 ft below ground surface (bgs) at the facility in 2007 (MWH, 2010), and is shallowest near the wildlife ponds east of the Mill and tailings management cells. Groundwater within the perched zone generally flows south to southwest beneath the site. The Reclamation Plan, Revision 5.1 and MWH (2010) provide more details of the perched zone hydrogeology.

Aquifers of the Entrada sandstone and Navajo sandstone are located approximately 1,200 ft bgs, and are considered one aquifer for purposes of this report. The Navajo/Entrada Aquifer is capable of yielding significant quantities of water to wells (hundreds of gallons per minute (gpm)). Water in the Entrada/Navajo Aquifer is artesian, and rises approximately 800 ft above the base of the overlying Summerville Formation resulting in static water levels 390 to 500 ft below the ground surface (Denison, 2011). The Reclamation Plan, Revision 5.1 provides more information regarding the aquifer hydrogeology.

2.5 Reclamation Materials

The following sections summarize the characteristics of the tailings, the cover borrow materials to be used in reclamation of the tailings disposal cells, and the potential erosion protection materials.

2.5.1 Tailings Characterization

Geotechnical and radiological data on tailings were previously collected and data applicable to the cover design are included in Appendix A.1. This data was previously presented in Attachments D and E of the Reclamation Plan, Version 4.0 (Denison, 2009). Geotechnical laboratory testing was conducted by Western Colorado Testing, Inc. (1999b) on the tailings and included specific gravity, standard Proctor, Atterberg limits, and gradation (including hydrometer). Testing was conducted on four samples of tailings from Cell 2 and two samples of tailings from Cell 3. Rogers & Associates Engineering Corp. (1988) measured radium-226 activity concentration and the radon emanation coefficient on one tailings sample.

An additional investigation of the tailings in Cells 2 and 3 was performed in 2013 and results were presented in the Tailings Data Analysis Report (MWH, 2015a). This investigation was performed to satisfy DWMRC's request that EFRI collect site-specific tailings data to supplement previous investigations. The objectives of the investigation were to measure the physical properties of the tailings and characterize the stratigraphy of the tailings through Cone Penetration Test (CPT) soundings, direct push sampling, and geotechnical laboratory testing.

The geotechnical and radiological testing results for the tailings were used for the radon emanation modeling and the settlement and liquefaction analyses presented in this report.

2.5.2 Cover Borrow Material Characterization

Geotechnical and radiological data on potential cover materials were previously collected and data applicable to the cover design are included in Appendix A.1. Some of this data was previously presented in Attachment D of the Reclamation Plan, Version 4.0 (Denison, 2009) and in Titan (1996). Geotechnical laboratory testing of potential cover material (random fill) from on-site was conducted by Chen and Associates, Inc. (1978, 1979, and 1987), Geosyntec Consultants (2006), and Western Colorado Testing, Inc. (1999a). Geotechnical testing included in-situ moisture contents, specific gravity, standard Proctor, modified Proctor, Atterberg limits, gradation, and permeability. Radon diffusion coefficients of random fill samples collected from on-site stockpiles were measured by Rogers & Associates Engineering Corp. (1988). Geotechnical and radiological testing results were used for the radon emanation modeling and the settlement and liquefaction analysis presented in this report.

MWH conducted a field investigation at the Mill site on October 12, 2010 to supplement existing soils data and further evaluate the geotechnical properties of the potential cover material. Potential cover borrow material locations are shown on Figure 2-2. MWH visually evaluated all of the borrow locations and collected representative bulk samples from select locations. The bulk samples were sent to Advanced Terra Testing in Denver, Colorado for laboratory testing. Laboratory testing conducted on the collected samples included in-situ water contents, Atterberg limits, specific gravity, and gradation (including hydrometer). The laboratory testing results are summarized in Table 2-1 and provided in Appendix A.2.

An additional field investigation was conducted in April 2012 to supplement existing soils data and further evaluate the geotechnical properties of the potential cover material. Test pits were excavated into select on-site stockpiles and representative bulk samples were collected for laboratory testing. Laboratory testing included Atterberg limits, specific gravity, gradation, standard Proctor compaction, saturated hydraulic conductivity, and moisture retention. The test pit logs and laboratory testing logs are provided in Appendix A.3.

The volume of material available at each stockpile was estimated based on the 2010 and 2012 field investigations and is summarized in Table 2-1. The results from the cover borrow material characterization were used for the radon attenuation, settlement and liquefaction, and erosional stability cover design analyses presented in this report.

Table 2-1. Summary of Laboratory Test Results for Borrow Stockpiles and Estimated Volumes

Borrow Stockpile ID	Estimated Stockpile Volume[1] (cy)	Field Investigation Date	Material Description	Material USCS	Sample ID	Sample Depth (ft)	Gravimetric Water Content (%)	Atterberg Limits[2] LL/PL/PI (%)	Specific Gravity	Particle Size[3] % Gravel	% Sand	% Silt	% Clay	% Fines	Max. Density[5] (pcf)	Opt. Moist. Cont.[5] (%)	Sat. Hyd. Cond. (cm/s)	15 Bar Grav. Moist. Cont. (%)	Soil Group[4]
E1	15,900	Apr-2012	Topsoil (Sandy Silty Clay)	CL-ML	E1-A	0 - 3	--	23/18/5	2.61	0	41	43	16	59	118	11	1.3×10^{-4}	5.2	Topsoil
E2	92,000	Oct-2010	Silty Sand/Clayey Sand	SM	A	5	4.5	NP	--	0.5	77.1	13.5	8.9	22					B
				SC	B	12	5.7	23.3/11.2/12.1	2.64	13.1	50.3	22.6	14.0	37					U
E3	16,800	Apr-2012	Clay with Sand	CH	E3-A	0 - 3	--	54/24/30	2.53	0	23	29	48	77	105	19	9.5×10^{-5}	13.6	F
E4	66,600	Oct-2010	Sandy Clay	CL	A	5	8.6	30.3/14.4/15.9	--	0.0	41.2	39.1	19.7	59					U
E5	68,800	Oct-2010	Sandy Clay	CL	A	6	9.0	33.2/14.3/18.9	--	0.0	35.5	38.1	26.4	65					F
		Apr-2012	Clay with Sand	CH	E5-B	0 - 3	--	51/24/27	2.56	2	15	36	47	83					F
E6	100,700	Oct-2010	Clay	CL	A	5	14.4	40.2/15.8/24.4	2.74	0.1	17.7	49.5	32.7	82					F
E7	74,900	Oct-2010	Sandy Clay	CL	A	6	5.7	26.2/16.3/9.9	--	0.0	30.2	56.1	13.7	70					U
E8	227,300	Oct-2010	Sandy Clay	CL	A	2	7.4	23.0/12.0/11.0	--	0.0	47.0	36.9	16.1	53					U
		Apr-2012	Gravel with Clay and Sand	GW-GC	E8-B	0 - 4	--	27/16/11	2.63	40.0	31.0	18.0	11.0	29	125	11		6.0	B
W1	85,700	Oct-2010	Sandy Clay	CL	A	5	8.8	32.1/14.5/17.6	--	0.0	40.6	37.6	21.8	59					U
W2	584,500	Oct-2010	Sandy Clay	CL	A	surface	8.5	28.1/13.1/15.0	--	0.2	41.5	42.5	15.8	58					U
		Apr-2012	Clayey Sand with Gravel	SC	W2-A	0 - 3	--	24/14/10	2.62	30	45	15.0	10.0	25				6.9	B
		Apr-2012	Silty Clayey Sand with Gravel	SC-SM	W2-B	0 - 5	--	18/13/5	2.63	41	45	9.0	5.0	14	128	9	1.5×10^{-3}	3.5	B
W3	84,800	Oct-2010	Topsoil (Sandy Silty Clay)	CL-ML	A	surface	4.3	20.9/16.2/4.7	--	0.2	44.2	39.2	16.4	56					Topsoil
W4	90,000	Oct-2010	Topsoil (Sandy Silt)	ML	A	5	5.3	21.9/18.0/3.9	--	0.0	32.6	54.3	13.1	67					Topsoil
		Apr-2012	Topsoil (Sandy Silty Clay)	CL-ML	W4-B	0 - 4	--	26/19/7	2.60	0	38	44	18	62					Topsoil
W5	2,001,160	Apr-2012	Sandy Clay	CL	W5-A	0 - 4	--	27/18/9	2.61	1	49	32	18	50				7.0	U
			Clayey Sand with Gravel	SC	W5-B	0 - 4	--	24/15/9	2.63	29	44	19	8	27	122	10	1.1×10^{-3}	3.6	B
W6	93,400	Oct-2010	Topsoil (Sandy Silty Clay)	CL-ML	A	surface	3.3	23.1/16.5/6.6	--	0.0	34.3	51.8	13.9	66					Topsoil
W7	39,500	Oct-2010	Sandy Clay	CL	A	5	8.7	28.0/10.6/17.3	2.67	0.0	43.8	43.1	13.1	56					U
W8	178,411	Apr-2012	Silty Sand with Gravel	SM	W8-A	0 - 3	--	NP	2.64	35	51	9	5	14	117	13	1.2×10^{-3}	5.0	B
			Silty Sand with Gravel	SM	W8-B	0 - 4	--	NP	2.66	32	40	18	10	28				6.4	B
W9	60,250	Oct-2010	Sandy Clay	CL	A	surface	4.4	25.9/12.3/13.5	--	0.0	37.4	45.2	17.4	63					U
		Apr-2012	Sandy Clay	CL	W9-B	0 - 4	--	28/16/12	2.63	6	44	35	15	50	115	14	4.1×10^{-4}	7.7	U

Notes:
1. Volumes estimated using 2009 topography and assuming a relatively flat bottom surface, except for stockpiles W5, W8 and W9. The volumes for stockpiles W8 and W9 were estimated by comparing the 2011 versus 2009 topography. The volume for stockpile W5 was estimated using a combination of both methods.
2. LL = Liquid Limit, PL = Plastic Limit, PI = Plasticity Index (PI = LL-PL)
3. Gravel = 4.75 mm to 75 mm, Sand = 0.075 mm to 4.75 mm, Fines: Silt = 0 .075 mm to 0.002 mm, Clay = less than 0.002 mm
4. Group B (broadly graded), Group U (uniformly graded), and Group F (fine textured) based on evaluation of gradations and Benson (2012)*.
5. From standard Proctor test

*Benson, C., 2012. Electronic communication from Craig Benson, University of Wisconsin-Madison, to Melanie Davis, MWH, regarding evaluation of gradations performed for potential cover soils for White Mesa, May 20.

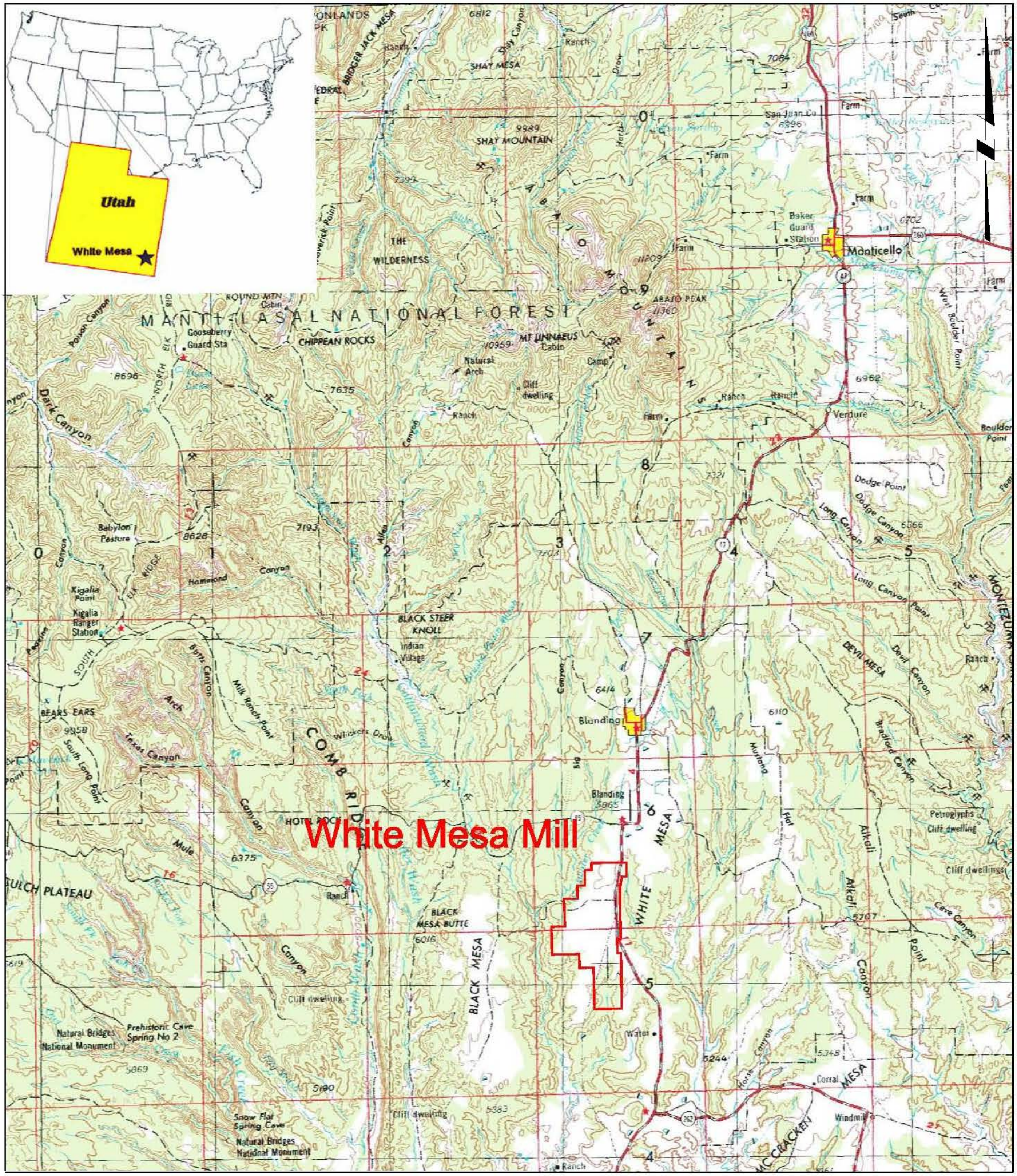
2.5.3 Erosion Protection Material Characterization

Three rock sources were evaluated as potential material sources for use as erosion protection material (riprap and gravel) at the site. Samples were tested from the Cow Canyon pit located 15 miles south of the Mill, the Brown Canyon pit located 4 miles northeast of the Mill, and the North Pit located 1 mile northeast of Blanding. Samples from each quarry were tested for durability in general accordance with guidelines for long-term performance outlined by the US Nuclear Regulatory Commission (NRC). These guidelines are for rock to be used as erosion protection material on exposed surfaces and utilize a rock scoring value (Johnson, 2002). The following laboratory tests were performed, in accordance with U.S. Bureau of Reclamation (1987), to develop scoring criteria: specific gravity, absorption, sulfate soundness and L.A. Abrasion. Durability testing results are provided in Appendix K and were previously presented as Attachment H to the Reclamation Plan, Revision 4.0 (Denison, 2009). Table 2-2 summarizes the scoring of each potential rock source.

Table 2-2. NRC Riprap Scoring of Potential Rock Sources

Rock Source	Score (%)	Oversizing Required (%)
Cow Canyon Pit	87.61	None
Brown Canyon	60.98	19.02
North Pit	70.65	9.35

Based on information provided in Johnson (2002), areas defined as critical areas must meet a score of 65 percent or greater, and areas defined as non-critical areas must meet a score of 50 percent or higher. Critical areas include frequently saturated areas, all channels, poorly drained toes and aprons, control structures and energy dissipation areas. Non-critical areas include occasionally saturated areas, top slopes, side slopes, and well-drained toes and aprons. The scores calculated for each rock borrow site indicate that all three rock borrow sites would provide suitable rock for construction of the erosion protection along the embankment slopes. The Cow Canyon and North Pit sources would be used for the rock toe apron areas at the base of the toes of cell outslopes. Oversizing of both the Brown Canyon and North Pit rock would be required if used for construction. The Brown Canyon source would not be used to construct the rock toe apron areas at the base of the toes of cell outslopes.



REFERENCE:
ADAPTED FROM FIGURE 1-1 IN DENISON MINES (USA) CORPORATION, 2009. RECLAMATION PLAN WHITE MESA MILL, BLANDING, UTAH. VERSION 4.0. NOVEMBER.

ENERGY FUELS

PROJECT
WHITE MESA MILL TAILINGS RECLAMATION

TITLE
REGIONAL LOCATION MAP

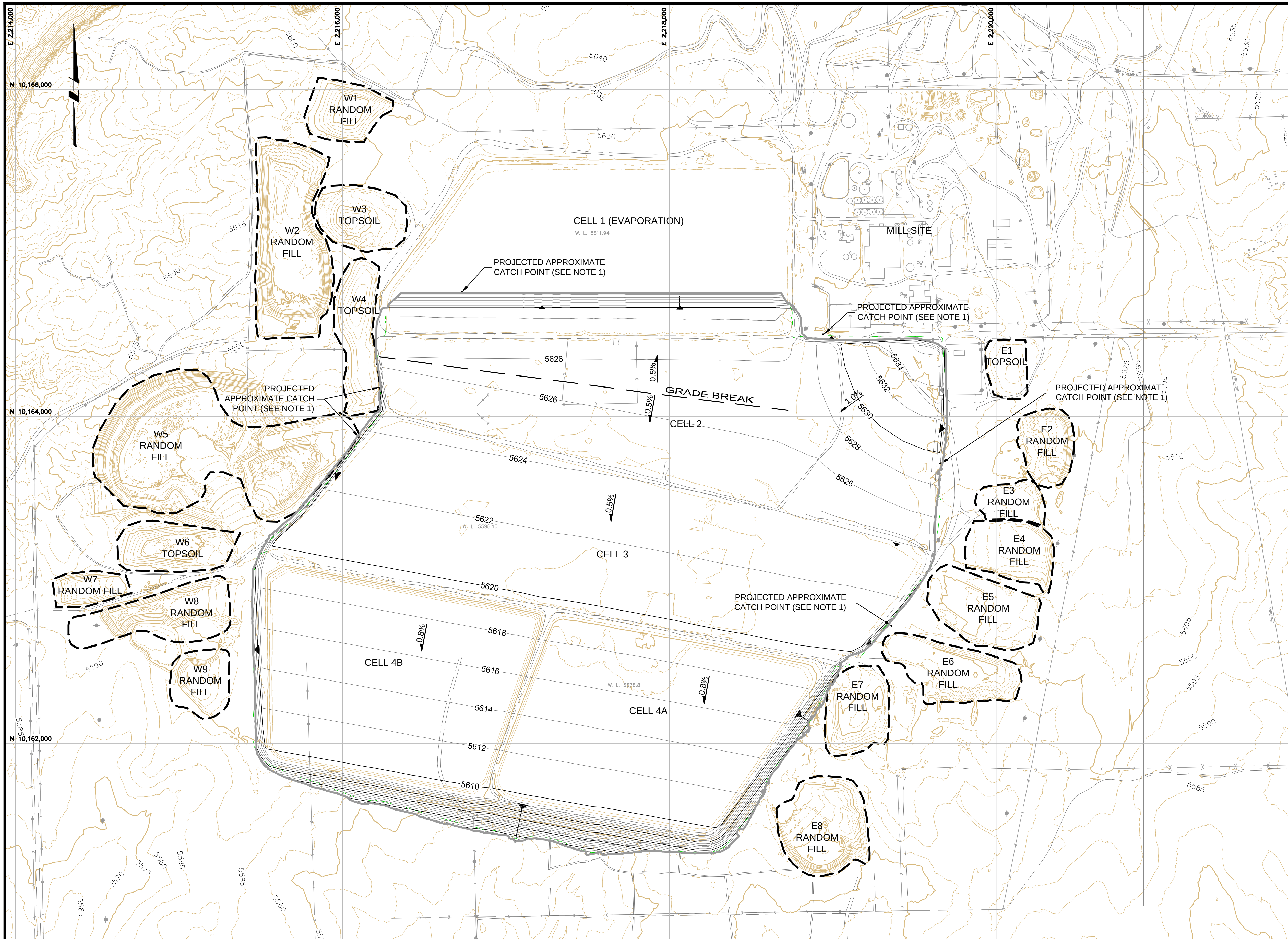
MWH

DATE
AUG 2016

FIGURE 2-1

FILE NAME
1009740 LOC MAP

L:\Design-Drafting\Clients-A-H\ENERGY FUELS\013-Sheet Set\2015-08-31 COVER DSGN DWGS\1009740 LOC MAP



LEGEND

- 5582.6 EXISTING SPOT ELEVATION
- 5630 ELEVATION OF TOP OF COVER
- 5560 EXISTING GROUND CONTOUR (2007 LIDAR SURVEY)
- APPROX LIMITS OF BORROW STOCKPILE

NOTE:

1. THE COVER WILL MEET THE GROUND WITH A DOWNWARD SIDE SLOPE OF 5H:1V.

ESTIMATED STOCKPILE VOLUMES

BORROW STOCKPILE ID	ESTIMATED STOCKPILE VOLUME (CY)
E1	15,900
E2	92,000
E3	16,800
E4	66,600
E5	68,800
E6	100,700
E7	74,900
E8	227,300
W1	85,700
W2	584,500
W3	84,800
W4	90,000
W5	2,001,160
W6	93,400
W7	39,500
W8	178,411
W9	60,250

SCALE 300 0 300 600 FT

ENERGY FUELS

PROJECT
WHITE MESA MILL TAILINGS RECLAMATION

TITLE
COVER MATERIAL BORROW LOCATIONS

MWH

DATE AUG 2016
FIGURE 2-2
FILE NAME 1009740 BORROW

L:\Design-Drafting\Clients-A-H\ENERGY FUELS\013-Sheet Set\2015-08-31 COVER DSGN DWGS\1009740 BORROW

3.0 REGULATORY CRITERIA

Prior to the State of Utah obtaining agreement state status in 2004, the tailings at the White Mesa Mill were regulated primarily by the NRC pursuant to 10 CFR 40, Appendix A, and the U.S. Environmental Protection Agency (EPA) under 10 CFR 61, Subparts A and W, which are administered by the State of Utah's Division of Air Quality. The State of Utah regulates the site according to rules and regulations presented in Title R313 – Environmental Quality, Radiation Control. These rules include, through reference, clarification, or exception, sections of 10 CFR 40 extending through Appendix A, and sections of 10 CFR Part 20. Additionally, the site is regulated under the site's approved Groundwater Discharge Permit (Permit No.UGW370004) (GWDP), which is administered by the State of Utah's Department of Environmental Quality.

NRC and EPA have a Memorandum of Understanding (MOU) that covers joint expectations under what was originally Subpart T of 40 CFR 61 (uranium mill tailings closure) and a generic MOU on elimination of dual regulation. The NRC regulations also incorporate other standards by reference that were promulgated by the EPA pursuant to the Uranium Mill Tailings Radiation Control Act (UMTRCA – 1978), and Section 112 of the Clean Air Act, as amended. Compliance with these regulations under the authority of the State of Utah is provided through UAC R313-24.

The reclamation cover design has been developed in accordance with UAC R313-24, 40 CFR Part 192, and Part I.D.8 of the GWDP. The following documents have also provided design guidance:

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The key state and federal performance criteria for tailings cover design and reclamation include:

- Attenuate radon flux to a rate of 20 pCi/m^2-s, averaged over each entire cell
- Minimize infiltration into the reclaimed tailings cells
- Maintain a design life of up to 1,000 years and at least 200 years
- Provide long-term isolation of the tailings, including slope stability and geomorphic durability to withstand erosional forces of wind and runoff (up to the probable maximum precipitation event) as well as design to accommodate seismic events (up to the peak ground acceleration from the maximum credible earthquake)
- Designs to accommodate minimum reliance on active maintenance

Following reclamation of the Mill, a designated area of the site (including the tailings cells) will be transferred to the U.S. Department of Energy (DOE) for long-term care and maintenance and institutional control. Prior to transfer, the site closure and reclamation is reviewed by the NRC for compliance with applicable design criteria and guidance (specifically Appendix A of 10 CFR 40). The guidelines of reclamation review of a Title II facility are presented in NUREG-1620 (NRC, 2003).

4.0 COVER DESIGN

4.1 Drainage and Slopes

The slopes and drainage for the new ET cover have been modified from the 2009 Reclamation Plan (Denison, 2009) to incorporate the current ET cover system design. The slopes and drainage are to provide acceptable erosional stability under long-term conditions, represented by storms up to the Probable Maximum Precipitation (PMP) event. The evaluation of acceptable erosional stability was conducted according to current NRC guidelines documented in NRC (1990) and Johnson (2002). Results of analyses conducted for drainage and slopes are presented in Appendix G. The drainage and slopes are shown on the Drawings (Attachment A to the Reclamation Plan, Revision 5.1).

The drainage on the top surface of the ET cover at Cells 1, 2, and 3 is designed at a 0.5 percent slope, with portions of Cell 2 top surface at a 1 percent slope, and portions of Cells 4A and 4B top surfaces at 0.8 percent slope. The external side slopes of the embankments will be graded to 5:1 (horizontal:vertical). The overall site drainage around the reclaimed tailings cells is the same as presented in Denison (2011).

4.2 Cover System

The current cover system proposed for reclamation of the tailings cells is designed as a monolithic ET cover. This is different from the cover system proposed in Denison (2009). A monolithic ET cover is the preferred design in this environment to minimize infiltration, meet the radon emanation standard, minimize maintenance over the short and long term, and promote sustainability. The proposed cover design has been designed with sufficient thickness to protect against frost penetration, attenuate radon flux, minimize both plant root and burrowing animal intrusion, and provide adequate water storage capacity to minimize the rate of infiltration into the underlying tailings. Furthermore, the cover is designed to be stable under both static and anticipated seismic conditions, and to provide tailings isolation under long-term wind and water erosion conditions.

The ET cover system has a total thickness of 9.5 feet for Cells 1, 4A, and 4B, 10 feet for Cell 3, and 10.5 feet for Cell 2. The difference in cover thicknesses is based on the radon emanation analyses (Appendix C). The cover system will consist of the following materials listed below from top to bottom:

- Layer 4 - 0.5 ft (15 cm) thick Erosion Protection Layer (gravel-admixture or topsoil)
- Layer 3 - 3.5 ft (107 cm) thick Growth Medium Layer acting as a Water Storage/Biointrusion/Frost Protection/Secondary Radon Attenuation Layer (loam to sandy clay)
- Layer 2 – 3.0 to 4.0 ft (91 to 122 cm) thick Compacted Cover Layer acting as the Primary Radon Attenuation Layer (highly compacted loam to sandy clay)
- Layer 1 - 2.5 ft (76 cm) thick (minimum) Interim Fill Layer actin as a Secondary Radon Attenuation and Grading Layer (loam to sandy clay)

All the layers combined comprise the monolithic ET cover system. Layer 1 was placed in stages on Cell 2 and the majority of Cell 3 as interim cover. Layer 1 will be placed on the remaining area of Cell 3, all of the Cell 1 Disposal Area, and Cells 4A and 4B. It is assumed that this material was or will be dumped and minimally compacted by construction equipment to approximately 80 percent of standard Proctor density. Layer 1 will provide the platform for the remaining cover system and act as a secondary radon attenuation layer. Layer 2 will be compacted cover layer and act as the primary radon attenuation layer. It will be 3 - 4 feet thick (3 feet for Cells 1, 4A and 4B, 3.5 feet for Cell 3, and 4 feet for Cell 2) and compacted to 95 percent of standard Proctor density. Layer 3 will be the growth medium layer. Layer 3 will also act as a secondary radon attenuation layer and a protection layer for the primary radon attenuation layer (Layer 2). Layer 3 will be 3.5 feet thick and placed at 85 percent of standard Proctor density to optimize water storage and rooting characteristics for plant growth. Layer 4 will be a 0.5-foot thick erosion protection layer. This layer will consist of topsoil in areas where the cover is sloped at 0.5 percent and topsoil-gravel admixture in areas where the cover is sloped at 1 percent. The topsoil-gravel admixture will consist of topsoil (75 percent) mixed with 1-inch minus gravel (25 percent).

4.3 Freeze/Thaw

Titan (1996) included a freeze/thaw analysis for the reclamation cover design. Updates to these analyses were provided in Denison (2011) and Denison (2012). These updates reflect modifications to the proposed cover to incorporate an ET cover, a revised grading design, and results of cover material testing conducted in 2010. The 2012 update also included revisions to address review comments from DWMRC on Reclamation Plan, Revision 5.0 (DRC, 2012a). The analyses provided in Denison (2012) are included as Appendix B. The updated calculations of frost penetration at the site were performed with the computer program ModBerg (CRREL), which uses a built-in weather database, as well as user-defined soil parameters.

The freeze/thaw calculations estimate the total depth of frost penetration for the cover system as 32 inches (2.67 ft). The frost penetration depth is not anticipated to exceed the depth of Layers 3 and 4 of the cover system (combined depth of 4 ft). The physical and hydraulic properties of these cover system layers after construction are expected to be close to long-term properties from pedogenic processes, such that post-construction changes due to freeze/thaw should be minimal. A complete description of the freeze/thaw analyses conducted for the proposed cover system is presented in Appendix B.

4.4 Radon Attenuation

Titan (1996) included an analysis of radon attenuation for the reclamation cover design. Radon attenuation analyses were later conducted by MWH (2010) for the conceptual design of the monolithic ET cover. The results were presented in Appendix H of the Infiltration and Contaminant Transport Modeling Report (MWH, 2010). These analyses have been updated for this report to incorporate the revised design of the ET cover, changes to the grading plan, and additional geotechnical testing of material properties.

Emanation of radon-222 from the top surface of the proposed cover system for the tailings cells was calculated using the NRC RADON model (NRC, 1989). The model was used to confirm that the designed cover system can achieve the State of Utah's long-term radon emanation standard for uranium mill tailings (Utah Administrative Code, Rule 313-24), 20 picocuries per square meter per second (pCi/m^2-s). The analyses were conducted following the guidance presented in NRC publications NUREG/CR-3533 (NRC, 1984) and Regulatory Guide 3.64 (NRC, 1989). Results of the analyses show that the proposed cover system can reduce the rate of radon-222 emanation to less than 20 pCi/m^2-s, averaged over the entire area of each tailings cell. A complete description of the radon attenuation analyses conducted for the ET cover system is included in Appendix C.

4.5 Vegetation and Biointrusion

The plant species proposed for the cover system consist of native perennial grasses, forbs, and shrubs. The use of these species in reclamation of the tailing management cells provide a permanent or sustainable plant cover because of the highly adapted nature of these species to existing site conditions, their tolerance to environmental stresses such as drought, fire, and herbivory, and their ability to effectively reproduce over time. These species can coexist and fully utilize plant resources to minimize the establishment of invasive weeds and deep rooted woody species on the site. Once established, the proposed seed mixture produce a grass-forb-shrub community of highly adapted and productive species that can effectively compete with undesirable species. A complete discussion of cover vegetation is provided in Appendix D.

The proposed cover system is designed to minimize both plant root and burrowing animal intrusion through the use of thick layers of soil cover (total thickness 9.5 to 10.5 ft) in combination with a highly compacted layer placed at a depth that is below the expected rooting and burrowing depths of species that may inhabit the site. Root growth and animal burrowing into the highly compacted radon attenuation layer (beginning at a depth of 4 ft) will be restricted because of the high density of this material (compaction to 95 percent relative compaction based on the standard Proctor test). In addition, both root density and the size of roots decrease at a rapid rate with rooting depth, further limiting the potential for root growth into the compacted radon attenuation layer of the cover system. A complete discussion of the biointrusion evaluation through the ET cover is presented in Appendix D.

4.6 Infiltration

Infiltration modeling was conducted for the monolithic ET cover and a complete description of the analyses were provided in the ICTM Report (MWH, 2010). The modeling was updated to address DWMRC comments on the ICTM Report (DRC, 2012b; 2013) and to incorporate additional geotechnical and hydrologic data collected in as part of field investigations conducted in 2010 and 2012 for cover borrow material and in 2013 for in situ tailings. The updated infiltration modeling results were presented in EFRI (2012b) and EFRI (2015b). The evaluation of infiltration of precipitation through the cover system was evaluated with the computer program HYDRUS-1D (Simunek et al., 2009). The modeling used historical daily meteorological data for precipitation and evapotranspiration over a 57-year climate period, as well as assumptions that were either conservative or based on anticipated conditions. Given the flat nature of the cover (less than 1 percent slope), no run-on- or runoff-based processes were assumed to occur. As a result, precipitation applied to the cover surface was removed through evaporation or transpiration, retained in the soil profile as storage, or transmitted downward as infiltration.

The model-predicted average long-term water flux rate through the cover system is 2.3 mm/yr. Additional model scenarios were analyzed to evaluate the sensitivity of the soil properties, climate, and reduced vegetation parameters. The range of average long-term water flux rates for these scenarios varied from 1.9 to 8.6 mm/yr. The model-predicted water flux rates through the monolithic ET cover indicate that the available cover storage capacity should be sufficient to significantly reduce infiltration through the cover system.

4.7 Slope Stability Analysis

Static (long-term) and pseudo-static slope stability analyses were performed for two critical cross sections through the tailings embankments. The analyses were performed using limit equilibrium methods with the computer program SLOPE/W (Geo-Slope, 2007). A complete description of the input parameters and assumptions used in the analyses is provided in Appendix E. Material strength parameters used for the analyses were based on historical laboratory testing on tailings and clay materials (Advanced Terra Testing, 1996; Chen and Associates, 1987; D'Appolonia, 1982; and Western Colorado Testing, 1999b), laboratory testing conducted in 2010 and 2012 on potential cover borrow materials (see Attachment B of EFRI, 2012b), laboratory testing conducted in 2013 on tailings (MWH, 2015a) and typical published values.

The mean Peak Ground Acceleration (PGA) for reclaimed conditions is 0.15g based on the site specific PSHA (MWH, 2015b). This PGA represents the seismic loading from the Maximum Credible Earthquake (MCE). The seismic coefficient used for the pseudo static stability analysis was 0.10 g (equal to 2/3 of the PGA).

The calculated factors of safety range from 2.6 to 3.9 and 1.7 to 2.5 for static and pseudo-static loading conditions, respectively. The calculated factors of safety for both the long-term static condition and the pseudo-static condition exceed the required values of 1.5 and 1.1 respectively (NRC, 2003).

4.8 Settlement and Liquefaction Analyses

Settlement analyses and evaluation of liquefaction potential for the tailings were performed for the tailings cells. A discussion of the analyses and results are provided in Appendix F.

One-dimensional settlement analyses were conducted to evaluate settlement due to placement of final cover, dewatering of the tailings cells, long-term static (creep) settlement, and seismically induced (seismic) settlement. The results of these analyses of specific locations were used to evaluate differential settlement and the potential for cover cracking. The CPT locations in Cell 2 and 3 from the October 2013 tailings investigation (MWH, 2015a) were selected as the locations for the settlement analyses. Parameters used for the settlement analyses are summarized in Appendix F. Tailings profiles and properties are based on results presented in MWH (2015a). Parameters for cover materials are based on cover material testing conducted in 2010 and 2012 (summarized in Appendix A). Evaluation of total settlement due to final cover placement and dewatering indicates potential future settlement during active maintenance ranging from 0.9 to 1.6 feet.

The majority of this settlement is expected occur after Phase 1 cover construction with the remaining settlement occurring soon after Phase 2 cover construction. During this time, additional fill may be placed in low areas to maintain positive drainage of the cover surface. The estimated total predicted future long-term settlement that could occur (due to creep and seismic settlement) after the maintenance period is complete ranges from approximately 0.3 to 0.7 feet. Estimates of total long-term settlement were calculated by summing the static creep and seismic settlement estimates. As such, these estimates are considered somewhat conservative, as they are not independent (i.e. as long-term static creep progresses, void ratio reduction will occur and the potential for seismic settlement will reduce over time as a result). The estimated differential settlement after completion of active maintenance is sufficiently low that slope reversal and ponding is not expected to occur on a cover slope of 0.5 to 1.0 percent.

In addition, the results indicate that cracking of the highly-compacted radon barrier due to settlement-induced strains is not expected.

Liquefaction analyses were performed to evaluate the risk of earthquake-induced liquefaction of the tailings. Two methods (Idriss and Boulanger, 2008; Youd et al., 2001) were used for the analyses. Material properties were obtained from results of laboratory tests on tailings samples collected during the October 2013 tailings investigation of Cells 2 and 3 (MWH, 2015a). Other parameters used were based on CPT data measured during the October 2013 tailings investigation. Results of the site-specific PSHA (MWH, 2015b) were used in the analyses and include a PGA of 0.15g for an approximate 10,000-year return period, with the mean seismic source being a magnitude (Mw) 5.5 event occurring 20 km from the site. Computed factors of safety against liquefaction range from 2.0 to 2.8. Based on the calculated factors of safety, the tailings are not susceptible to earthquake-induced liquefaction.

4.9 Erosion Protection

The erosional stability of the reclaimed tailings cells was evaluated in terms of long-term water erosion under extreme storm conditions. The analyses were conducted in general accordance with NRC guidelines (NRC, 1990; Johnson, 2002). A description of the analyses performed is presented in Appendix G.

The components of erosion protection for the reclaimed tailings cells consist of the following:

- The cover on the top surface of Cells 1, 2, and 3, with slopes of 0.5 percent, would be constructed as a vegetated slope, with 6 inches of topsoil.
- The portions of Cell 2 with a top surface of 1 percent slope, and the portions of Cells 4A and 4B with 0.8 percent slope, would be constructed as a vegetated slope with 6 inches of topsoil mixed with 25 percent (by weight) gravel (maximum diameter of 1 inch).
- Erosion protection of external (5H:1V) side slopes would be provided by various sized angular and rounded riprap with layer thicknesses ranging from 6 to 8 inches and median particle sizes ranging from 1.7 to 5.3 inches. A 6-inch layer of filter material would be placed between the erosional protection layer and underlying soil layer in locations with riprap greater than 1.7 inches. A narrow zone of this filter will also be placed at the interface between the riprap on the external side slopes and the cover surface erosion protection layer.
- The toe of embankment slopes will have erosional protection and scour protection on the west and east sides of the cells provided by a rock apron measuring approximately 10 inches deep and 5 feet wide, with a median particle size of 3.4 inches. On the south side of cells 4A and 4B, and east side of Cell 4A, the rock apron would be approximately 3 feet in depth, 13 feet in width, and have a median particle size of 10.6 inches. On the north side slope of the Cell 1 disposal area, the rock apron would be approximately 3 feet deep, 11 feet wide, and have a median particle size of 9 inches.
- The Sedimentation Basin area will be graded to 0.1 percent slope and constructed as a vegetated slope with 6 inches of topsoil.
- The Diversion Channel will be excavated into bedrock.

4.10 Tailings Dewatering

Cells 2, 3, 4A, and 4B are constructed to allow tailings dewatering. Dewatering analyses have been conducted for these tailings management cells assuming the cells receive tailings to the maximum permitted tailings elevation. Dewatering analyses for Cells 2 and 3 were conducted by MWH and are presented in Appendix J of MWH (2010). Dewatering analyses for Cells 4A and 4B were conducted by Geosyntec (2007a, 2007b). The pertinent excerpts from MWH (2010), Geosyntec (2007a, 2007b), and DRC (2008) are included in Appendix H and summarized in the following sections.

Water levels in Cells 2 and 3 were measured during the October 2013 tailings investigation (MWH, 2015a). Results of the investigation indicated migration of water towards the sump in Cell 2. This was expected since water has been pumped from the Cell 2 sump since 2008. Dewatering of Cell 3 has not yet started and the October 2013 investigation reflected this, with measured water levels a few feet below the tailings surface.

To monitor changes in water levels due to dewatering prior to and after final cover placement, installation of standpipe piezometers was recommended across the cells prior to the first phase of final cover placement and extension of the piezometers during final cover placement. These piezometers will provide information on the rate and extent of dewatering of the tailings. The piezometers are primarily located adjacent to the settlement monuments to minimize damage to the piezometers during cover construction, while providing sufficient locations to evaluate the water levels. Water levels are recommended to be monitored at the same frequency and duration as the settlement monuments. Standpipe piezometers were installed across Cell 2 in June 2016 and locations are shown in Appendix L.

4.10.1 Tailings Cells 2 and 3

Dewatering of Cells 2 and 3 is performed via the drain network consisting of perforated PVC pipe located across the base of the cells. The pipes drain to an extraction sump on the southern side of each cell. Tailings pore water drains by gravity to the sump and (for Cell 2) is then pumped to Cell 1 for evaporation. Dewatering of Cell 3 has not started. The design for the drains is the same for both cells, and each drain system covers an approximate area of 400 by 600 feet in each cell. The drain pipes are covered by an envelope of sand over the drains, in contrast to a continuous layer of sand across the bottom of the tailing cells.

The analyses of dewatering of Cells 2 and 3 were performed with the computer code MODFLOW (McDonald and Harbaugh, 1988; Harbaugh et al., 2000) with the Department of Defense Groundwater Modeling System (GMS) pre- and post-processor. The slimes drains were simulated with the Drain package in MODFLOW, and values of hydraulic conductivity were based on measured values reported for uranium mill tailings at a similar facility (MWH, 2010). A complete description of the dewatering modeling conducted for tailings Cells 2 and 3 is provided in Appendix J of MWH (2010), and is attached as Appendix H.1.

4.10.2 Tailings Cells 4-A and 4-B

The drain network design in Cells 4A and 4B is the same for each cell, and is different from that constructed in Cells 2 and 3. The drain network in Cells 4A and 4B consists of a series of 12-inch wide HDPE strip drains wrapped in geotextile, and covered by sand bags. The drain spacing is 50 feet across the entirety of both cells. The HDPE drains are connected to a perforated 4-inch diameter PVC pipe bedded in drain aggregate and wrapped in geotextile. The PVC pipe gravity drains the tailings water to the sump for extraction.

A tailings cell dewatering model was not constructed for Cells 4A and 4B because analytical solutions presented by Geosyntec Consultants (2007a, 2007b) were deemed adequate given the uniform distribution of the drain system in those cells. Material properties for tailings in Cells 4A and 4B were estimated based on results of laboratory tests and assuming the tailings would be similar to the tailings in Cells 2 and 3. Cell 4B is currently used for evaporation and has not received tailings. These analyses assume Cell 4B will be used for tailings storage in the future. Dewatering of Cells 4A and 4B are estimated to be dewatered significantly faster than Cells 2 and 3 due to the more extensive drain network.

4.11 Material Quantities

Material volumes required for construction of the interim cover, final cover, and erosion protection are provided in Table 4-1. The quantities of materials available for construction of the cover are also provided in Table 4-1. A summary of the volumes of borrow stockpiles was provided in Table 2-1. Sufficient quantities are available from on-site sources for the topsoil and random fill materials. The bedding and gravel materials would be obtained from off-site commercial sources. Three commercial sources have been identified as potential sources for the bedding and gravel materials. The potential off-site sources were listed in Section 2.5. Sufficient quantities of material are available from the off-site sources identified.

Table 4-1. Reclamation Cover Material Quantity Summary

Material	Quantity Required for Reclamation (cy)	Quantity Available (Identified Sources) (cy)
Topsoil (for Erosion Protection Layer)	195,000	284,100 (on-site stockpiles)
Gravel (1-inch minus for Erosion Protection Layer)	24,000	Sufficient quantity available (off-site commercial source)
Random Fill (total for additional Layer 1 material, Layer 2, and Layer 3)	3,500,000	3,596,621 (on-site stockpiles)
Riprap (for 5H:1V side slopes and rock aprons)	38,000	Sufficient quantity available (off-site commercial source)
Riprap Bedding/Filter Layer	16,000[1]	Sufficient quantity available (off-site commercial source)

Note:
1. Based on 6-inch thick medium sand bedding/filter layer beneath riprap.

5.0 CELL 2 COVER CONSTRUCTION AND PERFORMANCE ASSESSMENT

5.1 Overview

On November 11, 2015, DWMRC recommended that EFRI develop a plan to begin reclamation of the tailings management cells. This plan would consist of placing the proposed cover system presented in White Mesa Reclamation Plan, Revision 5.1 on Cell 2 and demonstrating acceptable cover performance via a performance monitoring program.

Cell 2 final cover construction will take place before final cover construction on other cells at the White Mesa Mill. Cell 2 final cover construction will occur in two phases and includes a performance monitoring test section (Primary Test Section) containing a lysimeter constructed in the southeast portion of Cell 2 concurrently with the Phase 1 cover placement. A Supplemental Test Section will be constructed north of the tailings management cells relating to vegetative cover and erosion control. The plan for implementing final cover placement on Cell 2 and performance assessment and monitoring is presented in Appendix L.

5.2 Cover Placement and Revegetation

Layer 1 of the reclamation cover was placed in stages on Cell 2 as interim cover from 1991 through 2008. The remaining reclamation cover layers will be placed in two phases.

Phase 1 cover construction began in April 2016, and includes placement of: (1) additional interim cover to achieve Layer 1 design grades prior to placement of cover Layer 2 and (2) the entirety of Layer 2. Between the first and second phase of cover placement, additional cover material will be placed as needed in low areas to maintain positive drainage of the Phase 1 cover surface.

A cover performance monitoring test section, containing a lysimeter, was constructed in the southeast portion of Cell 2 in the fall of 2016 concurrently with the Phase 1 cover placement. The Supplemental Test Section is proposed to be constructed in the fall of 2017. Instrumentation for monitoring Cell 2 after Phase 1 cover placement will also include settlement monuments and piezometers.

Cell 2 Phase 2 cover placement will occur after the following milestones have been met:

- Test section performance monitoring is complete
- Phase 1 cover settlement criteria has been met
- DWMRC approval of performance of the Cell 2 cover test section

Additional discussion of performance monitoring and settlement criteria is presented in Appendix L.

Phase 2 cover construction will consist of placement of Layer 3 and placement of Layer 4, the erosion protection layer. The top surface of the final cover will be revegetated after Phase 2 cover construction is completed. As-built reports will be provided to DWMRC within 90 days after completion of each phase of cover construction.

5.3 Cover Performance Assessment

EFRI constructed a performance monitoring test section within the Cell 2 cover concurrently with the Phase 1 cover placement. The test section will be monitored to assess performance of the overall cover system for the tailings cells. A Supplemental Test Section will be constructed north of the tailings management cells relating to vegetative cover and erosion control. Appendix L contains discussion of the Cell 2 cover performance assessment plan.

The performance monitoring area is constructed as a large Alternative Cover Assessment Program (ACAP) drainage lysimeter to provide direct measurement of all components of the water balance, except evapotranspiration. In-situ soil water content and temperature measurements of the cover soils will be taken within the performance monitoring area, and a weather station installed adjacent to the performance monitoring area will be used to collect weather data.

Percolation rate and vegetation success are the performance parameters for the cover system. The performance monitoring requirements follow NUREG/CR-7028 (Benson et al., 2011) and incorporate site-specific recommendations from Dr. Craig H. Benson (personal communication). Data from secondary variables (i.e. meteorological conditions, all water balance quantities, soil water content, soil temperature, in-service soil and vegetation properties, etc.) related to the primary performance parameter will be used for interpretative purposes, as recommended in NUREG/CR-7028 (Benson et al., 2011). Although performance criteria are not suggested in NUREG/CR-7028 for these parameters and are not stipulated herein, monitoring of these parameters is recommended so that the percolation data can be interpreted mechanistically.

Current monitoring of radon emanation rates from the top surface of Cell 2 and settlement will continue during placement of the Cell 2 cover. Existing settlement monuments will be extended upward during cover construction. Standpipe piezometers were installed across Cell 2 during Phase 1 Cell 2 cover construction to monitor water levels within the tailings. After Phase 1 cover construction is complete, it is recommended that settlement monuments and piezometers be monitored weekly for the first month, biweekly for the second month, and monthly thereafter.

Settlement and dewatering data will be evaluated concurrently with the cover performance monitoring. The evaluation will determine if sufficient settlement has occurred to facilitate Phase 2 cover placement. Decreasing trends in settlement followed by maximum of 0.1 feet (30 mm) of cumulative settlement over 12 months (for at least 90 percent of the settlement monuments) will be considered acceptable to proceed with placement of the Phase 2 Cell 2 cover.

Monitoring of Cell 2 will also occur after Cell 2 Phase 2 cover construction is complete and will include radon emanation, settlement, and vegetation monitoring. Closure monitoring is discussed in Section 6.4.

A data quality report will be provided to the DWMRC quarterly and a comprehensive performance monitoring report will be submitted annually to the DWMRC during monitoring. The annual performance monitoring report will include quarterly data quality reports and will also summarize settlement and standpipe piezometer monitoring, and include the annual vegetation monitoring report.

6.0 ADDITIONAL PLANS AND MONITORING PROGRAMS

6.1 Settlement Monitoring

There are two objectives for monitoring settlement associated with the tailings cells: (1) assurance that the materials in the tailings cells have stabilized prior to construction of the final cover system, and (2) verification that the final cover surface is not experiencing significant settlement after final cover construction. Monitoring of interim cover surface will be conducted at the end of operations to measure rates and locations of settlement prior to construction of the final cover system. After construction of the final cover system, settlement monitoring will be conducted as part of post-closure performance monitoring. Additional discussion on settlement monitoring is presented in Appendix I.

6.2 Revegetation Plan

Revegetation of the tailing cells at the Mill site will be completed following construction of the cover system. The revegetation process will establish a grass-forb community consisting primarily of native, perennial grasses and forbs that are highly adapted to the climatic and edaphic conditions of the site. Revegetation methods will follow state-of-the-art techniques for soil amendments, seedbed preparation, seeding and mulching. In addition, quality assurance and quality control procedures will be followed to ensure that revegetation methods are implemented correctly and the results of the process meet expectations. A revegetation plan presenting seedbed preparation, soil amendments, species types, seeding rates, and quality assurance is presented in Appendix J.

6.3 Final Cover Verification

Following construction of the final reclamation cover, testing will be performed to verify that the cover meets the requirements of long-term radon-222 emanation (less than 20 pCi/m^2-s averaged over the entire area of the tailings cell). Verification testing will be performed in accordance with procedures described in 40 CFR Part 61, Appendix B, Method 115, or another method of verification approved by the DWMRC. Verification testing will be conducted for the entire reclaimed tailings area at once. Results of the verification testing will be reported within 90 days of the completion of all testing and analysis relevant to the verification.

Measurement, calculation of radon-222 emanation or flux, and reporting will be performed in accordance with procedures described in 40 CFR Part 61, Appendix B, Method 115. The documentation will include the results of all measurements, the calculations and/or analytical methods used to derive radon flux, and the procedure used to determine compliance. EFRI will maintain these records will be maintained on site or at an off-site storage facility until the time of site transfer to the DOE.

6.4 Closure and Post-Closure Monitoring

The performance monitoring and verification tasks for the reclaimed tailings cells are consistent with plans for overall site reclamation and review guidelines in NRC (2003). Key tasks outlined below will be performed from the time of site reclamation until property transfer to the DOE.

- **Settlement.** After construction of the final reclamation cover, settlement monitoring will be conducted as discussed in Appendix I as part of post-closure performance monitoring to verify that the final cover surface is not experiencing significant settlement. It is recommended that settlement monuments be monitored weekly for the first month after final cover construction, biweekly for the second month, and monthly thereafter for the first two years. Quarterly monitoring is recommended after two years. A minimum monitoring period of 5 years is recommended. Decreasing trends in settlement followed by maximum of 0.1 feet (30 mm) of cumulative settlement over 12 months (based on 90 percent of the settlement monuments) is recommended as acceptable for defining when the final cover surface is no longer experiencing significant settlement.

- **Vegetative Cover.** The Revegetation Plan discussed in Section 6.2 and Appendix J will be followed. The vegetation performance will be monitored annually for ten years after final cover construction or until revegetation goals have been achieved.
- **Erosional Stability.** The erosional stability of the cover surface will be monitored on a semi-annual basis, most likely at the same time as the vegetation monitoring. Elements of the erosional stability monitoring are degree of vegetation cover (in terms of surface coverage), identification of settled or ponded areas (such as on the top surface), and identification of rills, gullies, or other areas of runoff concentration. Areas that are identified as having erosional stability issues will be monitored to determine if corrective action is necessary. Corrective action would include fill placement with topsoil or erosion-resistant materials on the surface, such as a gravel-admixture. The erosional stability of the cover surface will be monitored by EFRI until that responsibility is changed with property transfer to the DOE.

7.0 REFERENCES

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APPENDIX A

MATERIALS CHARACTERIZATION

APPENDIX A.1

HISTORICAL LABORATORY TESTING

APPENDIX A.1.1

CHEN AND ASSOCIATES, INC.

1978

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CONSULTING ENGINEERS

SOIL & FOUNDATION ENGINEERING
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SECTION 2

Extracted Data From

SOIL PROPERTY STUDY
EARTH LINED TAILINGS RETENTION CELLS
WHITE MESA URANIUM PROJECT
BLANDING, UTAH

Prepared for:

ENERGY FUELS NUCLEAR, INC.

PARK CENTRAL
1515 ARAPAHOE STREET
DENVER, COLORADO 80202

Job No. 16,406

July 18, 1978

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Test Hole	Depth (Ft.)	NATURAL Moisture Content (%)	NATURAL Dry Density (pcf)	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	ATTERBERG LIMITS Liquid Limit (%)	ATTERBERG LIMITS Plasticity Index (%)	GRADATION ANALYSIS Maximum Size	GRADATION ANALYSIS Passing #200 (%)	GRADATION ANALYSIS Less than 2 μ (%)	REMOLDED Dry Density (pcf)	REMOLDED Moisture Content (%)	PERMEABILITY ft./yr.	PERMEABILITY cm./sec.	Specific Gravity	Soil Type
2	0-5			117.5	10.8	20	3	#16	58	19	111.6	16.4	0.57	5.5×10^{-7}		Sandy Silt
3	7-8	7.2				21	6	#16	62							Sandy Clayey Silt
5	7½-10			104.1	18.5	33	8	3/4 In.	56	12	102.1	22.0	0.085	8.2×10^{-8}	2.65	Calcareous Silty Clay
6	1-2	10.3				25	7	#16	77							Sandy Clayey Silt
6	8½-9	6.1				27	8	#4	70							Sandy Clay
8	5-5½	13.1					NP	3/4 In.	62							Calcareous Sandy Silt
9	0-1	8.1					NP	#16	53							Sand - Silt
10	4-6½					24	10	#4	73							Sandy Clay
11	5½-6½	14.0				26	6	#16	65							Siltstone-Claystone
12	2-5			101.0	20.6	53	35	#16	88	59	95.0	18.3	0.068	6.6×10^{-8}	2.67	Weathered Claystone
13	7-8	13.1				39	13	#8	84							Calcareous Silt Clay
14	1-2	19.3				40	21	#4	89							Weathered Claystone
15	1½-4½			106.8	19.0	26	8	3/8 In.	65	27	103.4	18.0	0.012	1.2×10^{-8}	2.64	Mod. Calcareous Sandy Clay
17	2-3	11.4				19	4	#8	59							Sandy Silt
19	0-3			117.5	12.8	23	6	#16	70		109.9	12.4	0.035	3.4×10^{-8}		Sandy Clayey Silt
22	1-2	13.2				26	10	#4	73							Sandy Clay
23	1-3					48	24	#30	87							Weathered Claystone
23	6-8					61	30	#30	96							Claystone
25	1-3½	13.3				26	9	#4	57							Sandy Clay
26	4½-5	15.3				41	20	#4	91							Weathered Claystone
28	0-2	12.7				28	10	3/8 In.	72							Sandy Clay
29	2-3	8.5				19	2	#16	59							Sandy Silt
32	8-8½	5.6				23	6	#30	73							Sandy Clayey Silt
37	0-4			118.8	11.5	23	5	#8	72		110.5	11.5	0.63	6.1×10^{-7}		Sandy Clayey Silt
38	5-7			111.0	16.7	29	14	3/8 In.	69		102.4	17.9	0.041	4.0×10^{-8}		Sandy Clay
40	4-5½			110.0	16.2	26	9	#8	64	27	106.4	16.4	0.017	1.6×10^{-8}	2.65	Sandy Clay

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Test Hole	Depth (Ft.)	NATURAL Moisture Content (%)	NATURAL Dry Density (pcf)	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	ATTERBERG LIMITS Liquid Limit (%)	ATTERBERG LIMITS Plasticity Index (%)	GRADATION ANALYSIS Maximum Size	GRADATION ANALYSIS Passing #200 (%)	GRADATION ANALYSIS Less than 2 µ (%)	REMOLDED Dry Density (pcf)	REMOLDED Moisture Content (%)	PERMEABILITY ft./yr.	PERMEABILITY cm./sec.	Specific Gravity	Soil Type
40	9-9½	6.8				22	8	3/8 In.	60							Sandy Clay
42	13½-14½	7.6				26	10	3/8 In.	73							Sandy Clay
43	11-12	12.1				41	22	#4	86							Claystone
43	13½-16½			110.0	16.9	40	24	3/8 In.	85	44	104.1	15.8	0.024	2.3×10^{-8}	2.62	Claystone
44	6½-7	7.5				30	11	3/8 In.	79							Calcareous Sandy Clay
46	0-2	12.3				22	6	#16	76							Sandy Clayey Silt
48	5-5½					30	9	3/8 In.	65							Sandy Clay
49	5-7			110.7	15.6	25	9	#16	71		105.2	13.9	0.33	3.2×10^{-8}		Sandy Clay
49	14-15					28	5	#8	55							Calcareous Sandy Silt
54	0-2	12.1				23	9	#8	64							Sandy Clay
55	5-5½	7.8				28	14	#30	71							Sandy Clay
55	9½-10½					28	13	#4	71							Sandy Clay
58	5½-6	12.5				35	11	#4	75							Sandy, Silty Clay
61	0-1	11.5				21	4	#16	75							Sandy Silt
62	11-11½	8.1					NP	1 In.	34							Calcareous Sand & Silt
63	4-6					30	14	#8	68							Sandy Clay
65	1-2	9.0					NP	#16	44							Silty Sand
68	7½-8	8.6				28	13	#8	67							Sandy Clay
70	3½-4½	16.4				27	4	1½ In.	46							Calcareous Sand & Silt
72	0-2	12.2				22	8	#16	59							Sandy Clay
75	10-11	12.4				41	25	#4	75							Weathered Claystone
75	12-14					45	22	#16	93							Claystone

TABLE II

LABORATORY PERMEABILITY TEST RESULTS

Sample	Soil Type	Compaction: Dry Density (pcf)	Compaction: Moisture Content (%)	Compaction: % of ASTM D698	Surcharge Pressure (psf)	Permeability (Ft/Yr)	Permeability (Cm/
TH 2 @ 0'-5'	Sandy Silt	111.6	16.4	95	500	0.57	5.5x1
TH 5 @ 7½'-10'	Calcareous Silty Clay	102.1	22.0	101	500	0.085	8.2x1(
TH 12 @ 2'-5'	Weathered Claystone	95.0	18.3	94	500	0.068	6.6x1(
TH 15 @ 1½'-4½'	Calcareous Sandy Clay	103.4	18.0	97	500	0.012	1.2x1(
TH 19 @ 0'-3'	Sandy, Clayey Silt	109.9	12.4	94	500	0.035	3.4x1(
TH 37 @ 0'-4'	Sandy, Clayey Silt	110.5	11.5	93	500	0.63	6.1x1(
TH 38 @ 5'-7'	Sandy Clay	102.4	17.9	92	500	0.041	4.0x1(
TH 40 @ 4'-5½'	Sandy Clay	106.4	16.4	97	500	0.017	1.6x1(
TH 43 @ 13½-16½'	Claystone	104.1	15.8	95	500	0.024	2.3x1(
TH 49 @ 5'-7'	Sandy Clay	105.2	13.9	95	500	0.33	3.2x1(

ft / year	cm / sec
0.57	5.5E-07
0.085	8.2E-08
0.068	6.6E-08
0.012	1.2E-08
0.035	3.4E-08
0.63	6.1E-07
0.041	4.0E-08
0.017	1.6E-08
0.024	2.3E-08
0.33	3.2E-07

TABLE III

RESULTS OF ATTERBERG LIMITS

SAMPLE	SOIL TYPE	PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS			SHRINKAGE RATIO
			Liquid Limit (%)	Plastic Limit (%)	Shrinkage Limit (%)	
2 @ 0 - 5'	Sandy Silt	58	20	17	17.	1.81
5 @ 7½ - 10'	Calcareous Silty Clay	56	33	25	25	1.62
15 @ 1½-4½'	Calcareous Sandy Clay	65	26	18	17.5	1.76
19 @ 0-3'	Sandy, Clayey Silt	70	23	17	18	1.80
26 @ 4½-5'	Weathered Claystone	91	41	21	12	1.90
38 @ 5 - 7'	Sandy Clay	69	29	15	14	1.89

APPENDIX A.1.2

CHEN AND ASSOCIATES, INC.

1979

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CONSULTING ENGINEERS

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SECTION 3

Extracted Data From

SOIL PROPERTY STUDY
PROPOSED TAILINGS RETENTION CELLS
WHITE MESA URANIUM PROJECT
BLANDING, UTAH

Prepared for:

ENERGY FUELS NUCLEAR, INC.
1515 ARAPAHOE STREET
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Job No. 17,130

January 23, 1979

CHEN AND ASSOCIATES

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

HOLE	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS		PERCENT PASSING NO. 200 SIEVE	SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)		DEVIATOR STRESS (PSF)	CONFINING PRESSURE (PSF)		
76	0 - 1	4.5		21	5				78	Sandy silt
	9.5 - 10	4.4			NP				26	Silty, gravelly sand
77	7.5 - 8	8.6		30	15				71	Sandy clay
79	0 - 1	4.1		20	5				83	Sandy silt
	5 - 5.5	5.5			NP				41	Calcareous sandy clay
80	4.5 - 7			39	20				78	Calcareous sandy clay
	8 - 8.5	10.1		40	20				86	Weathered claystone
81	3 - 4	6.3		26	8				64	Silty, sandy clay
83	4 - 6			24	7				64	Sandy, clayey silt
84	0 - 2			18	2				65	Sandy silt
	9 - 9.5	2.7			NP				27	Silty sand
86	8 - 8.5	2.6			NP				12	Sandstone
87	0 - 1	3.1		16	1				61	Sandy silt
89	0 - 3			21	5				66	Sandy silt
90	8 - 8.5	12.9		35	15				61	Weathered claystone
92	0 - 1	5.9		21	5				80	Sandy silt
94	5 - 5.5	13.7		27	10				68	Sandy clay
95	6 - 7			23	5				62	Sandy silt
96	0 - 2	5.2		21	4				79	Sandy silt
	8.5 - 9.5			32	6				66	Calcareous sandy clay
98	0 - 1	3.8		20	5				74	Sandy silt
	4 - 4.5	17.8		49	25				76	Weathered claystone
99	8 - 9.5			40	20				89	Weathered claystone

CHEN AND ASSOCIATES

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

HOLE	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS		PERCENT PASSING NO. 200 SIEVE	SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)		DEVIATOR STRESS (PSF)	CONFINING PRESSURE (PSF)		
99	11 - 12	13.5		26	10				73	Claystone
100	0 - 1			17	NP				44	Silty sand
	5.5 - 6	12.0			NP				61	Sandstone-siltstone
102	6.5 - 7	16.7		30	8				79	Calcareous sandy clay
	13.5 - 14	9.5		23	6				87	Claystone-siltstone
103	10 - 10.5	7.0		28	12				57	Sandy clay
104	8 - 8.5	9.2		33	9				70	Calcareous sandy clay
105	0 - 1	5.4		22	6				77	Sandy silt
	6.5 - 7	4.5			NP				86	Sandy silt
106	5 - 5.5	10.4		28	6				59	Claystone-sandstone
107	7.5 - 9				NP				23	Sandstone
108	0 - 1	4.0		18	3				69	Sandy silt
	9.5 - 10	9.9		38	16				93	Claystone
109	4 - 5			25	7				75	Sandy, clayey silt
111	9 - 9.5	5.8		25	10				53	Claystone
113	5 - 8			40	20				84	Weathered claystone
	10.5 - 11			24	10				54	Claystone-sandstone
114	0 - 2			22	6				58	Sandy, clayey silt
115	4.5 - 6				NP				58	Calcareous
116	0 - 3			22	5				72	Sandy silt
	7 - 8			24	10				42	Claystone-sandstone
117	1 - 2	10.6		25	5				77	Sandy silt
118	0 - 2			25	6				77	Sandy silt

CHEN AND ASSOCIATES

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

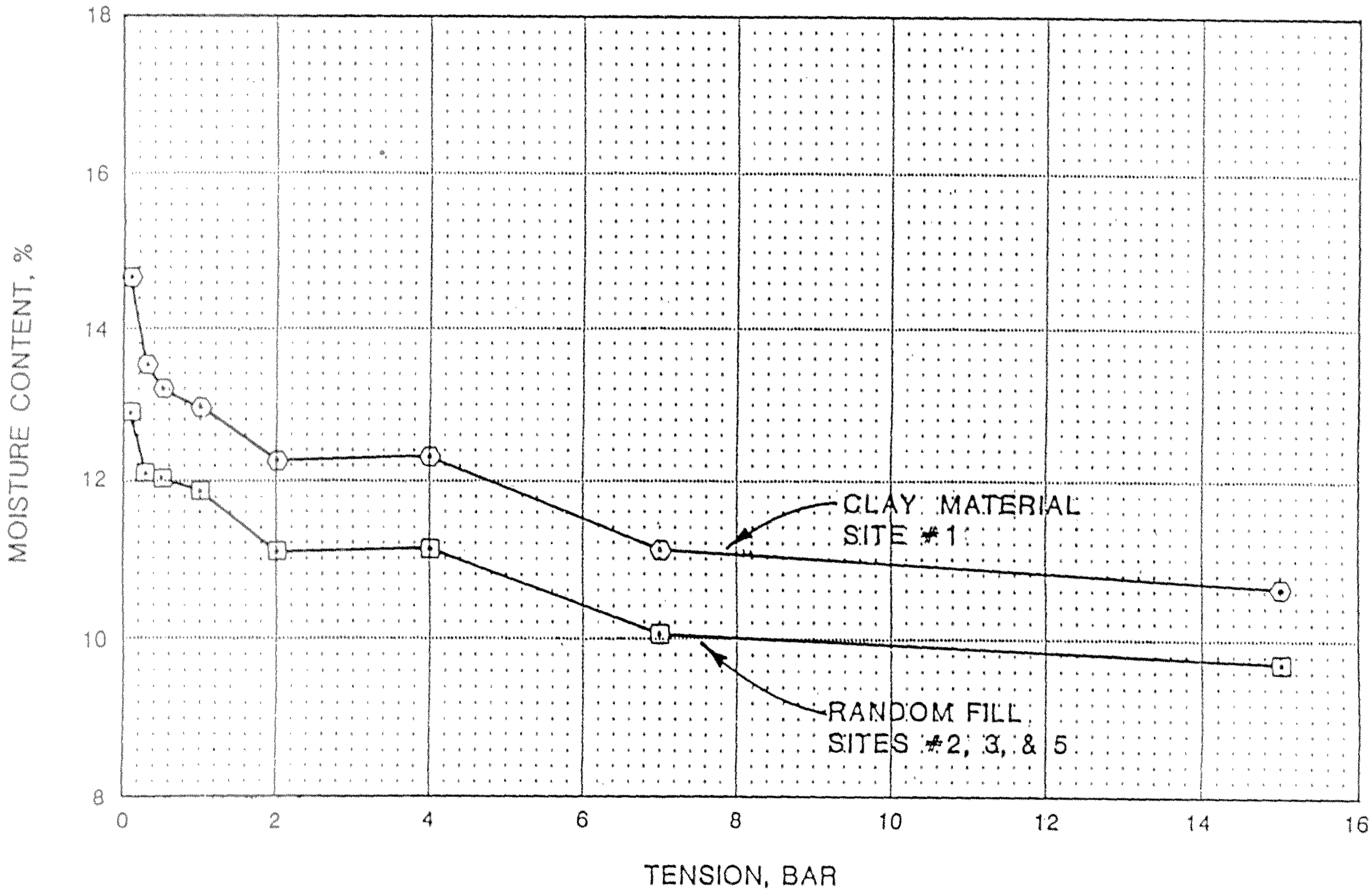
HOLE	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS LIQUID LIMIT (%)	ATTERBERG LIMITS PLASTICITY INDEX (%)	UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAXIAL SHEAR TESTS DEVIATOR STRESS (PSF)	TRIAXIAL SHEAR TESTS CONFINING PRESSURE (PSF)	PERCENT PASSING NO. 200 SIEVE	SOIL TYPE
118	6.5 - 8.5			40	20				89	Weathered claystone
119	4.5 - 5	10.0		26	12				68	Sandy clay
120	1 - 2			25	8				69	Sandy, clayey silt
	5 - 5.5	15.5		29	10				78	Sandy clay
	11 - 11.5	11.6		42	24				90	Claystone
122	4 - 6			25	8				66	Sandy, silty clay
	14.5 - 15	6.4		26	8				66	Sandy clay
123	1 - 3			23	7				71	Sandy, clayey silt
124	4.5 - 5	6.0		23	7				69	Sandy, clayey silt
125	0 - 1	3.8		22	6				67	Sandy silt
127	5 - 6			54	34				89	Claystone
128	6 - 8			41	24				90	Claystone

.E II

LABORATORY PERMEABILITY TEST RESULTS

Sample	Classification	Compaction: Dry Density (pcf)	Compaction: Moisture Content (%)	Compaction: % of ASTM D698	Surcharge Pressure (psf)	Permeability Ft./Yr.	Permeability Cm/Sec
TH 80 @ 4½-7'	Calcareous sandy clay -200=78; LL=39; PI=20	100.2	19.4	96	500	0.81	7.8×10^{-7}
TH 84 @ 0-2'	Sandy silt -200=65; LL=18; PI=2	113.8	11.7	96	500	4.45	4.3×10^{-6}
TH 96 @ 8½-9½'	Calcareous sandy clay -200=66; LL=32; PI=6	96.9	20.7	97	500	1.55	1.5×10^{-6}
TH 96 @ 8½-9½'	Calcareous sandy clay	95.7	20.3	96	500	26.90*	2.6×10^{-5}
TH 99 @ 8-9½'	Weathered claystone -200=89; LL=40; PI=20	99.8	18.5	95	500	0.22	2.1×10^{-7}
TH 100 @ 0-1'	Very silty sand -200=44; PI=NP	117.5	9.7	98	500	0.38	3.7×10^{-7}
TH 114 @ 0-2'	Sandy, clayey silt -200=58; LL=22; PI=6	112.4	12.9	95	500	0.60	5.8×10^{-7}
TH 120 @ 1-2'	Sandy, clayey silt -200=69; LL=24; PI=6	108.2	14.7	95	500	0.11	1.1×10^{-7}
TH 122 @ 4-6'	Sandy, silty clay -200=66; LL=25; PI=8	108.8	15.5	96	500	0.43	4.2×10^{-7}
TH 123 @ 1-3'	Sandy, clayey silt -200=71; LL=23; PI=7	110.9	12.6	95	500	0.56	5.4×10^{-7}
TH 128 @ 6-7'	Claystone -200=89; LL=41; PI=24	92.4	23.9	93	500	0.12	1.2×10^{-7}
TH 128 @ 6-7'	Claystone -200=89; LL=41; PI=4	93.1	22.1	94	500	0.52*	5.0×10^{-7}*

* 1.5 pH sulfuric acid liquor used during percolation test interval.

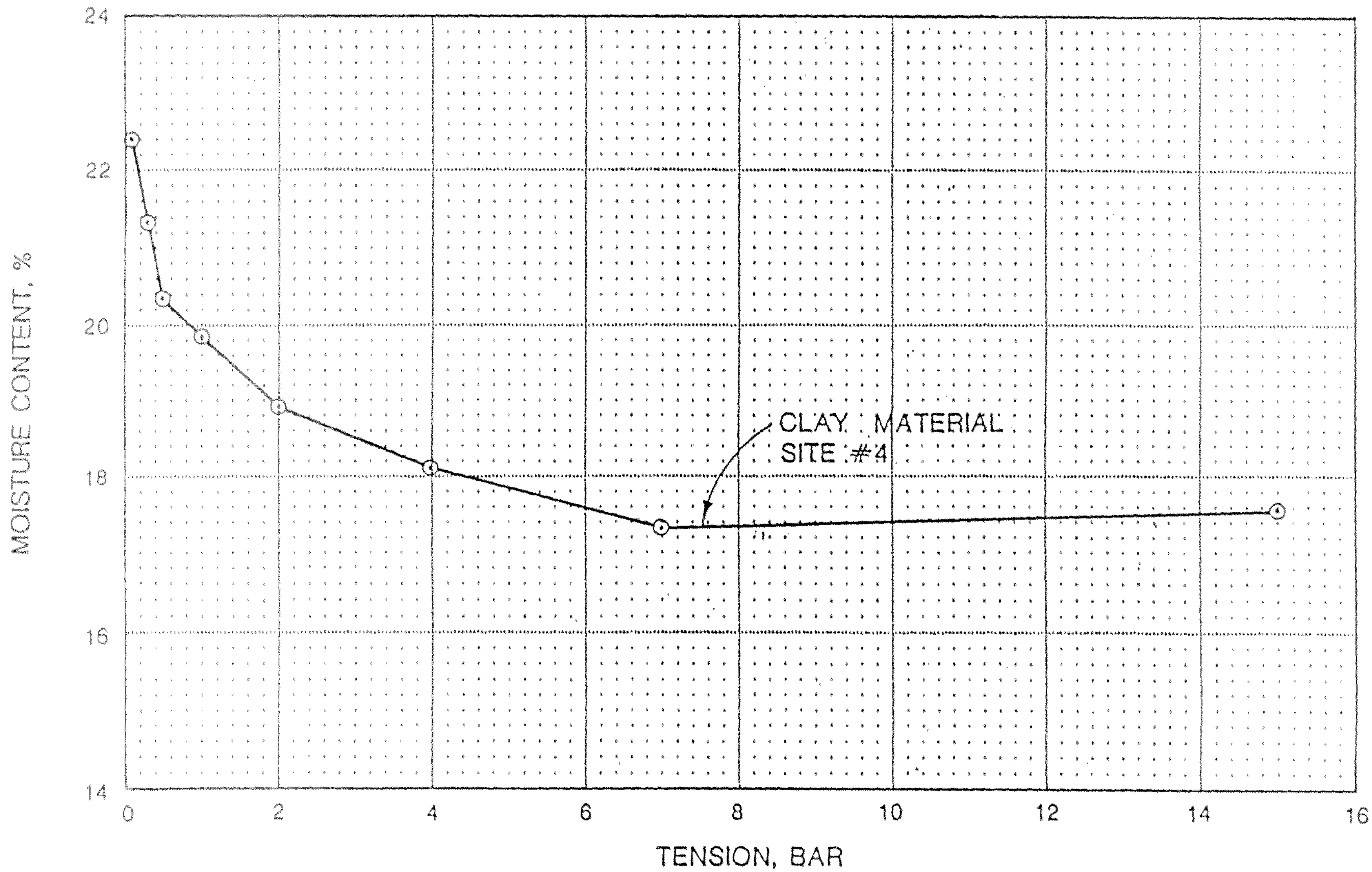


SUMMARY OF CAPILLARY MOISTURE RELATIONSHIP TEST RESULTS

WHITE MESA PROJECT

DATA FROM CHEN & ASSOCIATES

FIGURE 3.5-1



SUMMARY OF CAPILLARY MOISTURE
RELATIONSHIP TEST RESULTS
WHITE MESA PROJECT
FIGURE 3.5-2

DATA FROM CHEN & ASSOCIATES

APPENDIX A.1.3

CHEN AND ASSOCIATES, INC.

1987

Table 3.4-1

Physical Properties of Tailings

and

Proposed Cover Material

Material Type	Atterberg Limits LL	Atterberg Limits PI	Specific Gravity	% Passing No. 200 Sieve	Maximum Dry Density (pcf)	Optimum Moisture Content
Tailings	28	6	2.85	46	104.0	18.1
Random Fill	22	7	2.67	48	120.2	11.8

Note: Physical Soil Data from Chen and Associates (1987).

APPENDIX A.1.4

GEOSYNTEC CONSULTANTS

2006

GeoSyntec Consultants

11305 Rancho Bernardo Rd., Suite 101
San Diego, CA 92127 USA
Tel (858) 674-6559 Fax (858) 674-6586

23 January 2006

Mr. Harold R. Roberts
Vice President, Corporate Development
International Uranium (USA) Corporation
Independence Plaza, Suite 950
1050 Seventeen Street
Denver, Colorado 80265

Subject: Stockpile Evaluation
Tailings Cell 4A, White Mesa Mill
Blanding, Utah

Dear Mr. Roberts:

GeoSyntec Consultants (GeoSyntec) is pleased to provide this letter report to International Uranium (USA) Corporation (IUC) presenting the results of the GeoSyntec soil stockpile evaluation at the White Mesa Mill facility (site) in Blanding, Utah. This stockpile evaluation was performed in accordance with an authorized proposal dated 5 October 2005.

INTRODUCTION

The site is located at 6425 S. Highway 191, approximately 6 miles south of the City of Blanding, San Juan County, Utah (Figure 1). The 5,415-acre site is bordered on all sides by undeveloped land that is sparsely vegetated. The mill is utilized to process ores and alternate feed streams for the extraction and enrichment of uranium and other approved materials.

BACKGROUND

In addition to marketable product produced during the milling process, ore spoils (tailings) and highly acidic wastewaters are also generated as process by-products. The tailings and wastewater are stored on site within constructed surface cells that are lined with low-permeability soil (clay) and geosynthetic materials to mitigate potential impacts to underlying soils and groundwater. Cell 4A was a previously constructed surface impound at the south end of the site (Figure 2) and contained a compacted clay liner and a geosynthetic liner.

PURPOSE

A new geosynthetic lining system may be installed in future cell base liner systems. In addition to the potential need for clay material for the construction of future base liner systems, clay material will be needed for final cover system installation overlying closed cells. Although many soil stockpiles exist on site, the material in many of these stockpiles would not meet specific permeability requirements and are not considered available for use.

Based on discussions between IUC and GeoSyntec during a 29 September 2005 meeting at the site, it was understood that clay soil may be available in two on-site stockpiles. Clay liner materials are typically required to have an in-situ hydraulic conductivity of 1×10^{-7} cm/sec or less. In order to prepare design drawings, appropriately budget and plan for the future liner system construction, and evaluate final cover system soil materials, the two existing soil stockpiles with potentially-suitable clay soil were characterized to evaluate quality and consistency of the material. In addition, a third on-site stockpile was sampled and evaluated at the request of IUC.

FIELD INVESTIGATION

As part of this investigation, soil from three existing on site soil stockpiles was sampled. Before field work began, GeoSyntec reviewed and discussed documentation for previous sampling events performed by others on many of the soil stockpiles on site. In agreement with IUC, stockpiles C1, C2, and RF5 were identified as potential stockpiles of clay material and were the focus of the GeoSyntec field evaluation and sampling event (Figure 2). Prior to mobilizing to site, GeoSyntec field personnel prepared a project-specific health and safety plan (HASP) for the field work to be performed.

The field investigation was performed for the three stockpiles on 10 and 11 November 2005. Soil stockpile evaluation was assisted by an IUC employee operating a Caterpillar 426B backhoe on 10 November 2005 and a Caterpillar front-end loader on 11 November 2005. Stockpile evaluation included the visual evaluation of stockpile surface and excavated test-pits and the collection and transport of soil samples for off-site laboratory geotechnical testing. General observations made during the stockpile evaluation by GeoSyntec field personnel, including surficial conditions of the three stockpiles, were recorded on Daily Field Reports (Appendix A).

On 10 November 2005 nine test-pits were excavated in soil stockpile C1, and seven test pits were excavated in soil stockpile C2. One test pit in stockpile C2 and two test pits in stockpile RF5 were excavated on 11 November 2005. The approximate test pit locations are shown on Figures 3 through 5. Test pits were excavated to depths ranging from approximately 2 to 10 feet below ground surface (bgs) and from approximately 10 to 15 feet long. Test pits excavated with the backhoe were approximately 2 feet wide and those excavated with the loader were approximately 6 feet wide. General visual observations were made of the materials excavated for each test pit and the soils were logged in general accordance with the American Society for Testing and Materials (ASTM) soil classification system, as outlined in ASTM standard D2488. Logs of the test pits are presented in Appendix A.

Representative soil samples were obtained from the soil cuttings in 5-gallon buckets and shipped, via courier, to the off-site geotechnical laboratory for further testing and classification.

LABORATORY TESTING

Geotechnical laboratory testing was performed on selected soil samples to evaluate the suitability of the soil within the stockpiles for use as clay liner. Laboratory testing was performed by a GeoSyntec subcontractor, Excel Geotechnical Testing. The following laboratory tests were performed in general accordance with ASTM test methods on selected soil samples or on a composite of two or more like samples, as selected by the GeoSyntec project manager:

- Grain size analyses (ASTM D422)
- Atterberg Limits (ASTM D4318)
- Laboratory Compaction by Modified Effort (ASTM D1557)
- Permeability (ASTM D5084)

The laboratory test results are presented in Appendix B and summarized in Table 1.

CONCLUSIONS AND RECOMMENDATIONS

Based on observations made during the field investigation and review of the results of the laboratory testing performed for this evaluation, the soil within each of the three on-site stockpiles (C1, C2, and RF5) is suitable for construction of the clay liner or soil cover. The soil encountered within the test pits performed for the three stockpiles was generally consistent (e.g. the soils encountered in the test pits performed in stockpile C1 were generally consistent throughout stockpile C1). The samples tested from all three stockpiles, although different, are generally suitable for use as clay liner.

Based on the results of laboratory testing, the on-site stockpile soils, compacted to a minimum relative compaction of 90 percent using modified effort and a moisture content of at least 4 percent above optimum, should have a hydraulic conductivity of less than $1x10^{-7}$ cm/s when subjected to a consolidation pressure of 30 pounds per square inch (consistent with anticipated bottom liner system normal stresses).

GeoSyntec recommends that the soil to be used from the three sampled stockpiles (C1, C2, and RF5) as clay liner be compacted to a minimum relative compaction of 90 percent of the maximum laboratory dry density, as determined in accordance with ASTM D1557 – Laboratory Compaction using Modified Effort. Soil compacted for the clay liner should be compacted at least 4 percent wet of the optimum moisture content as determined in accordance with ASTM D1557.

Should you have questions or require additional information regarding this letter report, please contact us at (858) 674-6559.

Sincerely,

Chad Bird, E.I.T. 020454
Environmental Engineer

REGISTERED PROFESSIONAL ENGINEER
No. 6020077-2202
GREGORY T. CORCORAN
STATE OF UTAH

Gregory T. Corcoran, R.C.E. 6020077-2202
Associate

Attachments:

- Table 1 – Summary of Laboratory Testing
- Figure 1 – Site Location Map
- Figure 2 – Site Plan
- Figure 3 – Location of Stockpile Samples (C1)
- Figure 4 – Location of Stockpile Samples (C2)
- Figure 5 – Location of Stockpile Samples (RF5)
- Appendix A – Field Investigation
- Appendix B – Laboratory Testing

Table 1
Summary of Laboratory Testing
Stockpile Evaluation - Tailings Cell 4A

Sample ID	Stockpile	Permeability	Lab. Compaction		Atterberg Limits			Gradation Analyses		
		Permeability (cm/s)	Max. Dry Unit Wt. (pcf)	Optimum Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Percent Passing #200 Sieve	Classification	Description
C1S1-C	C1				34	15	19	67.6	CL	Sandy lean clay
C1S1-E	C1				33	15	18	75.9	CL	Lean clay with sand
C1S1-G	C1				31	14	17	66.2	CL	Sandy lean clay
Mix 1[1]	C1	4.7E-07	125.4	10.4						
Mix 1[2]	C1	2.1E-08								
C2S1-C	C2				32	15	17	47.3	SC	Clayey fine sand
C2S1-F	C2				32	14	18	60.2	CL	Sandy lean clay
C2S1-G	C2				35	17	18	50.7	CL	Sandy lean clay
Mix 2[1]	C2	5.7E-07	128.7	9.5						
Mix 2[2]	C2	3.2E-08								
RF5-S1-A	RF5				53	16	37	81.2	CH	Fat clay with sand
RF5-S1-B	RF5				40	14	26	73.9	CL	Lean clay with sand
Mix 3[1]	RF5	4.6E-08	126.8	11.2						
Mix 3[2]	RF5	3.3E-08								

<u>Notes:</u>

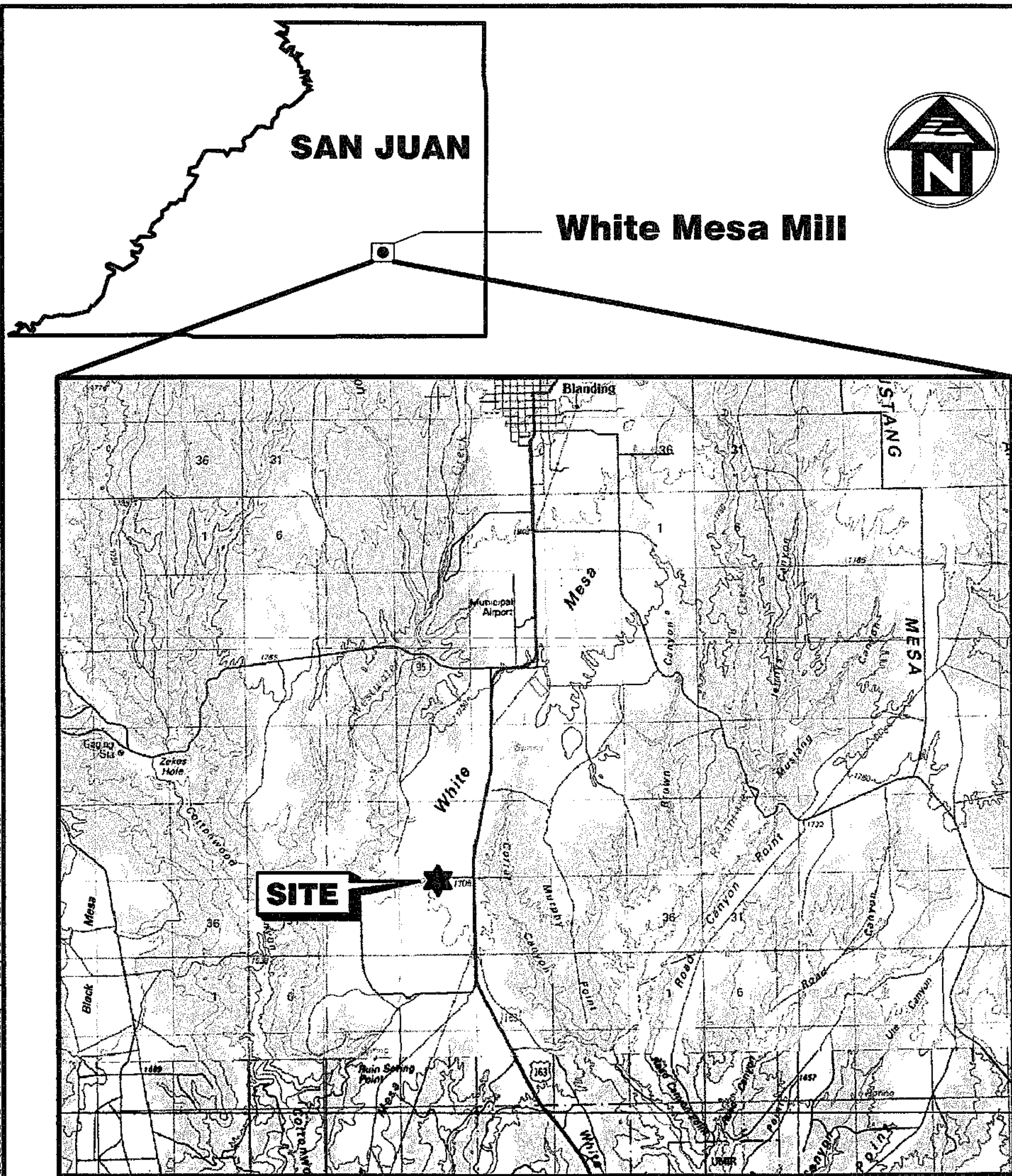
Mix 1 - a mixture of equal volumes of C1S1-C, C1S1-E, and C1S1-G

Mix 2 - a mixture of equal volumes of C2S1-C, C2S1-F, and C2S1-G

Mix 3 - a mixture of equal volumes of RF5-S1-A and RF5-S1-B

[1] - Sample compacted to approximately 90 percent relative compaction at a moisture content 2% above optimum

[2] - Sample compacted to approximately 90 percent relative compaction at a moisture content 5% above optimum



SOURCE:
TerraServer-USA;
USGS 7.5 MINUTE
TOPOGRAPHIC MAP
1 JULY 1982

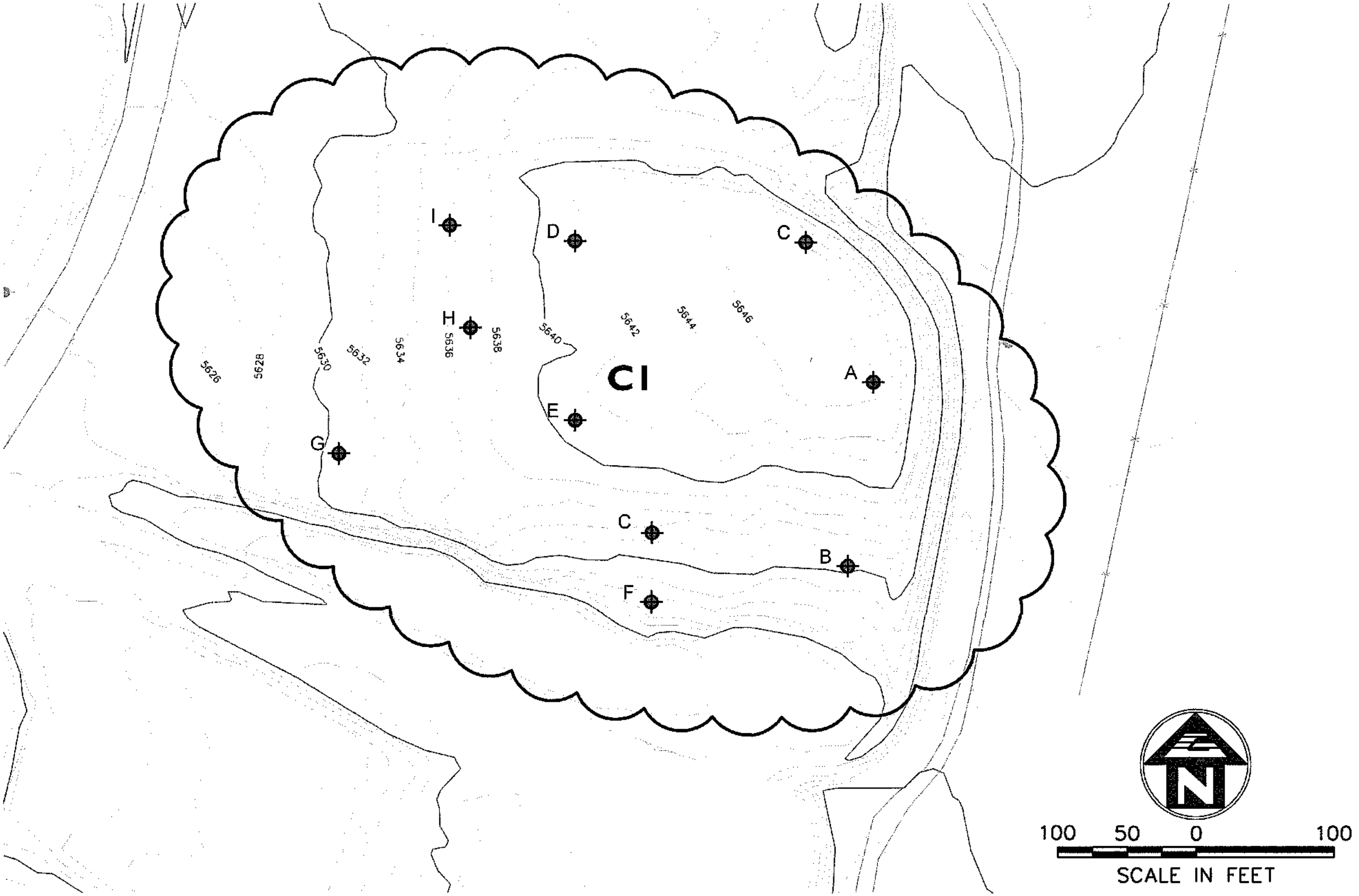
3,000 1,500 0 3,000 6,000
SCALE IN FEET

GEOSYNTEC CONSULTANTS

SITE LOCATION
WHITE MESA MILL
BLANDING, UTAH

FIGURE NO. 1
PROJECT NO. SC0349-01-06
DATE: JANUARY 2006

P:\PRJ\SDCadd\CADD\SC0349\01-06-Figs\SC0349-01-06-SL.dwg 1/23/06 15:21 Administrator



LEGEND

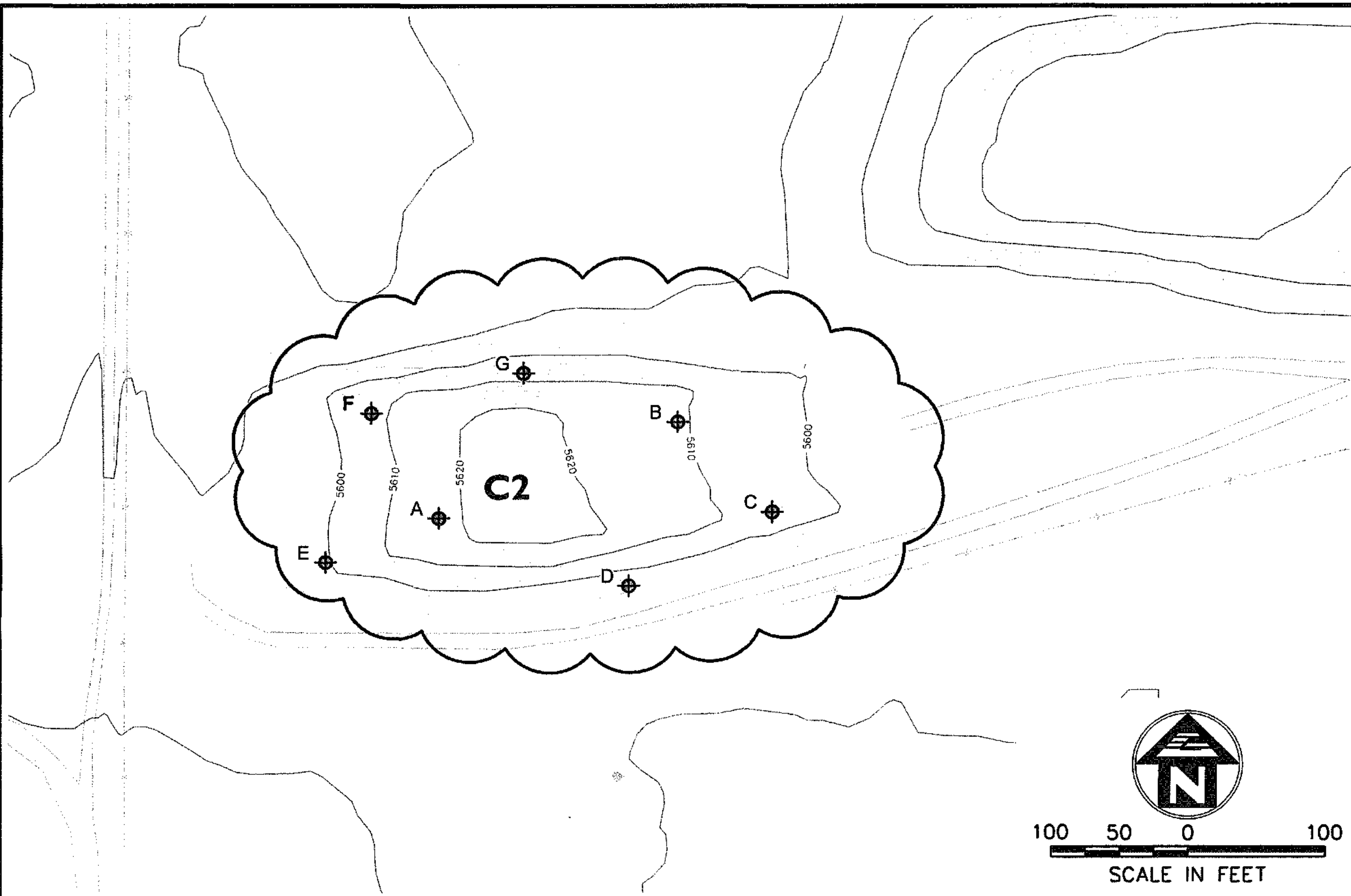
G ⊕ SOIL SAMPLE LOCATION AND ID

GEOSYNTEC CONSULTANTS

LOCATION OF STOCKPILE SAMPLES
WHITE MESA MILL
BLANDING, UTAH

FIGURE NO.	3
PROJECT NO.	SC0349-01-06
DATE:	JANUARY 2006

P:\PRJ\SDCadd\CADD\SC0349\01-06-Figs\SC0349-01-06-C1-S1.dwg 1/23/06 17:05 Administrator



LEGEND

G ⊕ SOIL SAMPLE LOCATION AND ID

GeoSyntec Consultants

LOCATION OF STOCKPILE SAMPLES
WHITE MESA MILL
BLANDING, UTAH

FIGURE NO.	4
PROJECT NO.	SC0349-01-06
DATE:	JANUARY 2006

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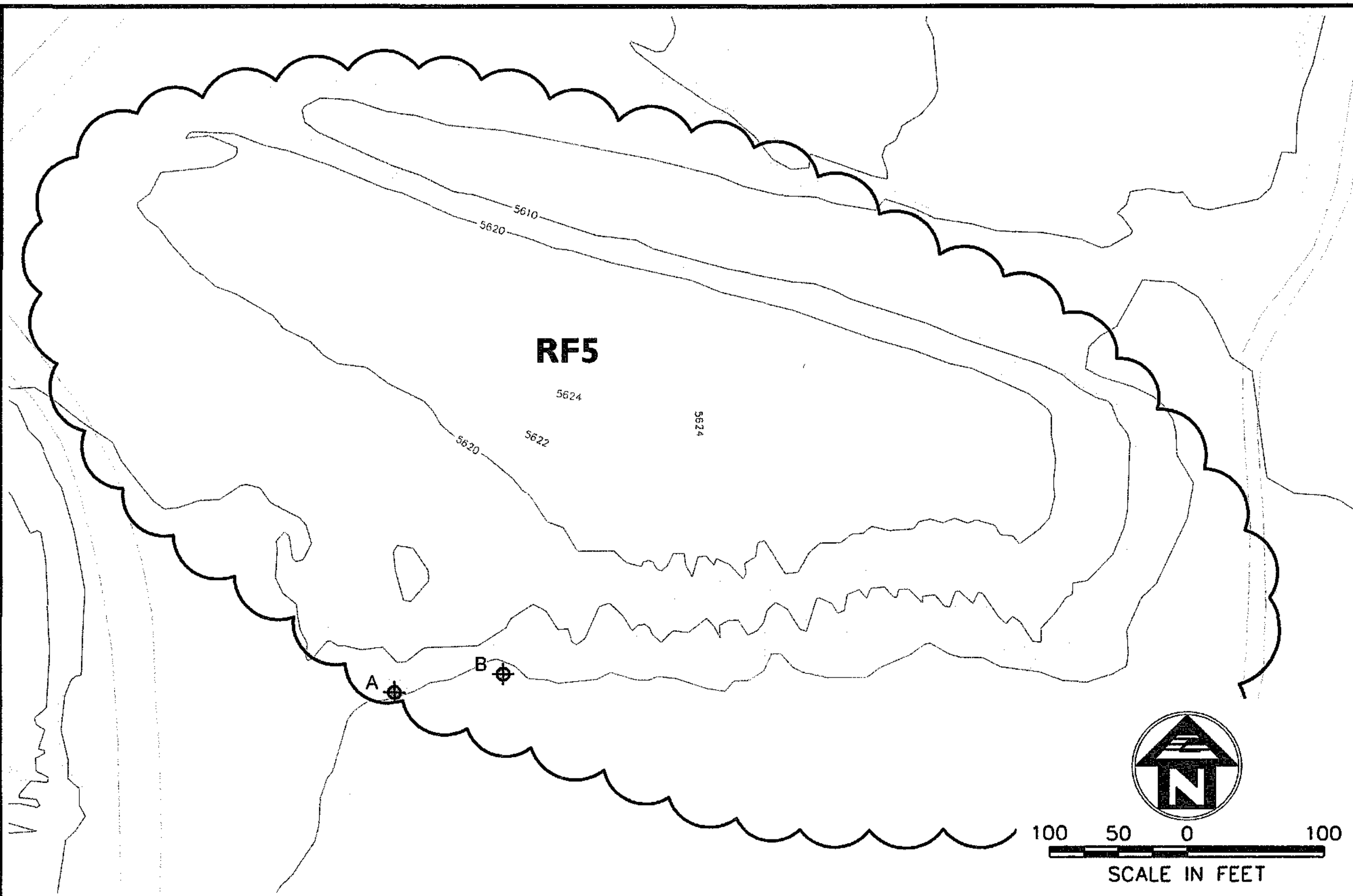


LEGEND

G ⊕ SOIL SAMPLE LOCATION AND ID

GEOSYNTEC CONSULTANTS

LOCATION OF STOCKPILE SAMPLES
WHITE MESA MILL
BLANDING, UTAH

FIGURE NO.	5
PROJECT NO.	SC0349-01-06
DATE:	JANUARY 2006

P:\PRJ\SDCadd\CADD\SC0349\01-06-Figs\SC0349-01-06-RF5-S1.dwg 1/23/06 15:19 Administrator

GeoSyntec Consultants

DAILY FIELD REPORT

PROJECT: IUC WHITE MESA MILL
LOCATION: BLANDING, UTAH PROJECT NO.: SC0349 TASK NO.: 01-06
DESCRIPTION: CLAY STOCKPILE SAMPLING DATE: 10 day NOV month 05 year
CONTRACTOR: NA CLIENT: INTERNATIONAL URANIUM CORP. THURSDAY
WEATHER: MOSTLY SUNNY, H ~ 70°?, L ~ 45°?

0745: ARRIVE ON SITE. MEET KEN MATOSHI OF INTERNATIONAL URANIUM ~~(USA)~~ (USA) CORPORATION (IUC).

~0815 - MEET RICH BARTLETT OF IUC. VISIT C1-S1 SOIL STOCKPILE AREA. ~~(KE)~~ R. BARTLETT ARRANGES FOR BACKHOE AND OPERATOR FOR WRITER.

- THE C1-S1 STOCKPILE BOUNDS ARE MANIFEST. PILE IS COVERED WITH LOW VEGETATION (~2-3 FT TALL). THERE ARE MANY LENGTHS OF APPARENTLY USED PREVIOUSLY POLYETHYLENE PIPES OF VARYING DIAMETER ON PILE AND OTHER DEBRIS. AN ACCESS ROAD ASCENDS FROM WEST TO EAST ALONG NORTH SIDE OF STOCKPILE.

0900 - OPERATOR W/ BACKHOE ASSIGNED (WAYLAN). PROCEED BACK TO C1-S1 (FIGURE 1) (CB)

0915 - TEST PIT C1S1-A AS SHOWN ON ATTACHED FIGURE. SOIL SAMPLE STICKY WHEN WETTED. MAKES BALL. STICKS TO SIDE OF PE PIPE. (SEE TEST PIT LOGS.)

~0950 - TEST PIT C1S1-B (SEE FIGURE). SOIL BELOW ~1.5' DIFFICULT TO DIG. DRY SURFACE (TOP ~1.5') SOIL SLOUGHS INTO TEST PIT (T.P.). DEEP SOIL IS STIFFER, HARD TO EXCAVATE.

~1010 - T.P. C1S1-C (SEE FIGURE). SOIL COMES OUT ~~(W)~~ MAINLY IN ~6" CLODS OR LARGER. DIFFICULT TO EXCAVATE W/ DEPTH. SIDEWALLS ARE STIFF AND MODERATELY SMOOTH. OBTAIN 5-GAL BUCKET SAMPLE.

1050 - TP. C1S1-D (SEE FIGURE). NOT TOO DIFFICULT TO EXCAVATE.

(CB) ~~1100~~ - 1105 - WAYLON BREAKS FOR LUNCH.

~~1110~~ 1115 - CALL NADER RAD AT SOILS LAB AND DESCRIBE SOIL OBSERVATIONS. NADER REQUESTS ~1/2 - 3/4 FULL 5-GALLON BUCKET SOIL SAMPLE VOLUME FOR LABORATORY TESTING.

1135 - RETURN TO C1S1. FINISH LOGGING C1S1-D.

~~1140~~ 1150 - C1S1-E (SEE FIGURE). SEMI-MOIST RED CLAY. COMES UP IN ~4" TO 6" CLODS, EASILY CRUMBLED. OBTAIN OFF-SITE LAB SAMPLE.

COPY TO: FILE PER: [signature] CHAD BIRD HRS: 8.5

GeoSyntec Consultants

DAILY FIELD REPORT

DATE: 10 day NOV month 05 year

~1210 - TP C1S1-F (SEE FIG). REDDISH BROWN ~~CLAY~~ SAND W/ FINES AND BROWN SAND W/ FINES. SMALL (~1" φ) CLODS. ROUGH SIDEWALLS THAT EASILY SLOUGH. ~~SAND ROUGH SIDEWALLS. CLAY SMOOTH.~~ (CB)

~1230 - TP C1S1-G (SEE FIG). REDDISH TAN SAND W/FINES (SHALLOW) AND TANNISH RED CLAY (~1.5'+). SAND - DRY; ROUGH SIDEWALLS. CLAY - WETTER; SMOOTH SIDEWALLS; HARD TO EXCAVATE. OBTAIN SAMPLE FOR OFF-SITE LAB TESTING.

~1250 - TP C1S1-H (SEE FIG). REDDISH BROWN CLAY. DRY SHALLOW; ROUGH SIDEWALLS. WETTER DEEPER; SMOOTH SIDEWALLS. SOME BROWN CLAY CLODS, EASILY CRUMBLED. DIFFICULT TO EXCAVATE DEEP. ~~X~~ (CB)

~1310 - TP C1S1-I (SEE FIG). REDDISH TAN CLAY SHALLOW. ROUGH SIDEWALLS. DRY.

1325 - EXCAVATOR IS LEAKING HYDRAULIC FLUID AND NEEDS REPAIR. TP C1S1-I EXCAVATION DISCONTINUED.

1350 - TP C1S1-I EXCAVATION RESUMES BEFORE REPAIR COMPLETE. REDDISH BROWN CLAY (~1.0' - ~2.0'). HARD CLODS: ~4"-6" φ. DIFFICULT EXCAVATION DEEPER. CONCLUDES C1S1 SAMPLING.

~1410 - ARRIVE AT C2S1 STOCKPILE. PILE IS DOTTED WITH A FEW SMALL BUSHES, BUT IS (CB) MOSTLY UNVEGETATED.

~~THE~~ (CB) 1415 - TP C2S1-A (SEE FIGURE 2). SOIL IS BROWN SAND W/SOME FINES AND FRAGMENTS OF SANDSTONE. SOIL IS EASILY EXCAVATED. SANDSTONE: COMBINATION OF EASY + DIFFICULT TO CRUMBLE.

- WITH END OF WORK DAY APPROACHING, THE WRITER REQUESTS HOE OPERATOR TO EXCAVATE SEVERAL TEST PITS IN ADVANCE OF LOGGING. ~~EXCA~~ (CB) WRITER DIRECTS LOCATIONS. TP C2S1- ~~B~~ (CB) B (CB) THROUGH F. EXCAVATED BEFORE END OF DAY. THIS PITS NOT LOGGED.

1530 - RETURN TO COMPLEX AREA. CHECK PERSONS FOR RADIOACTIVITY W/ GEIGER COUNTER. NONE DETECTED.

1545 - DEPART SITE.

0.25 HR OFF-SITE PHONE MEETING W/ GREG CORCORAN (GEOSYNTEC) REGARDING FIELD ACTIVITIES.

COPY TO: FILE

PER: [signature]

GeoSyntec Consultants

DAILY FIELD REPORT

PROJECT: IUC WHITE MESA MILL

LOCATION: BLANDING, UTAH PROJECT NO.: SC0349 TASK NO.: 01-06

DESCRIPTION: CLAY STOCKPILE SAMPLING DATE: 11 day NOV month 05 year

CONTRACTOR: NA CLIENT: INTENATIONAL URANIUM (USA) CORPORATION (IUC) FRIDAY

WEATHER: OVERCAST, T-STORMS, H ~ 55°?, L ~ 35°?

0700 - ARRIVE ON SITE. MEET ~~HAROLD~~ CB RICH BARTLETT (IUC). DISCUSS OBTAINING SAMPLES FROM ~~CL~~ CB SOIL STOCKPILE RFS-S1 FOR OFF-SITE LAB TESTING. PER PHONE CONVERSATION W/ GREG CORCORAN (GEOSYNTEC) ON 10 NOV 05, THIS HAS BEEN AGREED TO AND DIRECTED BY HAROLD ROBERTS OF IUC.

0710 - MEET WAYLON (EQUIPMENT OPERATOR). CAT 426 B HOE UTILIZED YESTERDAY IS BEING USED FOR OTHER PLANT ACTIVITIES. A LOADER WILL ALTERNATELY BE USED. (REMAINING EXCAVATIONS ARE INTO STOCKPILE SIDESLOPES.) CB (SEE FIGURE 2)

0715 - ARRIVE AT C2S1 STOCKPILE. BEGIN LOGGING TEST PITS.

0720 - ~~C2S1~~ CB TP C2S1-B - EASILY EXCAVATED (ON 10 NOV 05). MAINLY BROWN SAND W/ SOME CLAY ~~+ SAND~~ CB CLODS (EASILY BROKEN).

~0735 - TP C2S1-C - EASILY EXCAVATED (ON 10 NOV 05). MOSTLY SAND W/ FINES, BUT POSSIBLY CLAY AT BOTTOM - MAY BE COMPACTED, WETTER SAND. CONTAINS SOFT AND HARD PIECES OF SANDSTONE. OBTAIN SAMPLE FOR OFF-SITE LAB TESTING.

~0750 - TP C2S1-D - EASILY EXCAVATED (ON 10 NOV 05). DUG INTO SIDESLOPE OF PILE. MAINLY BROWN TAN SAND. CONTAINS SANDSTONE/CLAYSTONE PARTICLES - EASY AND DIFFICULT TO CRUMBLE.

~0805 - TP C2S1-E - TANNISH BROWN SAND. NOTABLY VERY ROUGH SIDEWALLS. COMES OUT MAINLY IN LARGE HARD PIECES OF SANDSTONE.

~0820 - TP C2S1-F - TANNISH BROWN SAND W/FINES AND SANDSTONE PIECES. SOME SANDSTONE PIECES ARE GRAY. OBTAIN SAMPLE FOR OFF-SITE LABORATORY TESTING.

~0840 - TP C2S1-G - EXCAVATED TODAY W/ LOADER INTO SIDESLOPE OF STOCKPILE. COMPARATIVELY FEWER FINES AND SANDSTONE. OBTAIN SAMPLE FOR OFF-SITE LAB TESTING. RAIN AND T-STORMS IN AREA: EVACUATE.

(SEE FIGURE 2 FOR C2S1 TEST PIT LOCATIONS)

COPY TO: FILE PER: [signature] HRS: 5.0

CHAD BIRD

GeoSyntec Consultants

DAILY FIELD REPORT

DATE: 11 day NOV month 05 year

~0900 – ARRIVE AT RFS-S1 STOCKPILE. PILE HAS BEEN EXCAVATED ~~RECENTLY~~ RECENTLY. SPARSE VEGETATION ON TOP OF PILE. RAIN ARRIVES (LIGHT).

~0905 – ~~TP RFS-S1-A~~ LOADER SPREADS EXISTING SOIL MOUND TO ALLOW WRITER TO OBTAIN SAMPLE FROM UNEXPOSED (RECENTLY) SOIL. OBTAIN SOIL SAMPLE RFS-S1-A FOR OFF-SITE TESTING.

~0910 – LOADER DIGS INTO SIDE OF STOCKPILE. WRITER OBTAINS SOIL SAMPLE FOR OFF-SITE TESTING ~~SOIL~~ (RFS-S1-B).

– BOTH RFS-S1 A+B ARE MAINLY CLAY AND CLAY STONE, NOT EASILY BROKEN BY HAND. PARTICLE SIZES RANGE FROM SMALL (~¼"?) TO ~8" IN ~~DIA~~ DIAMETER. SEE FIG. 3 FOR SAMPLE LOCATIONS.

~0915 – CONCLUDE SOIL SAMPLING AS RAIN FALLS HARDER. RETURN TO COMPLEX.

– ARRANGE WITH ADMIN. STAFF TO SHIP SOIL SAMPLES. IUC SHIPS SAMPLES (WITH IUC ACCOUNT) VIA UPS COURIER. UPS GROUND UTILIZED.

– WORK ON PROJECT DOCUMENTATION.

1130 – UPS PICKS UP SAMPLES.

– MAKE COPIES OF SAMPLING MAPS (FIGURES) FOR KEN MAYOSHI (IUC).

1200 – END OF WORK DAY.

COPY TO: FILE PER: [signature]

GeoSyntec Consultants

TEST PIT LOG

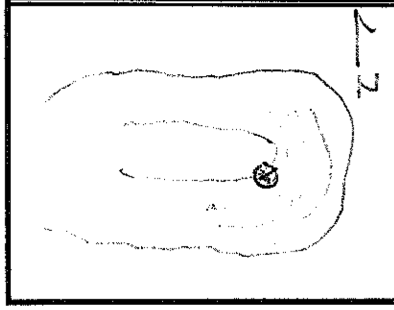
Project Name: IUC WMM
Project Number: SC0349-01-06
Site: C1S1

Date: 10 NOV 05
Weather: M. SUNNY
Test Pit Logged By: CB
Samples Collected by: CB

Test Pit ID: C1S1-(A)
Test Pit Width: ~12'
Test Pit Depth: ~4'
Equipment Used: CAT 426B HOE
Subcontractor: —

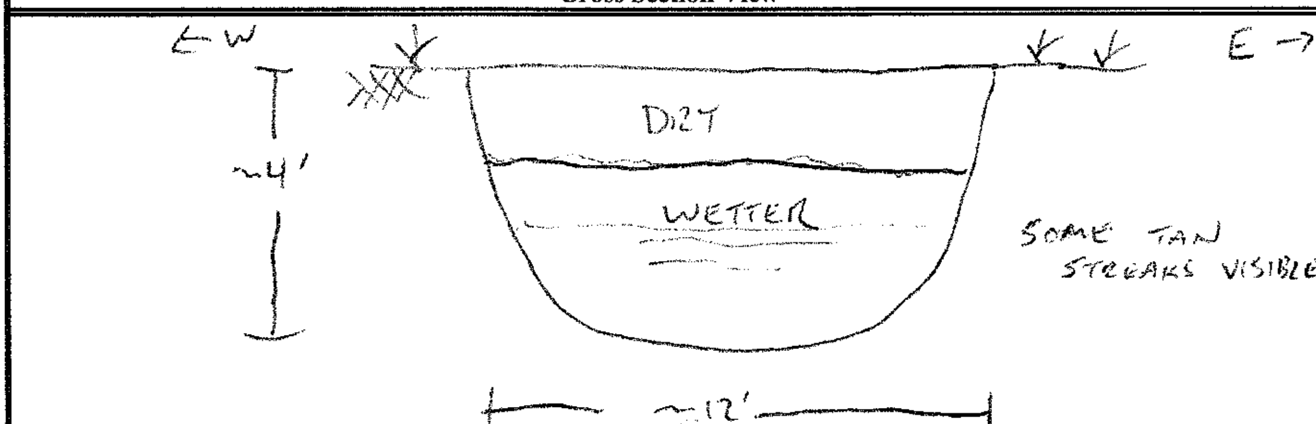
Depth to Water (ft): NA
Immiscible Layer: ~~Y / N~~
Start/Stop Time: ~9:19 /

Sketch of Test Pit Location



Depth (ft)	Description	PID (ppm)	Sample ID/Comments
0 - ~1.5	DRY, LIGHT BROWNISH RED CLAY. CRUMBLES. NO PARTICLES.	NA	
~1.5 - ~4	WETTER, BROWNISH RED CLAY W/ SOME THIN STREAKS OF TAN MATERIAL.		

Cross Section View



Samplers Signature: [signature]

GEOSYNTEC CONSULTANTS

TEST PIT LOG

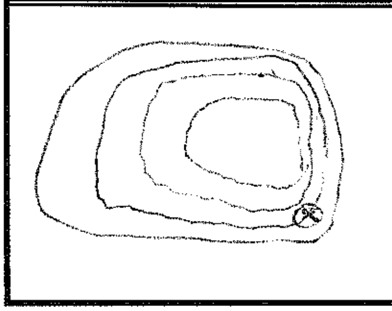
Project Name: IUC WMM
Project Number: SC0349-01-06
Site: C151

Test Pit ID: C151-(B)
Test Pit Width: ~12'
Test Pit Depth: ~3'
Equipment Used: CAT 426 B HOE
Subcontractor: NA

Date: 10 NOV 05
Weather: M. SUNNY
Test Pit Logged By: CB
Samples Collected by: CB

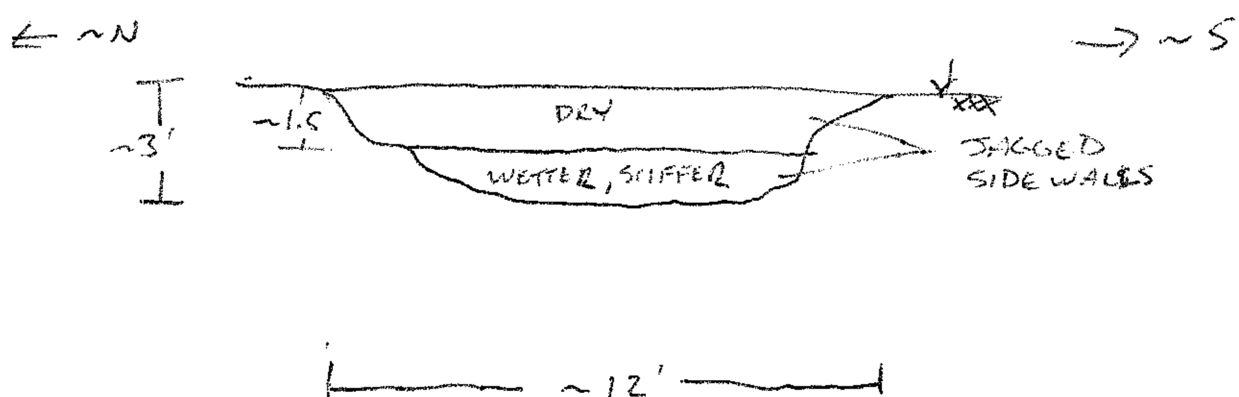
Depth to Water (ft): NA
Immiscible Layer: ~~Y / N~~
Start/Stop Time:

Sketch of Test Pit Location



Depth (ft)	Description	PID (ppm)	Sample ID/Comments
0-~1.5	REDDISH TAN SAND W/ FINES. DRY. SOME CLODS. NO ROCKS.		
~1.5-~3	REDDISH TAN SAND W/ FINES. SLIGHTLY WETTER. SIDEWALLS NOT SMOOTH, BUT ARE STIFF. DIFFICULT TO EXCAVATE.		

Cross Section View



Samplers Signature: [signature]

GeoSyntec Consultants

TEST PIT LOG

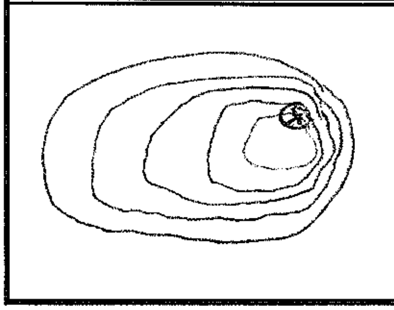
Project Name: IUC WMM
Project Number: SC0349-01-06
Site: C1S1

Test Pit ID: C1S1-(C)
Test Pit Width: ~12
Test Pit Depth: ~3.5
Equipment Used: CAT 426 B HOE
Subcontractor: NA

Date: 10 NOV 05
Weather: M. SUNNY
Test Pit Logged By: CB
Samples Collected by: CB

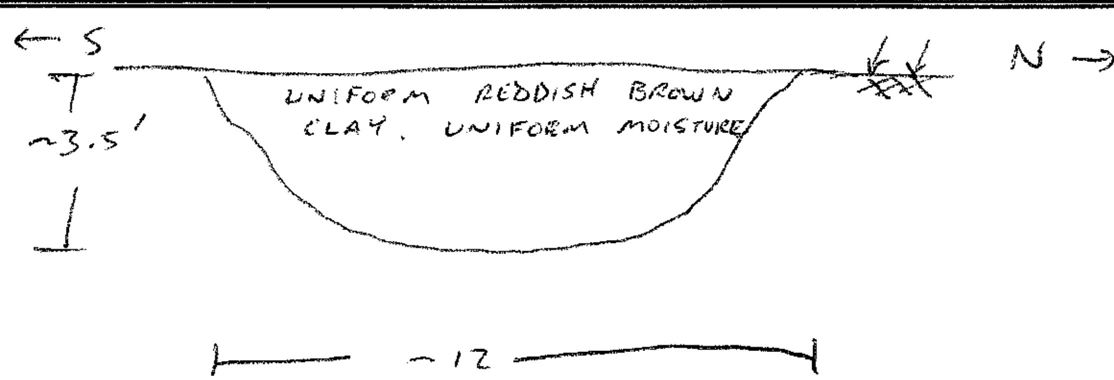
Depth to Water (ft): NA
Immiscible Layer: ~~Y / N~~
Start/Stop Time:

Sketch of Test Pit Location



Depth (ft)	Description	PID (ppm)	Sample ID/Comments
0 ~ 3.5'	REDDISH BROWN CLAY. DIFFICULT TO EXCAVATE JAGGED STIFF SIDE WALLS. MOISTURE NEARLY UNIFORM W/ DEPTH.		

Cross Section View



Samplers Signature: [signature]

GeoSyntec Consultants

TEST PIT LOG

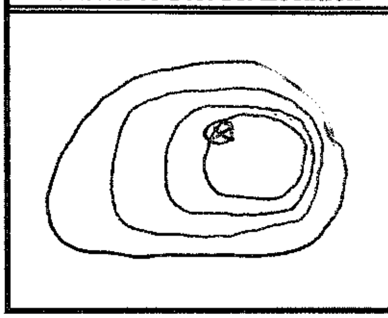
Project Name: ~~SC0349-01-06~~ FUC WMM
Project Number: SC0349-01-06
Site: C151

Test Pit ID: C151-D
Test Pit Width: ~10
Test Pit Depth: ~3.5
Equipment Used: CAT 426 B HOE
Subcontractor: NA

Date: 10 NOV 05
Weather: M. SUNNY
Test Pit Logged By: CB
Samples Collected by: CB

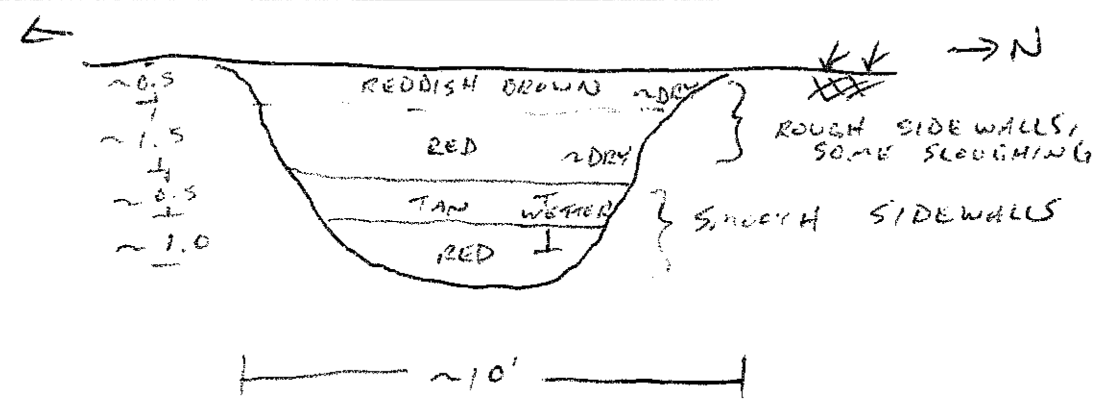
Depth to Water (ft): NA
Immiscible Layer: ~~Y/N~~
Start/Stop Time:

Sketch of Test Pit Location



Depth (ft)	Description	PID (ppm)	Sample ID/Comments
0 – ~0.5	DRY, REDDISH BROWN CLAY	N/A	
0.5 – ~~1.5~~ 2.0	DRY RED CLAY		
2.0 ~ 2.5	WETTER, TAN CLAY		
2.5 – ~3.5	WETTER, RED CLAY		

Cross Section View



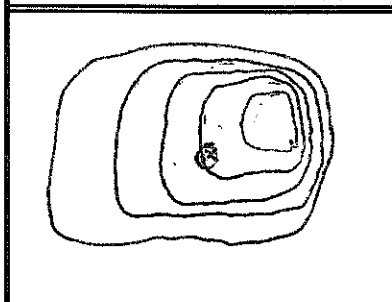
Samplers Signature:

GEOSYNTEC CONSULTANTS

TEST PIT LOG

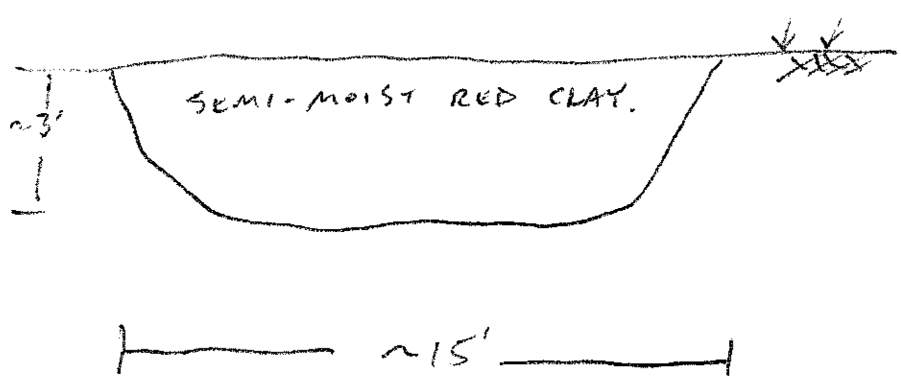
Project Name: JUC WMM Sc0349-01-06	Date: 10 NOV 05
Project Number: ↓	Weather: M. SUNNY
Site: C1S1	Test Pit Logged By: CB
	Samples Collected by: CB
Test Pit ID: C1S1-E	
Test Pit Width: ~15'	Depth to Water (ft): NA
Test Pit Depth: ~3	Immiscible Layer: ~~Y~~ / N
Equipment Used: CAT 416B Hoe	Start/Stop Time:
Subcontractor: NA	

Sketch of Test Pit Location



Depth (ft)	Description	PID (ppm)	Sample ID/Comments
0 - ~3'	SEMI-MOIST RED CLAY. EXCAVATES MAINLY IN 4" - 6" EASILY CRUMBLED CLODS.		

Cross Section View



Samplers Signature: [signature]

GEOSYNTEC CONSULTANTS

TEST PIT LOG

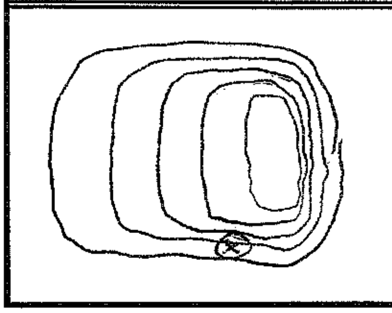
Project Name: IUC WMM
Project Number: SC0349-01-06
Site: C151

Test Pit ID: C151-(F)
Test Pit Width: ~10'
Test Pit Depth: ~5
Equipment Used: CAT 426B HOE
Subcontractor: NA

Date: 10 NOV 05
Weather: M. SUNNY
Test Pit Logged By: CB
Samples Collected by: CB

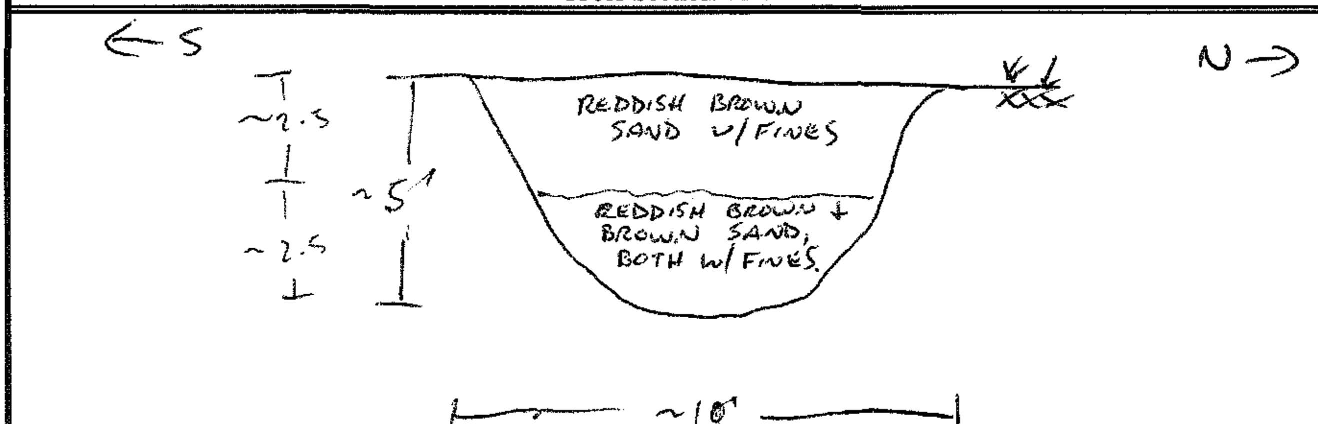
Depth to Water (ft): NA
Immiscible Layer: ~~Y / N~~
Start/Stop Time:

Sketch of Test Pit Location



Depth (ft)	Description	PID (ppm)	Sample ID/Comments
0 - ~2.5	REDDISH BROWN SAND W/ FINES. MOSTLY DRY. SOME SMALL (~~~1~~ CB) (~1" ϕ) EASILY CRUMBLED CLODS. ROUGH SIDEWALLS. CB		
(CB) 2.5 ~ 5	REDDISH BROWN SAND AND BROWN SAND, BOTH WITH FINES. SMALL CLODS. ROUGH SIDEWALLS. MOSTLY DRY.		

Cross Section View



Samplers Signature: [signature]

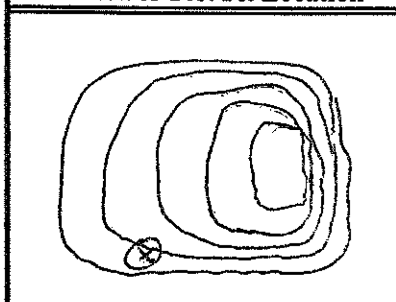
GEOSYNTEC CONSULTANTS

TEST PIT LOG

Project Name: ~~8~~ (CB) IUC WMM
Project Number: SC0349-01-06
Site:
Test Pit ID: C1S1-(G)
Test Pit Width: ~12
Test Pit Depth: ~3
Equipment Used: CAT 426 B HOE
Subcontractor: NA

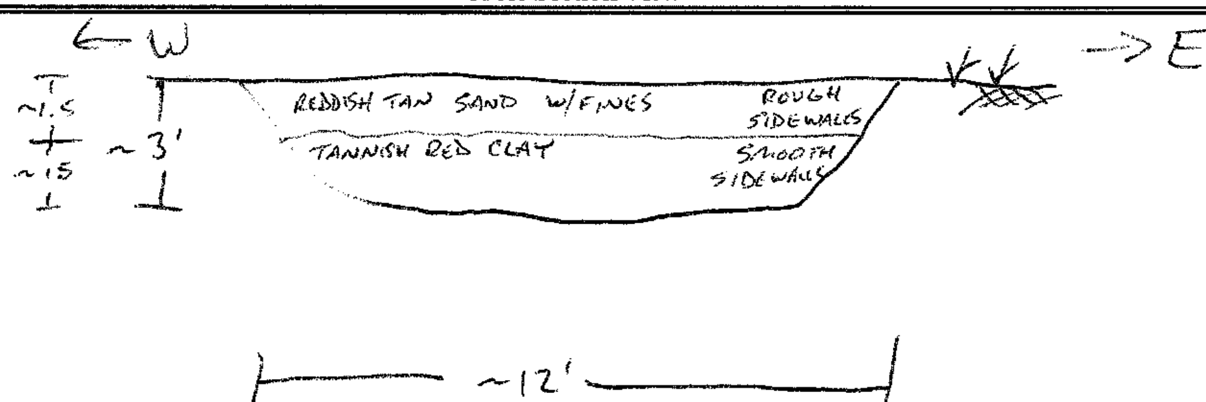
Date: ~~8T~~ (CB) 10 NOV 05
Weather: M. SUNNY
Test Pit Logged By: CB
Samples Collected by: CB
Depth to Water (ft): NA
Immiscible Layer: ~~Y / N~~
Start/Stop Time:

Sketch of Test Pit Location



Depth (ft)	Description	PID (ppm)	Sample ID/Comments
0 - ~~3~~			
0 - ~1.5	REDDISH TAN SAND W/FINES. MOSTLY DRY, ROUGH SIDEWALLS.		
~1.5 - ~3.0	TANNISH RED CLAY. ~~some~~ (CB) ~4" ϕ HARD CLODS. MOSTLY DRY. SMOOTH SIDEWALLS. HARD TO EXCAVATE.		

Cross Section View



Samplers Signature: [signature]

GEOSYNTEC CONSULTANTS

TEST PIT LOG

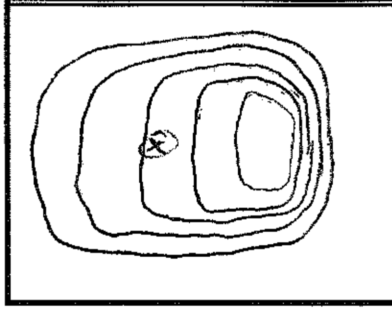
Project Name: ~~SC~~ IUC WMM (CB)
Project Number: SC0349-01-06
Site: C151

Test Pit ID: C151-(H)
Test Pit Width: ~10'
Test Pit Depth: ~3'
Equipment Used: CAT 426 B HOE
Subcontractor: NA

Date: 10 NOV 05
Weather: M. SUNNY
Test Pit Logged By: CB
Samples Collected by: CB

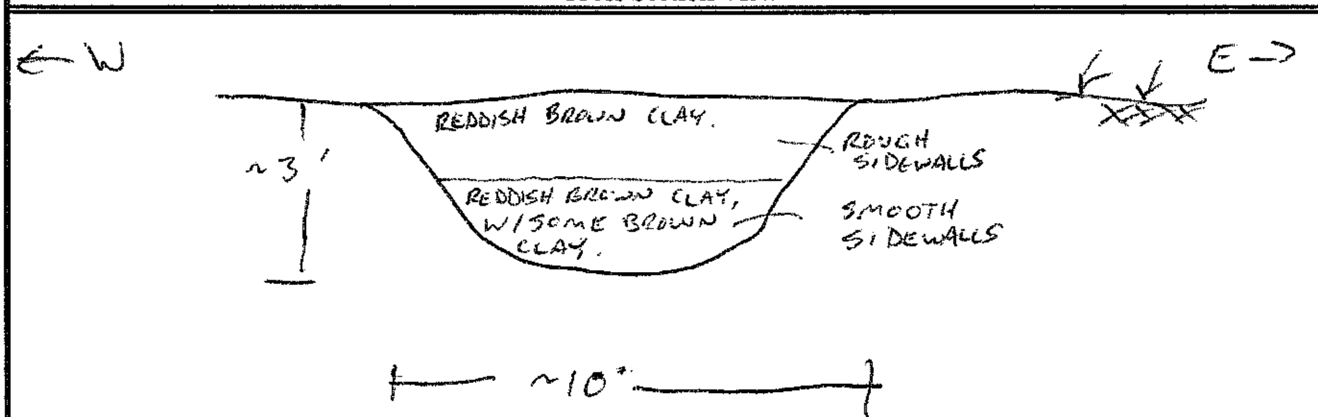
Depth to Water (ft): NA
Immiscible Layer: ~~Y/N~~
Start/Stop Time:

Sketch of Test Pit Location



Depth (ft)	Description	PID (ppm)	Sample ID/Comments
0 - ~1.5	REDDISH BROWN CLAY. SEMI-MOIST. ~2" - 6" EASILY CRUMBLED CLODS. ROUGH SIDEWALLS.		
~1.5 - 3	REDDISH BROWN CLAY, SOME BROWN CLAY CLODS. DIFFICULT TO EXCAVATE. SMOOTH SIDEWALLS. SEMI-MOIST.		

Cross Section View



Samplers Signature: [signature]

GEOSYNTEC CONSULTANTS

TEST PIT LOG

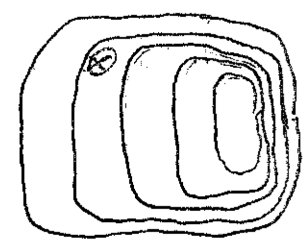
Project Name: IUC WMM
Project Number: SC0349-01-06
Site: C1S1

Test Pit ID: C1S1-(I)
Test Pit Width: ~10'
Test Pit Depth: ~2'
Equipment Used: CAT 426B Hoe
Subcontractor: NA

Date: 10 NOV 05
Weather: M. SUNNY
Test Pit Logged By: CB
Samples Collected by: CB

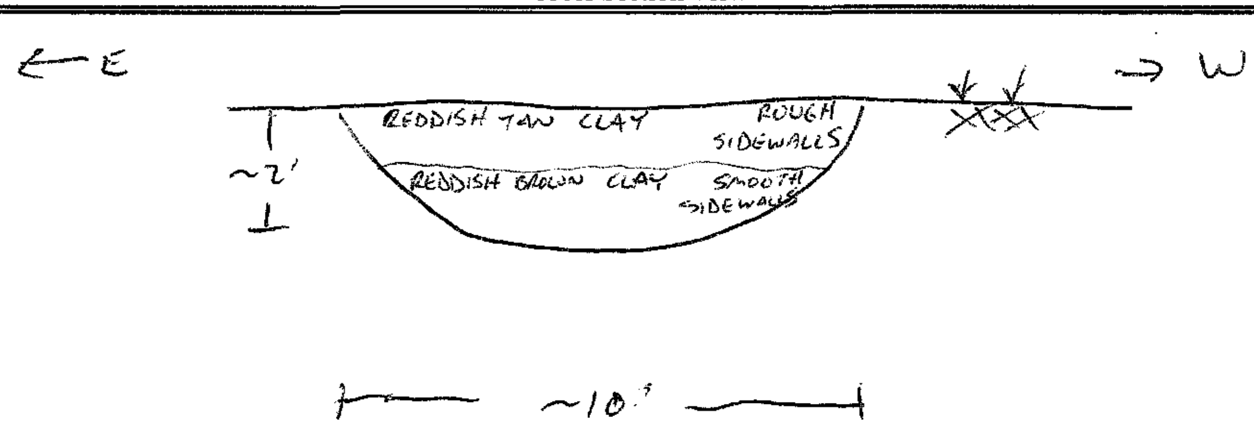
Depth to Water (ft): NA
Immiscible Layer: ~~Y/N~~
Start/Stop Time:

Sketch of Test Pit Location



Depth (ft)	Description	PID (ppm)	Sample ID/Comments
0 - ~1.0	REDDISH TAN CLAY. DRY + CRUMBLY. ~4" ϕ CLODS. ROUGH SIDEWALLS THAT SLOUGH.		
~1.0 - ~2.0	REDDISH BROWN CLAY. SLIGHTLY WETTER ~4" - 6" ϕ CLODS, NOT EASILY CRUMBLED. HARD TO EXCAVATE.		

Cross Section View



Samplers Signature: [signature]

GEOSYNTEC CONSULTANTS

TEST PIT LOG

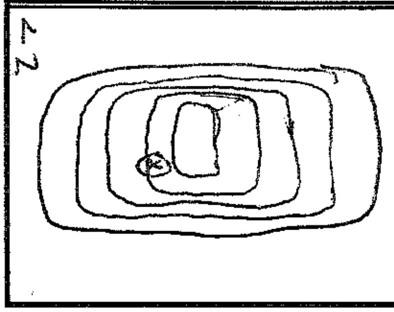
Project Name: IUC WMM
Project Number: SC0349-01-06
Site: C251-B

Test Pit ID: C251-A
Test Pit Width: ~10'
Test Pit Depth: ~5'
Equipment Used: CAT 426 B
Subcontractor: NA

Date: 10 NOV 05
Weather: M. SUNNY
Test Pit Logged By: CB
Samples Collected by: CB

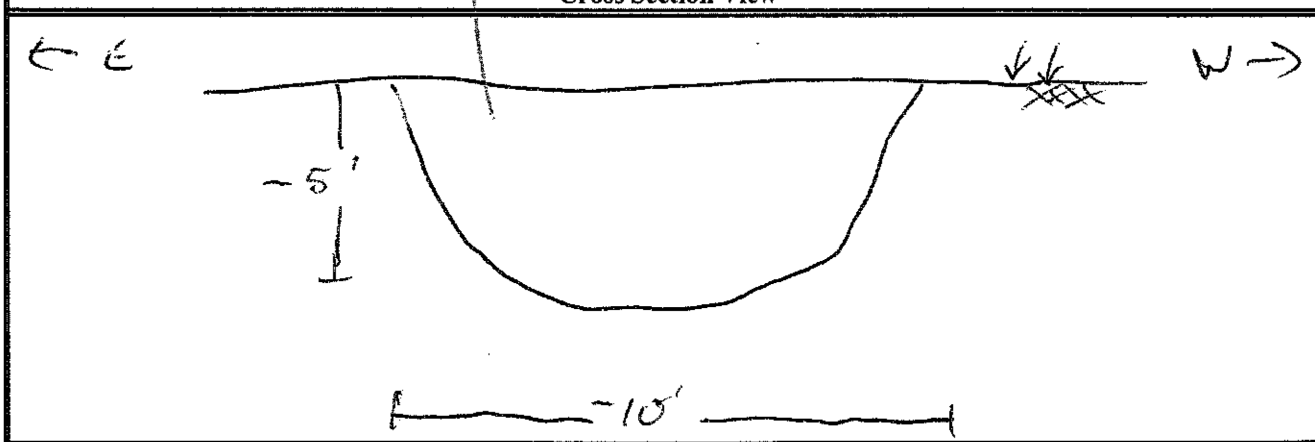
Depth to Water (ft): NA
Immiscible Layer: ~~Y/N~~
Start/Stop Time:

Sketch of Test Pit Location



Depth (ft)	Description	PID (ppm)	Sample ID/Comments
0 - ~5'	BROWN SAND W/ SOME FINES. CONTAINS SAND STONE FRAGMENTS. SEMI-MOIST. ROUGH SIDEWALLS THAT SLOUGH EASILY.		

Cross Section View



Samplers Signature: [signature]

GEOSYNTEC CONSULTANTS

TEST PIT LOG

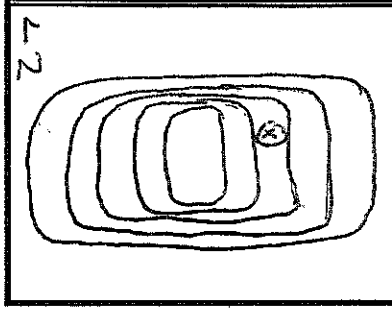
Project Name: IUC WMM
Project Number: SC0349-01-06
Site: C2S1

Test Pit ID: C2S1-(B)
Test Pit Width: ~10'
Test Pit Depth: ~4'
Equipment Used: CAT 426B HOE
Subcontractor: NA

Date: EXC: 10 NOV 05; (CB) LOGGED 11 NOV 05
Weather: M. SUNNY
Test Pit Logged By: CB
Samples Collected by: CB

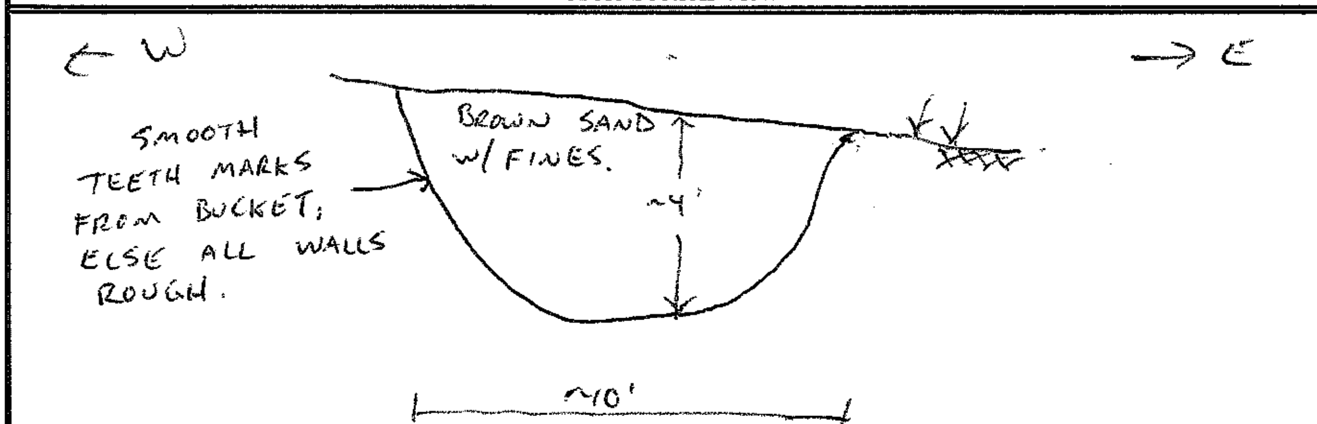
Depth to Water (ft): NA
~~Immiscible Layer: Y/~~N
Start/Stop Time:

Sketch of Test Pit Location



Depth (ft)	Description	PID (ppm)	Sample ID/Comments
0-~4'	BROWN SAND W/ FINES. SOME CLAY CLODS (~2"-4" Ø), BROKEN W/ MODERATE EFFORT. SEMI-MOIST. ROUGH SIDEWALLS W/ SLOUGHING.		

Cross Section View



Samplers Signature: [signature]

GEOSYNTEC CONSULTANTS

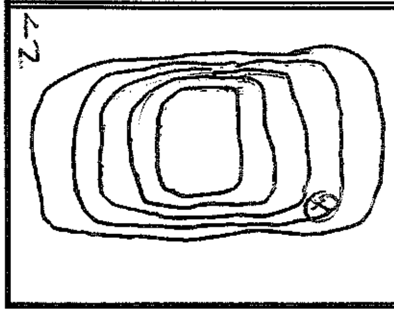
TEST PIT LOG

EXC: 10 NOV 05, LOGGED..

Project Name: IUC WMM
Project Number: SC0349-01-06
Site: C251
Test Pit ID: ~~C1~~ CS C251-C
Test Pit Width: ~15
Test Pit Depth: ~4.5
Equipment Used: CAT 426B HOE
Subcontractor: NA

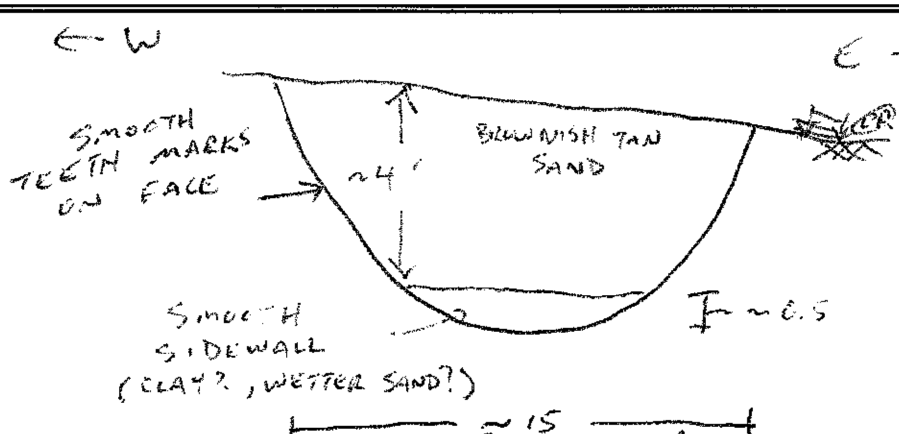
Date: 11 NOV 05 (CB)
Weather: 10NOV: M.S., 11NOV: OC, TS
Test Pit Logged By: CB
Samples Collected by: CB
Depth to Water (ft): NA
Immiscible Layer: ~~Y/N~~
Start/Stop Time:

Sketch of Test Pit Location



Depth (ft)	Description	PID (ppm)	Sample ID/Comments
0 - ~4'	BROWNISH TAN SAND W/ FINES. SEMI-MOIST. ROUGH SIDEWALLS.		
~4' - ~4.5'	APPEARS TO BE ~~CA~~ (CB) POSSIBLY CLAY, BUT MAY BE SAME MATERIAL AS ABOVE, ONLY WETTER. SMOOTH SIDEWALLS.		
	EXCAVATED SOIL CONTAINS SOME SOFT AND HARD PIECES OF SANDSTONE.		

Cross Section View



Samplers Signature: [signature]

GEOSYNTEC CONSULTANTS

TEST PIT LOG

EXC: 10 NOV 05, LOGGED

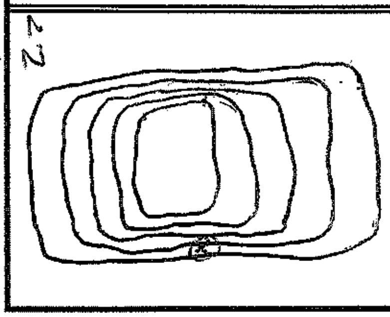
Project Name: IUC WMM
Project Number: SC0349-01-06
Site: C2S1

Date: 11 NOV 05
Weather: 10 NOV: M.S., 11 NOV: OC, 75
Test Pit Logged By: CB
Samples Collected by: CB

Test Pit ID: C2S1-(D)
Test Pit Width: ~12'
Test Pit Depth: ~8'
Equipment Used: 426 B HOE (CAT)
Subcontractor: NA

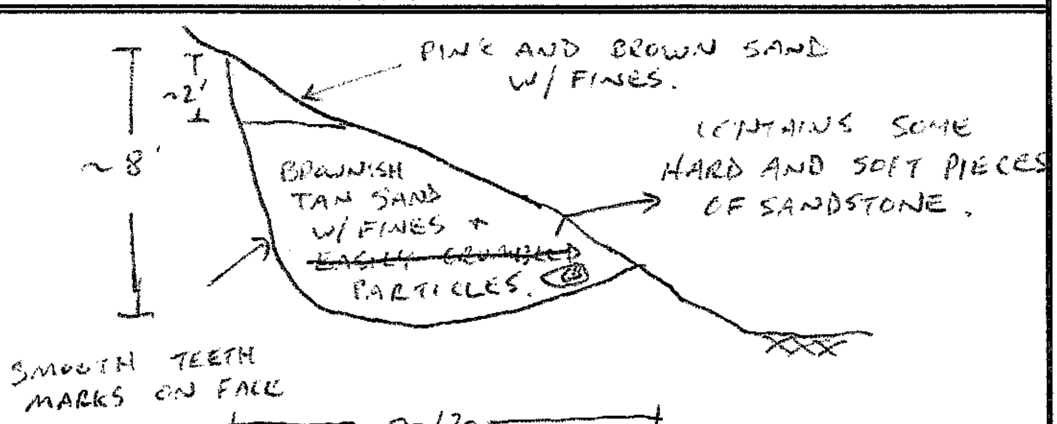
Depth to Water (ft): NA
Immiscible Layer: ~~Y/N~~
Start/Stop Time:

Sketch of Test Pit Location



Depth (ft)	Description	PID (ppm)	Sample ID/Comments
0 - ~2'	PINK AND BROWN SAND ~~LAYER~~ (CB) W/FINES. COLORS LAYERED, MOSTLY DRY. EASILY EXCAVATED. ~~DRE~~ (CB) MOSTLY DRY.		
~2' - ~8'	BROWNISH TAN SAND W/FINES AND CLAYSTONE PARTICLES - EASILY CRUMBLED AND DIFFICULT TO CRUMBLE. SEMI-MOIST.		

Cross Section View



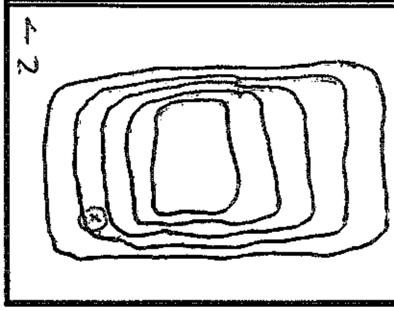
Samplers Signature: [signature]

GEOSYNTEC CONSULTANTS

TEST PIT LOG

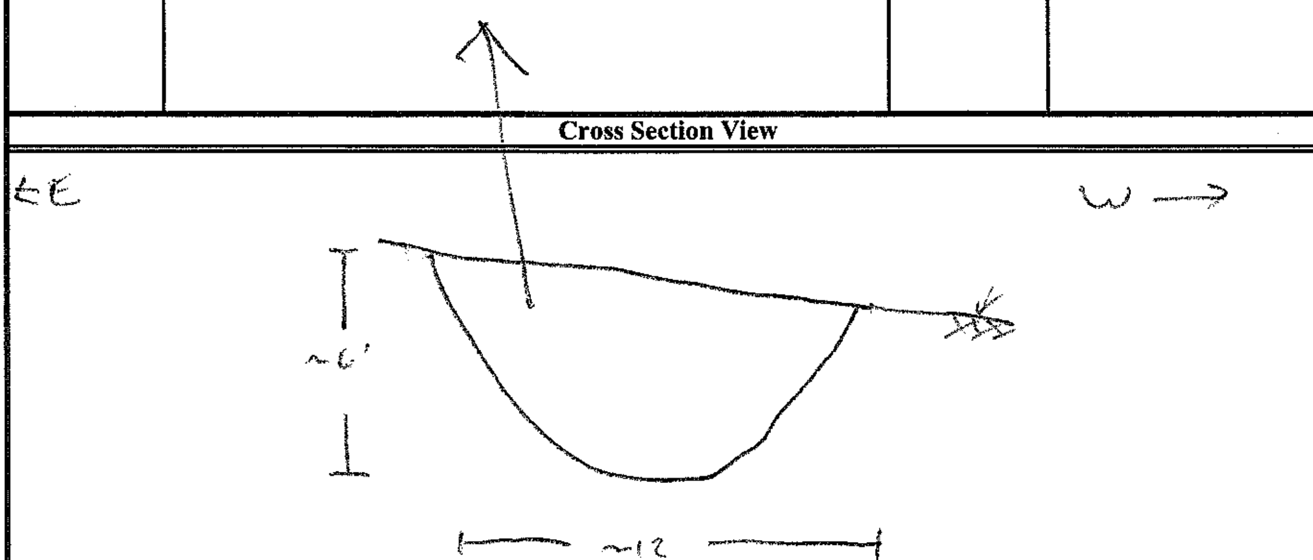
Project Name: IUC WMM	Date: EX: 10 NOV 05, LOGGED 11 NOV 05
Project Number: SC0349-01-06	Weather: 10 NOV: MS, 11 NOV: CC, TS
Site: C2S1	Test Pit Logged By: CB
	Samples Collected by: CB
Test Pit ID: C2S1-(E)	
Test Pit Width: ~12'	Depth to Water (ft): NA
Test Pit Depth: ~6'	Immiscible Layer: Y/N
Equipment Used: CAT 426B HOE	Start/Stop Time:
Subcontractor: NA	

Sketch of Test Pit Location



Depth (ft)	Description	PID (ppm)	Sample ID/Comments
0 - ~6'	TANNISH BROWN SAND W/ FINES. SEMI-MOIST, VERY ROUGH SIDEWALLS LARGE PIECES OF SANDSTONE (HARD). LARGE QUANTITY OF SANDSTONE PIECES ~ (2" ~ 8" Ø).		

Cross Section View



Samplers Signature: [signature]

GEOSYNTEC CONSULTANTS

TEST PIT LOG

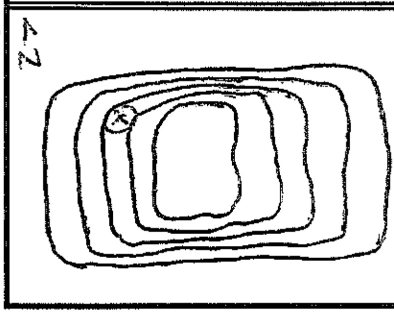
Project Name: IUC WMM
Project Number: SC0349-01-06
Site: C2S1

Test Pit ID: C2S1-(F)
Test Pit Width: ~15'
Test Pit Depth: ~10'
Equipment Used: CAT 426B HOE
Subcontractor: NA

Date: EXC: 10 NOV 05, LOGGED 11 NOV 05
Weather: 10 NOV: MS, 11 NOV: OC, TS
Test Pit Logged By: CB
Samples Collected by: CB

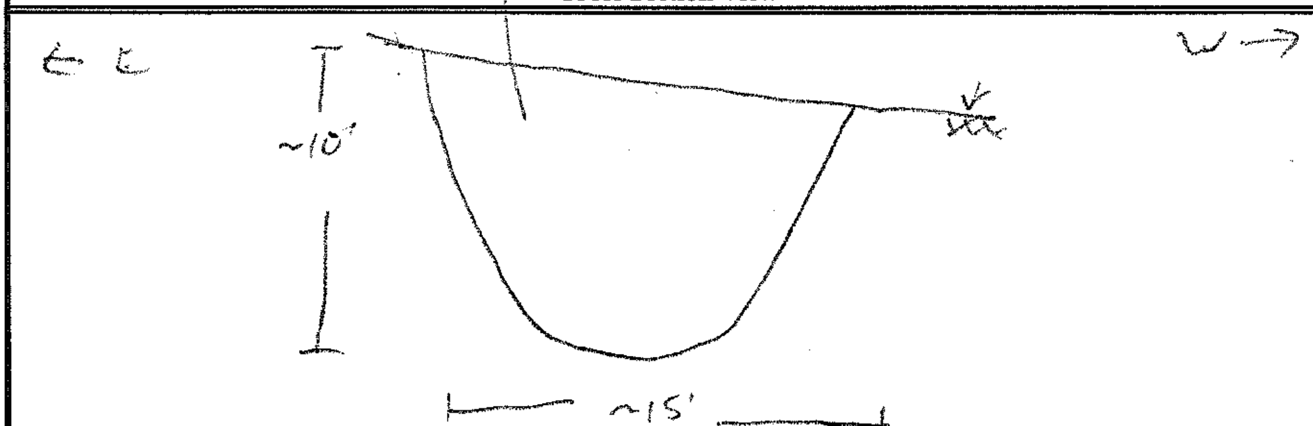
Depth to Water (ft): NA
Immiscible Layer: ~~Y / N~~
Start/Stop Time:

Sketch of Test Pit Location



Depth (ft)	Description ~~CLAY~~ SAND (CB)	PID (ppm)	Sample ID/Comments
0 - ~10'	TANNISH BROWN ~~CLAY~~ SAND W/ FINES AND SANDSTONE. SEMI-MOIST. ROUGH SIDEWALLS. EASILY EXCAVATED. SOME GRAY PIECES OF SANDSTONE		

Cross Section View



Samplers Signature: [signature]

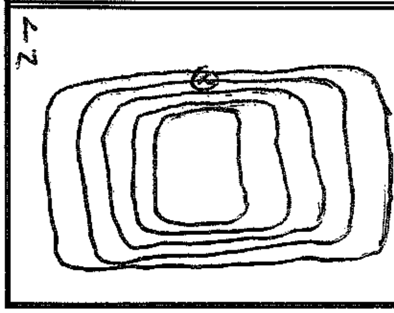
GEOSYNTEC CONSULTANTS

TEST PIT LOG

Project Name: SCC IVC WMM
Project Number: SC0349-01-06
Site:
Test Pit ID: C2S1-6
Test Pit Width: ~10'
Test Pit Depth: ~10'
Equipment Used: ~~CAT 426 HOE~~ → LOADER
Subcontractor: NA

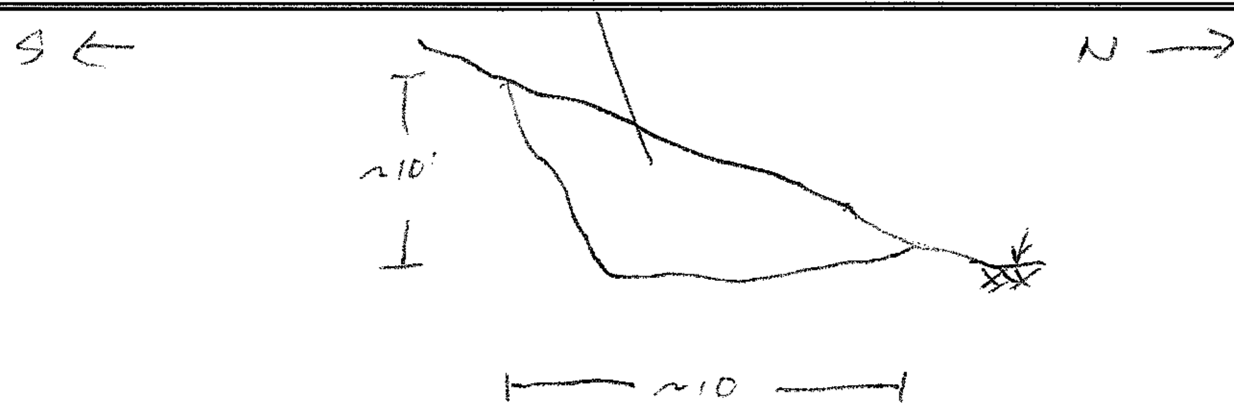
Date: 11 NOV 05
Weather: OVRCST, T-STORM
Test Pit Logged By: CB
Samples Collected by: CB
Depth to Water (ft): NA
Immiscible Layer: ~~Y / N~~
Start/Stop Time:

Sketch of Test Pit Location



Depth (ft)	Description	PID (ppm)	Sample ID/Comments
0 - ~10'	TANNISH BROWN SAND W/ FINES. ~~NO~~ (FEW) LITTLE SANDSTONE OBSERVED. ~~SA~~ SEMI-MOIST. SOME LENSES OF ~~RE~~ PINK CLAY. EASILY EXCAVATED. * WAS EXCAVATED W/ LOADER.		

Cross Section View



Samplers Signature: [signature]

GeoSyntec Consultants

SOIL SAMPLE LOG

PROJECT: IUC WHITE MESA MILL

LOCATION: BLANDING, UTAH   PROJECT NO.: SC0349   TASK NO.: 01-06

DESCRIPTION: CLAY STOCKPILE SAMPLING   YEAR: 2005

MATERIAL TYPE: CLAY/SAND

SITE SAMPLE NO.	OFF-SITE LAB SAMPLE NO.	VISUAL DESCRIPTION	SOURCE (LOCATION/DEPTH)	DATE SAMPLED (day/mo)	TEST METHODS	QA ID
C1S1-A		BROWNISH RED, CLAY		10 NOV		CB
B		REDDISH, TAN (CB) ~~BROWNISH RED~~ SAND W/FINES				CB
C		REDDISH BROWN CLAY	OBTAINED FROM SEV. PLACES IN EXCAVATED PILE FOR OFF-SITE LAB TESTING			CB
D		BROWN AND REDDISH BROWN CLAY.				CB
E		RED CLAY	OBTAINED SAMPLE C1S1 PER METHOD FOR (C) (CB)			CB
F		REDDISH BROWN SAND; BROWN SAND				CB
G		REDDISH TAN SAND, TANNISH RED CLAY	OBTAINED SAMPLE C1S2 PER METHOD FOR (C)			CB
H		REDDISH BROWN CLAY				CB
I		REDDISH TAN CLAY, REDDISH BROWN CLAY				CB
~~C1S2~~ (CB)						CB
C2S1-A		BROWN SAND, FINES, SANDSTONE FRAGMENTS				CB
B		BROWN SAND W/FINES		11 NOV		CB
C		BROWNISH TAN SAND (CB) W/FINES. SOME CLAY?	OBTAIN SAMPLE PER SAME METHOD AS C1S1-(C)			CB
D		PINK SAND, BROWN SAND, BROWNISH TAN SAND				CB

COMMENTS:

GeoSyntec Consultants

SOIL SAMPLE LOG

PROJECT: IUC WHITE MESA MILL

LOCATION: BLANDING, UTAH PROJECT NO.: SC0349 TASK NO.: 01-06

DESCRIPTION: CLAY STOCKPILE SAMPLING YEAR: 2005

MATERIAL TYPE: CLAY / SAND

SITE SAMPLE NO.	OFF-SITE LAB SAMPLE NO.	VISUAL DESCRIPTION	SOURCE (LOCATION/DEPTH)	DATE SAMPLED (day/mo)	TEST METHODS	QA ID
C2S1-E		TANNISH BROWN SAND		11 NOV		CB
F		TANNISH BROWN SAND	OBTAIN SAMPLE PER SAME METHOD AS C1S1-C	↓		CB
G		TANNISH BROWN SAND	↓	↓		CB
RFSS1-A		TANNISH BROWN CLAY		↓		CB
RFSS1-B		TANNISH BROWN CLAY		↓		CB

COMMENTS:

GeoSyntec Consultants

LABORATORY TEST REQUEST

PROJECT: IUC WHITE MESA MILL PROJECT NO.: SC0349 TASK NO. 01-06

SOURCE: ON-SITE CLAY STOCKPILES APPLICATION: ____ LAB SAMPLE NO.: ____

SHIPPER: UPS REQUESTED BY: CHAD BIRD DATE: ____ SITE SAMPLE ID.: C1S1-A ~~→ I~~, C, E, G; C2S1-C, F, G; RFS-S1-A, B

TASK	AS RECEIVED MOISTURE CONTEST ASTM D 2216 (%)	PERCENT PASSING NO. 200 ASTM D 1140 (%)	GRAIN SIZE ASTM D 422: SIEVE	GRAIN SIZE ASTM D 422: HYDROMETER	ATTEBERG LIMITS ASTM D 4318: LL (%)	ATTEBERG LIMITS ASTM D 4318: PL (%)	ATTEBERG LIMITS ASTM D 4318: PI ( )	SOIL CLASSIFICATION ASTM D 2487	LOI ASTM C 311 (%)	CARBO CONT. ASTM D3042 (%)	COMPACTION ASTM D 698 ☐ / ASTM D 1557 ☒; A B C D ASTM D 4710: MAX DRY UNIT WT. (pcf)	COMPACTION: OPT. MOIST. CONT. (%)	HYDRAULIC CONDUCTIVITY ASTM D 5084 ☒ / ASTM D 2434 ☐; TUBE SAMPLE ☐ / REMOLDED SAMPLE ☒; REL.COMP= ____% W=W$_{opt}$ ____(%); γ_d= ____ (pcf); W= ____(%): DRY UNIT WT. (pcf)	MOIST. CONT. (%)	K (cm/sec) at σ'_c = ____(psi) i= ____	
			✓		✓	✓	✓				✓		✓			

DEADLINE												

REMARKS: PERFORMANCE TEST ☐ CONFORMANCE TEST ☐

PLEASE HOLD C2S1-C, F, + G UNTIL/UNLESS DIRECTED TO TEST.

DISTRIBUTE RESULTS TO: GEOSYNTEC (GTC) CLIENT ____ SITE ____ OFFICE

 FILE NO. 2-23-LTR

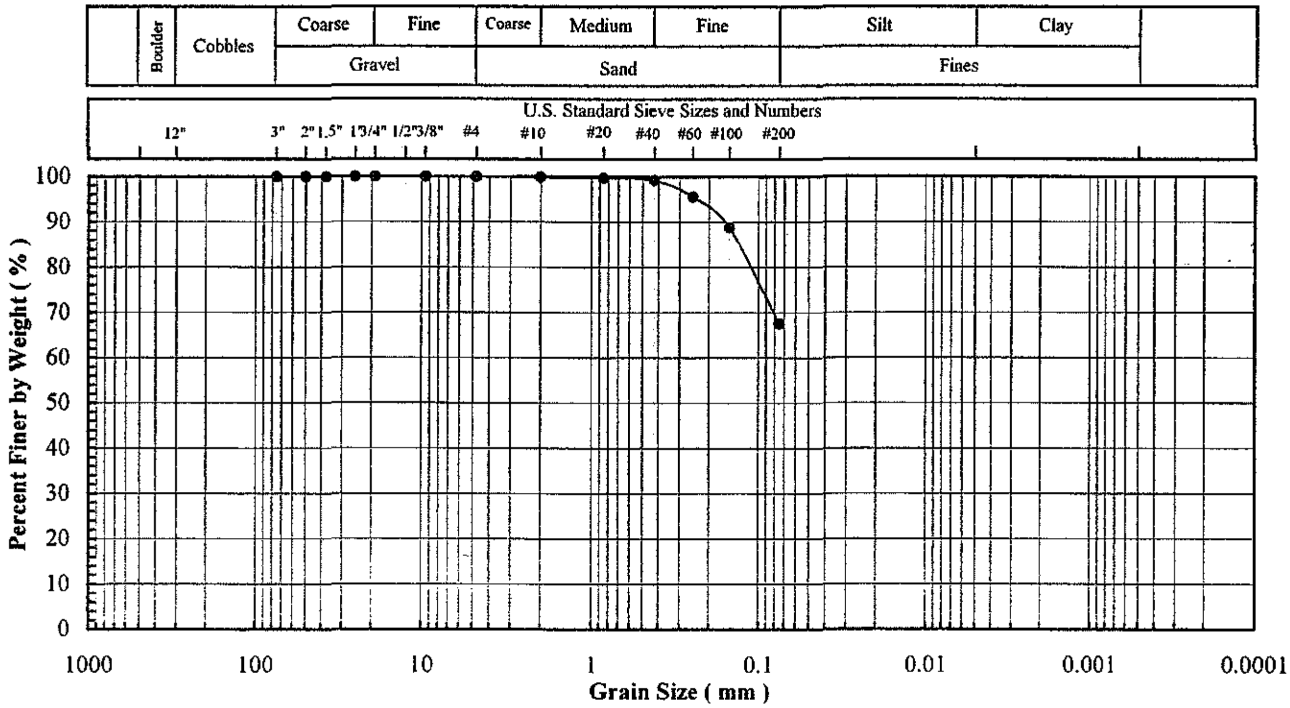
Excel Geotechnical Testing
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

Project Name: IUC White Mesa Mill
Project No: 165
Site Sample ID: C1S1-C
Lab Sample No: K236

ASTM D 2216, D 1140, D 422, D 854, C136

SOIL INDEX PROPERTIES

Moisture Content, Grain Size, Atterberg Limits, Classification



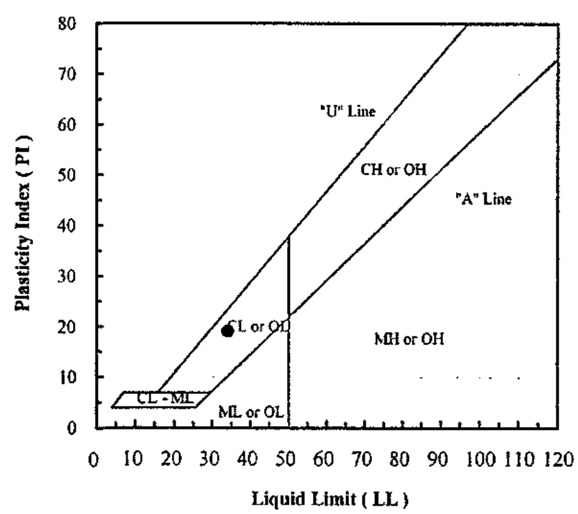
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.00	99.9
#20	0.850	99.7
#40	0.425	99.2
#60	0.250	95.6
#100	0.150	88.8
#200	0.075	67.6

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	
Sand (%):	32.4
Fines (%):	67.6
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
C1S1-C	K236	9.6	67.6	34	15	19	CL - Sandy lean clay

Note(s):

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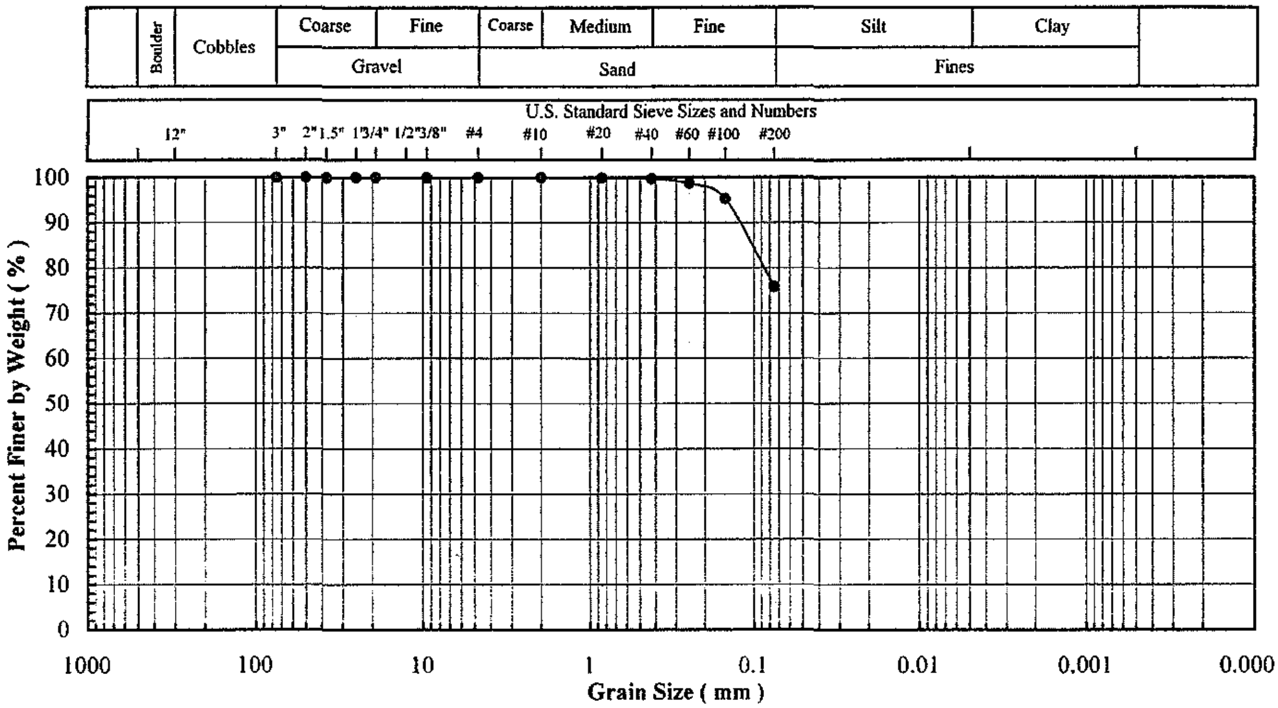
Project Name: IUC White Mesa Mill
Project No: 165
Site Sample ID: C1S1-E
Lab Sample No: K237

ASTM D 2216, D 1140, D 422, D 854, C136

SOIL INDEX PROPERTIES

Moisture Content, Grain Size, Atterberg Limits, Classification



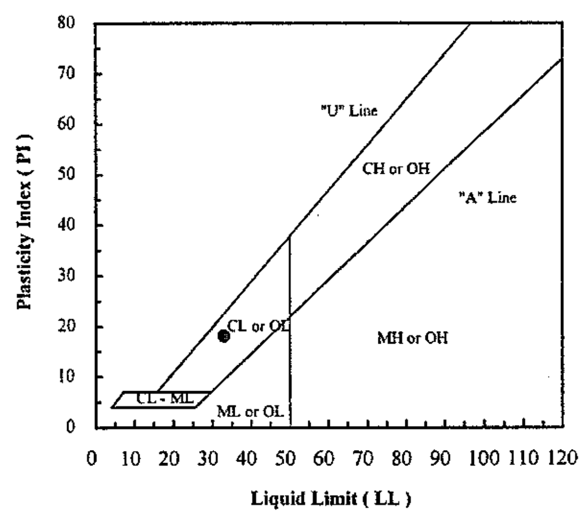
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.00	100.0
#20	0.850	99.9
#40	0.425	99.7
#60	0.250	98.7
#100	0.150	95.3
#200	0.075	75.9

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	
Sand (%):	24.1
Fines (%):	75.9
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
C1S1-E	K237	10.3	75.9	33	15	18	CL - Lean clay with sand

Note(s):

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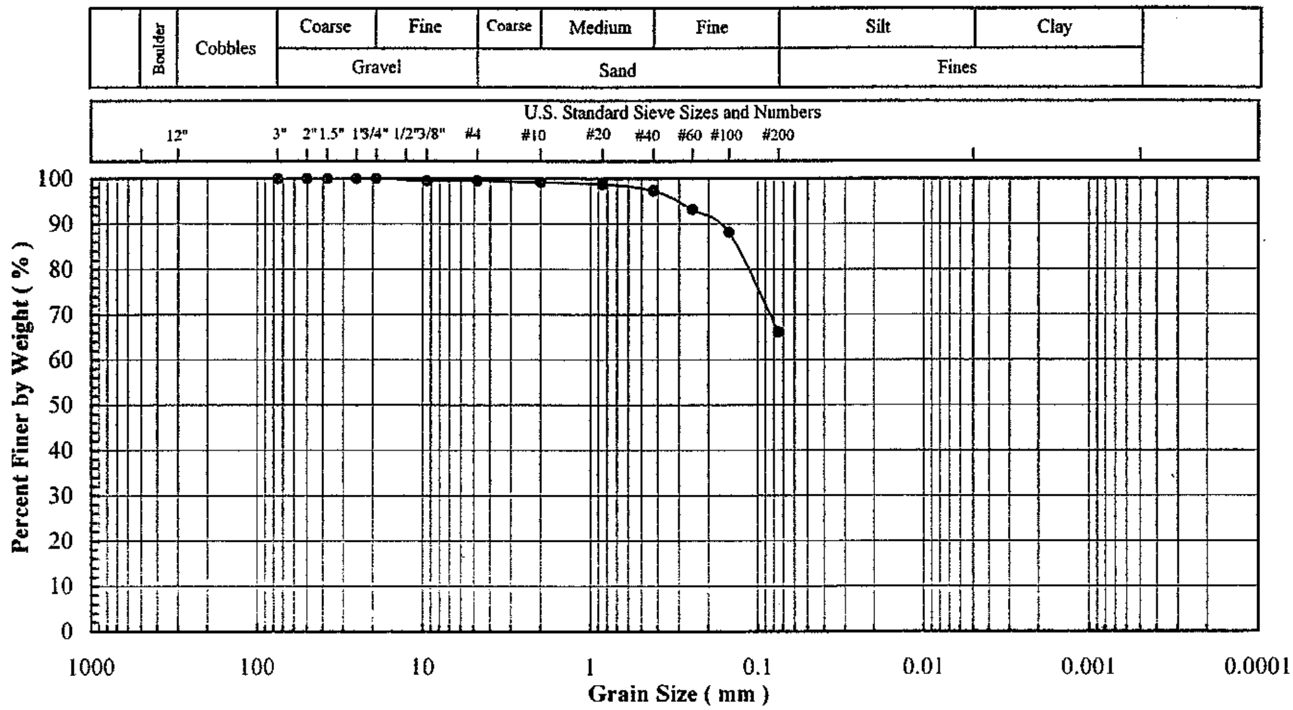
Project Name: IUC White Mesa Mill
Project No: 165
Site Sample ID: C1S1-G
Lab Sample No: K238

ASTM D 2216, D 1140, D 422, D 854, C136

SOIL INDEX PROPERTIES

Moisture Content, Grain Size, Atterberg Limits, Classification



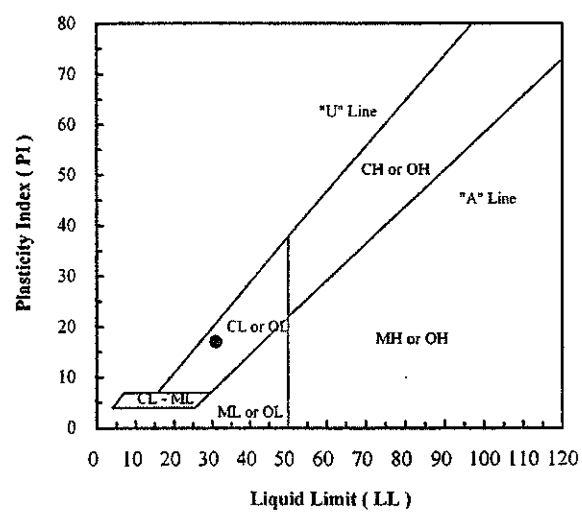
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	99.5
#4	4.75	99.5
#10	2.00	99.2
#20	0.850	98.8
#40	0.425	97.4
#60	0.250	93.2
#100	0.150	88.2
#200	0.075	66.2

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	0.5
Sand (%):	33.3
Fines (%):	66.2
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
C1S1-G	K238	8.0	66.2	31	14	17	CL - Sandy lean clay

Note(s):

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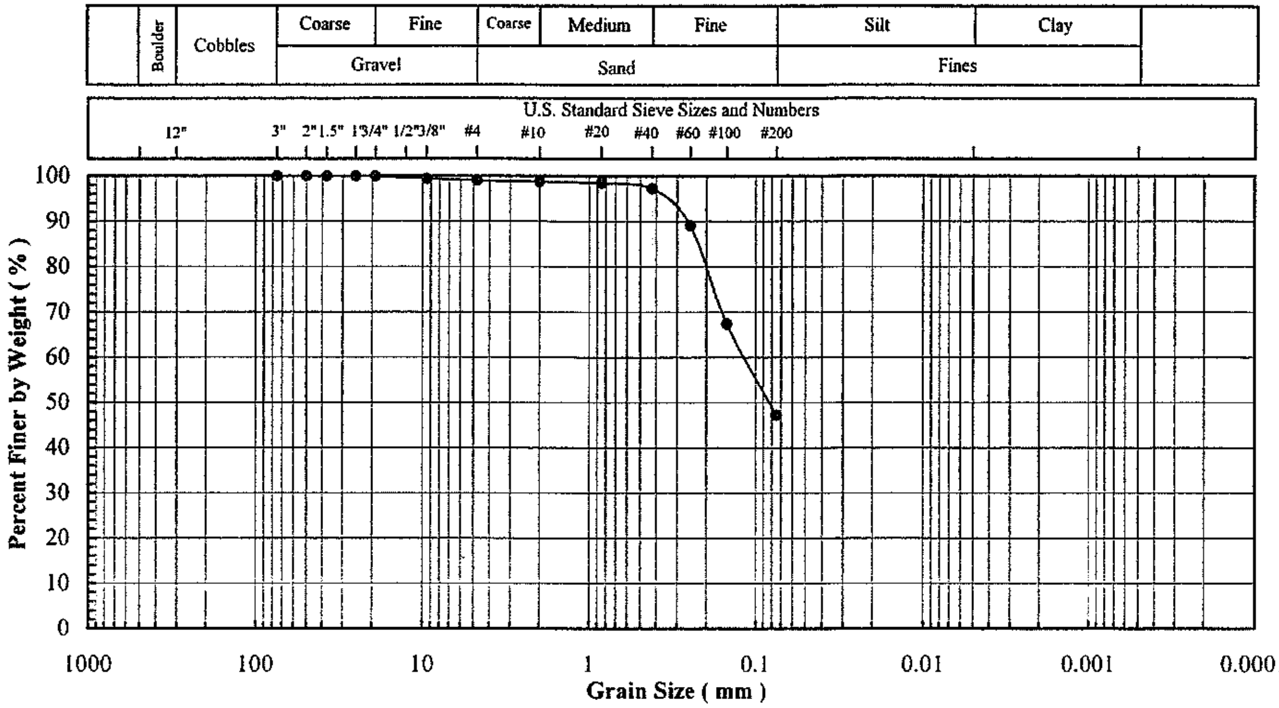
Project Name: IUC White Mesa Mill
Project No: 165
Site Sample ID: C2S1-C
Lab Sample No: K239

ASTM D 2216, D 1140, D 422, D 854, C136

SOIL INDEX PROPERTIES

Moisture Content, Grain Size, Atterberg Limits, Classification



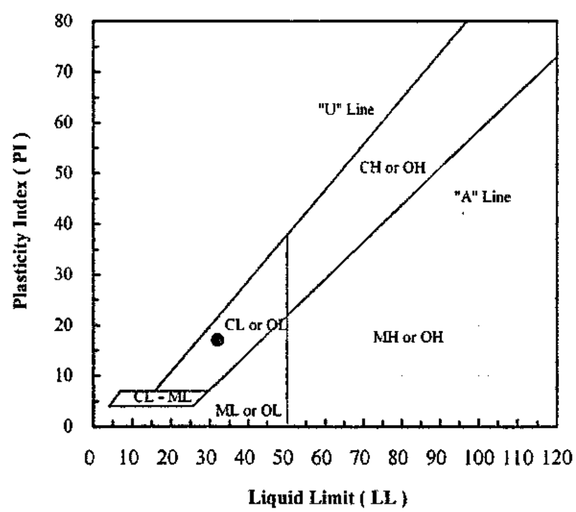
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	99.4
#4	4.75	99.1
#10	2.00	98.8
#20	0.850	98.5
#40	0.425	97.3
#60	0.250	89.1
#100	0.150	67.4
#200	0.075	47.3

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	0.9
Sand (%):	51.8
Fines (%):	47.3
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits			Engineering Classification
				LL (-)	PL (-)	PI (-)	
C2S1-C	K239	8.5	47.3	32	15	17	CL - Sandy lean clay

Note(s):

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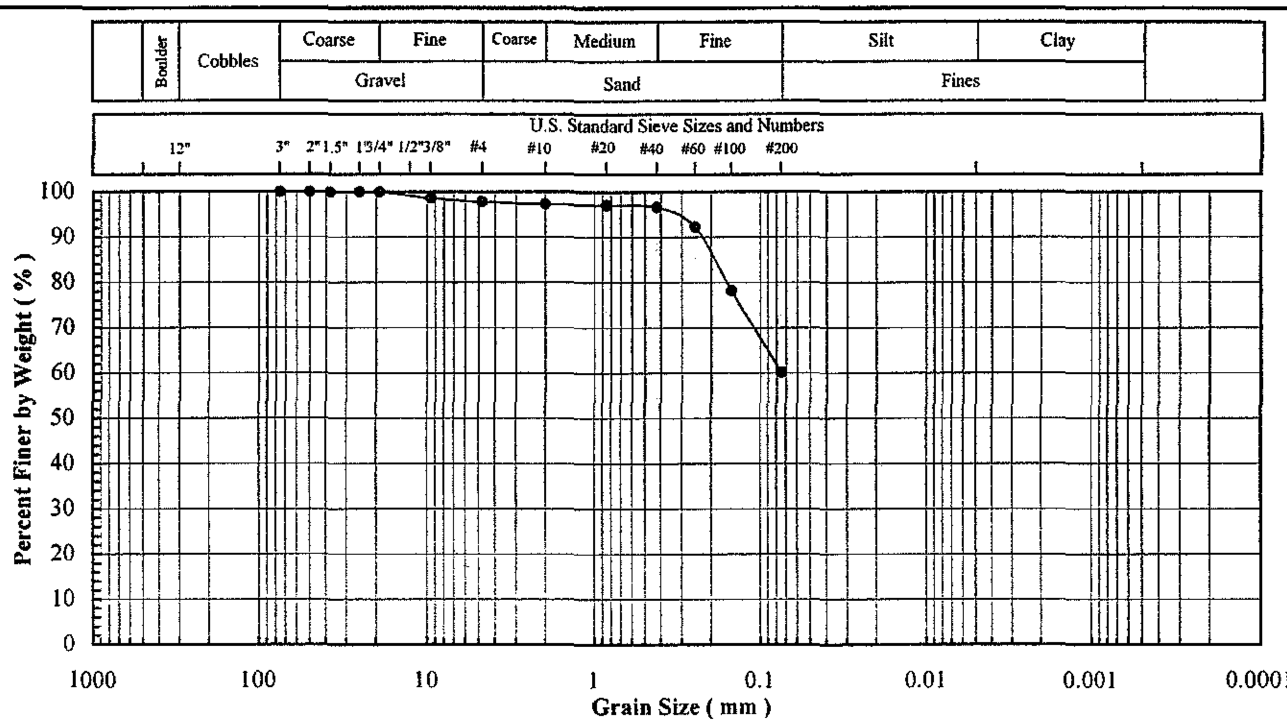
Project Name: IUC White Mesa Mill
Project No: 165
Site Sample ID: C2S1-F
Lab Sample No: K240

ASTM D 2216, D 1140, D 422, D 854, C136

SOIL INDEX PROPERTIES

Moisture Content, Grain Size, Atterberg Limits, Classification



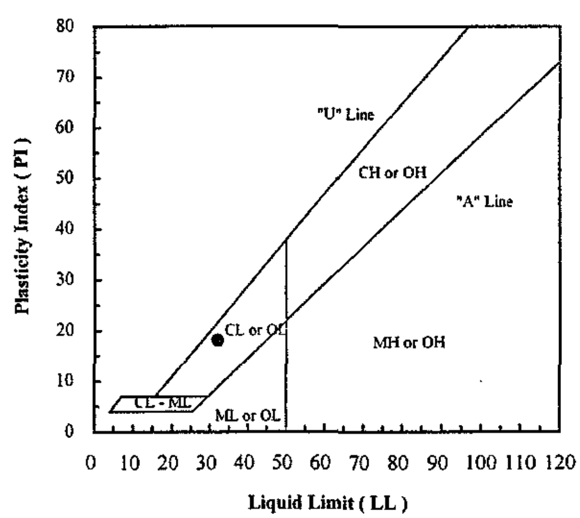
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	98.6
#4	4.75	97.8
#10	2.00	97.3
#20	0.850	97.1
#40	0.425	96.7
#60	0.250	92.3
#100	0.150	78.2
#200	0.075	60.2

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	2.2
Sand (%):	37.6
Fines (%):	60.2
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
C2S1-F	K240	8.4	60.2	32	14	18	CL - Sandy lean clay

Note(s):

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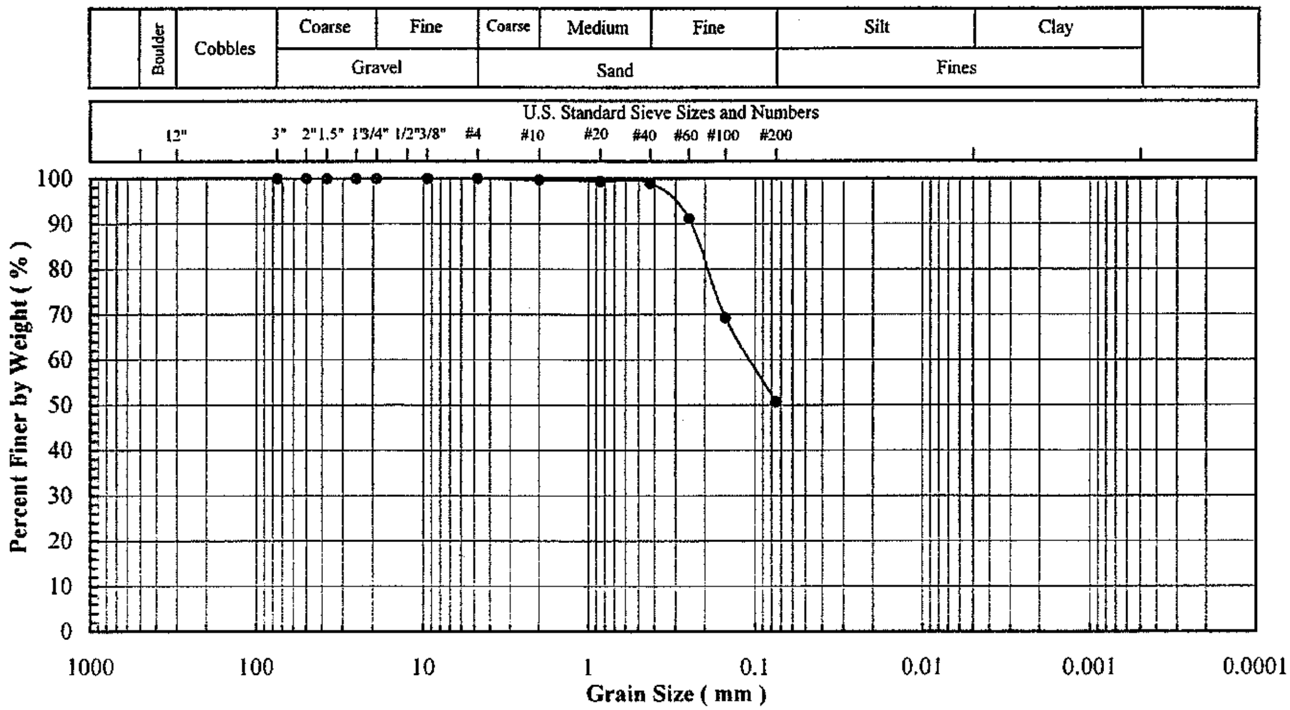
Project Name: IUC White Mesa Mill
Project No: 165
Site Sample ID: C2S1-G
Lab Sample No: K241

ASTM D 2216, D 1140, D 422, D 854, C136

SOIL INDEX PROPERTIES

Moisture Content, Grain Size, Atterberg Limits, Classification



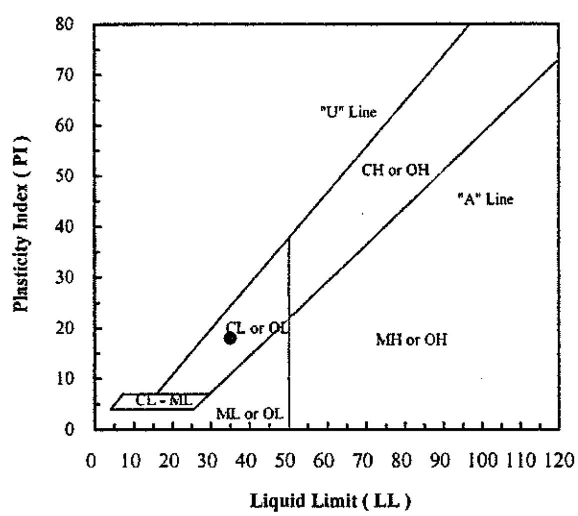
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.00	99.7
#20	0.850	99.4
#40	0.425	99.0
#60	0.250	91.2
#100	0.150	69.3
#200	0.075	50.7

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	
Sand (%):	49.3
Fines (%):	50.7
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
C2S1-G	K241	9.9	50.7	35	17	18	CL - Sandy lean clay

Note(s):

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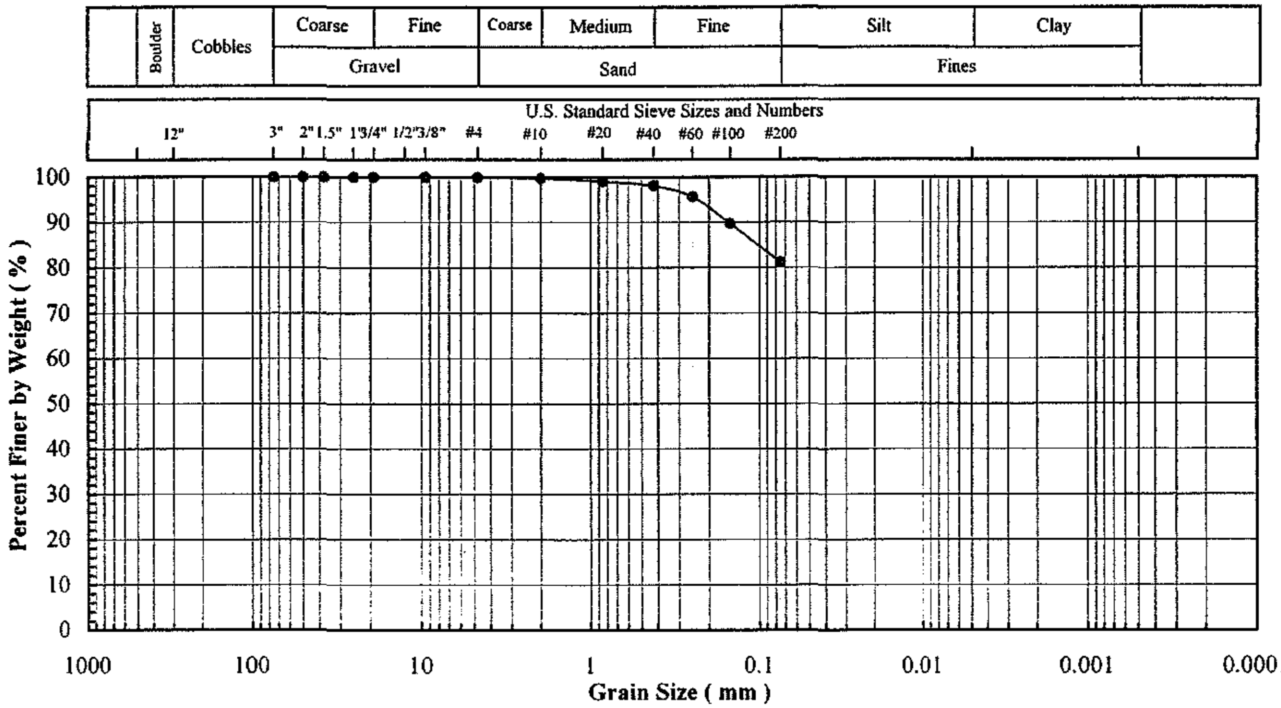
Project Name: IUC White Mesa Mill
Project No: 165
Site Sample ID: RF5-S1-A
Lab Sample No: K242

ASTM D 2216, D 1140, D 422, D 854, C136

SOIL INDEX PROPERTIES

Moisture Content, Grain Size, Atterberg Limits, Classification



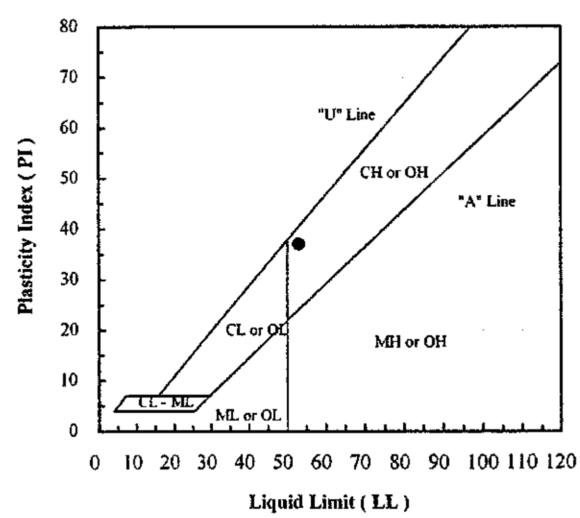
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	99.9
#10	2.00	99.7
#20	0.850	99.1
#40	0.425	98.1
#60	0.250	95.7
#100	0.150	89.7
#200	0.075	81.2

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	0.1
Sand (%):	18.7
Fines (%):	81.2
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
RF5-S1-A	K242	9.9	81.2	53	16	37	CH - Fat clay with sand

Note(s):

Excel Geotechnical Testing

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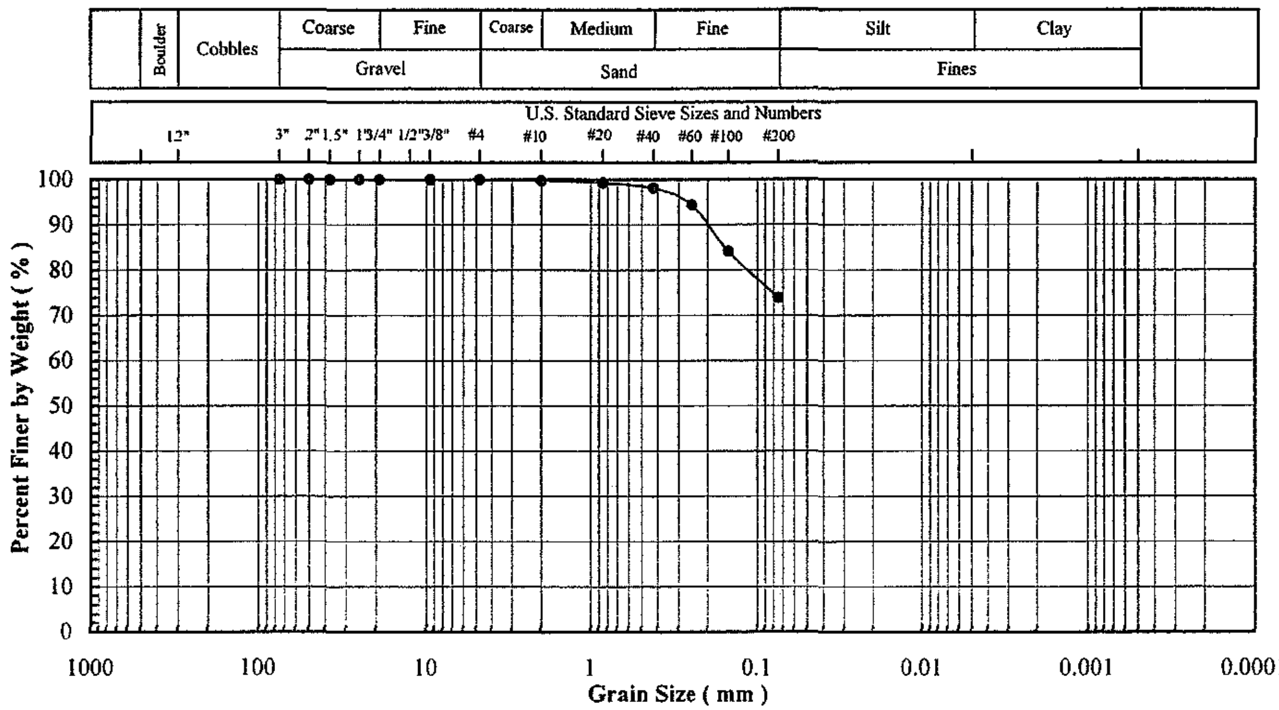
Project Name: IUC White Mesa Mill
Project No: 165
Site Sample ID: RF5-S1-B
Lab Sample No: K243

ASTM D 2216, D 1140, D 422, D 854, C136

SOIL INDEX PROPERTIES

Moisture Content, Grain Size, Atterberg Limits, Classification



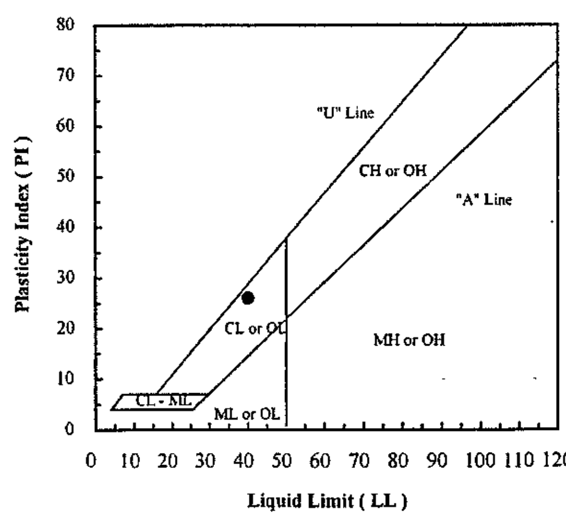
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.00	99.7
#20	0.850	99.3
#40	0.425	98.1
#60	0.250	94.4
#100	0.150	84.2
#200	0.075	73.9

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	
Sand (%):	26.1
Fines (%):	73.9
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
RF5-S1-B	K243	9.6	73.9	40	14	26	CL - Lean clay with sand

Note(s):

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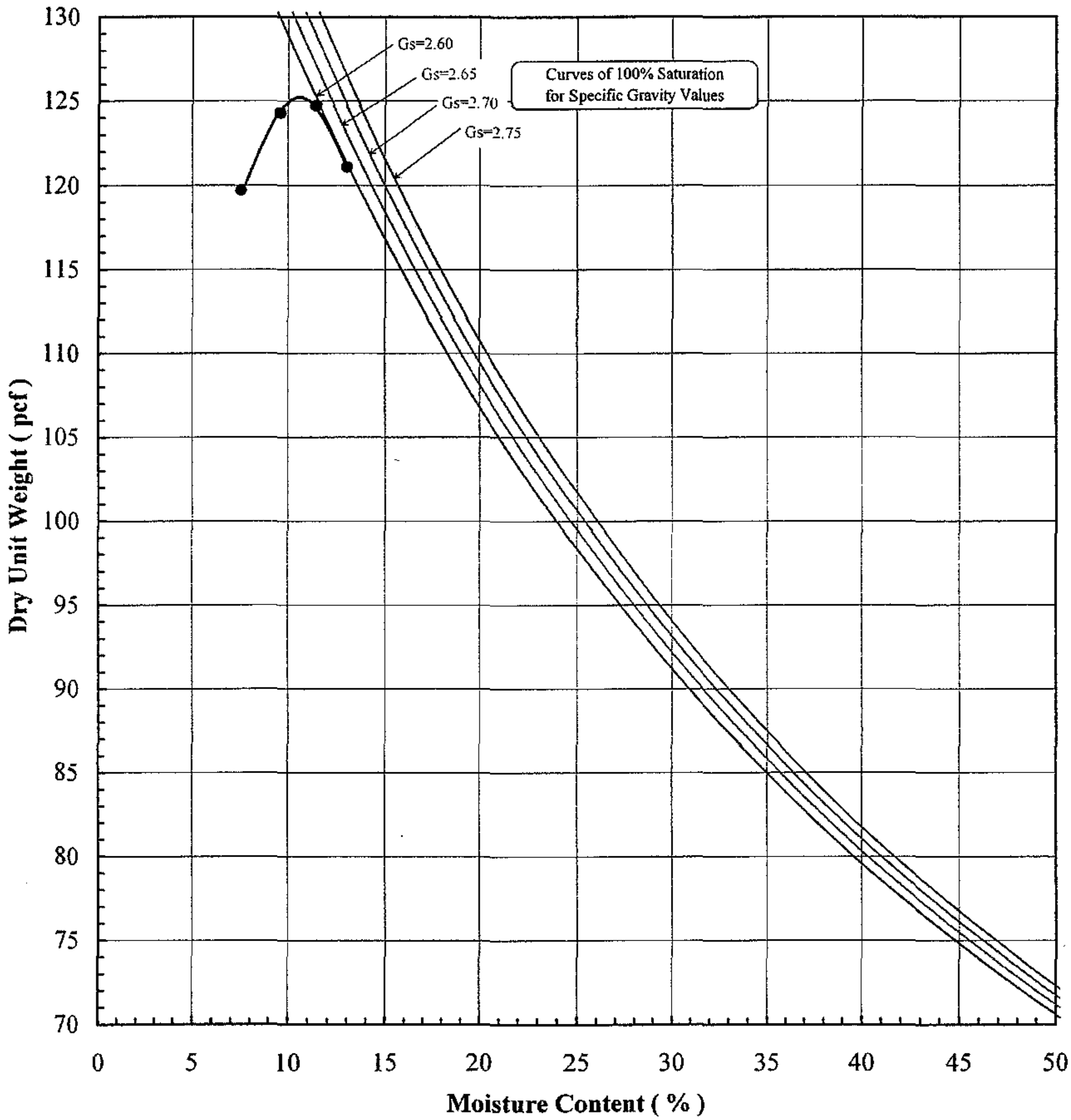
Project Name:	IUC White Mesa Mill
Project No:	165
Client Sample ID:	Mix 1*
Lab Sample No:	K265

ASTM D 1557 **COMPACTION MOISTURE-DENSITY RELATIONSHIP** **Modified - Method B**



Client/Site Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Remarks
Mix 1*	K265	125.4	10.4	

Note(s):

* A mixture of equal volumes of C1S1-C, C1S1-E and C1S1-G.

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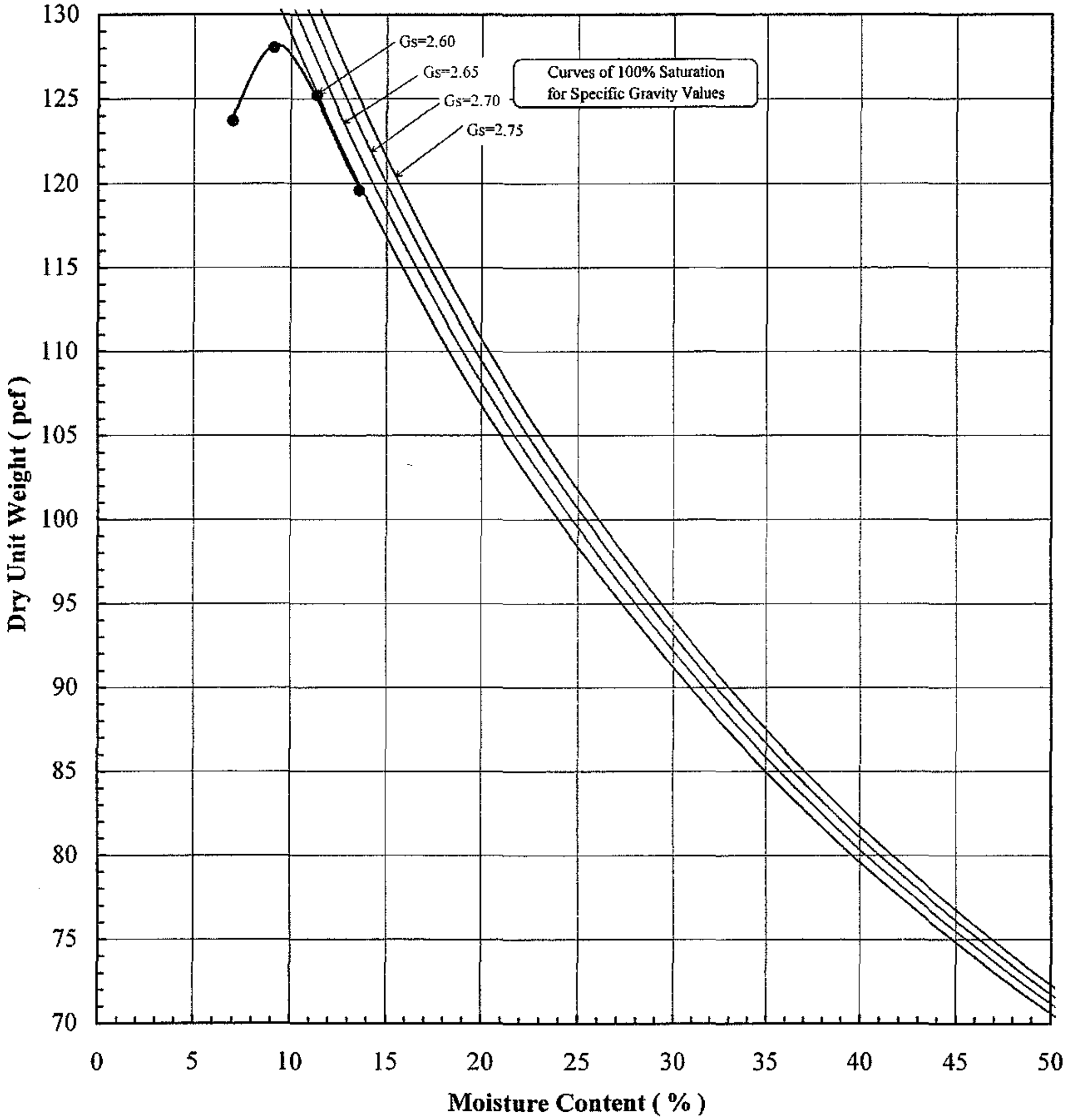
Project Name:	IUC White Mesa Mill
Project No:	165
Client Sample ID:	Mix 2*
Lab Sample No:	K266

ASTM D 1557 **COMPACTION MOISTURE-DENSITY RELATIONSHIP** Modified - Method B



Client/Site Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Remarks
Mix 2*	K266	128.7	9.5	

Note(s):

* A mixture of equal volumes of C2S1-C, C2S1-F and C2S1-G.

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FLEXIBLE WALL PERMEABILITY TEST (1)

ASTM D 5084 *

Project Name:	IUC White Mesa Mill
Project Number:	165
Client Name:	GeoSyntec Consultants
Site Sample ID:	Mix 2* (See Note 2)
Lab Sample Number:	K266
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	11/27/2005

Specimen	Test Specimen Initial Condition					Test Conditions					Hydraulic
No.	Spec. Prep. (3) (-)	Spec. Length (cm)	Spec. Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Permeant Liquid (4) (-)	Average Gradient (-)	Conductivity (cm/s)
1	R	5.99	7.21	118.4	14.6	90.0	60.0	30.0	DTW	23	3.2E-8

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. * A mixture of equal volumes of C2S1-C, C2S1-F and C2S1-G.
3. Specimen preparation: ST = Shelby Tube, R = Remolded, B = Block Sample.
4. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:
Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

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FLEXIBLE WALL PERMEABILITY TEST (1)

ASTM D 5084 *

Project Name:	IUC White Mesa Mill
Project Number:	165
Client Name:	GeoSyntec Consultants
Site Sample ID:	Mix 1* (See Note 2)
Lab Sample Number:	K265
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	11/27/2005

Specimen	Test Specimen Initial Condition					Test Conditions					Hydraulic
	Spec.	Spec.	Spec.	Dry Unit	Moisture	Cell	Back	Consolid.	Permeant	Average	Conductivity
No.	Prep. (3)	Length	Diameter	Weight	Content	Press.	Press.	Press.	Liquid (4)	Gradient	
	(-)	(cm)	(cm)	(pcf)	(%)	(psi)	(psi)	(psi)	(-)	(-)	(cm/s)
1	R	5.95	7.24	115.8	12.7	90.0	60.0	30.0	DTW	15	4.7E-7

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. * A mixture of equal volumes of C1S1-C, C1S1-E and C1S1-G.
3. Specimen preparation: ST = Shelby Tube, R = Remolded, B = Block Sample.
4. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

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FLEXIBLE WALL PERMEABILITY TEST (1)
ASTM D 5084 *

Project Name:	IUCW White Mesa Mill
Project Number:	165
Client Name:	GeoSyntec Consultants
Site Sample ID:	Mix 1* (See Note 2)
Lab Sample Number:	K265
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	11/27/2005

Specimen	Test Specimen Initial Condition					Test Conditions					Hydraulic
No.	Spec. Prep. (3) (-)	Spec. Length (cm)	Spec. Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Permeant Liquid (4) (-)	Average Gradient (-)	Conductivity (cm/s)
1	R	5.91	7.24	114.6	15.6	90.0	60.0	30.0	DTW	23	2.1E-8

Notes:
1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. * A mixture of equal volumes of C1S1-C, C1S1-E and C1S1-G.
3. Specimen preparation: ST = Shelby Tube, R = Remolded, B = Block Sample.
4. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:
Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

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FLEXIBLE WALL PERMEABILITY TEST (1)

ASTM D 5084 *

Project Name:	IUC White Mesa Mill
Project Number:	165
Client Name:	GeoSyntec Consultants
Site Sample ID:	Mix 2* (See Note 2)
Lab Sample Number:	K266
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	11/27/2005

Specimen	Test Specimen Initial Condition					Test Conditions					Hydraulic
No.	Spec. Prep. (3) (-)	Spec. Length (cm)	Spec. Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Permeant Liquid (4) (-)	Average Gradient (-)	Conductivity (cm/s)
1	R	5.97	7.23	118.6	11.7	90.0	60.0	30.0	DTW	22	5.7E-7

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. * A mixture of equal volumes of C2S1-C, C2S1-F and C2S1-G.
3. Specimen preparation: ST = Shelby Tube, R = Remolded, B = Block Sample.
4. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:
Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

Excel Geotechnical Testing
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

FLEXIBLE WALL PERMEABILITY TEST [1]
ASTM D 5084 *

Project Name:	IUC White Mesa Mill
Project Number:	165
Client Name:	GeoSyntec Consultants
Site Sample ID:	Mix 3* (See Note 2)
Lab Sample Number:	K267
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	11/27/2005

Specimen	Test Specimen Initial Condition					Test Conditions					Hydraulic
No.	Spec. Prep. [3] (-)	Spec. Length (cm)	Spec. Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Permeant Liquid [4] (-)	Average Gradient (-)	Conductivity (cm/s)
1	R	5.97	7.25	116.9	13.1	90.0	60.0	30.0	DTW	23	4.6E-8

Notes:
1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. * A mixture of equal volumes of RF5-S1-A and RF5-S1-B.
3. Specimen preparation: ST = Shelby Tube, R = Remolded, B = Block Sample.
4. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:
Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

Excel Geotechnical Testing
"Excellence in Testing"
941 Forrest Street, Roswell, Georgia 30075
Tel: (770) 650 1666 Fax: (770) 650 5786

FLEXIBLE WALL PERMEABILITY TEST [1]
ASTM D 5084 *

Project Name:	IUC White Mesa Mill
Project Number:	165
Client Name:	GeoSyntec Consultants
Site Sample ID:	Mix 3* (See Note 2)
Lab Sample Number:	K267
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	11/27/2005

Specimen	Test Specimen Initial Condition					Test Conditions					Hydraulic
No.	Spec. Prep. [3] (-)	Spec. Length (cm)	Spec. Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)	Cell Press. (psi)	Back Press. (psi)	Consolid. Press. (psi)	Permeant Liquid [4] (-)	Average Gradient (-)	Conductivity (cm/s)
1	R	5.93	7.23	115.5	17.3	90.0	60.0	30.0	DTW	23	3.3E-8

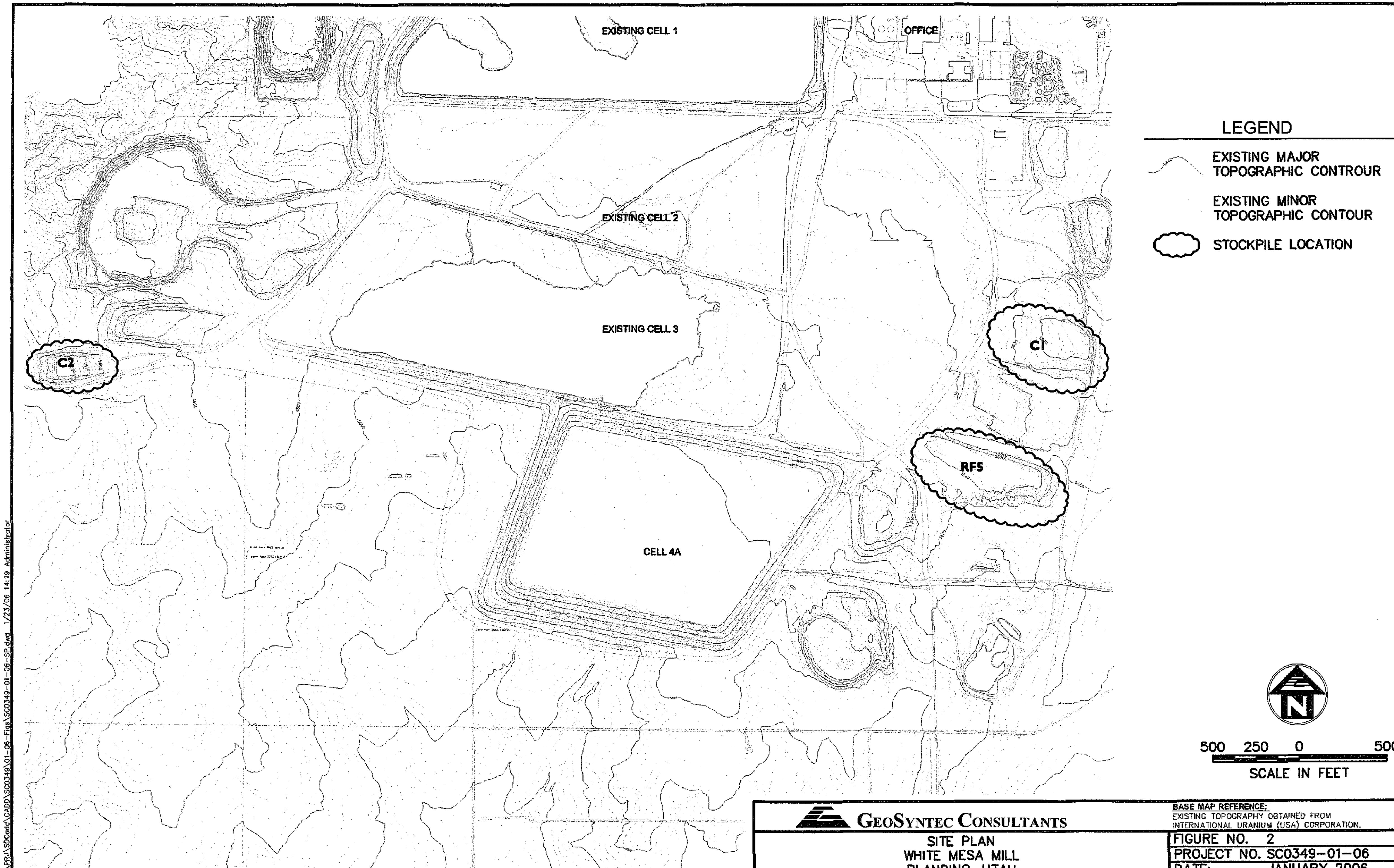
Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. * A mixture of equal volumes of RF5-S1-A and RF5-S1-B.
3. Specimen preparation: ST = Shelby Tube, R = Remolded, B = Block Sample.
4. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water

* Deviations:

Laboratory temperature at 22±3 °C.

Test specimen final conditions are not presented.



GEOSYNTEC CONSULTANTS

SITE PLAN
WHITE MESA MILL
BLANDING, UTAH

BASE MAP REFERENCE:
EXISTING TOPOGRAPHY OBTAINED FROM INTERNATIONAL URANIUM (USA) CORPORATION.

FIGURE NO. 2
PROJECT NO. SC0349-01-06
DATE: JANUARY 2006

APPENDIX A.1.5

ROGERS AND ASSOCIATES ENGINEERING CORP

1988

R
A
E
Rogers & Associates Engineering Corporation

Post Office Box 330
Salt Lake City, Utah 84110
(801) 263-1600

March 4, 1988

Mr. C.O.Sealy
Umetco Minerals Corporation
P.O. Box 1029
Grand Junction, CO 81502

C8700/22

Dear Mr. Sealy:

We have completed the tests ordered on the four samples shipped to us. The results are as follows:

Sample	Radium pCi/gm	Emanation Fraction	Diffusion Coeffic.	(g/cm^3) Density	Moisture	Saturation
Tailings	981±4	0.19±0.01	2.0E-02	1.45	13.2	0.39
			8.4E-03	1.44	19.1	0.56
Composite (2,3,&5)			1.6E-02	1.85	6.5	0.40
			4.5E-04	1.84	12.5	0.75
Site #1			1.6E-02	1.85	8.1	0.48
			1.4E-03	1.84	12.6	0.76
Site #4			1.1E-02	1.65	15.4	0.63
			4.2E-04	1.65	19.3	0.80

The samples will be shipped back to you in the next few weeks. If you have any questions regarding the results on the samples please feel free to call.

Sincerely,

Renee Y. Bowser

Renee Y. Bowser
Lab Supervisor

RYB/b

R
A
E

Rogers & Associates Engineering Corporation

Post Office Box 330
Salt Lake City, Utah 84110
(801) 263-1600

MAY 12 1988

May 9, 1988

Mr. C.O. Sealy
UMETCO Minerals Corporation
P.O. Box 1029
Grand Junction, CO 81502

C8700/22

Dear Mr. Sealy:

The tests for radium content and radon emanation coefficient in the following samples have been completed and the results are as follows:

Sample	Radium (pCi/g)	Radon Emanation Coefficient
Random (2,3 & 5)	1.9 ± 0.1	0.19 ± 0.04
Site 1	2.2 ± 0.1	0.20 ± 0.03
Site 4	2.0 ± 0.1	0.11 ± 0.04

If you have any questions regarding these results please feel free to call Dr. Kirk Nielson or me.

Sincerely,

Renee Y. Bowser
Lab Supervisor

RYB:ms

APPENDIX A.1.6

WESTERN COLORADO TESTING, INC.

1999a

The onsite random fill and clay stockpiles were sampled in characterized in a program detailed in the April 15, 1999, submittal to the NRC, "Additional Clarifications to the White Mesa Mill Reclamation Plan". A copy of this sampling and testing program are included in this Attachment as well as the results of the characterization work. The samples wee characterized for:

-- Classification
  - Grain size and sieve
  - Atterberg limits

-- Standard Proctor

The results of these tests for the onsite stockpiled material are included in this Attachment.

Soil Sampling and Testing Program – White Mesa Mill

The purpose of this Soil Sampling and Testing Program is to verify the soil classification, gradation and compaction characteristics (standard proctor) of the stockpiled random fill and clay materials that will be used for cover materials on the tailings cells at the White Mesa Mill. Additionally this program will verify the compaction characteristics and gradation of the random fill materials utilized in the platform fill previously placed on Cells 2 and 3.

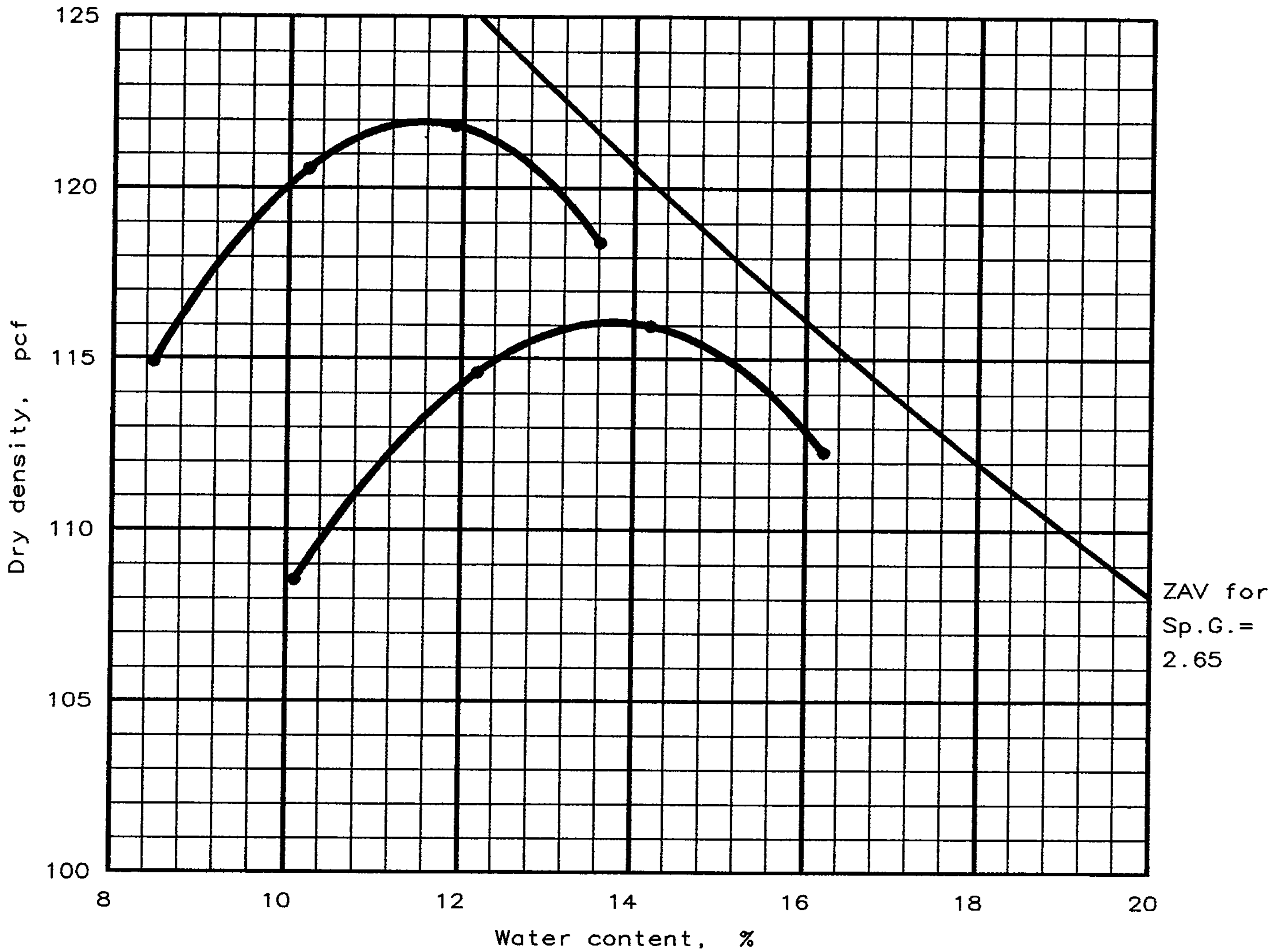
Sampling

Sampling will take place on each of six stockpiles of random fill (designated RF-1 through RF-6 on Exhibit A), two clay material stockpiles (C-1 and C-2 on Exhibit A), and on platform fill areas in Cells 2 & 3. A total of 9 samples will be taken from the random fill stockpiles. Two (2) samples will be taken from the clay stockpiles and three (3) samples will be taken from the covered areas of the cells. Samples will be taken from test pits excavated by a backhoe. Samples will be taken from a depth of 8 feet in stockpiles and from 2 foot depth in cells. One backhoe bucket full of material will be taken from the test pit at the specified depth and dumped separately. This sample will be quartered and one quarter will be screened to minus 2" (rocks over 8" will be removed prior to screening). Two five gallon sample buckets will be filled with sample randomly selected from the screened fraction. Oversized material remaining after the screening of the sample will be visually classified and then weighed. Sample locations will be indicated on a site map and sample descriptions will recorded and maintained in the facility's records. A total of fourteen samples will be submitted for testing during this program.

Testing

Samples will be packaged and shipped to a certified commercial testing laboratory for testing. Tests will be run on each sample for standard proctor (ASTM D698), particle size analysis (ASTM C117 and ASTM C136), soil classification (ASTM D2487) and plasticity index (Atterberg limits ASTM D4318).

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure B, Standard
Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in	% < No.200
	USCS	AASHTO						
			N/A %	2.65			16.1 %	

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 122.0 pcf Optimum moisture = 11.6 %	116.1 pcf 13.8 %	2-1-W Sand, clayey, grvly, brn

Project No.: 804899

Project: International Uranium Corporation

Location: Soil Sample Testing

Date: 5/3/99

Remarks:

SUBMITTED BY: Client

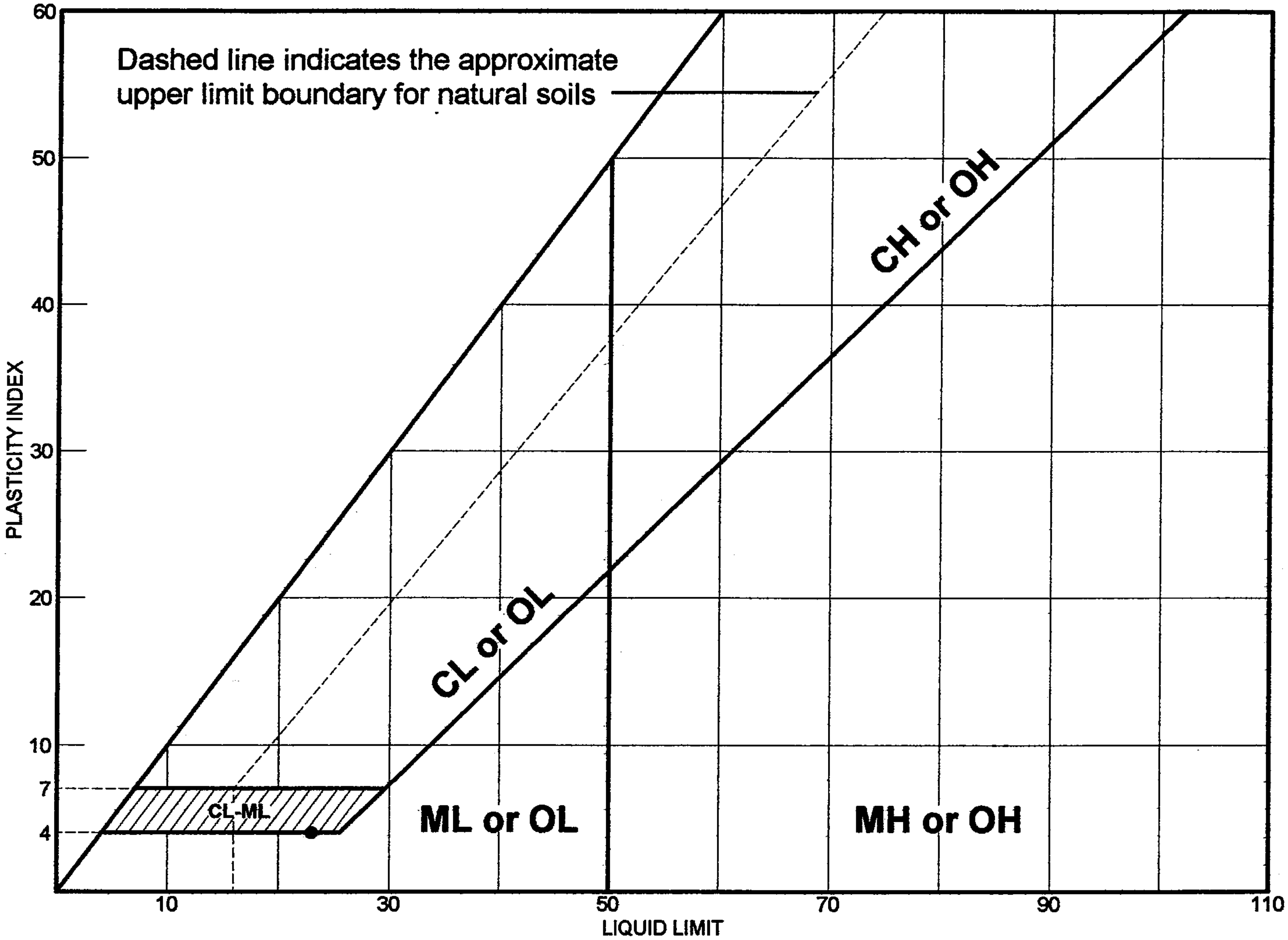
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST

WESTERN COLORADO TESTING, INC.

Fig. No. 7

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sand, very clayey, sl silty, red	23	19	4	56.9	25.1	SM

Project No. 804899 **Client:** International Uranium Corporation

Project: Soil Sample Testing

● **Source:** **Sample No.:** 2-1-W

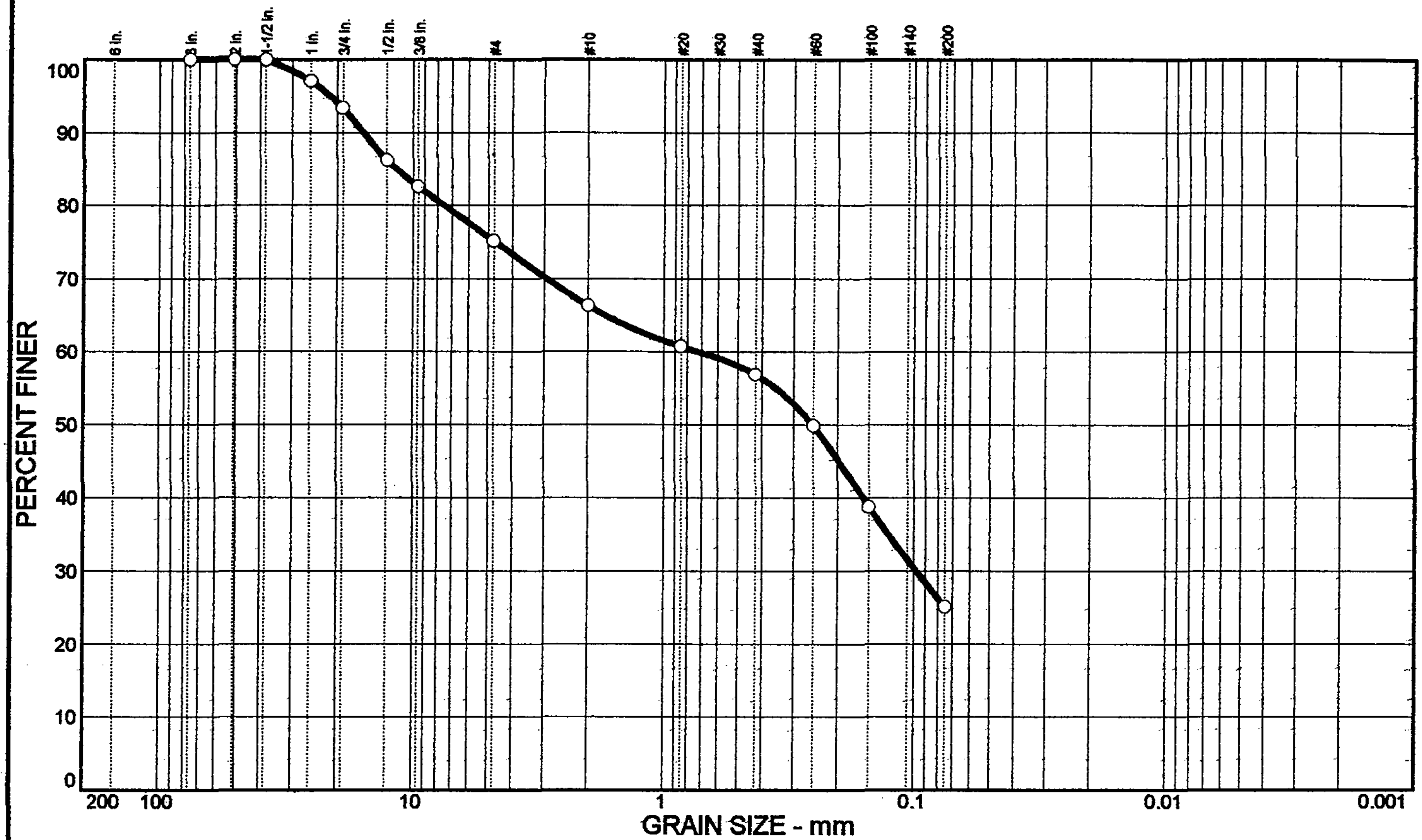
Remarks:
● Tested By: JH

LIQUID AND PLASTIC LIMITS TEST REPORT

WESTERN COLORADO TESTING, INC.

Figure 22

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		24.8	50.1			SM	A-2-4(0)	19	23

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	97.1		
3/4	93.4		
1/2	86.3		
3/8	82.6		
	GRAIN SIZE		
D_{60}	0.726		
D_{30}	0.0973		
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	75.2		
#10	66.3		
#20	60.7		
#40	56.9		
#60	49.9		
#100	38.8		
#200	25.1		

SOIL DESCRIPTION

○ Sand, very clayey, sl silty, red

REMARKS:

○ Tested By: JH

○ Source: Sample No.: 2-1-W

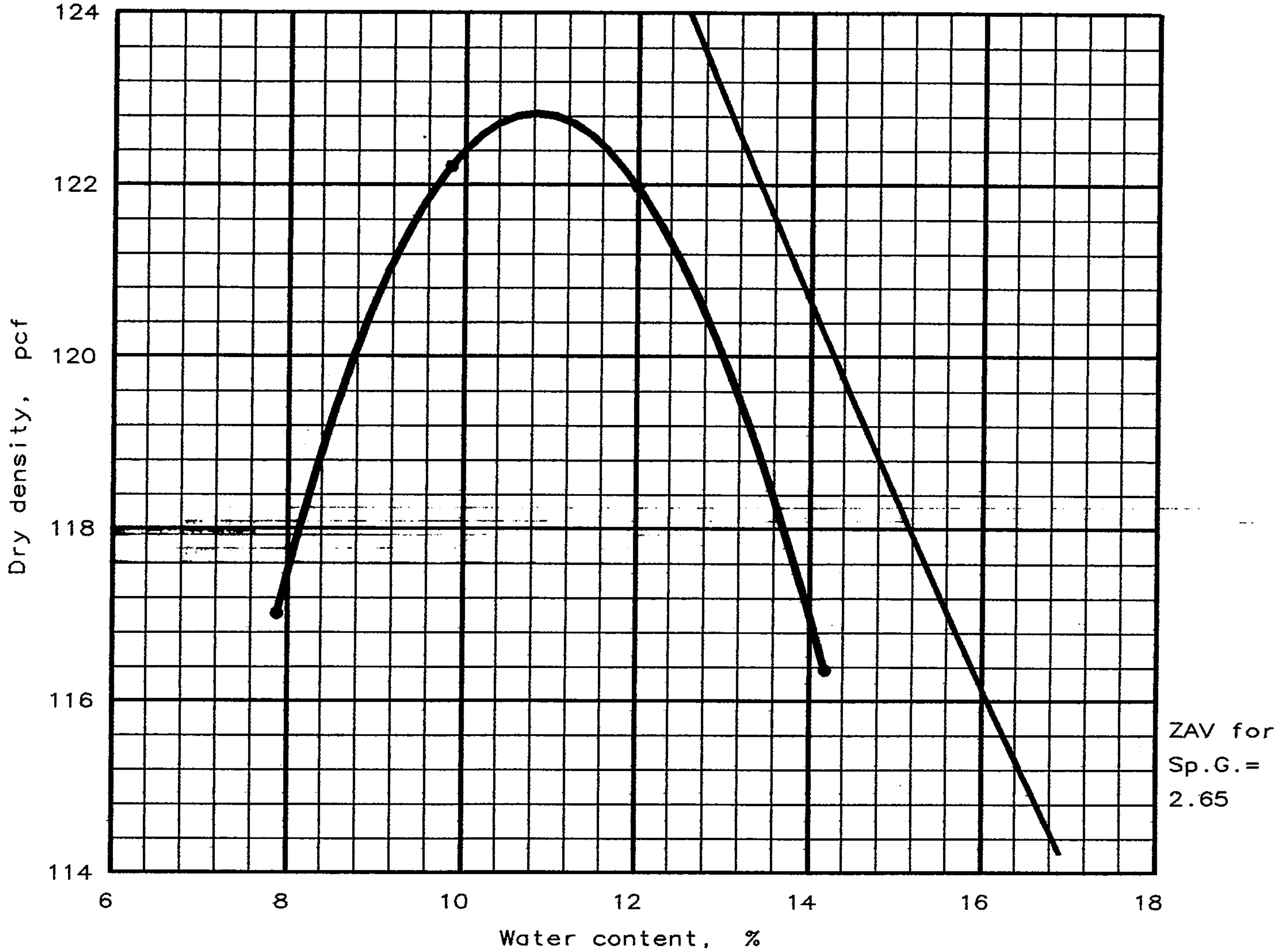
WESTERN COLORADO TESTING, INC.

Client: International Uranium Corporation

Project: Soil Sample Testing

Project No.: 804899 Figure 38

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure B, Standard
Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in	% < No.200
	USCS	AASHTO						
			N/A %	2.65			13.4 %	

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 122.8 pcf Optimum moisture = 10.8 %	122.8 pcf 10.8 %	2W-7C Sand, silty, gravely, br

Project No.: 804899

Project: International Uranium Corporation

Location: Soil Sample Testing

Date: 5/3/99

Remarks:

SUBMITTED BY: Client

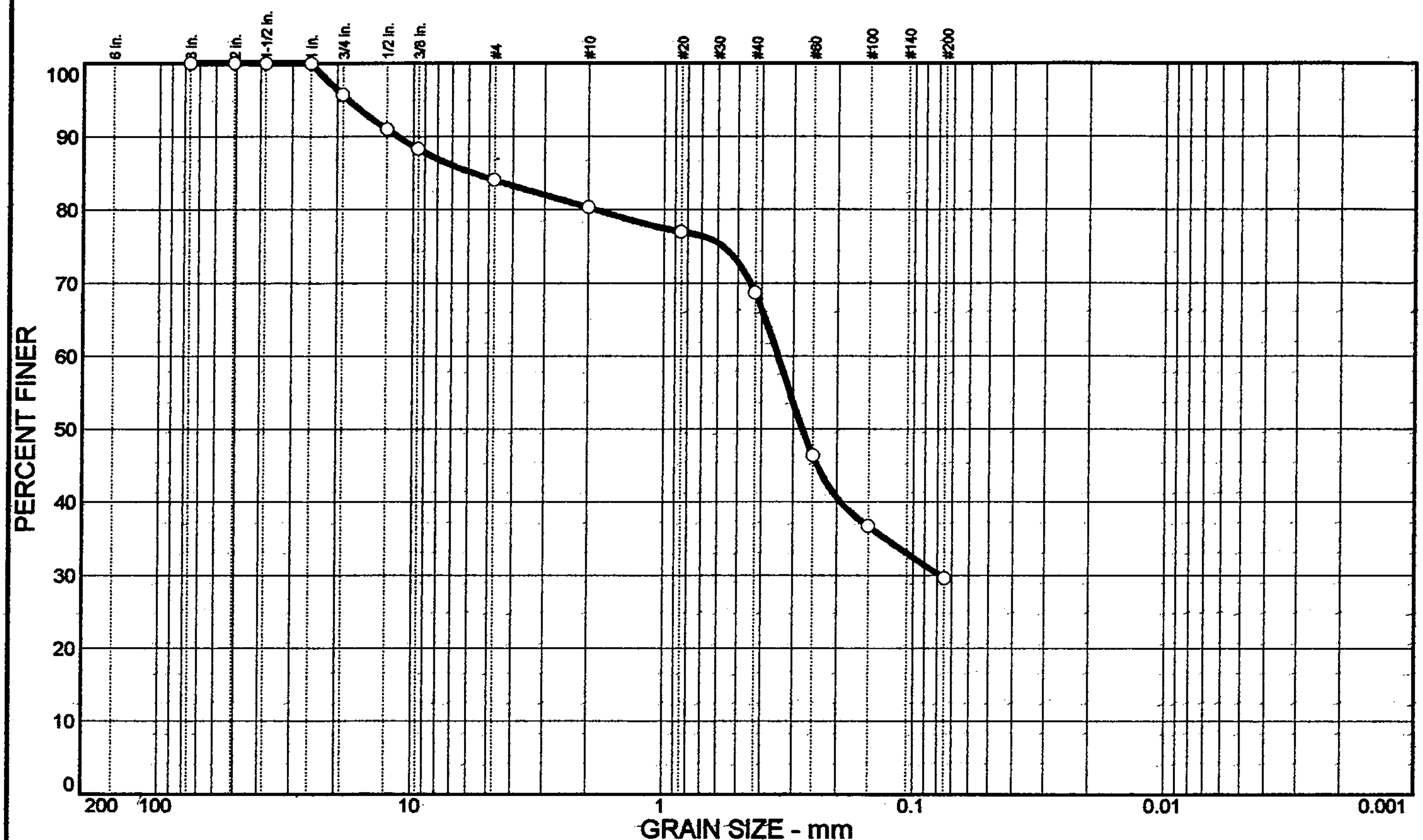
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST

WESTERN COLORADO TESTING, INC.

Fig. No. 8

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		15.9	54.5			SM	A-2-4(0)	NP	

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	100.0		
3/4	95.7		
1/2	91.0		
3/8	88.3		
	GRAIN SIZE		
D_{60}	0.344		
D_{30}	0.0781		
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	84.1		
#10	80.3		
#20	77.0		
#40	68.6		
#60	46.4		
#100	36.7		
#200	29.6		

SOIL DESCRIPTION

○ Sand, silty, gravely, brown

REMARKS:

○ Tested By: JH

○ Source:

Sample No.: 2W-7C

WESTERN COLORADO TESTING, INC.

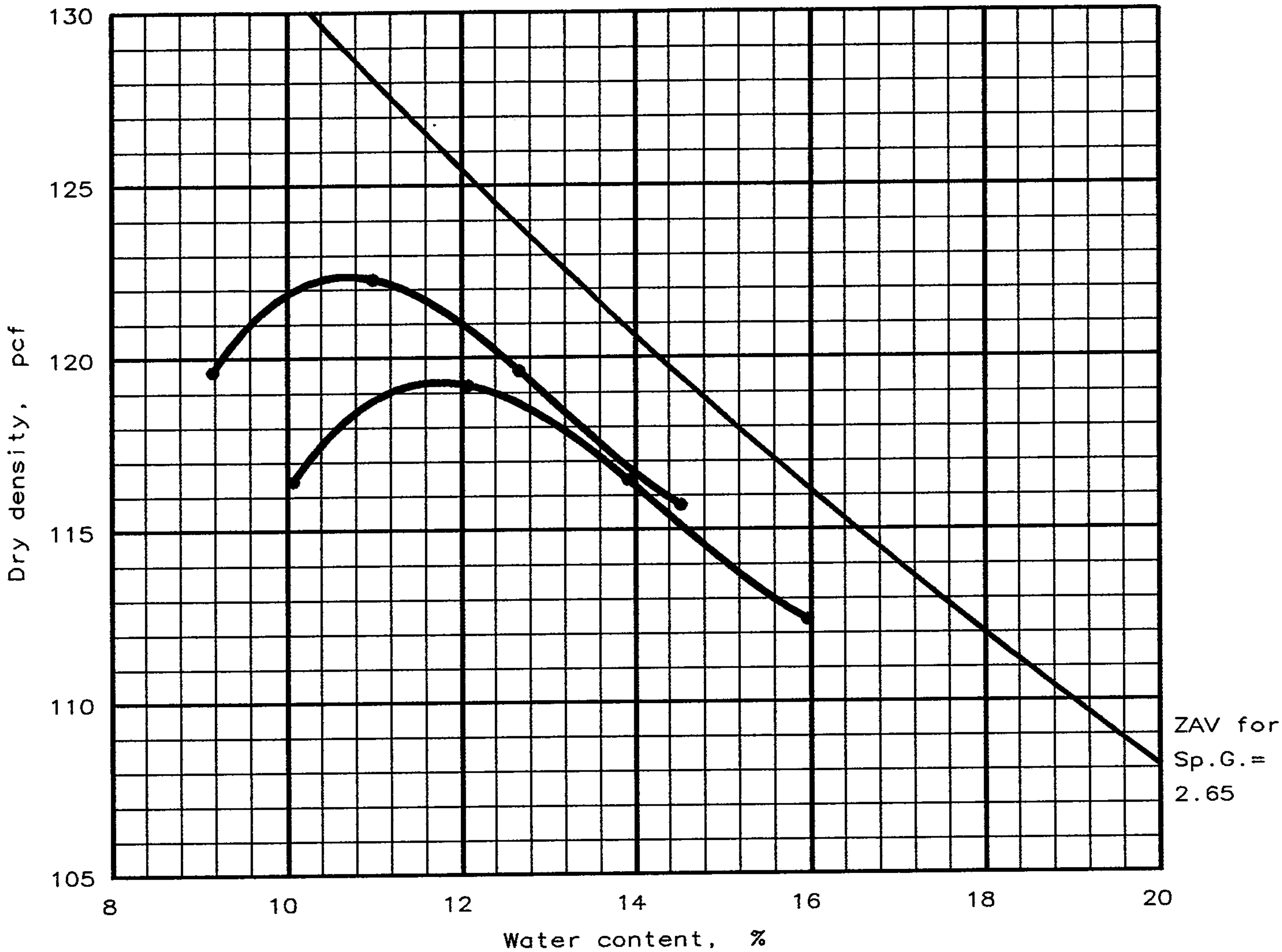
Client: International Uranium Corporation

Project: Soil Sample Testing

Project No.: 804899

Figure 39

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure C, Standard
Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in	% < No.200
	USCS	AASHTO						
			N/A %	2.65			9.0 %	

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 122.4 pcf Optimum moisture = 10.7 %	119.3 pcf 11.8 %	3-1C Sand, clayey, grvly, brn

Project No.: 804899
Project: International Uranium Corporation
Location: Soil Sample Testing

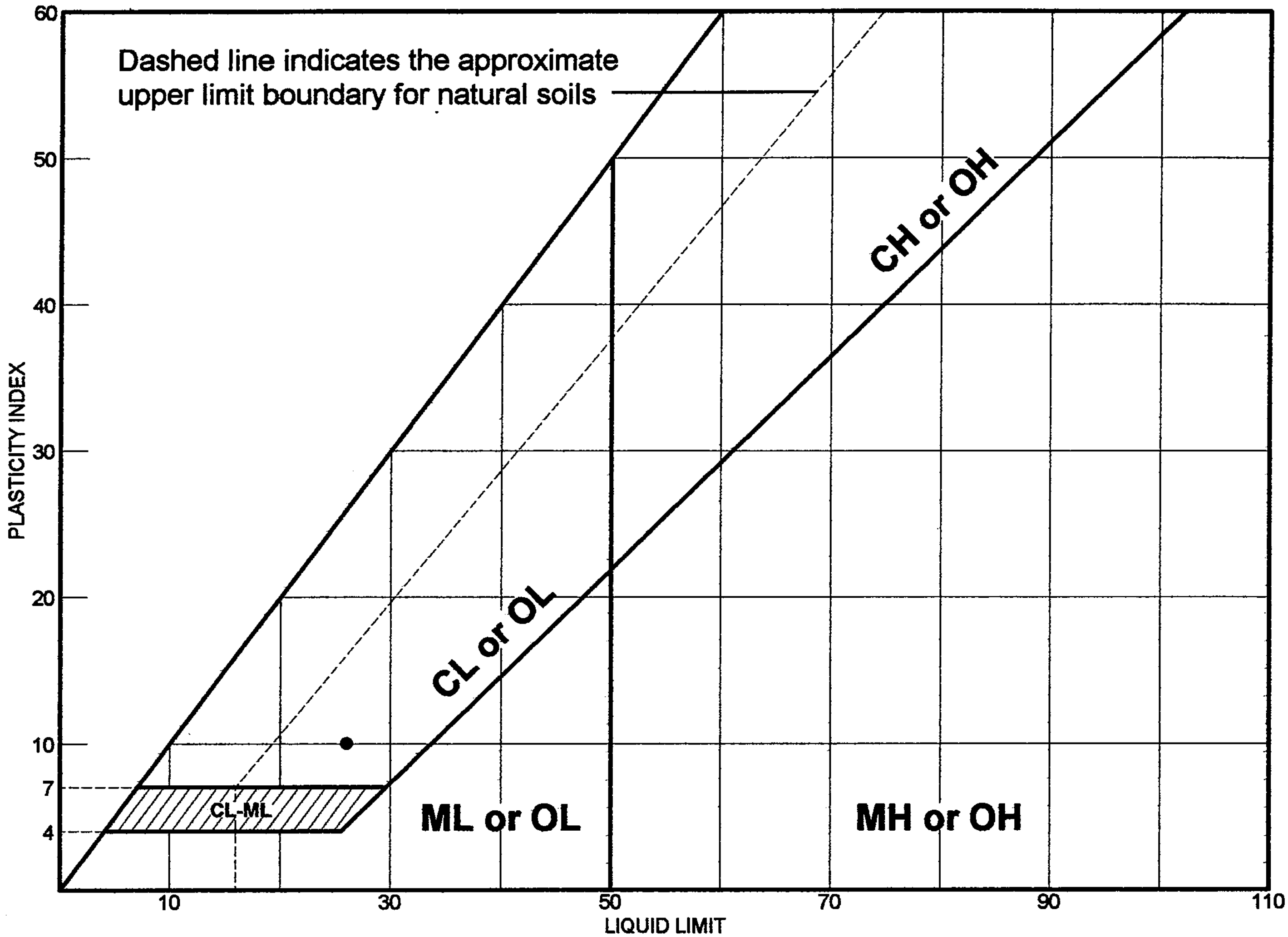
Date: 5/3/99

Remarks:
SUBMITTED BY: Client
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST
WESTERN COLORADO TESTING, INC.

Fig. No. 9

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sand, clayey, gravely, brown	26	16	10	69.5	36.9	SM

Project No. 804899 **Client:** International Uranium Corporation

Project: Soil Sample Testing

● **Source:** **Sample No.:** 3-1C

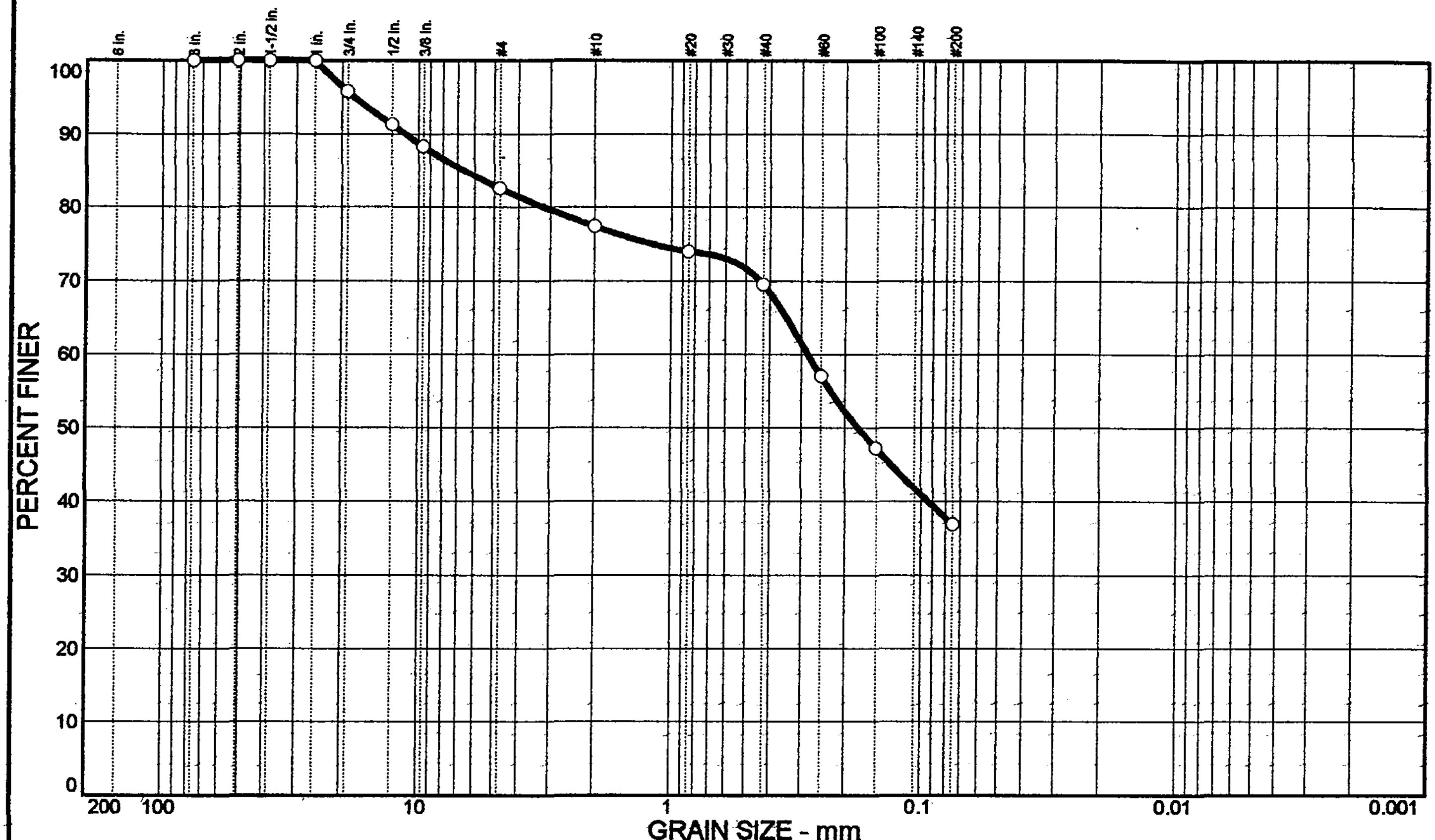
Remarks:

● Tested By: JH

LIQUID AND PLASTIC LIMITS TEST REPORT

WESTERN COLORADO TESTING, INC.

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		17.4	45.7			SM	A-4(0)	16	26

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	100.0		
3/4	95.8		
1/2	91.3		
3/8	88.3		
	GRAIN SIZE		
D_{60}	0.282		
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	82.6		
#10	77.4		
#20	74.0		
#40	69.5		
#60	57.0		
#100	47.2		
#200	36.9		

SOIL DESCRIPTION

○ Sand, clayey, gravely, brown

REMARKS:

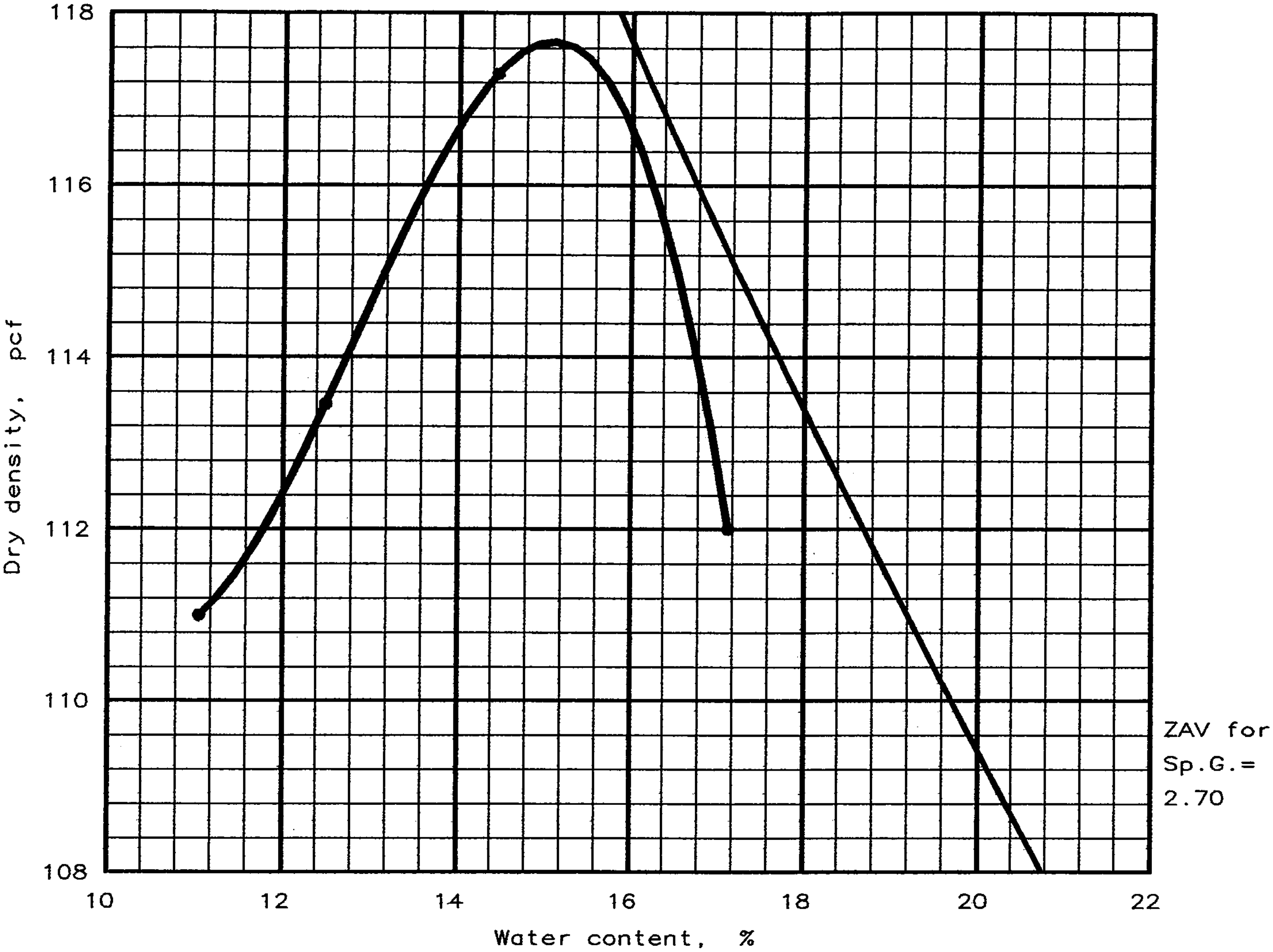
○ Tested By: JH

○ Source:

Sample No.: 3-1C

WESTERN COLORADO TESTING, INC.	Client: International Uranium Corporation Project: Soil Sample Testing Project No.: 804899 Figure 40

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure A, Standard

Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
			N/A %	2.70				

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 117.7 pcf Optimum moisture = 15.1 %	117.7 pcf 15.1 %	C1-S1 Clay, v sandy, silty, rd

Project No.: 804899

Project: International Uranium Corporation

Location: Soil Sample Testing

Date: 5/3/99

Remarks:

SUBMITTED BY: Client

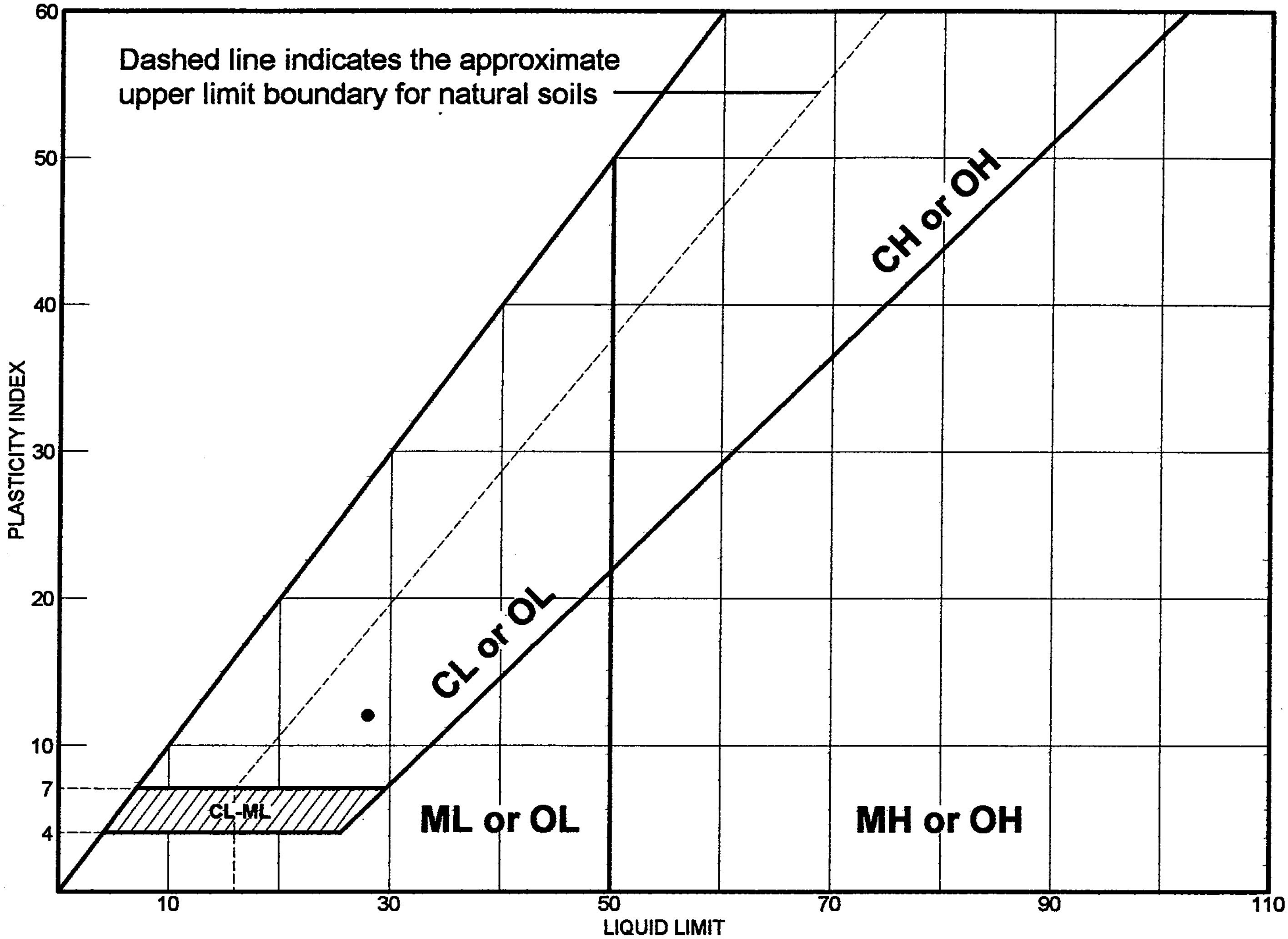
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST

WESTERN COLORADO TESTING, INC.

Fig. No. 10

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Clay, very sandy, silty, red	28	16	12	98.3	64.8	CL

Project No. 804899 **Client:** International Uranium Corporation

Project: Soil Sample Testing

● **Source:** **Sample No.:** C1-S1

Remarks:

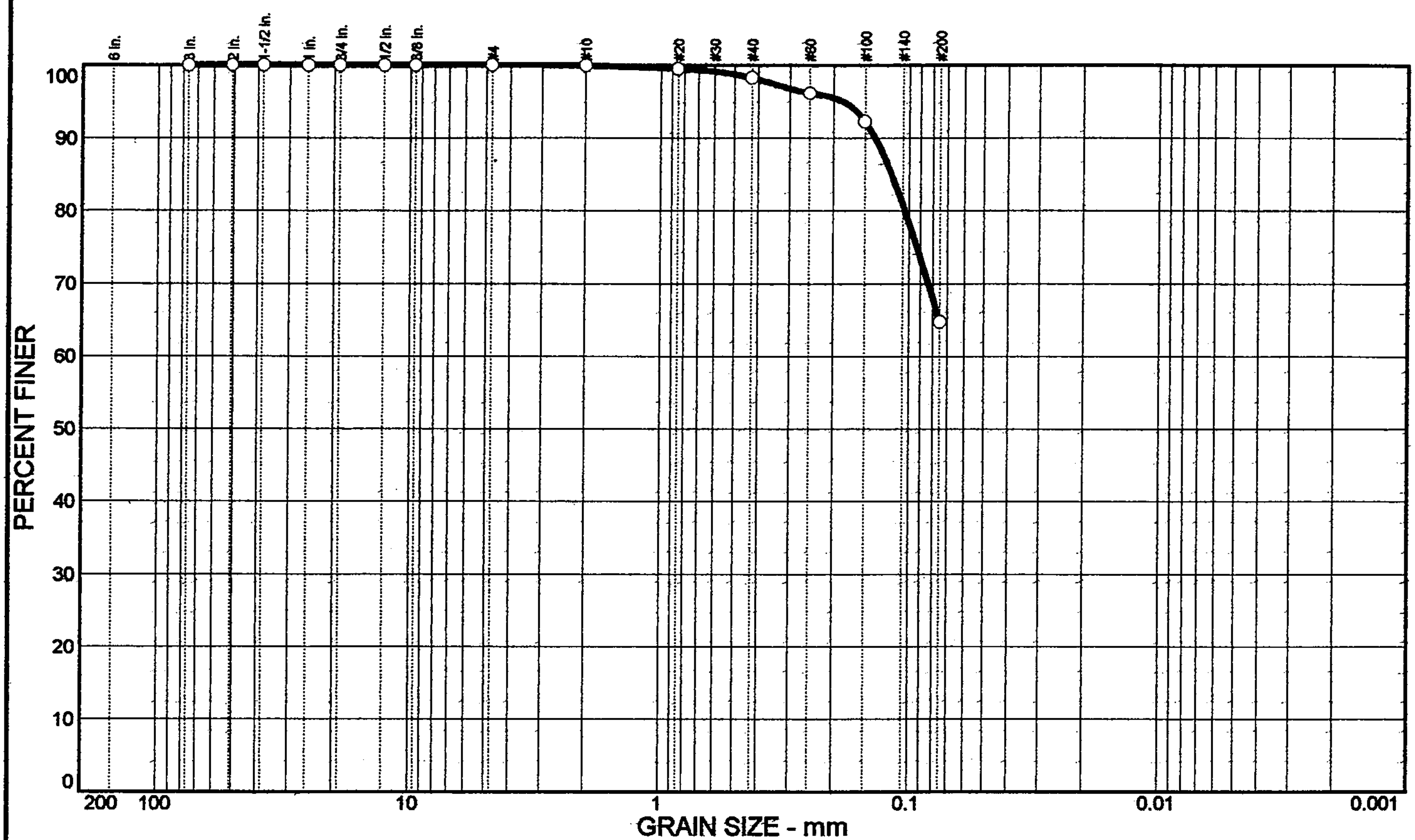
● Tested By: JH

LIQUID AND PLASTIC LIMITS TEST REPORT

WESTERN COLORADO TESTING, INC.

Figure 24

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		0.0	35.2			CL	A-6(5)	16	28

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	100.0		
3/4	100.0		
1/2	100.0		
3/8	100.0		
	GRAIN SIZE		
D_{60}			
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	100.0		
#10	99.9		
#20	99.5		
#40	98.3		
#60	96.2		
#100	92.3		
#200	64.8		

SOIL DESCRIPTION

○ Clay, very sandy, silty, red

REMARKS:

○ Tested By: JH

○ Source: Sample No.: C1-S1

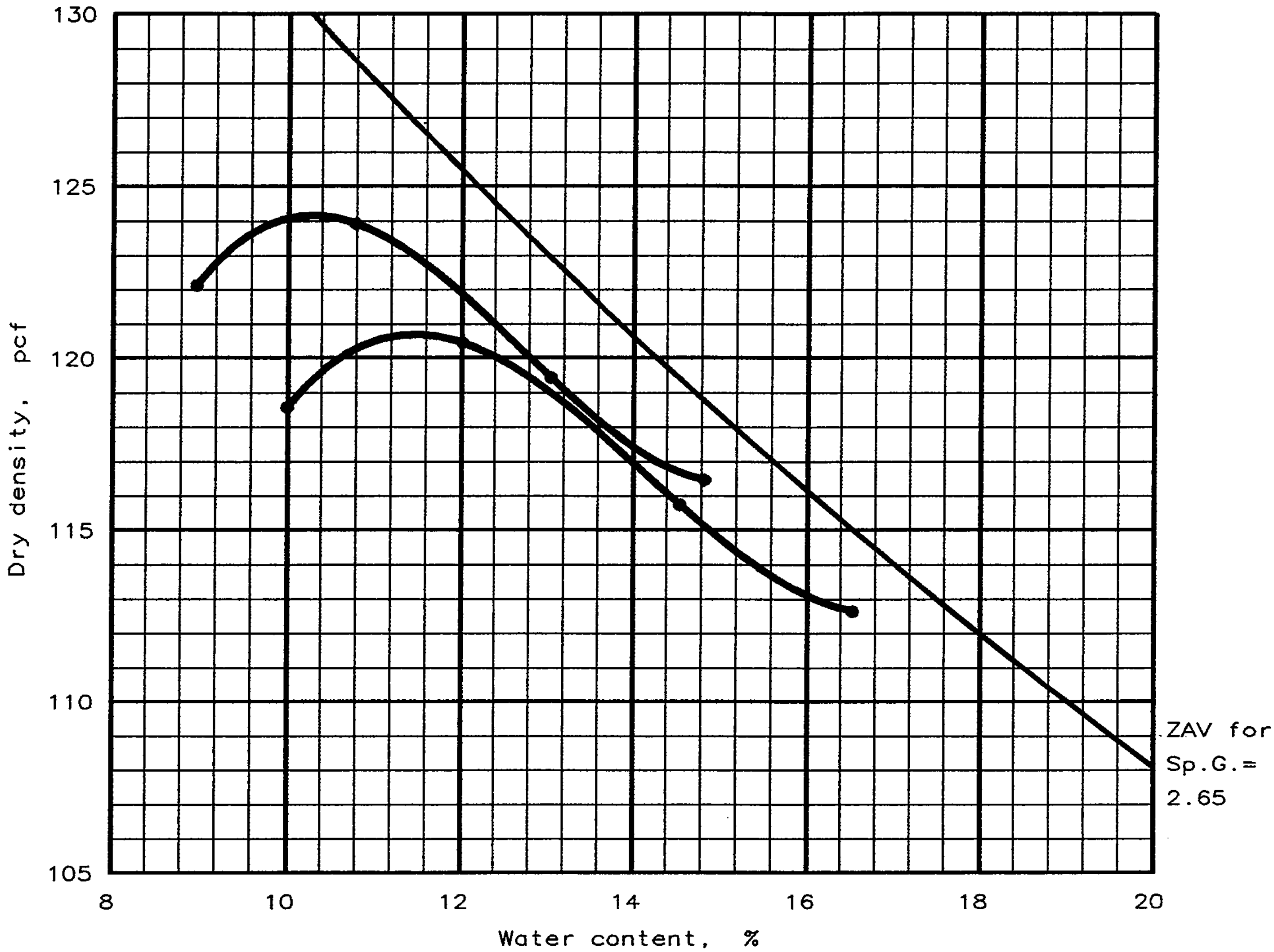
WESTERN COLORADO TESTING, INC.

Client: International Uranium Corporation

Project: Soil Sample Testing

Project No.: 804899 Figure 41

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure C, Standard
Oversize correction applied to each point

Elev/ Depth	Classification USCS	Classification AASHTO	Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in	% < No.200
			N/A %	2.65			10.3 %	

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 124.2 pcf	120.7 pcf	C2-S1
Optimum moisture = 10.3 %	11.5 %	Sand, clayey, grvly, brn

Project No.: 804899
Project: International Uranium Corporation
Location: Soil Sample Testing

Date: 5/3/99

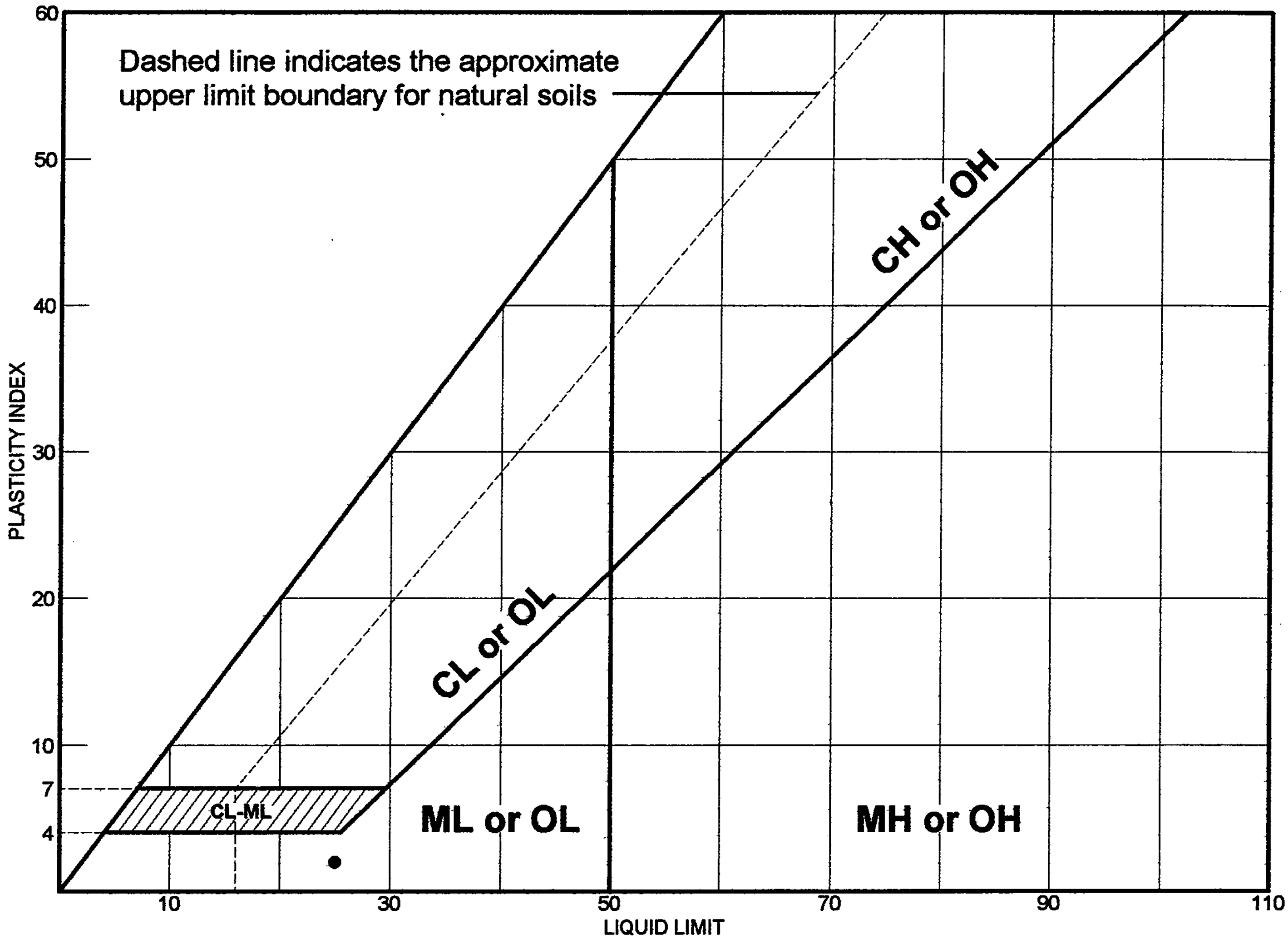
Remarks:
SUBMITTED BY: Client
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST

WESTERN COLORADO TESTING, INC.

Fig. No. 11

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sand, clayey, gravely, brown	25	23	2	48.2	26.7	SM

Project No. 804899 **Client:** International Uranium Corporation

Project: Soil Sample Testing

● **Source:** **Sample No.:** C2-S1

Remarks:

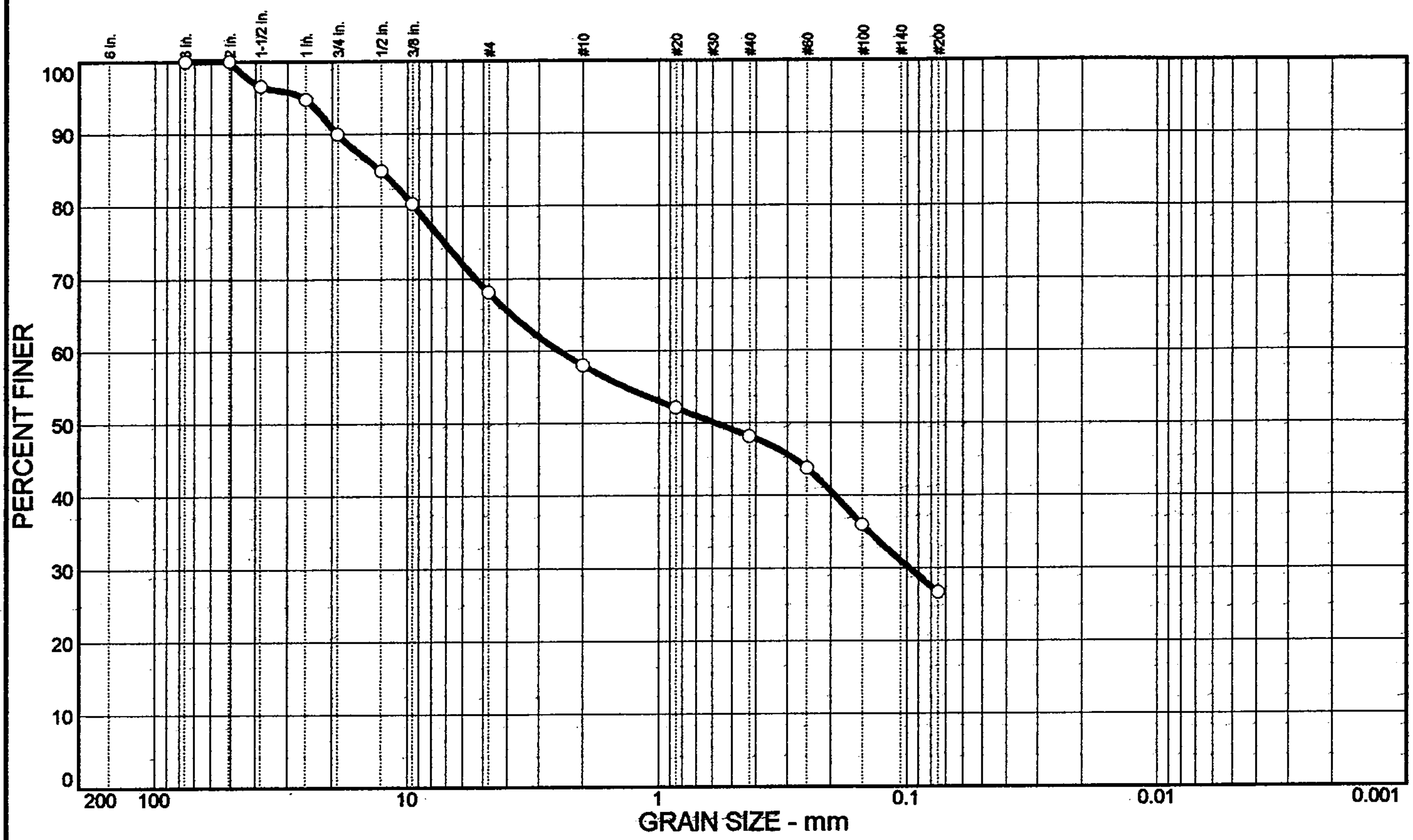
● Tested By: JH

LIQUID AND PLASTIC LIMITS TEST REPORT

WESTERN COLORADO TESTING, INC.

Figure 25

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		31.9	41.4			SM	A-2-4(0)	23	25

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	96.6		
1	94.8		
3/4	90.0		
1/2	84.9		
3/8	80.3		
	GRAIN SIZE		
D_{60}	2.48		
D_{30}	0.0977		
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	68.1		
#10	58.0		
#20	52.1		
#40	48.2		
#60	43.8		
#100	36.0		
#200	26.7		

SOIL DESCRIPTION

○ Sand, clayey, gravely, brown

REMARKS:

○ Tested By: JH

○ Source:

Sample No.: C2-S1

WESTERN COLORADO TESTING, INC.

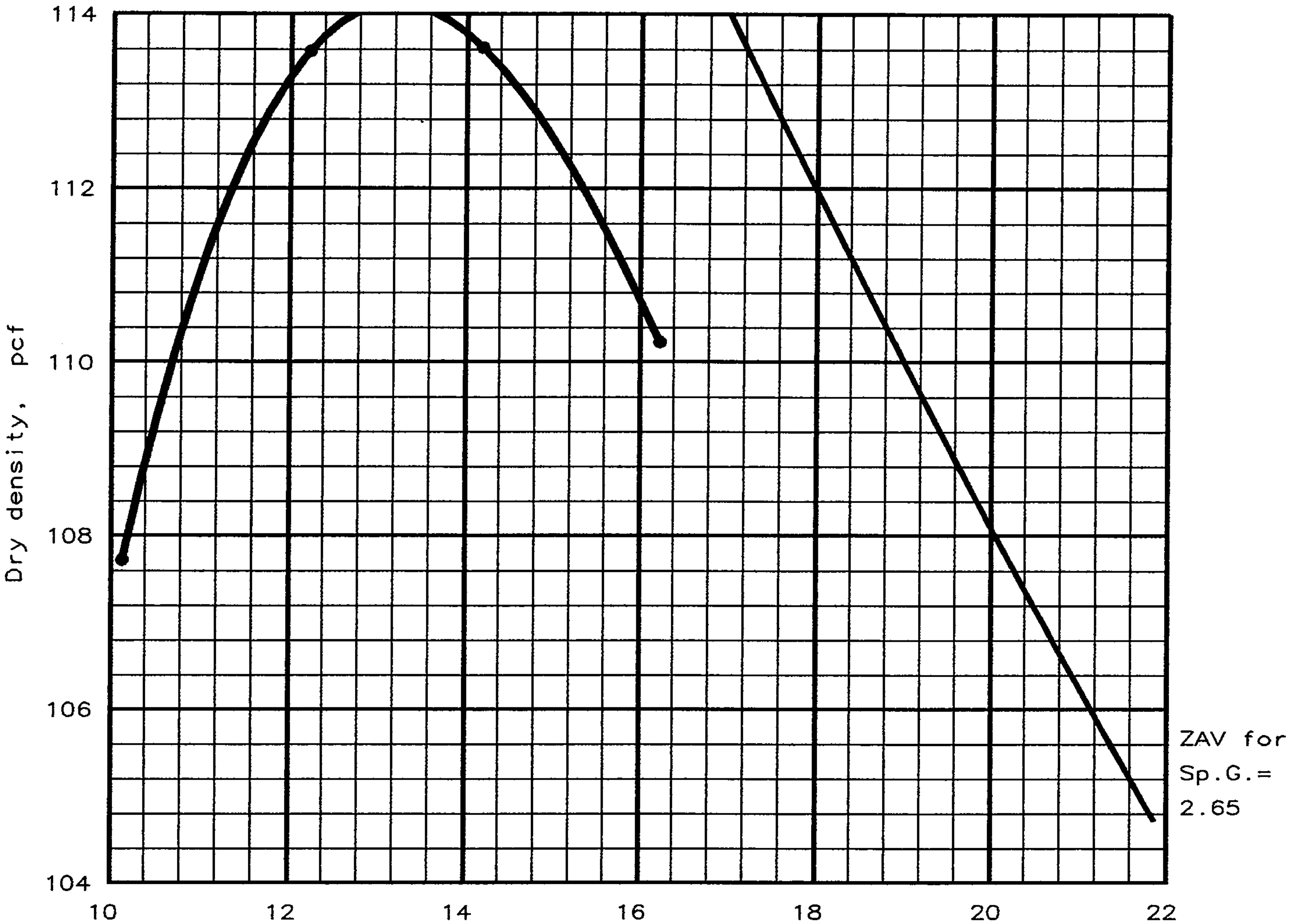
Client: International Uranium Corporation

Project: Soil Sample Testing

Project No.: 804899

Figure 42

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure A, Standard

Oversize correction applied to each point

Elev/ Depth	Classification USCS	Classification AASHTO	Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
			N/A %	2.65				

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 114.1 pcf Optimum moisture = 13.2 %	114.1 pcf 13.2 %	RF1-S1 Clay, silty, sandy, red

Project No.: 804899

Project: International Uranium Corporation

Location: Soil Sample Testing

Date: 5/3/99

Remarks:

SUBMITTED BY: Client

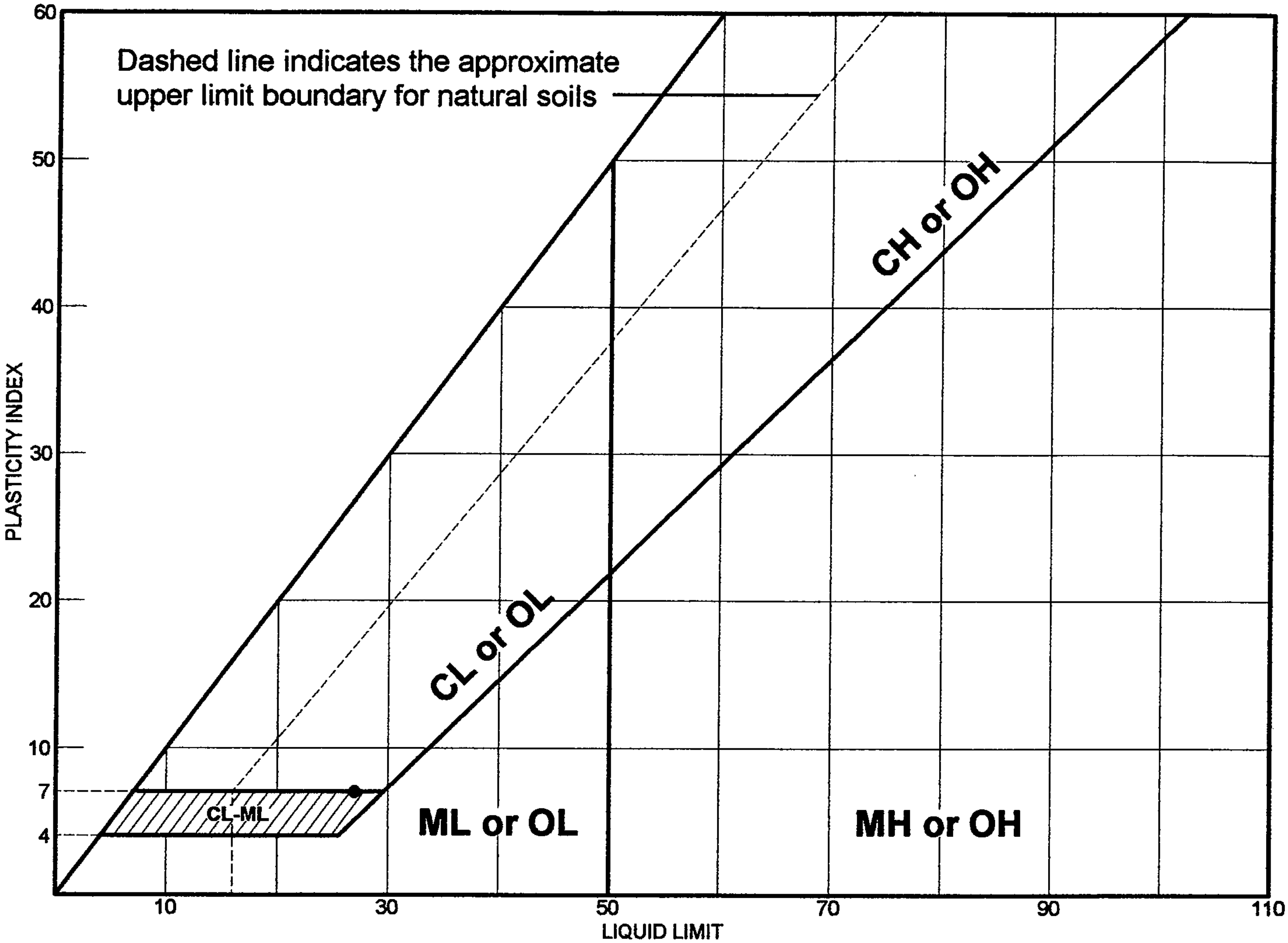
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST

WESTERN COLORADO TESTING, INC.

Fig. No. 12

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Clay, silty, sandy, red	27	20	7	99.1	63.1	ML

Project No. 804899 **Client:** International Uranium Corporation

Project: Soil Sample Testing

● **Source:** **Sample No.:** RF1-S1

Remarks:

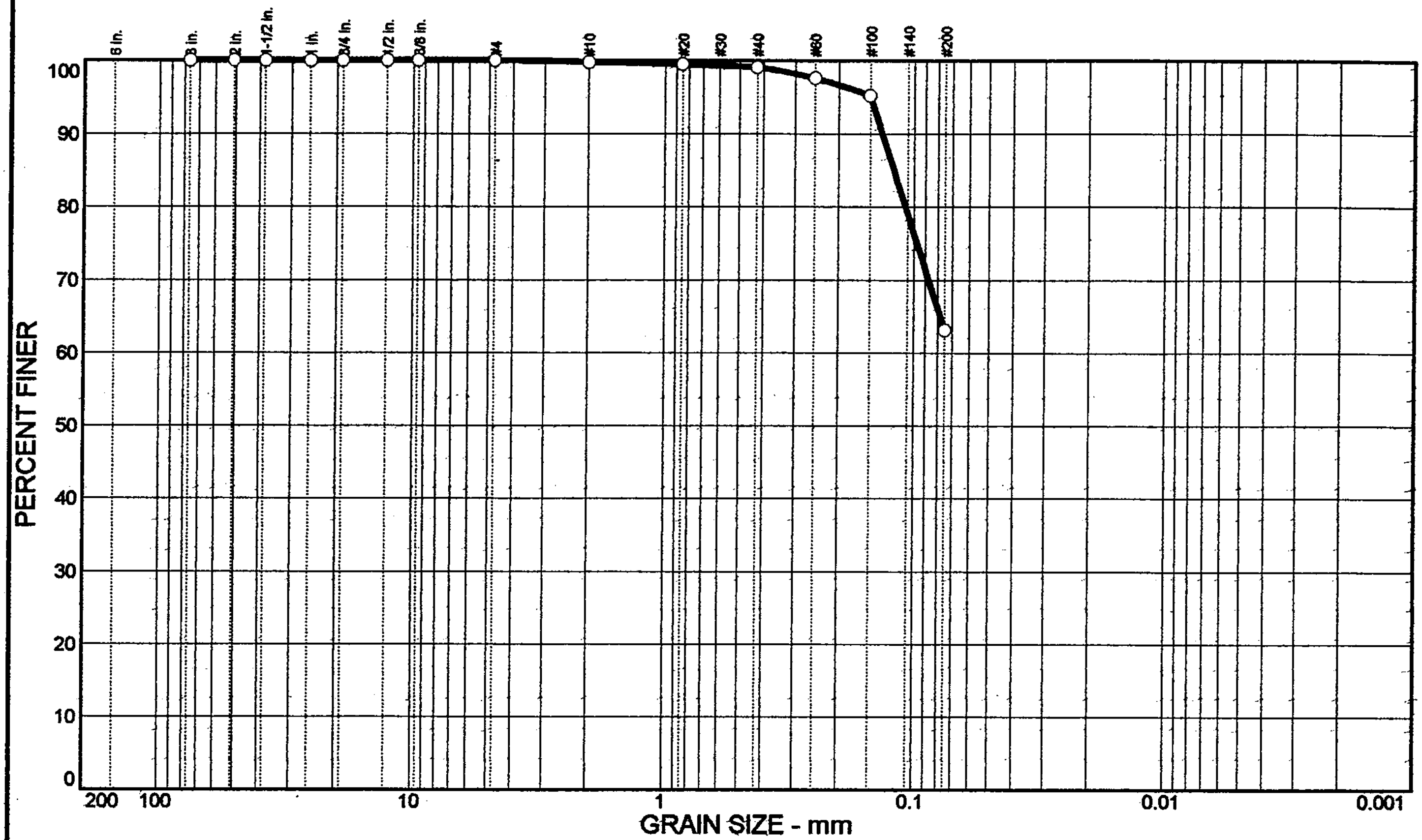
● Tested By: JH

LIQUID AND PLASTIC LIMITS TEST REPORT

WESTERN COLORADO TESTING, INC.

Figure 26

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		0.0	36.9			ML	A-4(0)		

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	100.0		
3/4	100.0		
1/2	100.0		
3/8	100.0		
	GRAIN SIZE		
D_{60}			
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	100.0		
#10	99.8		
#20	99.5		
#40	99.1		
#60	97.6		
#100	95.2		
#200	63.1		

SOIL DESCRIPTION

○ Clay, silty, sandy, red

REMARKS:

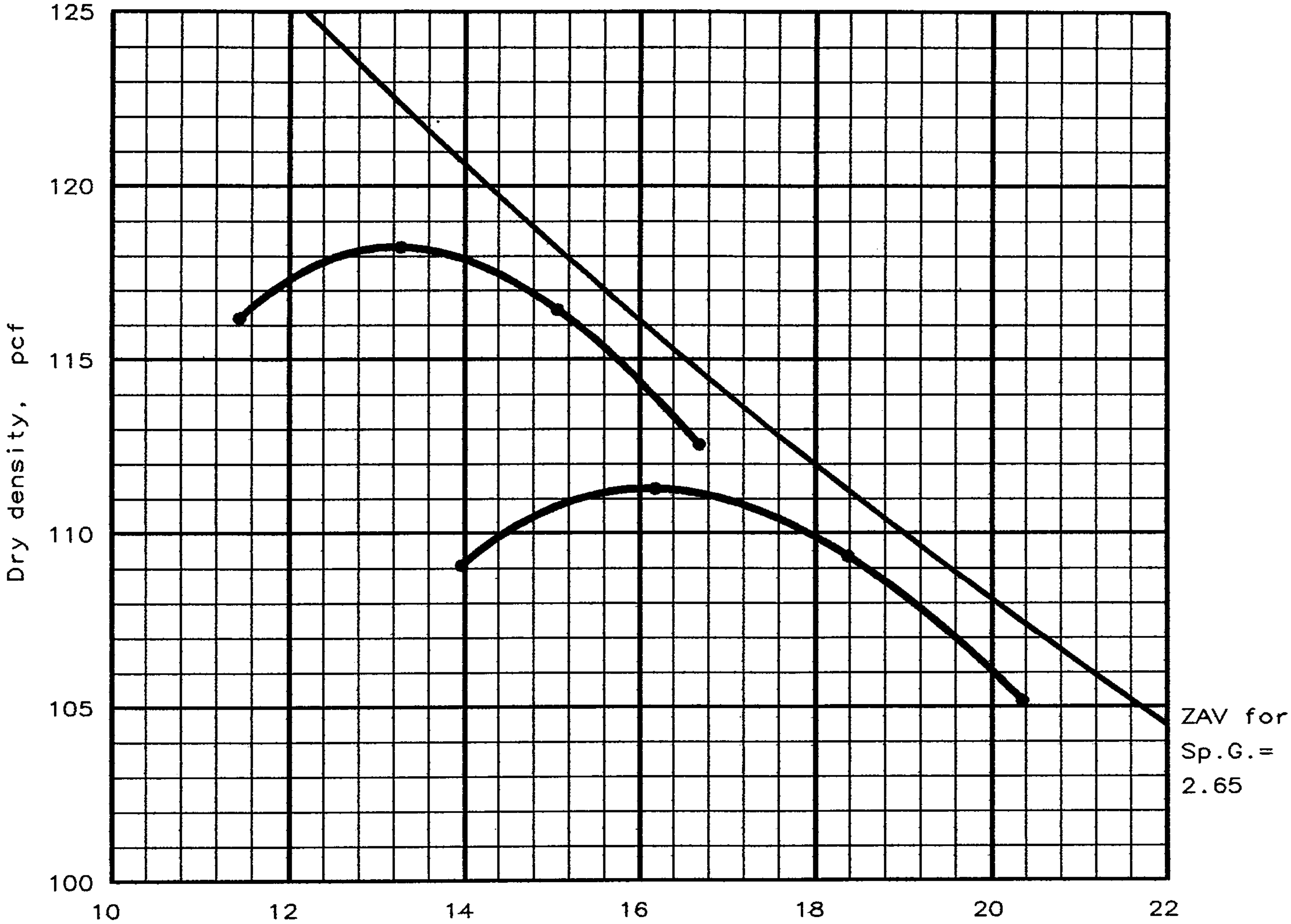
○ Tested By: JH

○ Source: Sample No.: RF1-S1

WESTERN COLORADO TESTING, INC.

Client: International Uranium Corporation
Project: Soil Sample Testing
Project No.: 804899 Figure 43

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure B, Standard

Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in	% < No.200
	USCS	AASHTO						
			N/A %	2.65			18.0 %	

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 118.3 pcf Optimum moisture = 13.2 %	111.3 pcf 16.1 %	RF2-S1 Sand, clayey, grvly, brn

Project No.: 804899

Project: International Uranium Corporation

Location: Soil Sample Testing

Date: 5/3/99

Remarks:

SUBMITTED BY: Client

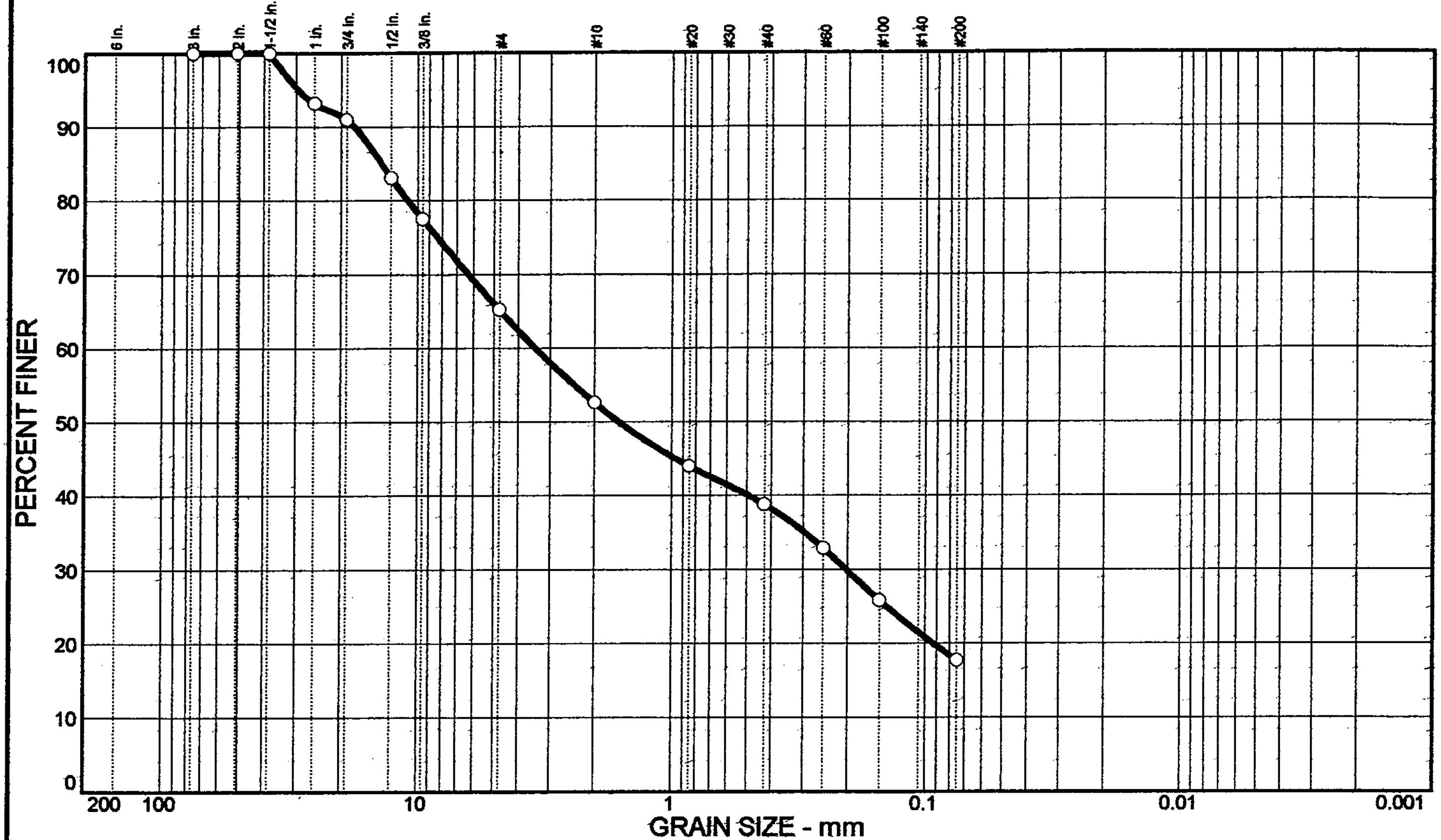
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST

WESTERN COLORADO TESTING, INC.

Fig. No. 13

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		34.8	47.5			SM	A-1-b	NP	NP

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	93.2		
3/4	91.0		
1/2	83.1		
3/8	77.5		
	GRAIN SIZE		
D_{60}	3.42		
D_{30}	0.203		
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	65.2		
#10	52.6		
#20	44.0		
#40	38.8		
#60	32.9		
#100	25.8		
#200	17.7		

SOIL DESCRIPTION

○ Sand, sl clayey, gravely, brown

REMARKS:

○ Tested By: JH

○ Source:

Sample No.: RF2-S1

WESTERN COLORADO TESTING, INC.

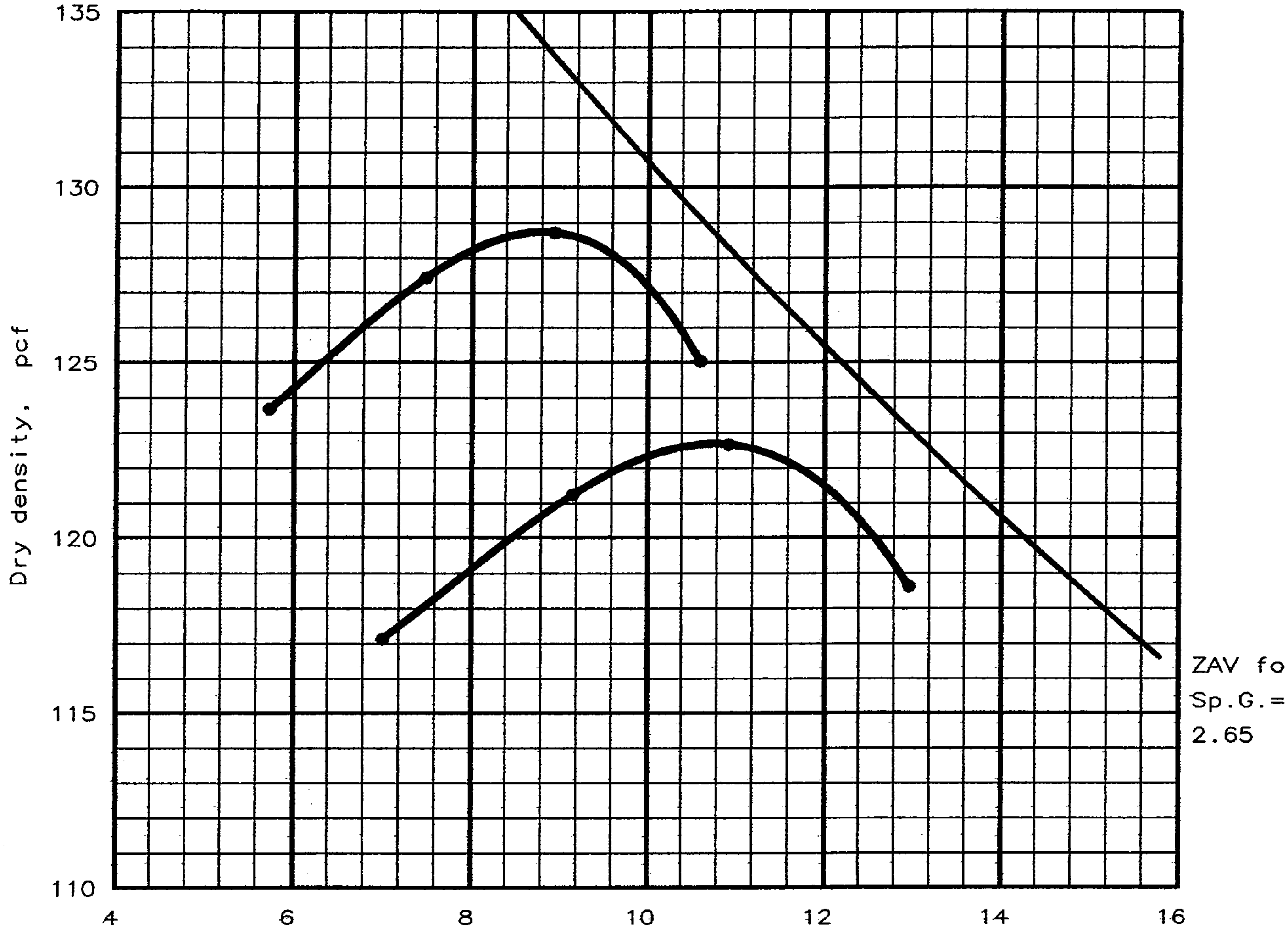
Client: International Uranium Corporation

Project: Soil Sample Testing

Project No.: 804899

Figure 44

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure C, Standard

Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in	% < No.200
	USCS	AASHTO						
			N/A %	2.65			18.2 %	

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 128.7 pcf Optimum moisture = 8.8 %	122.7 pcf 10.8 %	RF2-S2 Sand, gravely, brown

Project No.: 804899

Project: International Uranium Corporation

Location: Soil Sample Testing

Date: 5/3/99

Remarks:

SUBMITTED BY: Client

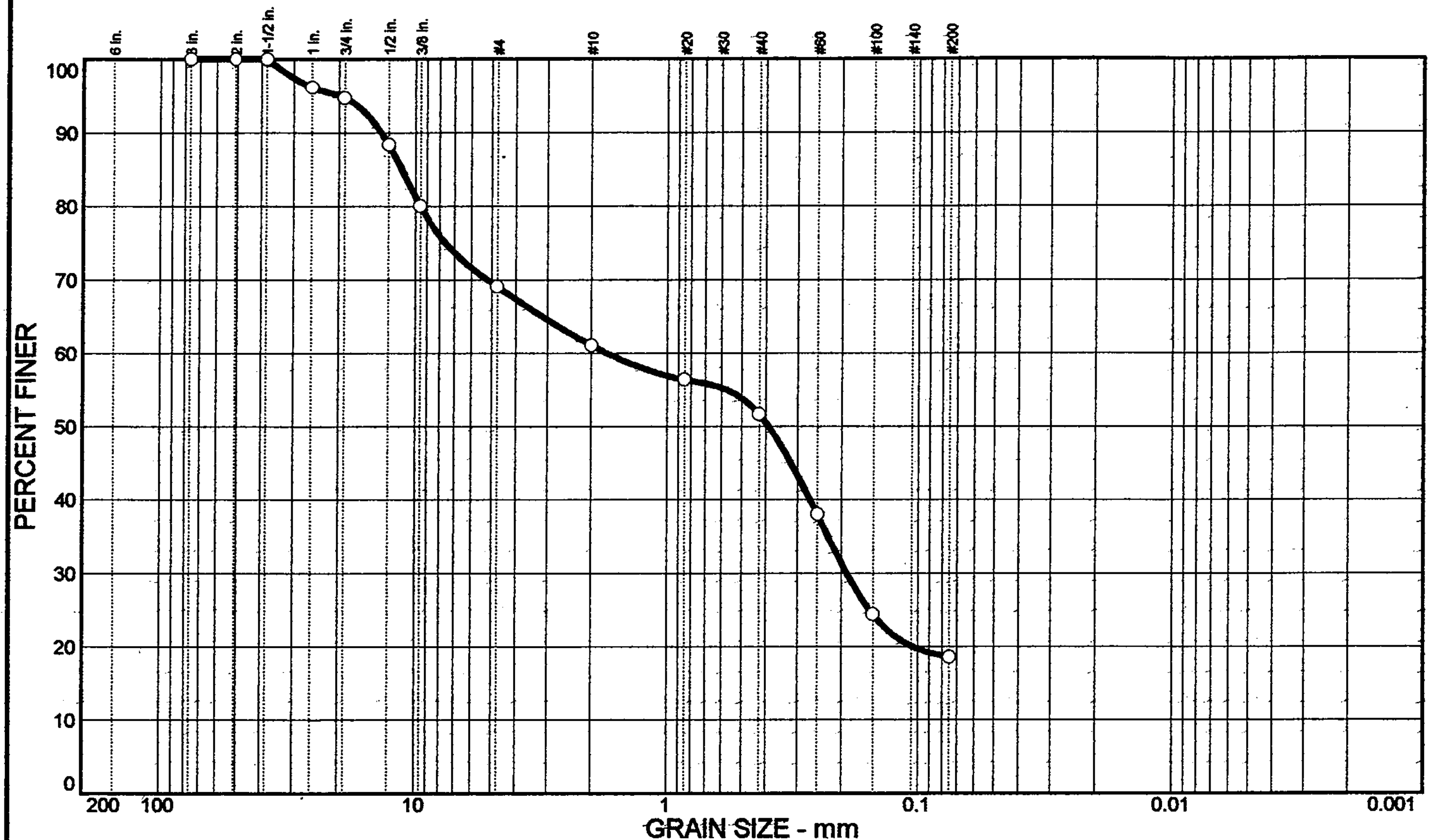
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST

WESTERN COLORADO TESTING, INC.

Fig. No. 14

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		30.9	50.5			SM	A-2-4(0)	NP	NP

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	96.2		
3/4	94.8		
1/2	88.4		
3/8	80.1		
	GRAIN SIZE		
D_{60}	1.73		
D_{30}	0.190		
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	69.1		
#10	61.1		
#20	56.4		
#40	51.7		
#60	38.0		
#100	24.4		
#200	18.6		

SOIL DESCRIPTION

○ Sand, gravely, brown

REMARKS:

○ Tested By: JH

○ Source:

Sample No.: RF2-S2

WESTERN COLORADO TESTING, INC.

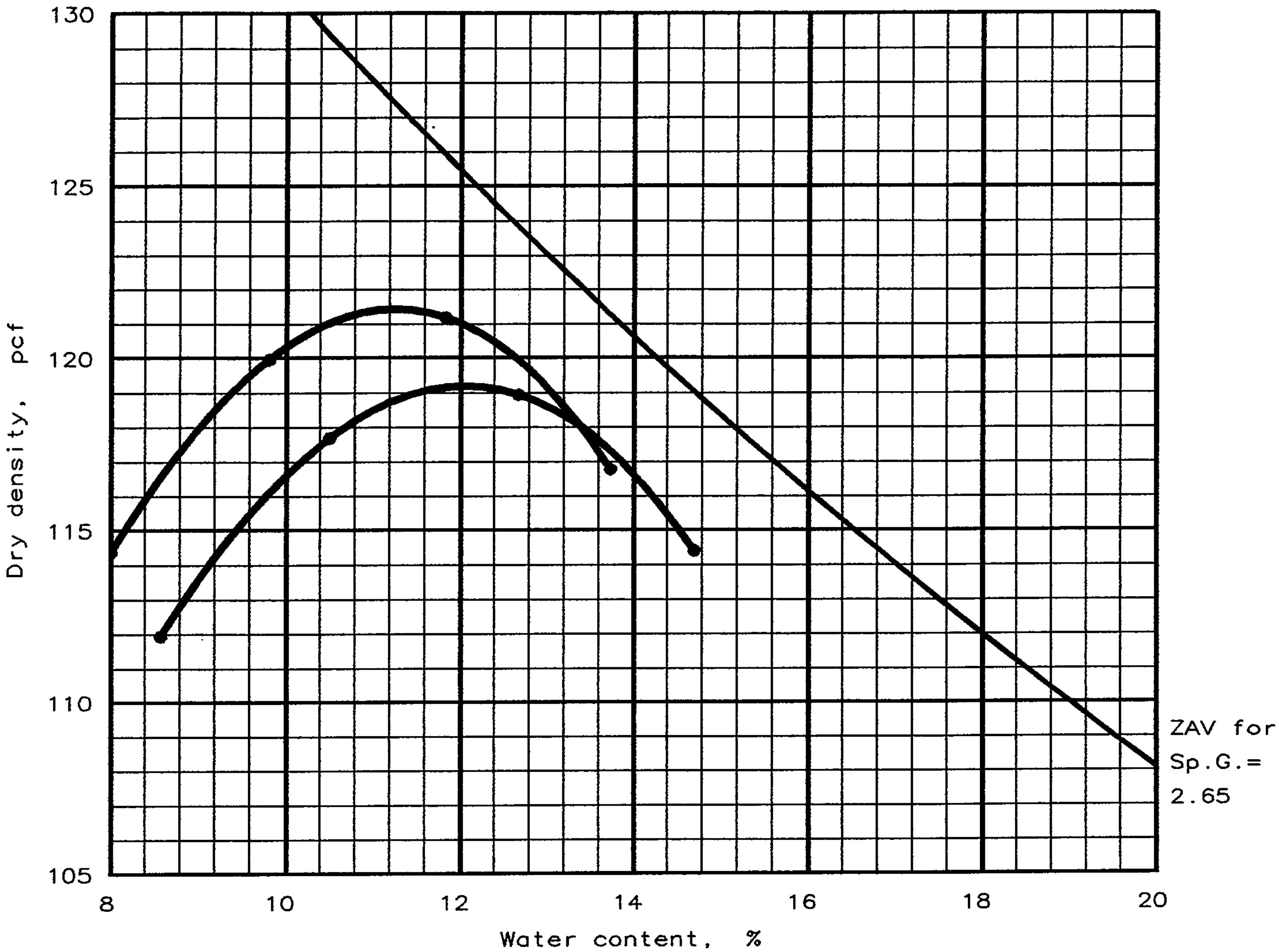
Client: International Uranium Corporation

Project: Soil Sample Testing

Project No.: 804899

Figure 45

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure C, Standard

Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in	% < No.200
	USCS	AASHTO						
			N/A %	2.65			6.6 %	

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 121.4 pcf Optimum moisture = 11.3 %	119.2 pcf 12.1 %	RF3-S1 Sand, clayey, grvly, brn

Project No.: 804899

Project: International Uranium Corporation

Location: Soil Sample Testing

Date: 5/3/99

Remarks:

SUBMITTED BY: Client

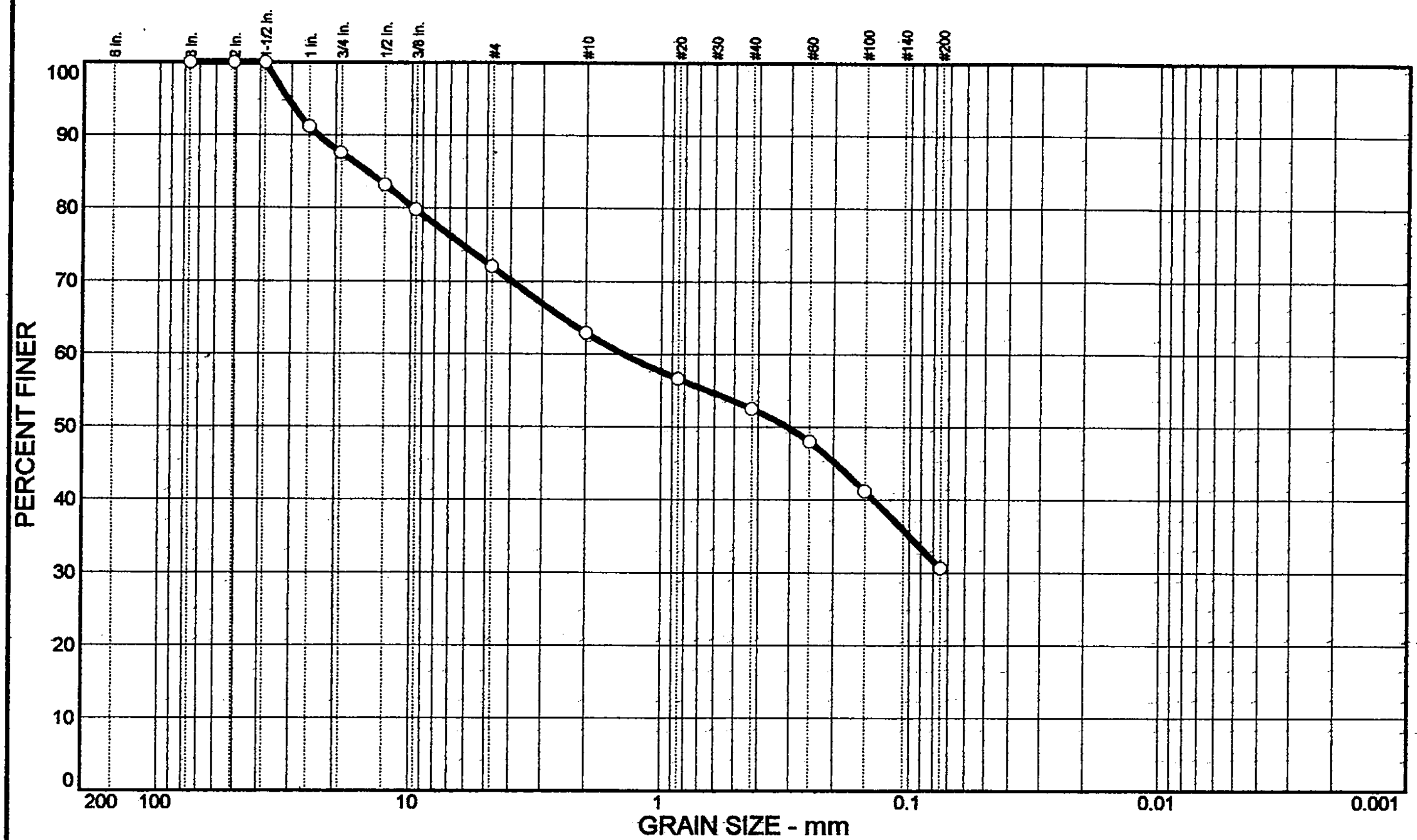
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST

WESTERN COLORADO TESTING, INC.

Fig. No. 15

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		28.0	41.4			SM	A-2-4(0)	NP	

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	91.2		
3/4	87.6		
1/2	83.2		
3/8	79.8		
	GRAIN SIZE		
D_{60}	1.41		
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	72.0		
#10	62.9		
#20	56.6		
#40	52.5		
#60	48.0		
#100	41.2		
#200	30.6		

SOIL DESCRIPTION

○ Sand, sl clayey, gravely, brown

REMARKS:

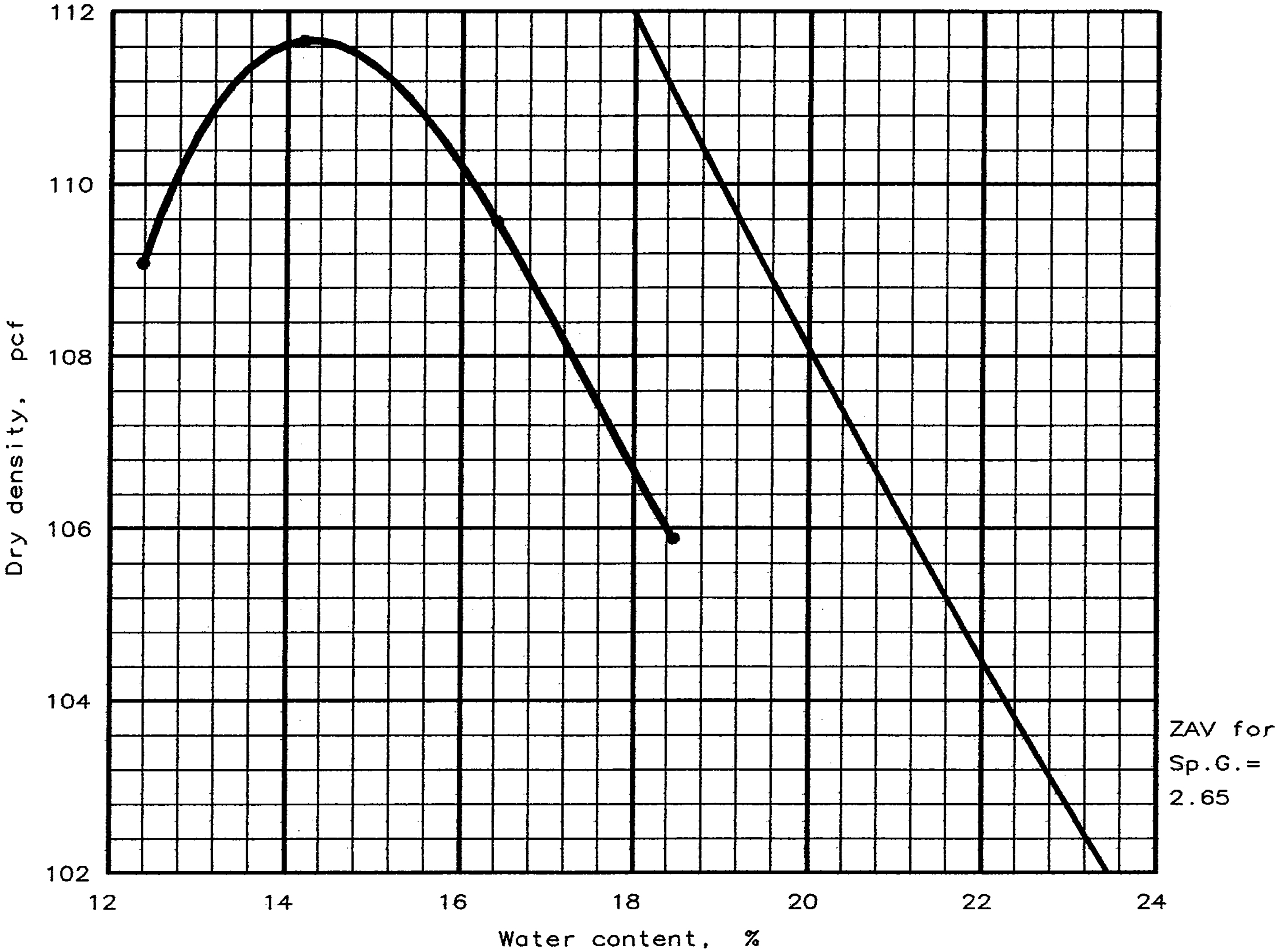
○ Tested By: JH

○ Source: Sample No.: RF3-S1

WESTERN COLORADO TESTING, INC.

Client: International Uranium Corporation
Project: Soil Sample Testing
Project No.: 804899 Figure 46

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure A, Standard

Oversize correction applied to each point

Elev/ Depth	Classification USCS	Classification AASHTO	Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
			N/A %	2.65				

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 111.7 pcf Optimum moisture = 14.3 %	111.7 pcf 14.3 %	RF3-S2 Clay, v sandy, red

Project No.: 804899

Project: International Uranium Corporation

Location: Soil Sample Testing

Date: 5/3/99

Remarks:

SUBMITTED BY: Client

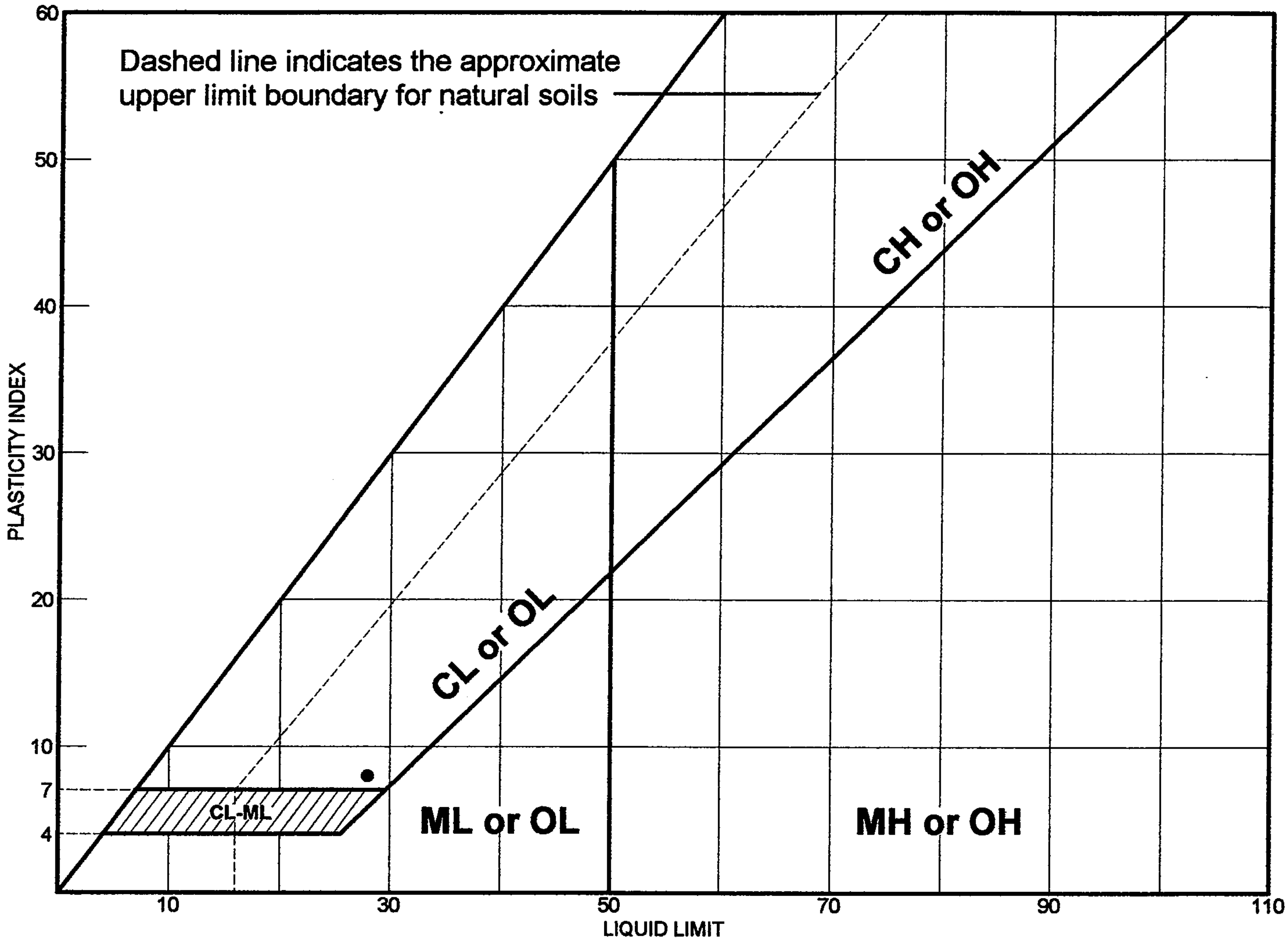
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST

WESTERN COLORADO TESTING, INC.

Fig. No. 16

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Clay, very sandy, red	28	20	8	69.0	39.0	SM

Project No. 804899 **Client:** International Uranium Corporation

Project: Soil Sample Testing

● **Source:** **Sample No.:** RF3-S2

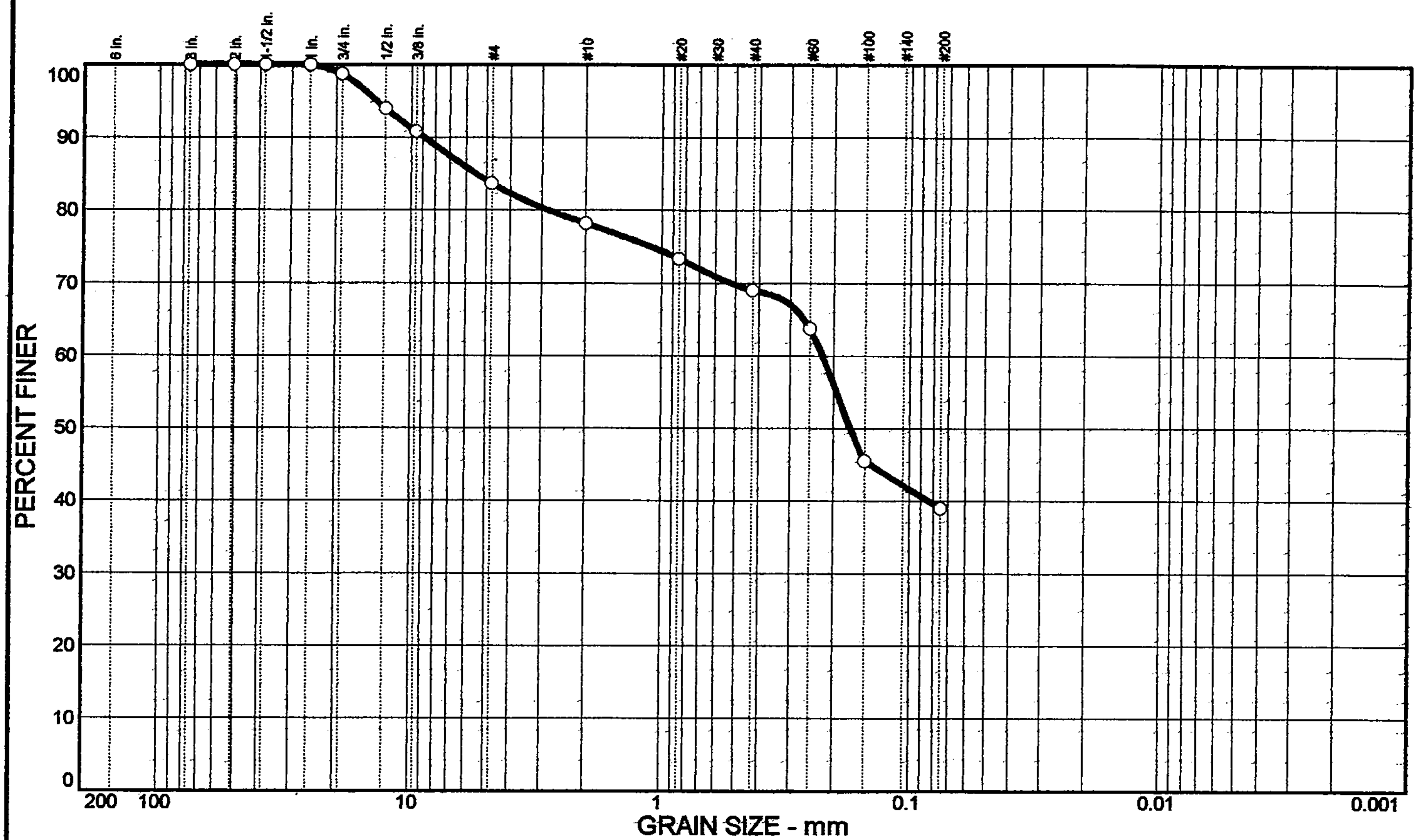
Remarks:
● Tested By: JH

LIQUID AND PLASTIC LIMITS TEST REPORT

WESTERN COLORADO TESTING, INC.

Figure 27

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		16.3	44.7			SM	A-4(0)		

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	100.0		
3/4	98.7		
1/2	94.0		
3/8	90.8		
	GRAIN SIZE		
D_{60}	0.222		
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	83.7		
#10	78.2		
#20	73.4		
#40	69.0		
#60	63.7		
#100	45.5		
#200	39.0		

SOIL DESCRIPTION

○ Clay, very sandy, red

REMARKS:

○ Tested By: JH

○ Source:

Sample No.: RF3-S2

WESTERN COLORADO TESTING, INC.

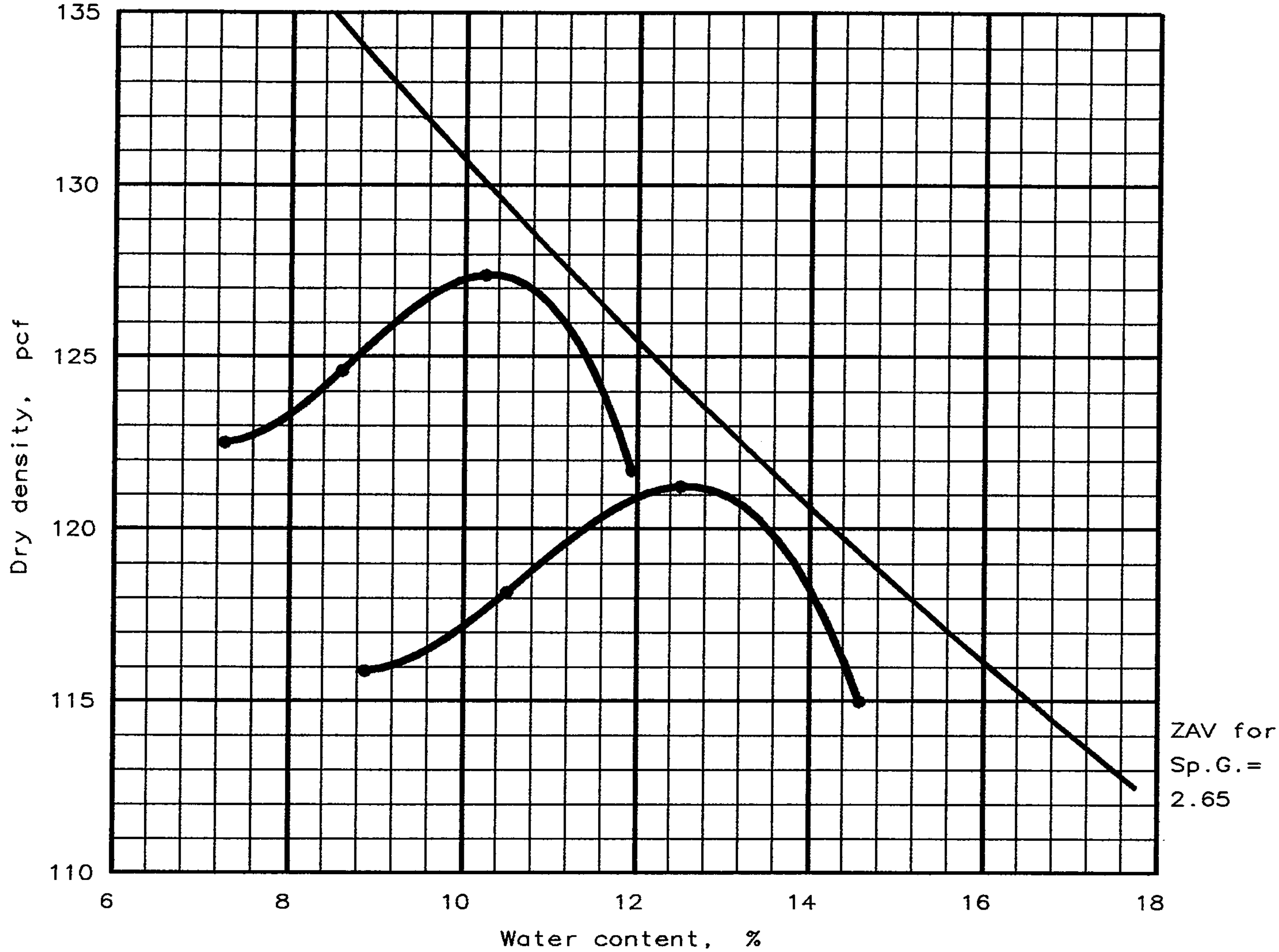
Client: International Uranium Corporation

Project: Soil Sample Testing

Project No.: 804899

Figure 47

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure C, Standard

Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in	% < No.200
	USCS	AASHTO						
			N/A %	2.65			18.1 %	

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 127.4 pcf Optimum moisture = 10.3 %	121.3 pcf 12.6 %	RF3-S3 Sand, clayey, grvly, brn

Project No.: 804899

Project: International Uranium Corporation

Location: Soil Sample Testing

Date: 5/3/99

Remarks:

SUBMITTED BY: Client

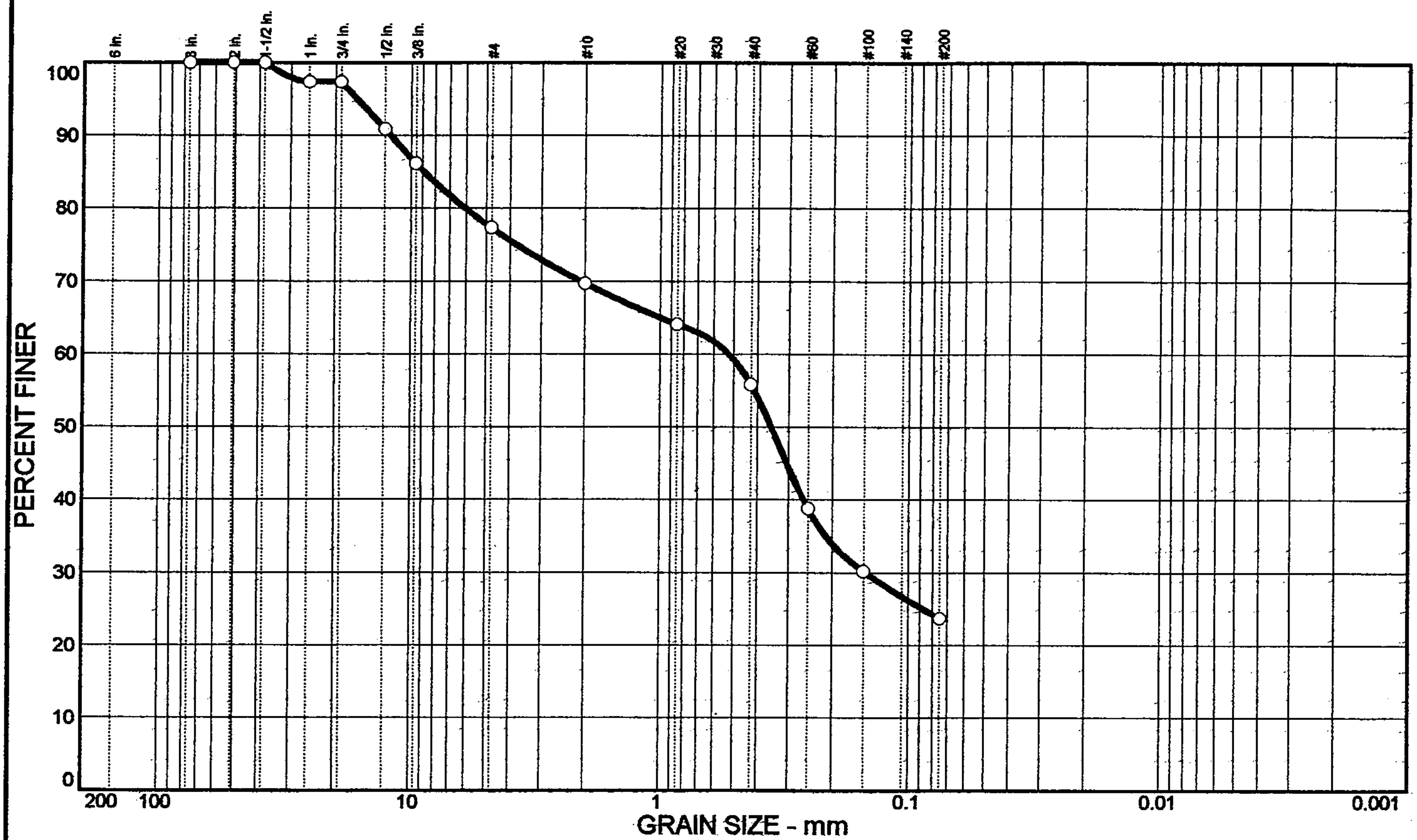
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST

WESTERN COLORADO TESTING, INC.

Fig. No. 17

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		22.7	53.6			SM	A-2-4(0)	NP	NP

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	97.4		
3/4	97.4		
1/2	90.9		
3/8	86.2		
	GRAIN SIZE		
D_{60}	0.523		
D_{30}	0.147		
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	77.3		
#10	69.7		
#20	64.1		
#40	55.8		
#60	38.8		
#100	30.2		
#200	23.7		

SOIL DESCRIPTION

○ Sand, sl clayey, gravely, brown

REMARKS:

○ Tested By: JH

○ Source:

Sample No.: RF3-S3

WESTERN COLORADO TESTING, INC.

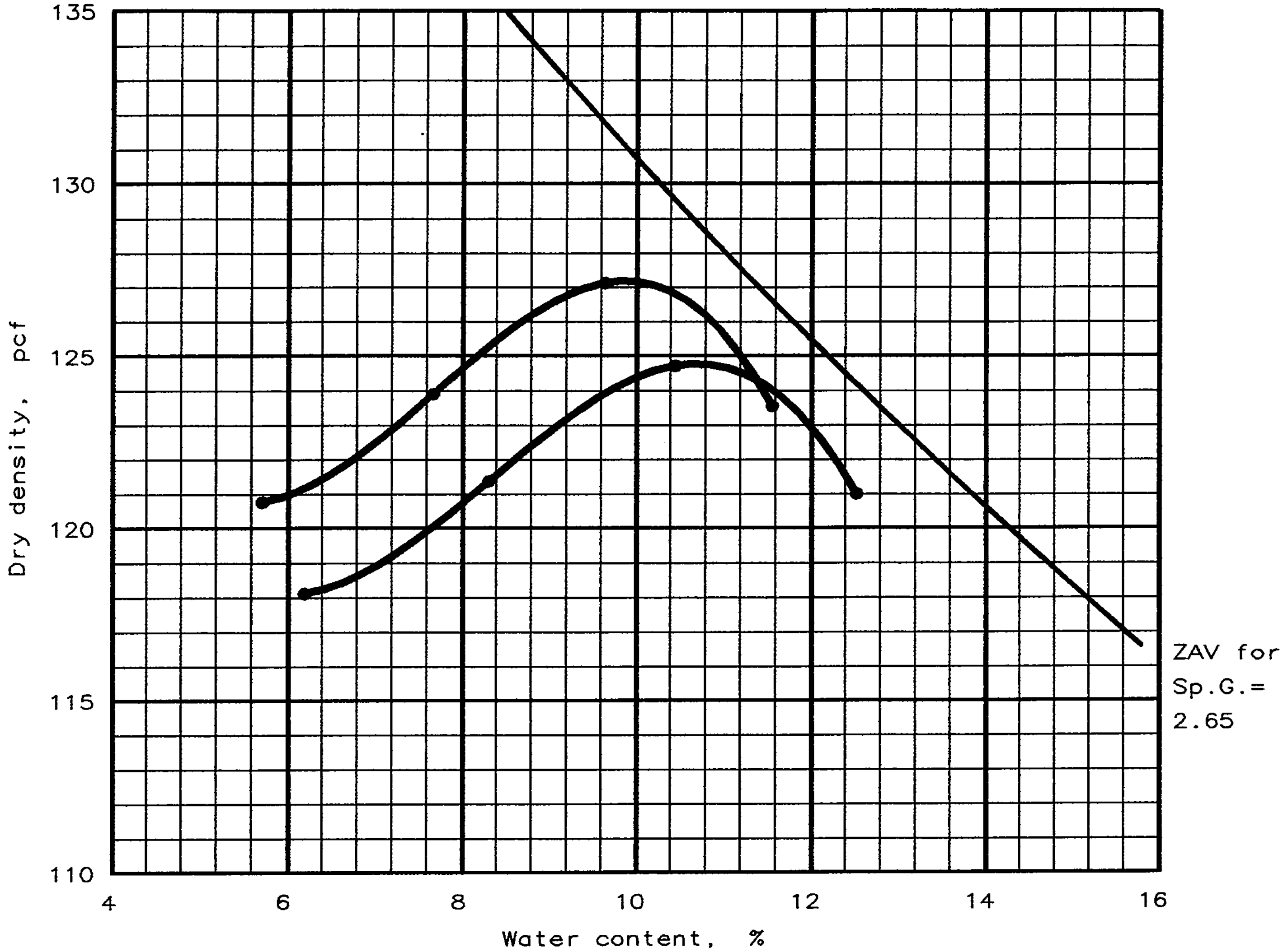
Client: International Uranium Corporation

Project: Soil Sample Testing

Project No.: 804899

Figure 48

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure C, Standard

Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in	% < No.200
	USCS	AASHTO						
			N/A %	2.65			7.7 %	

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 127.2 pcf Optimum moisture = 9.9 %	124.8 pcf 10.7 %	RF4-S1 Sand, clayey, grvly, brn

Project No.: 804899

Project: International Uranium Corporation

Location: Soil Sample Testing

Date: 5/3/99

Remarks:

SUBMITTED BY: Client

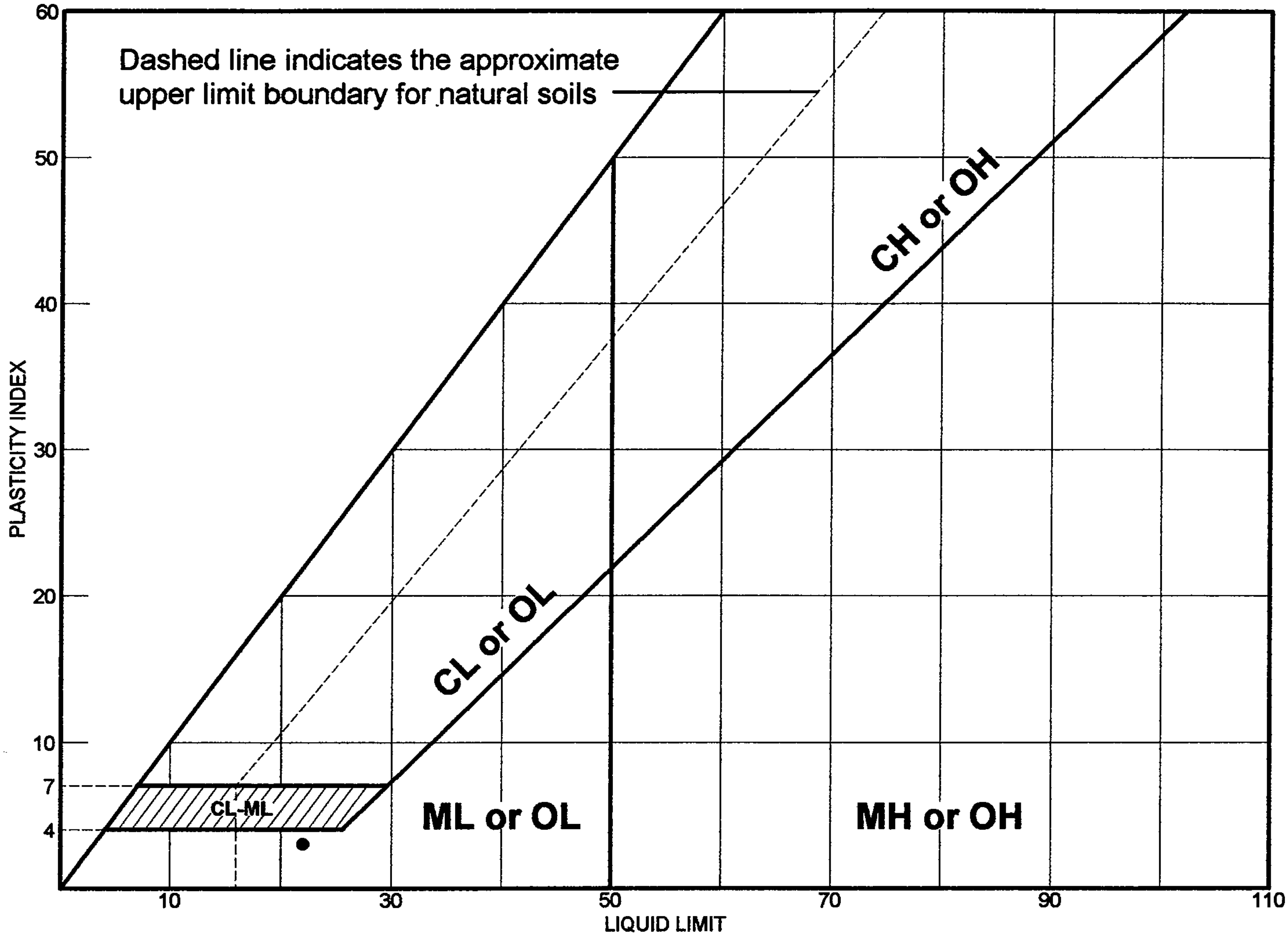
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST

WESTERN COLORADO TESTING, INC.

Fig. No. 18

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sand, clayey, gravely, brown	22	19	3	51.1	25.5	SM

Project No. 804899 **Client:** International Uranium Corporation

Project: Soil Sample Testing

● **Source:** **Sample No.:** RF4-S1

Remarks:

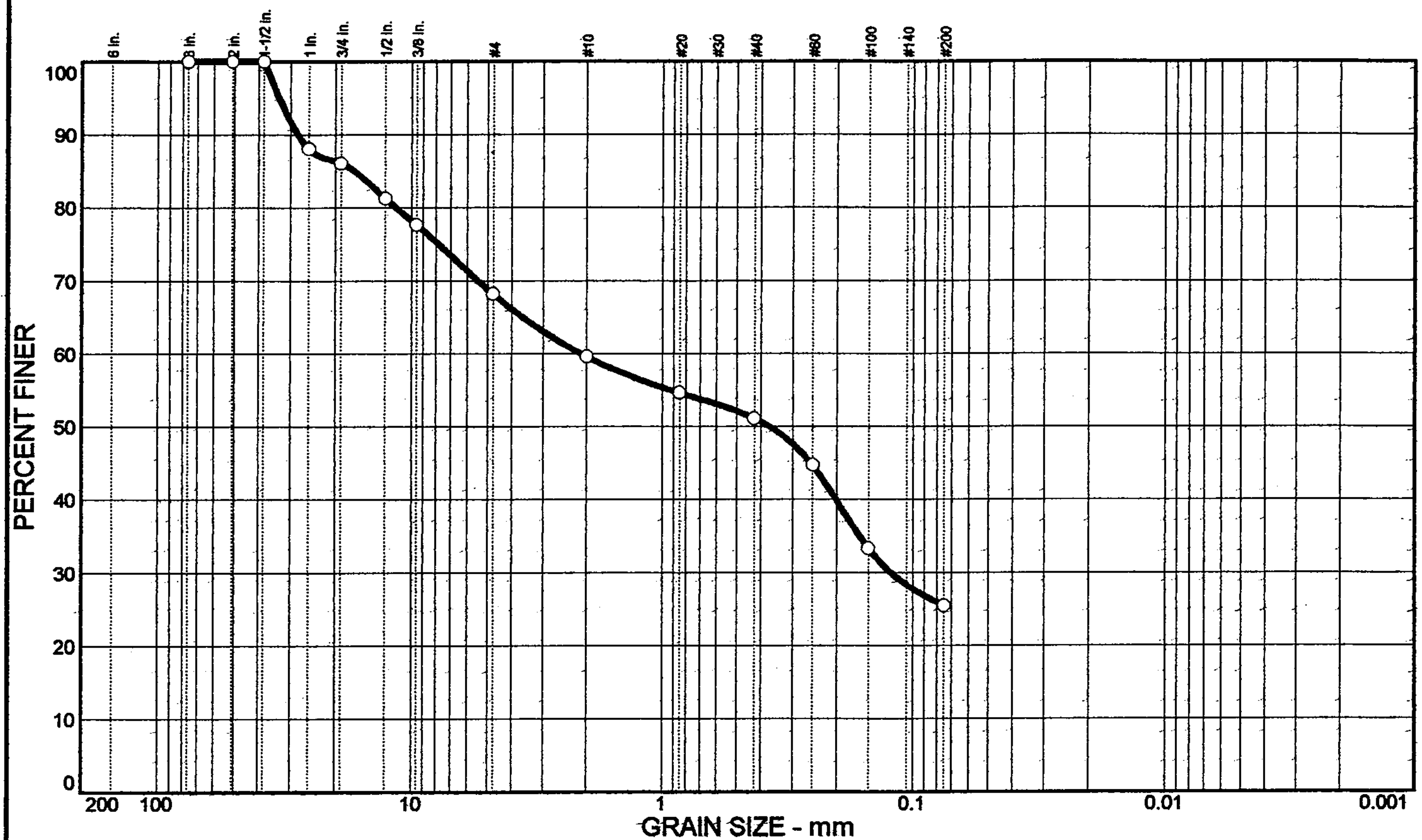
● Tested By: JH

LIQUID AND PLASTIC LIMITS TEST REPORT

WESTERN COLORADO TESTING, INC.

Figure 28

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		31.8	42.7			SM	A-2-4(0)		

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	88.1		
3/4	86.1		
1/2	81.3		
3/8	77.7		
	GRAIN SIZE		
D_{60}	2.11		
D_{30}	0.122		
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	68.2		
#10	59.6		
#20	54.6		
#40	51.1		
#60	44.7		
#100	33.3		
#200	25.5		

SOIL DESCRIPTION

○ Sand, clayey, gravely, brown

REMARKS:

○ Tested By: JH

○ Source:

Sample No.: RF4-S1

WESTERN COLORADO TESTING, INC.

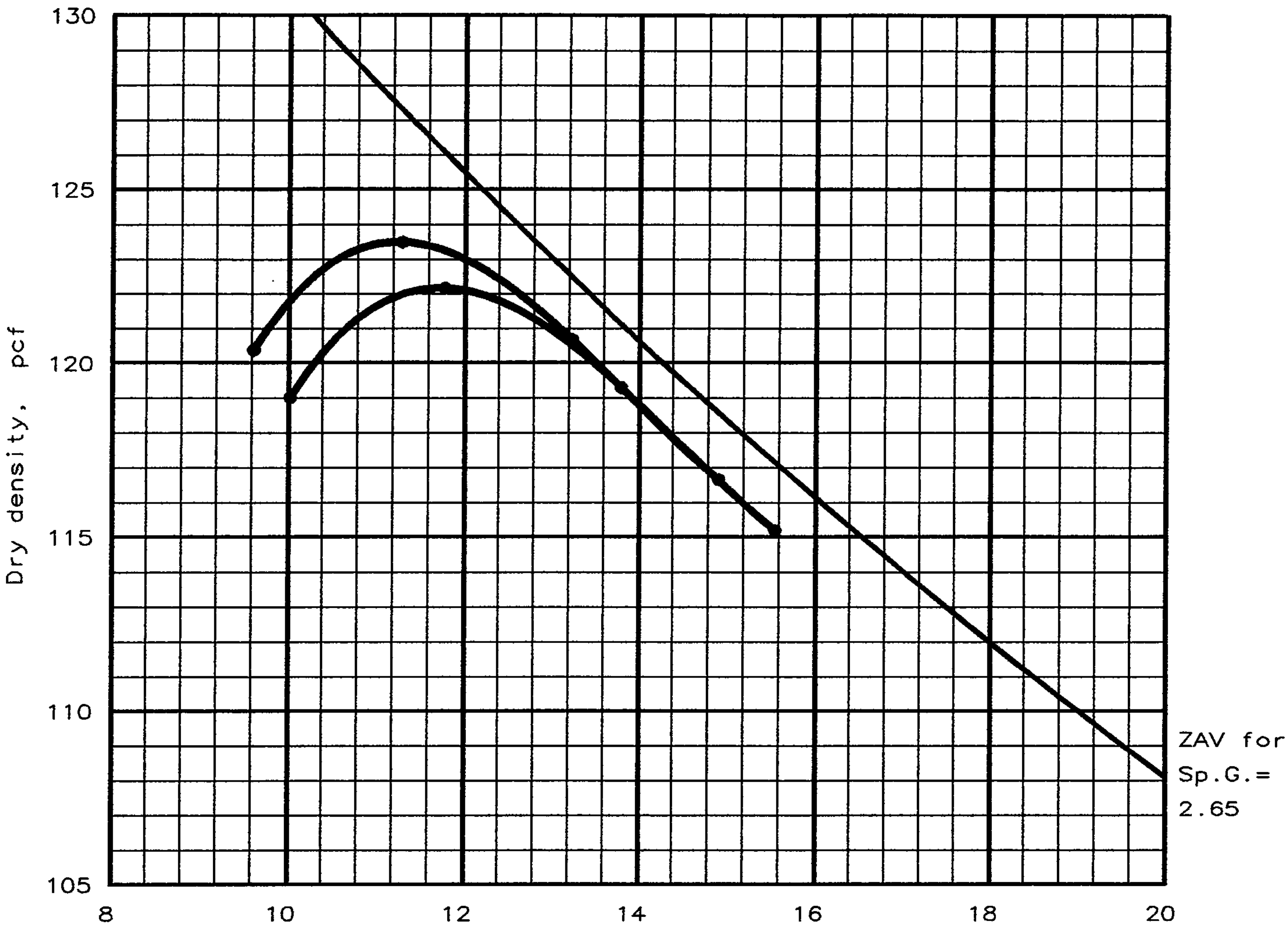
Client: International Uranium Corporation

Project: Soil Sample Testing

Project No.: 804899

Figure 49

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure B, Standard
Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in	% < No.200
	USCS	AASHTO						
			N/A %	2.65			4.1 %	

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 123.5 pcf Optimum moisture = 11.3 %	122.2 pcf 11.7 %	RF5-S1 Sand, clayey, grvly, brn

Project No.: 804899
Project: International Uranium Corporation
Location: Soil Sample Testing

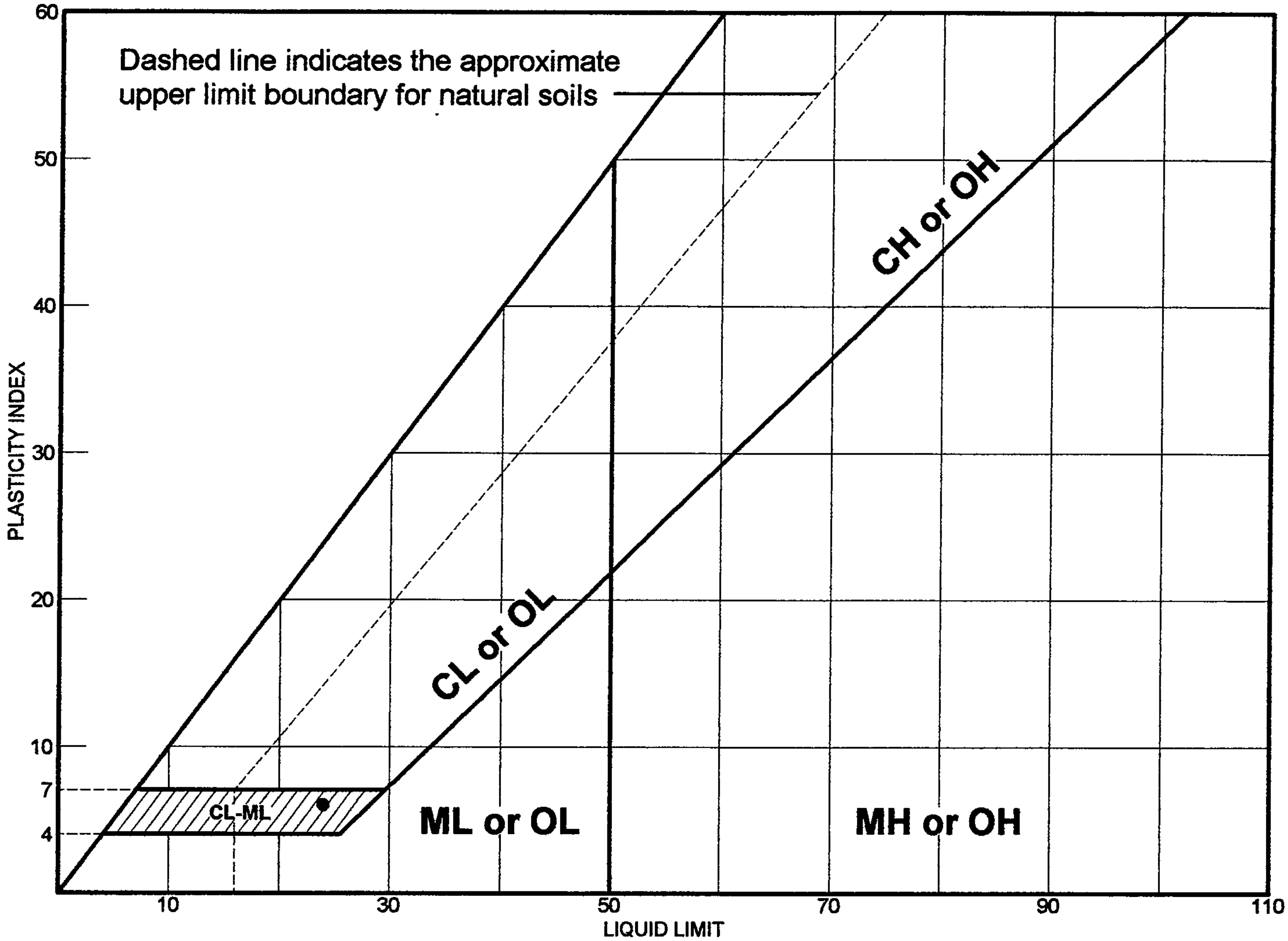
Date: 5/3/99

Remarks:
SUBMITTED BY: Client
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST
WESTERN COLORADO TESTING, INC.

Fig. No. 19

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sand, clayey, gravely, brown	24	18	6	74.3	41.6	SM

Project No. 804899 **Client:** International Uranium Corporation

Project: Soil Sample Testing

● **Source:** **Sample No.:** RF5-S1

Remarks:

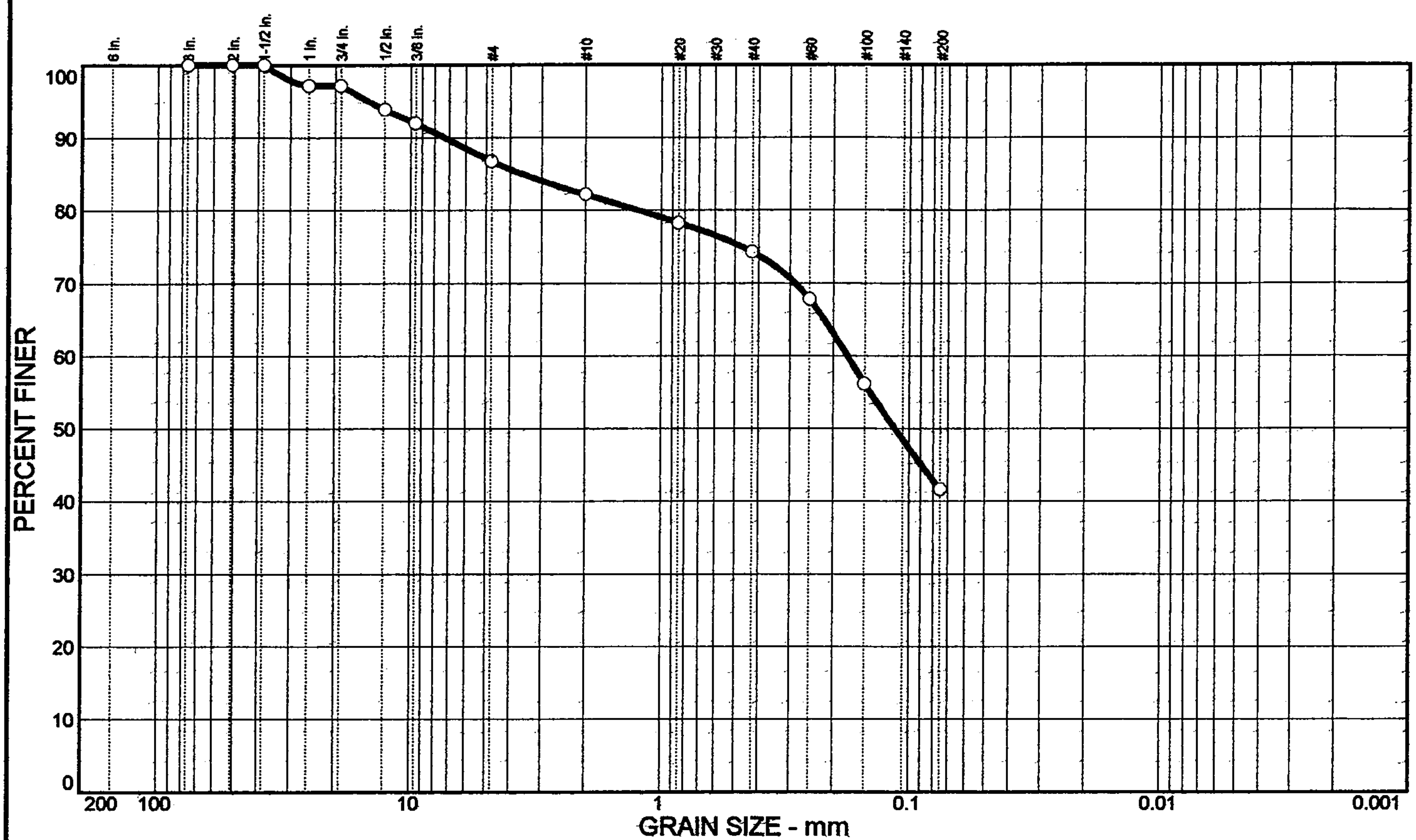
● Tested By: JH

LIQUID AND PLASTIC LIMITS TEST REPORT

WESTERN COLORADO TESTING, INC.

Figure 29

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		13.2	45.2			SM	A-4(0)		

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	97.2		
3/4	97.2		
1/2	93.9		
3/8	92.0		
	GRAIN SIZE		
D_{60}	0.176		
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	86.8		
#10	82.2		
#20	78.3		
#40	74.3		
#60	67.8		
#100	56.2		
#200	41.6		

SOIL DESCRIPTION

○ Sand, clayey, gravely, brown

REMARKS:

○ Tested By: JH

○ Source:

Sample No.: RF5-S1

WESTERN COLORADO TESTING, INC.

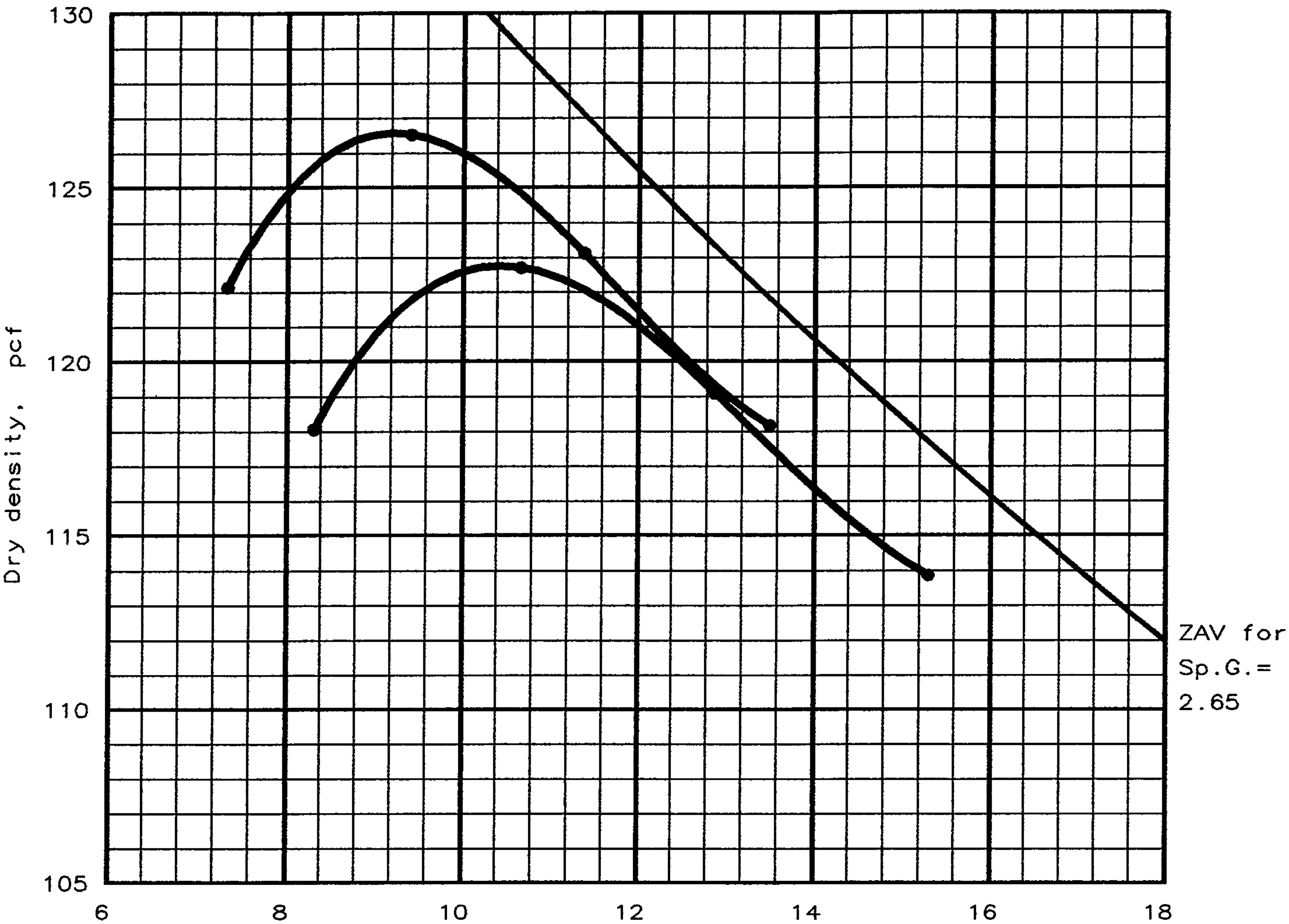
Client: International Uranium Corporation

Project: Soil Sample Testing

Project No.: 804899

Figure 50

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure C, Standard
Oversize correction applied to each point

Elev/ Depth	Classification USCS	Classification AASHTO	Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in	% < No.200
			N/A %	2.65			11.7 %	

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 126.6 pcf Optimum moisture = 9.2 %	122.8 pcf 10.4 %	RF6-S1 Sand, clayey, grvly, brn

Project No.: 804899
Project: International Uranium Corporation
Location: Soil Sample Testing

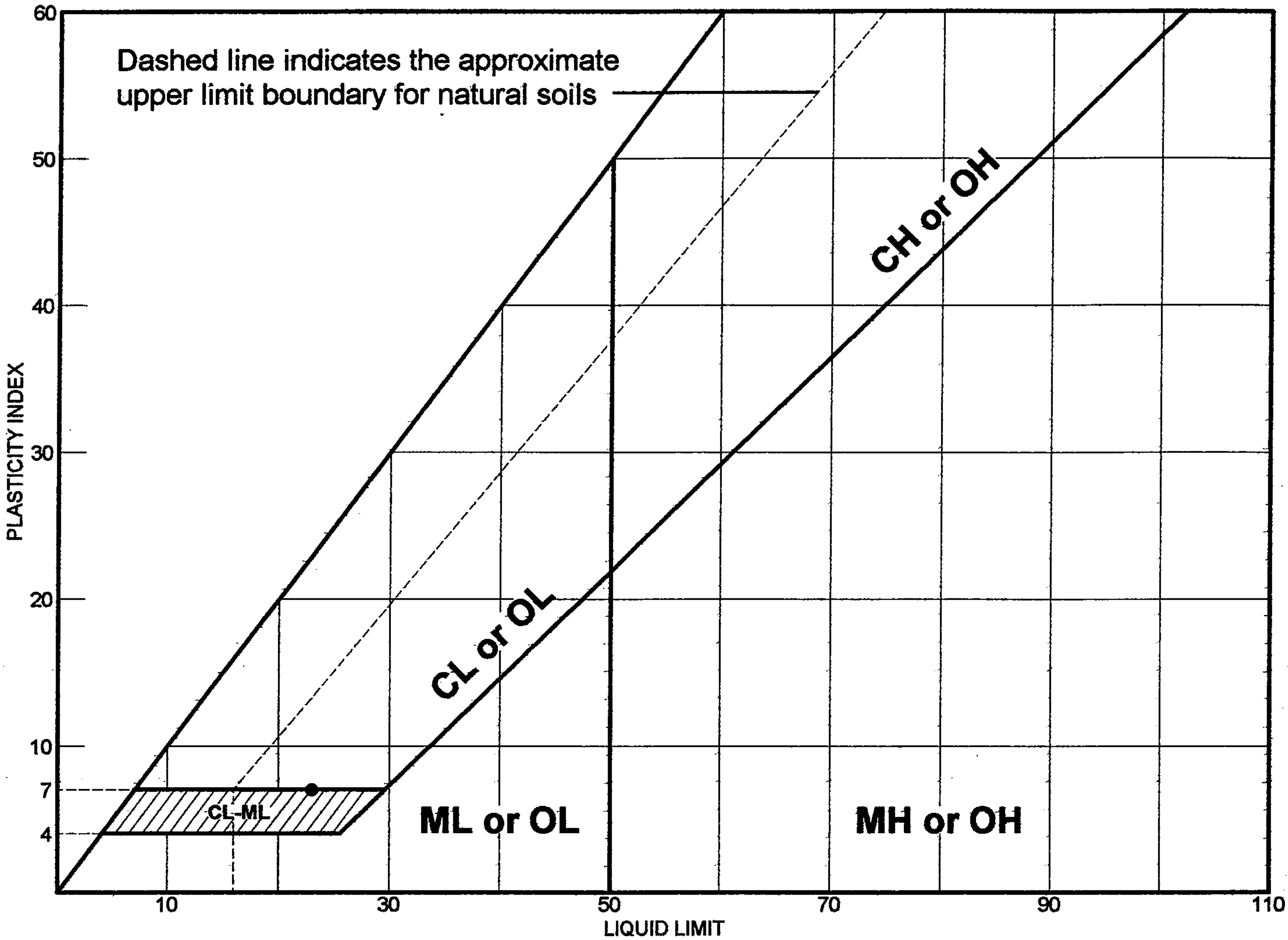
Date: 5/3/99

Remarks:
SUBMITTED BY: Client
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST
WESTERN COLORADO TESTING, INC.

Fig. No. 20

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Sand, clayey, gravely, brown	23	16	7	53.0	30.6	GC-GM

Project No. 804899 **Client:** International Uranium Corporation

Project: Soil Sample Testing

● **Source:** **Sample No.:** RF6-S1

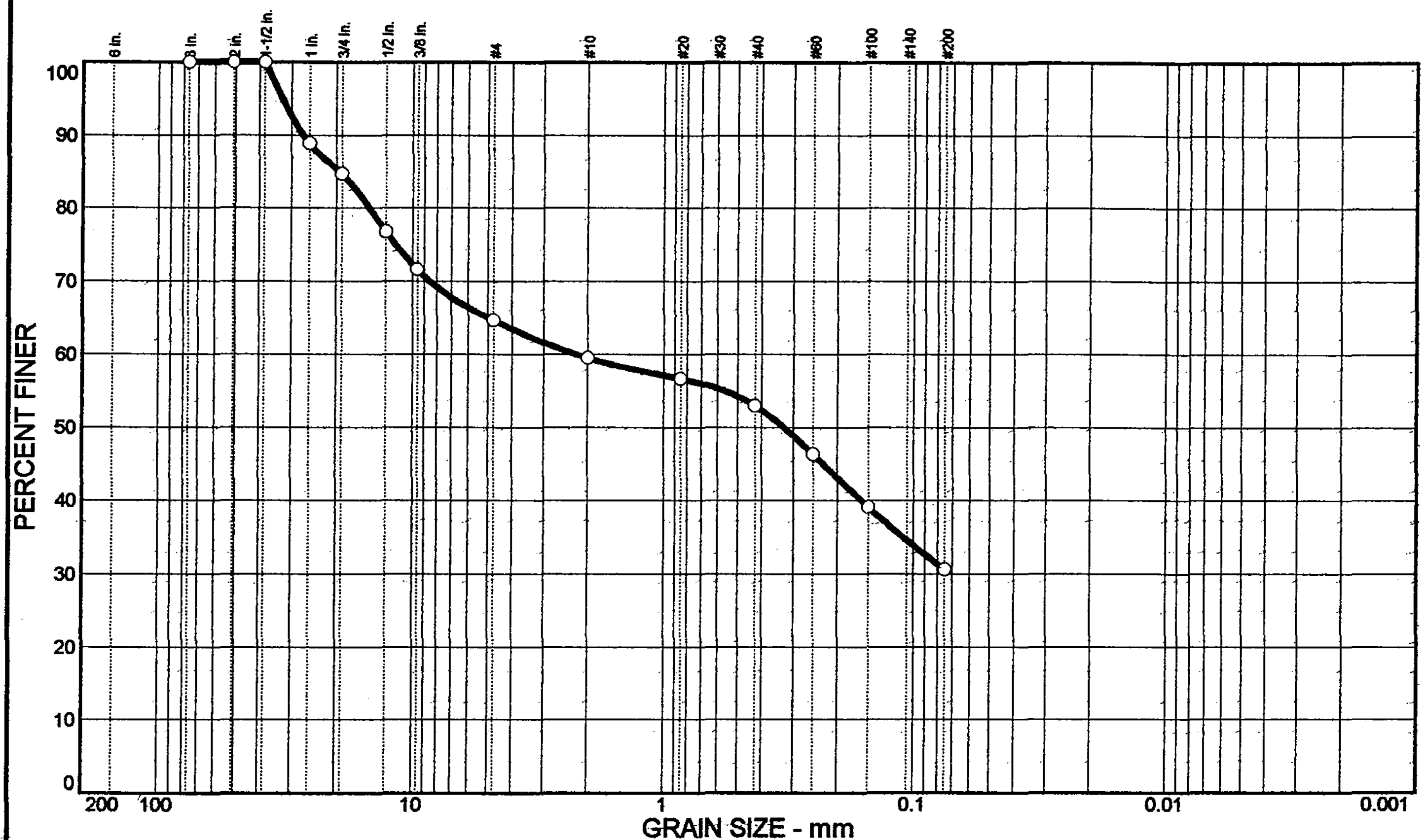
Remarks:
● Tested By: JH

LIQUID AND PLASTIC LIMITS TEST REPORT

WESTERN COLORADO TESTING, INC.

Figure 30

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		35.3	34.1			GC-GM	A-2-4(0)	16	23

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	88.9		
3/4	84.7		
1/2	76.8		
3/8	71.6		
	GRAIN SIZE		
D_{60}	2.23		
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	64.7		
#10	59.5		
#20	56.7		
#40	53.0		
#60	46.4		
#100	39.1		
#200	30.6		

SOIL DESCRIPTION

○ Sand, clayey, gravely, brown

REMARKS:

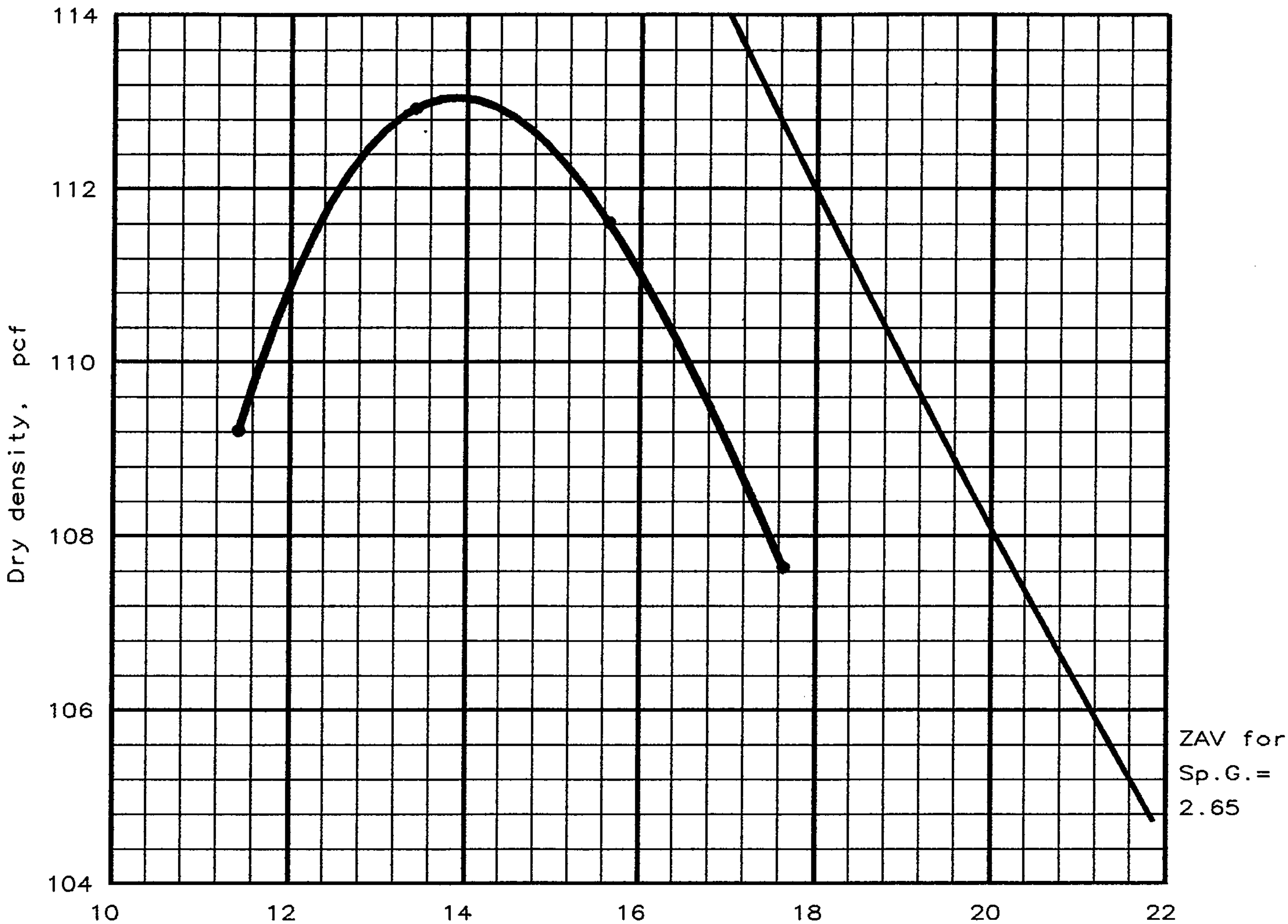
○ Tested By: JH

○ Source:

Sample No.: RF6-S1

WESTERN COLORADO TESTING, INC.	Client: International Uranium Corporation Project: Soil Sample Testing Project No.: 804899 Figure 51

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure A, Standard

Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
			N/A %	2.65				

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 113.1 pcf Optimum moisture = 13.9 %	113.1 pcf 13.9 %	RF7-S1 Clay, v sandy, silty, rd

Project No.: 804899

Project: International Uranium Corporation

Location: Soil Sample Testing

Date: 5/3/99

Remarks:

SUBMITTED BY: Client

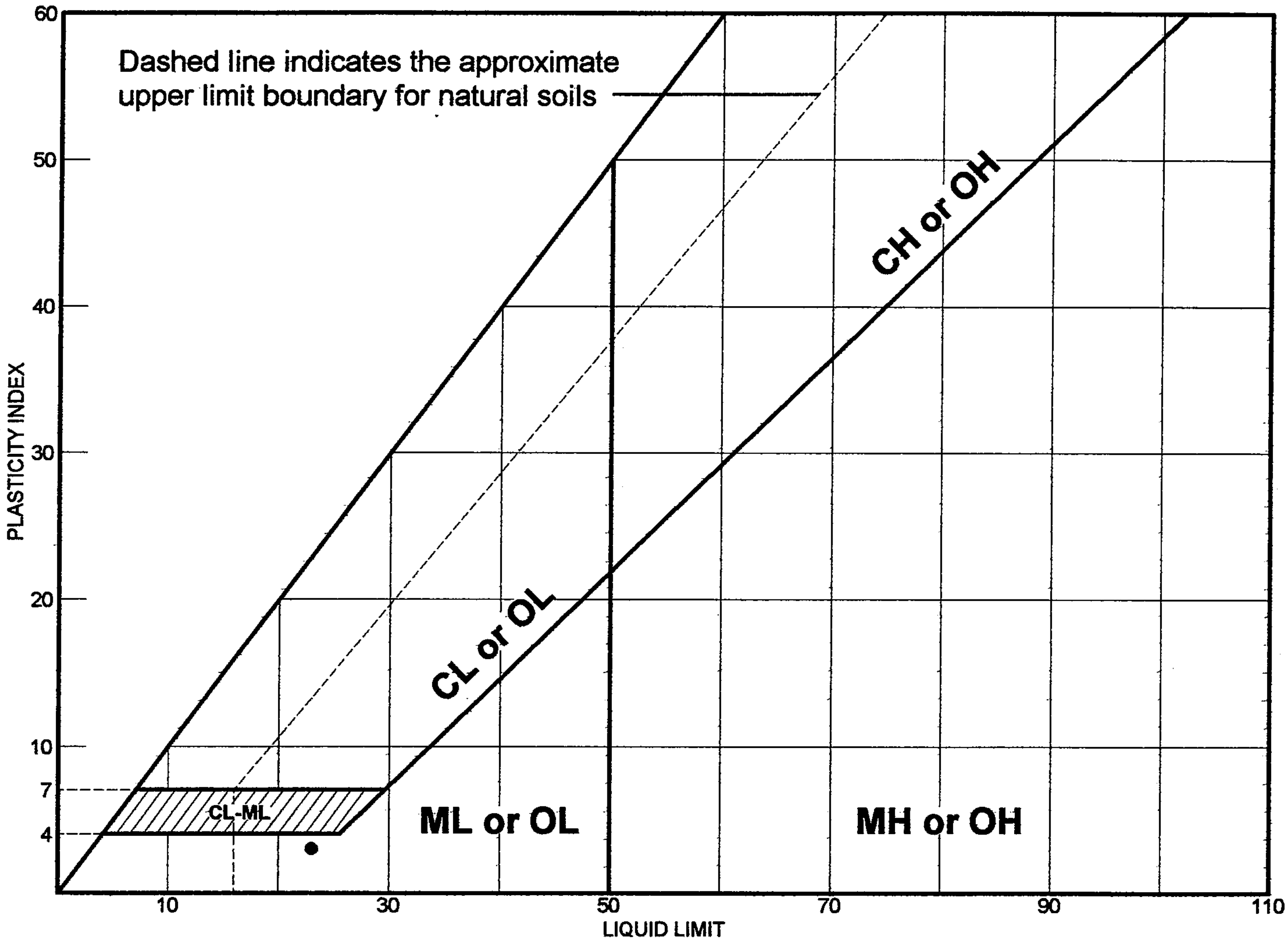
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST

WESTERN COLORADO TESTING, INC.

Fig. No. 21

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Clay, very sandy, silty, red	23	20	3	88.6	56.8	ML

Project No. 804899 **Client:** International Uranium Corporation

Project: Soil Sample Testing

● **Source:** **Sample No.:** RF7-S1

Remarks:

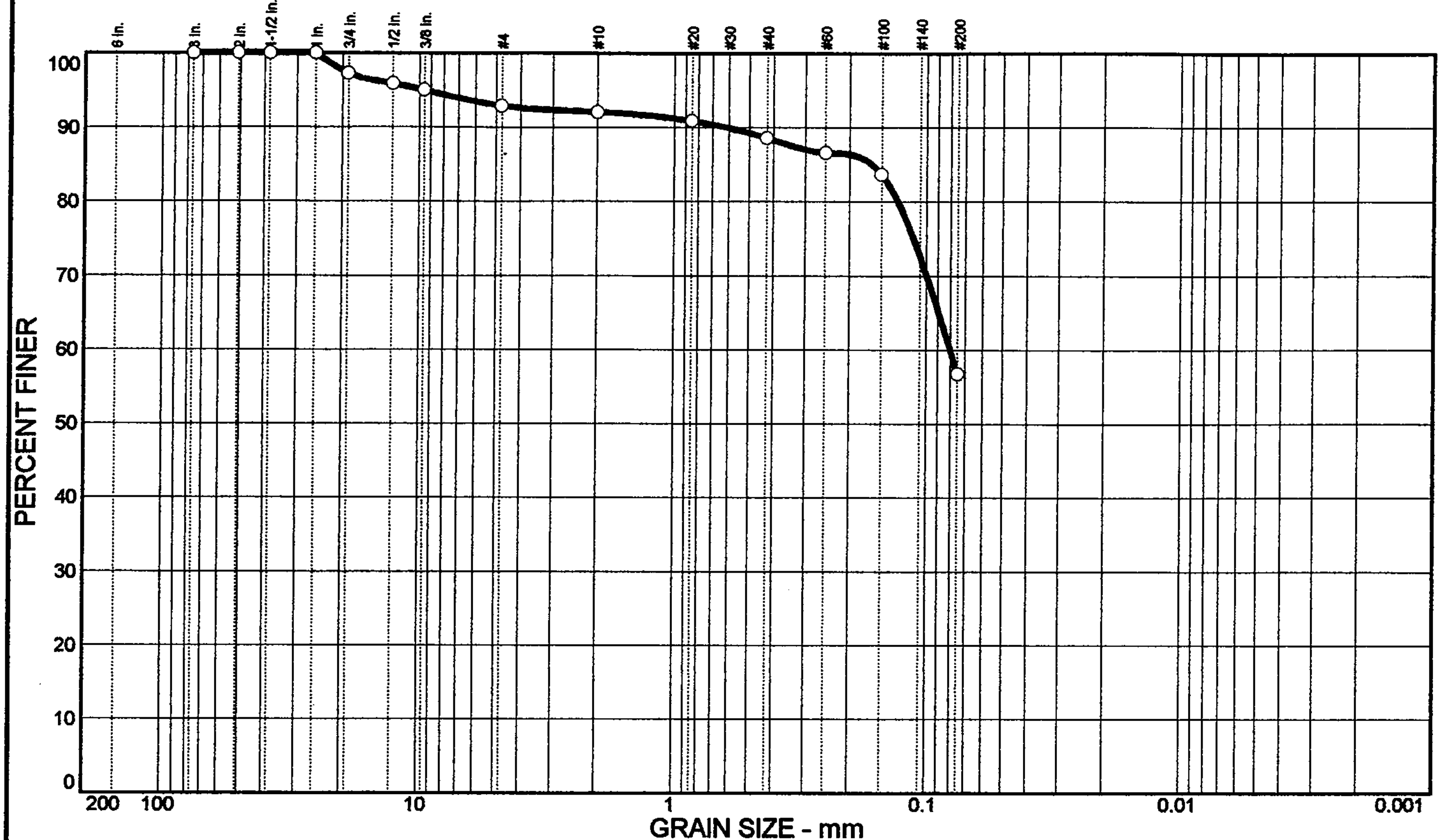
● Tested By: JH

LIQUID AND PLASTIC LIMITS TEST REPORT

WESTERN COLORADO TESTING, INC.

Figure 31

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		7.1	36.1			ML	A-4(0)	20	23

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	100.0		
3/4	97.3		
1/2	95.9		
3/8	95.0		
	GRAIN SIZE		
D_{60}	0.0801		
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	92.9		
#10	92.1		
#20	90.9		
#40	88.6		
#60	86.6		
#100	83.7		
#200	56.8		

SOIL DESCRIPTION

○ Clay, very sandy, silty, red

REMARKS:

○ Tested By: JH

○ Source:

Sample No.: RF7-S1

WESTERN COLORADO TESTING, INC.

Client: International Uranium Corporation

Project: Soil Sample Testing

Project No.: 804899

Figure 52

APPENDIX A.1.7

WESTERN COLORADO TESTING, INC.

1999b

WESTERN
COLORADO
TESTING,
INC.

529 25 1/2 Road, Suite B-101
Grand Junction, Colorado 81505
(970) 241-7700 • Fax (970) 241-7783

May 4, 1999
WCT #804899

International Uranium USA Corporation
Independence Plaza, Suite 950
1050 17th Street
Denver, Colorado 80265

Subject: Soil Sample Testing

As requested, we have completed the soil laboratory work for International Uranium USA Corporation. The testing performed included the following:

- 21 Sieve Analyses
- 21 Atterberg Limit Tests
- 21 Standard Proctor Tests (ASTM D698)
- 6 Hydrometer Tests
- 6 Specific Gravity Tests

Data sheets are included for each test except for the specific gravities. The results of these are shown below:

Sample	Avg. Bulk Specific Gravity	Avg. Bulk Specific Gravity (SSD)	Apparent Specific Gravity	Absorption Percent
C2 - TS1	2.337	2.468	2.673	5.372
C2 - TS2	2.137	2.392	2.868	11.926
C2 - TS3	2.157	2.359	2.705	9.396
C2 - TS4	2.265	2.432	2.721	7.402
C3 - TS1	2.456	2.562	2.746	4.294
C3 - TS2	2.349	2.464	2.655	4.900

We have been happy to be of service. If you have any questions or we may be of further assistance, please call.

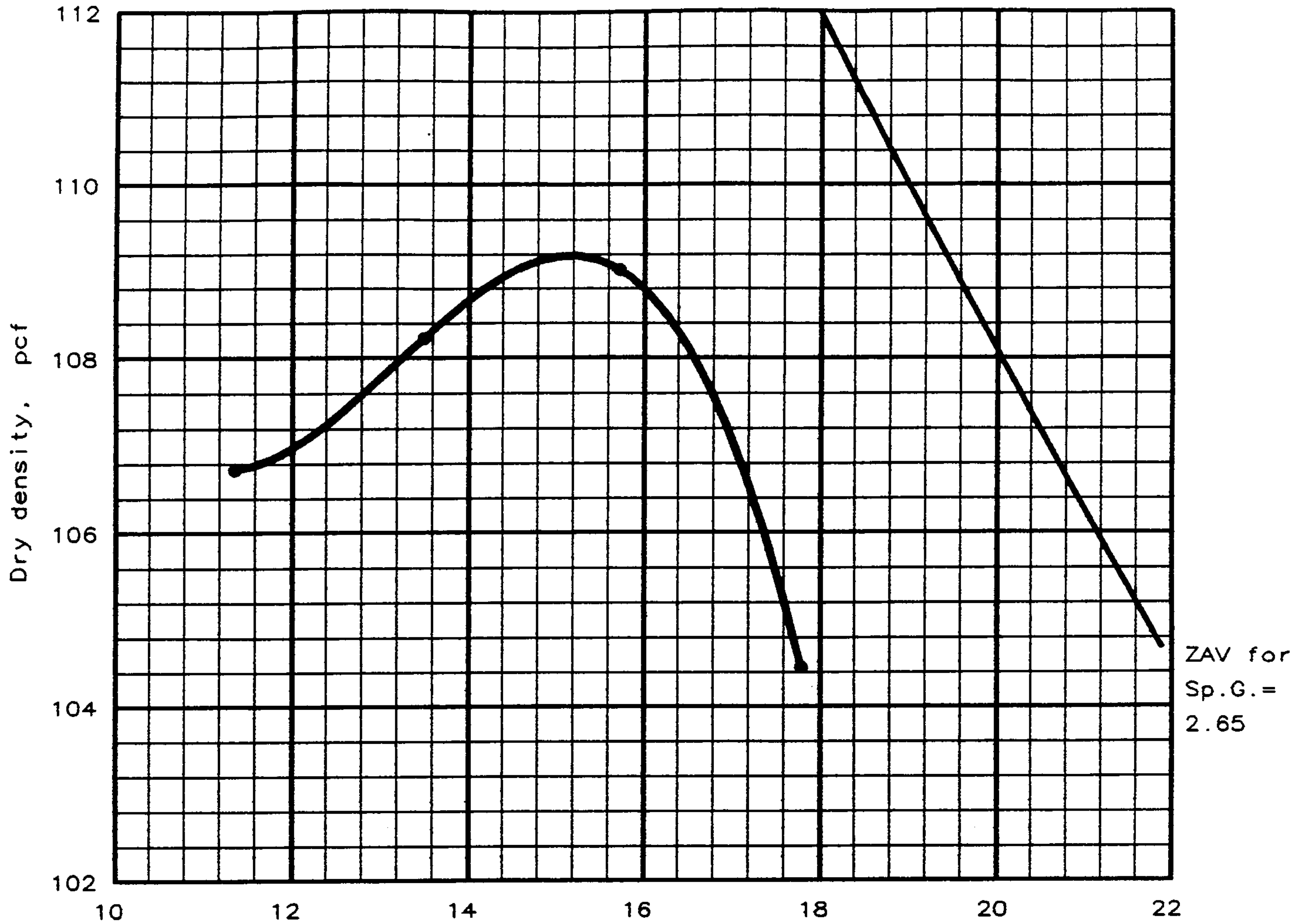
Respectfully Submitted:
WESTERN COLORADO TESTING, INC.

Wm. Daniel Smith

Wm. Daniel Smith, P.E.
Senior Geotechnical Engineer

WDS/mh
Msb:jobs\8048L0504

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure A, Standard

Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
			N/A %	2.65				

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 109.2 pcf Optimum moisture = 15.2 %	109.2 pcf 15.2 %	C2-ST1

Project No.: 804899

Project: International Uranium Corporation

Location: Soil Sample Testing

Date: 4/27/99

Remarks:

SUBMITTED BY: Client

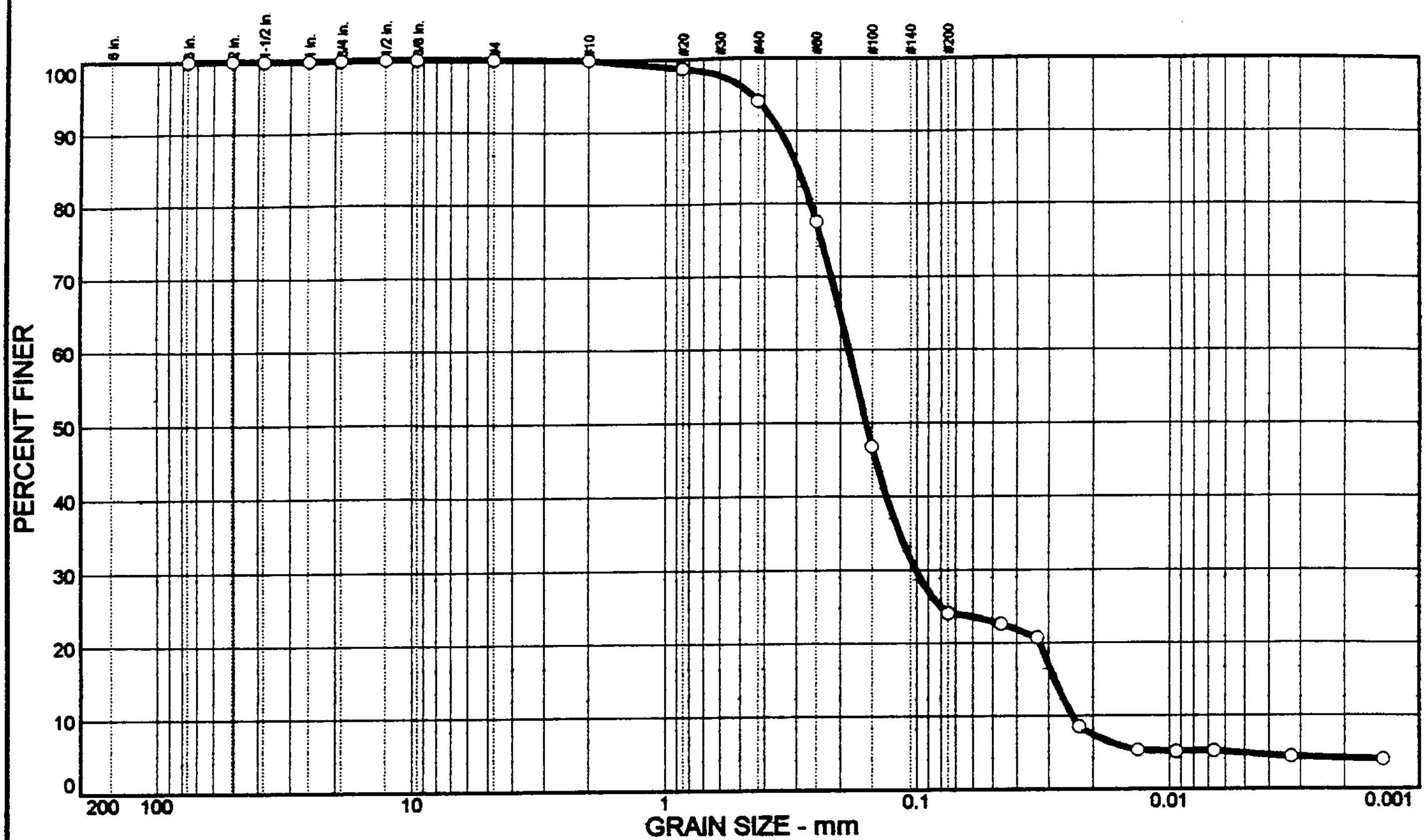
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST

WESTERN COLORADO TESTING, INC.

Fig. No. 1

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		0.0	75.9	19.3	4.8	SM	A-2-4(0)	NP	NP

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	100.0		
3/4	100.0		
1/2	100.0		
3/8	100.0		
	GRAIN SIZE		
D_{60}	0.186		
D_{30}	0.100		
D_{10}	0.0241		
	COEFFICIENTS		
C_c	2.25		
C_u	7.74		

SIEVE number size	PERCENT FINER ○		
#4	100.0		
#10	100.0		
#20	98.7		
#40	94.1		
#60	77.5		
#100	46.8		
#200	24.1		

SOIL DESCRIPTION

○ Sand, silty, gray/brown

REMARKS:

○ Tested by: JH

○ Source:

Sample No.: C2-ST1

WESTERN COLORADO TESTING, INC.

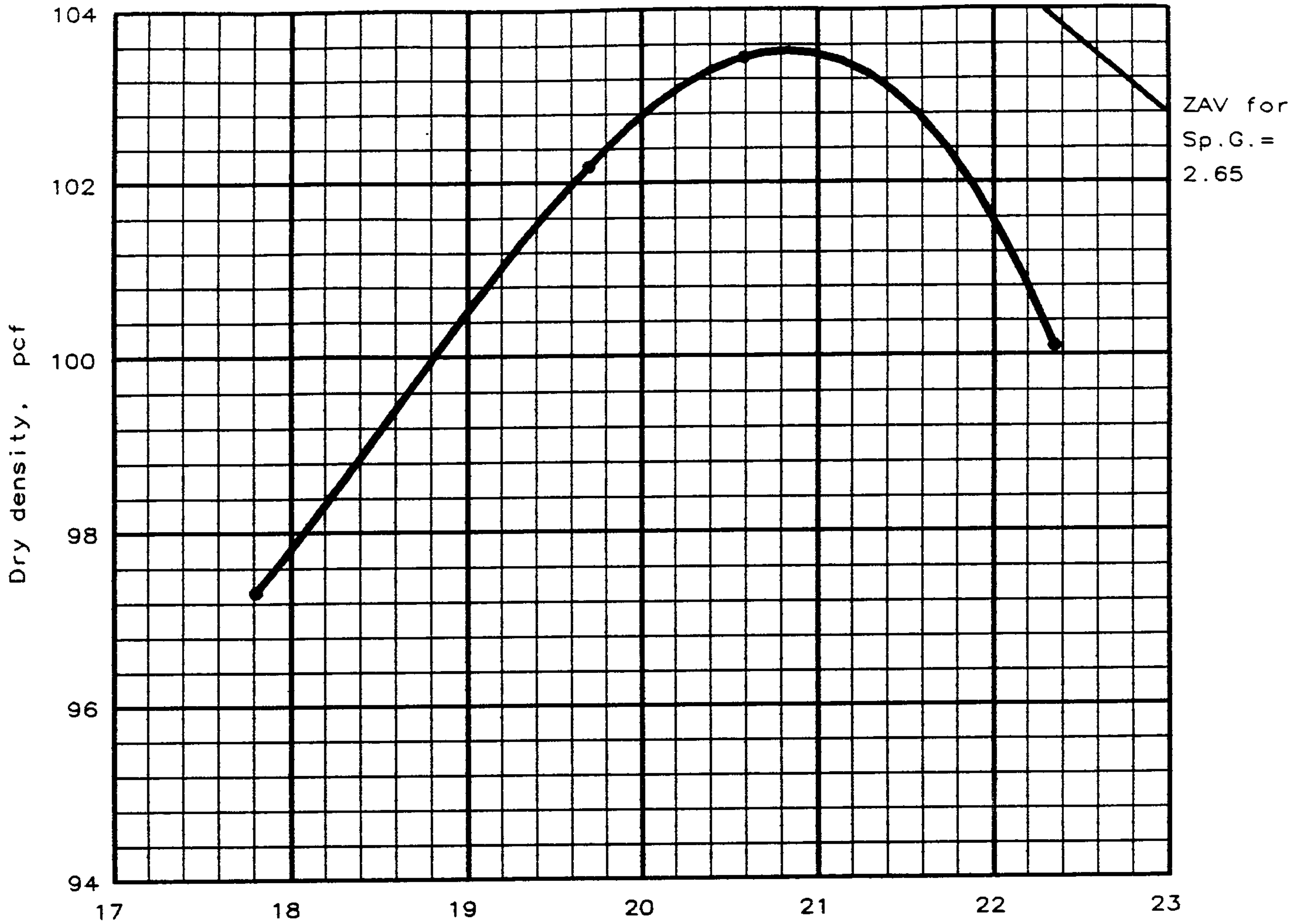
Client: International Uranium Corporation

Project: Soil Sample Testing

Project No.: 804899

Figure 32

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure A, Standard

Oversize correction applied to each point

Elev/ Depth	Classification USCS	Classification AASHTO	Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
			N/A %	2.65				

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 103.5 pcf Optimum moisture = 20.8 %	103.5 pcf 20.8 %	C2-TS2

Project No.: 804899

Project: International Uranium Corporation

Location: Soil Sample Testing

Date: 4/27/99

Remarks:

SUBMITTED BY: Client

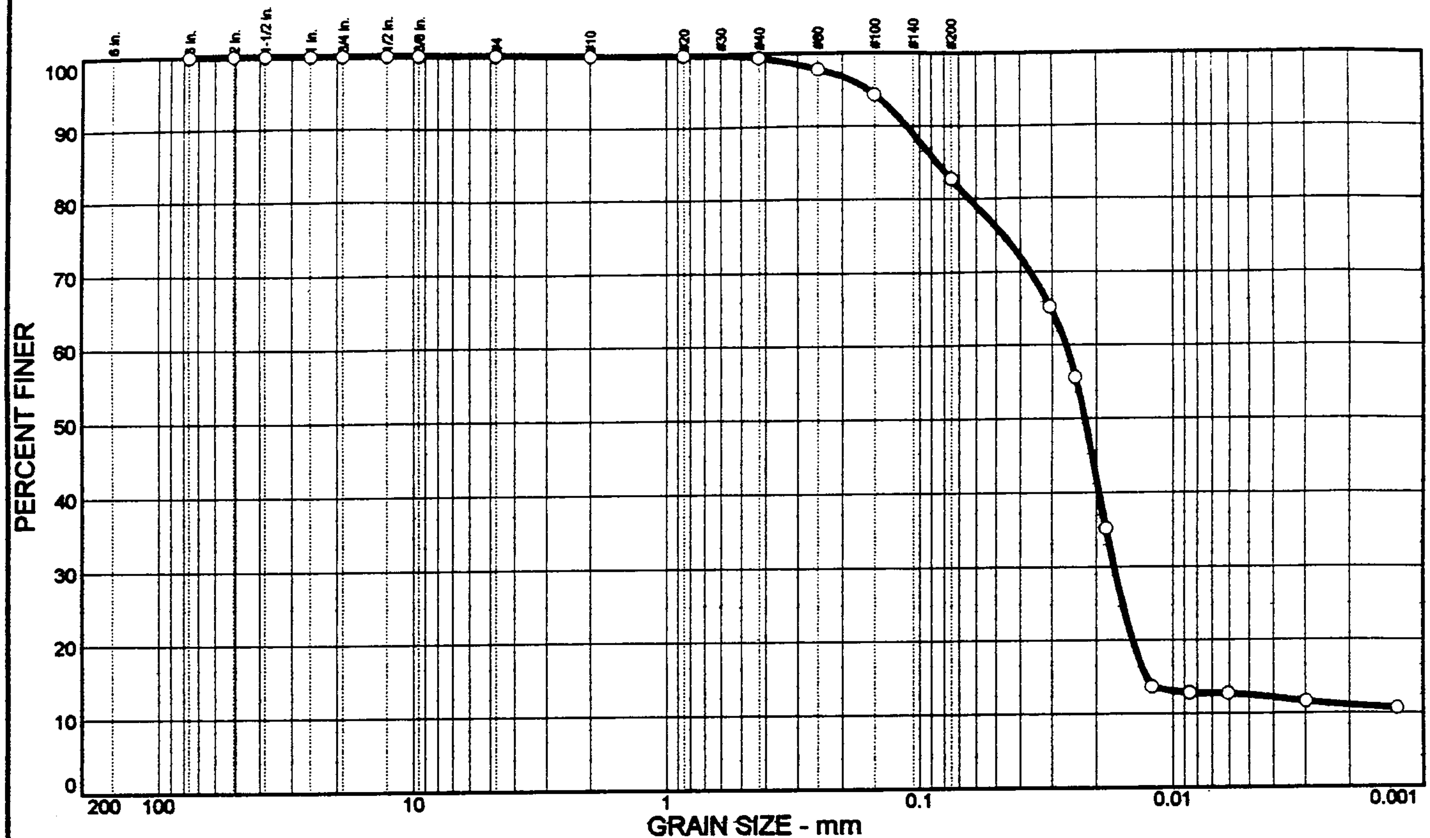
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST

WESTERN COLORADO TESTING, INC.

Fig. No. 2

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		0.0	17.3	70.2	12.5	ML	A-4(0)	29	29

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	100.0		
3/4	100.0		
1/2	100.0		
3/8	100.0		
	GRAIN SIZE		
D_{60}	0.0264		
D_{30}	0.0170		
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	100.0		
#10	100.0		
#20	99.9		
#40	99.4		
#60	97.8		
#100	94.3		
#200	82.7		

SOIL DESCRIPTION
○ Silt, clayey, sandy, gray

REMARKS:
○ Tested By: JH

○ Source:

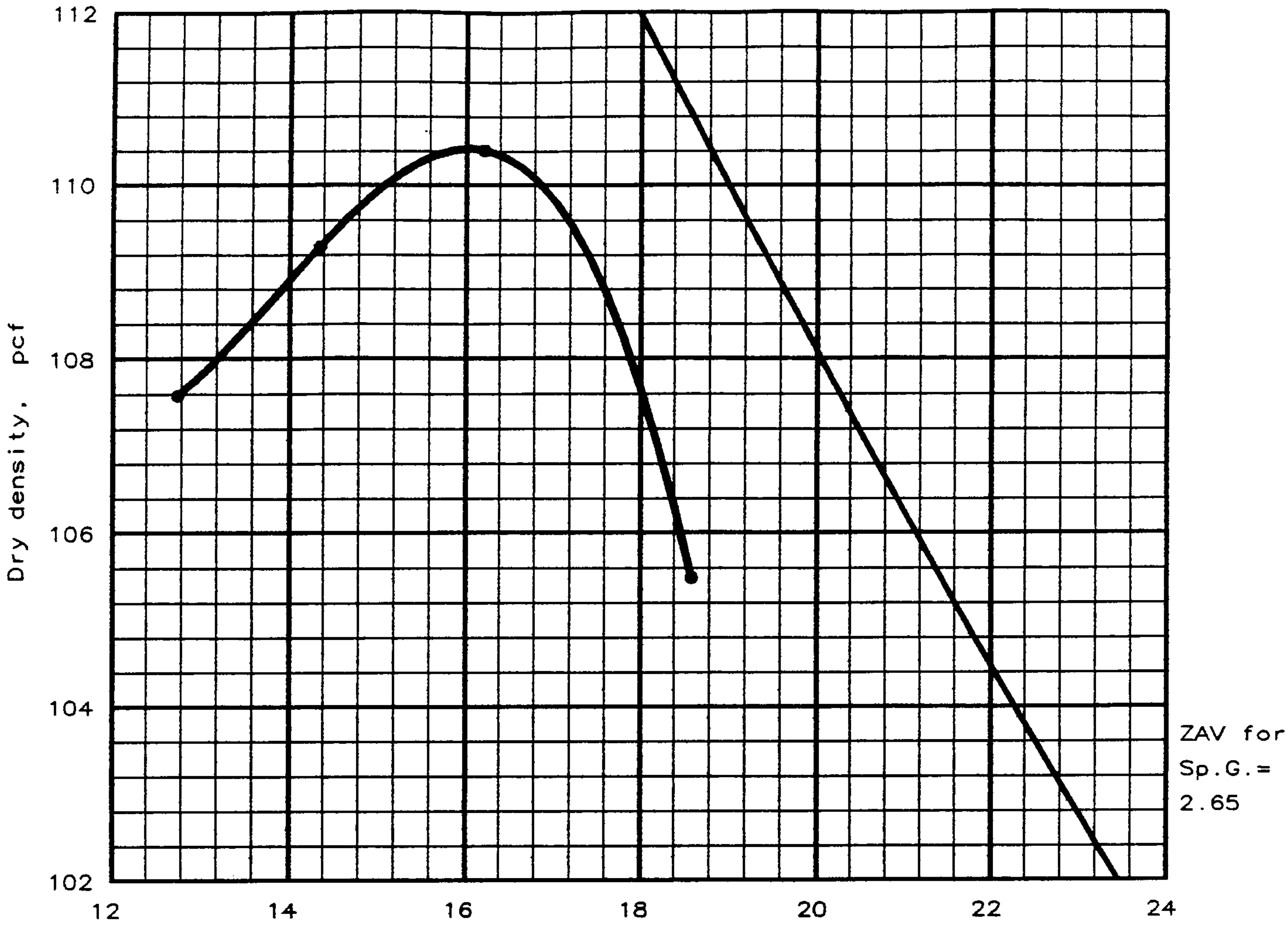
Sample No.: C2-TS2

WESTERN COLORADO TESTING, INC.

Client: International Uranium Corporation
Project: Soil Sample Testing
Project No.: 804899

Figure 33

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure A, Standard

Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
			N/A %	2.65				

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 110.4 pcf Optimum moisture = 16.0 %	110.4 pcf 16.0 %	C2-TS3

Project No.: 804899

Project: International Uranium Corporation

Location: Soil Sample Testing

Date: 4/27/99

Remarks:

SUBMITTED BY: Client

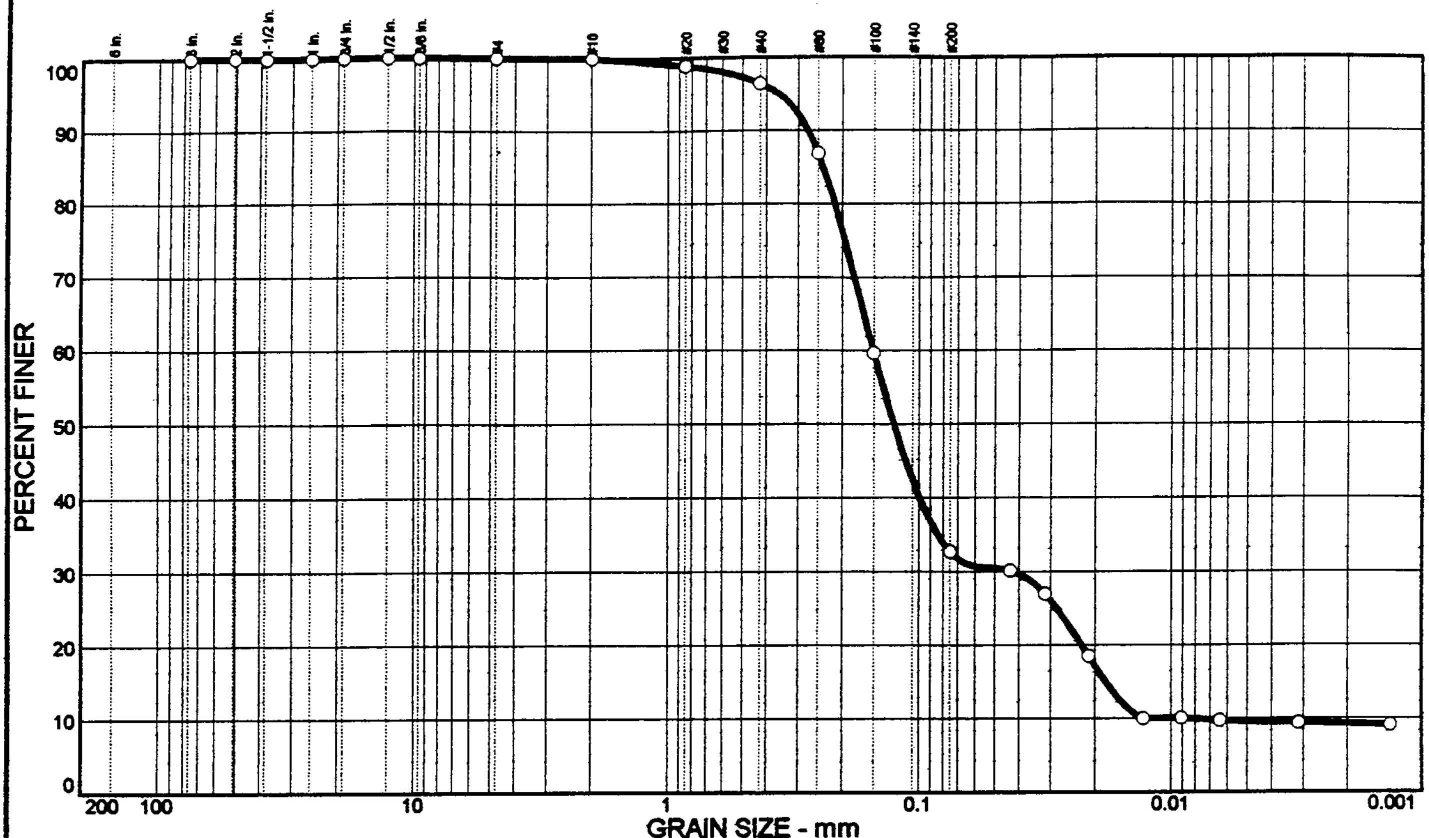
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST

WESTERN COLORADO TESTING, INC.

Fig. No. 3

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		0.0	67.3	23.2	9.5	SM	A-2-4(0)	NP	NP

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	100.0		
3/4	100.0		
1/2	100.0		
3/8	100.0		
	GRAIN SIZE		
D_{60}	0.151		
D_{30}	0.0425		
D_{10}	0.0084		
	COEFFICIENTS		
C_c	1.42		
C_u	18.03		

SIEVE number size	PERCENT FINER ○		
#4	100.0		
#10	100.0		
#20	98.9		
#40	96.4		
#60	86.9		
#100	59.6		
#200	32.7		

SOIL DESCRIPTION

○ Sand, silty, gray/brown

REMARKS:

○ Tested By: JH

○ Source:

Sample No.: C2-TS3

WESTERN COLORADO TESTING, INC.

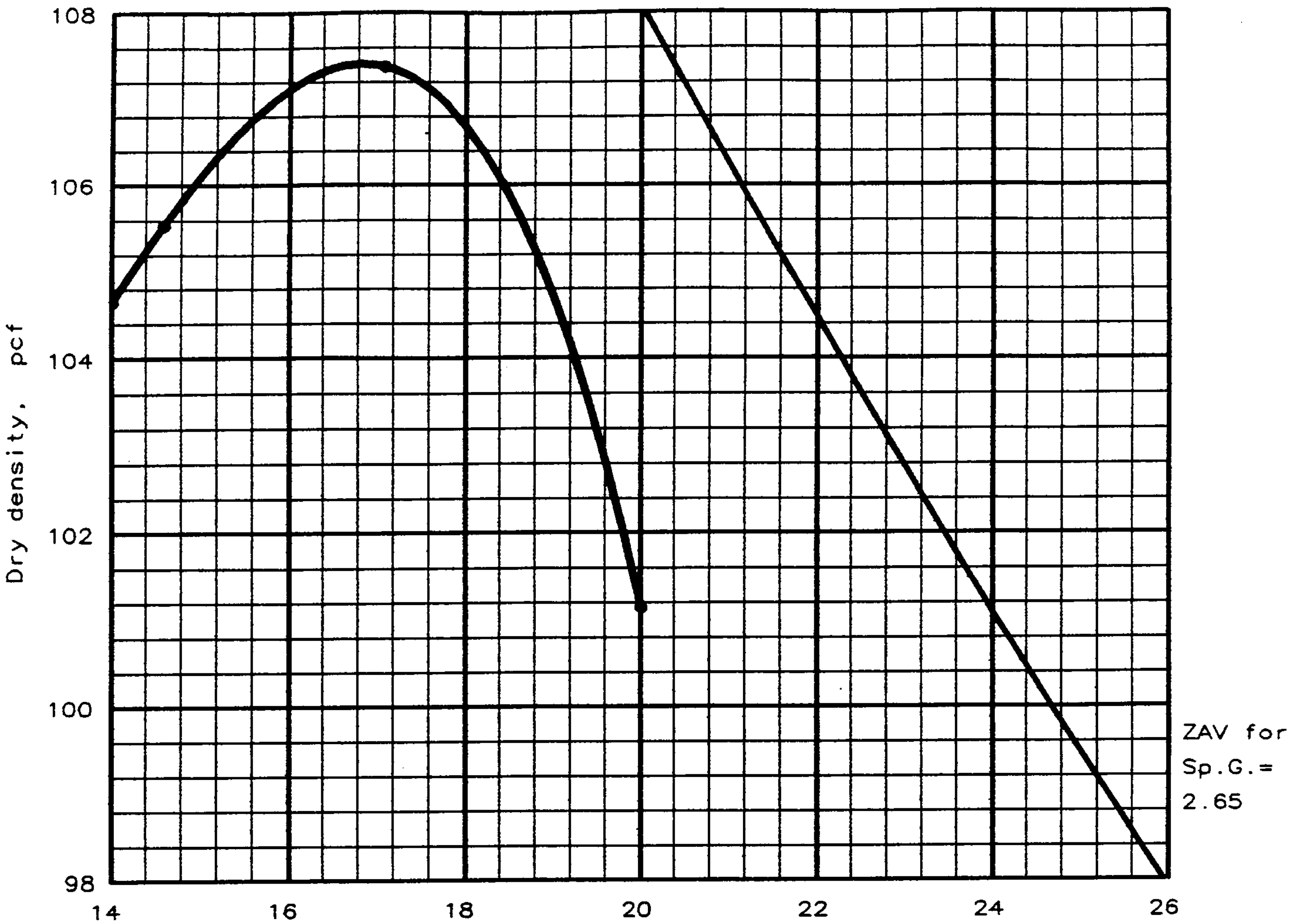
Client: International Uranium Corporation

Project: Soil Sample Testing

Project No.: 804899

Figure 34

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure A, Standard
Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
			N/A %	2.65				

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 107.4 pcf Optimum moisture = 16.8 %	107.4 pcf 16.8 %	C2-TS4

Project No.: 804899
Project: International Uranium Corporation
Location: Soil Sample Testing

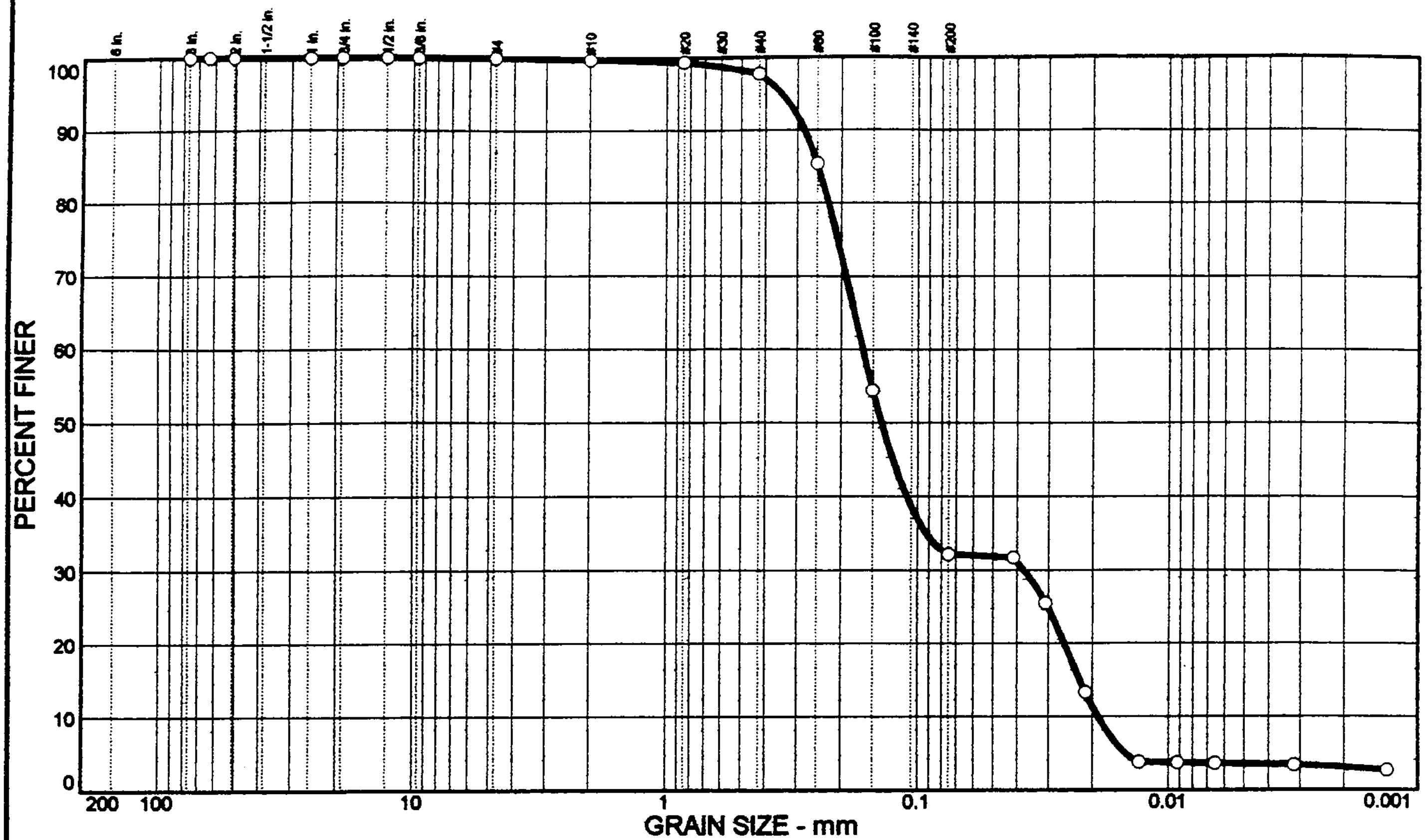
Date: 4/27/99

Remarks:
SUBMITTED BY: Client
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST
WESTERN COLORADO TESTING, INC.

Fig. No. 4

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		0.0	67.8	28.7	3.5	SM	A-2-4(0)	NP	NP

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2.5	100.0		
2	100.0		
1	100.0		
3/4	100.0		
1/2	100.0		
3/8	100.0		
	GRAIN SIZE		
D_{60}	0.164		
D_{30}	0.0376		
D_{10}	0.0189		
	COEFFICIENTS		
C_c	0.45		
C_u	8.69		

SIEVE number size	PERCENT FINER ○		
#4	100.0		
#10	99.8		
#20	99.4		
#40	97.8		
#60	85.4		
#100	54.4		
#200	32.2		

SOIL DESCRIPTION

○ Sand, silty, gray/brown

REMARKS:

○ Tested By: JH

○ Source:

Sample No.: C2-TS4

WESTERN COLORADO TESTING, INC.

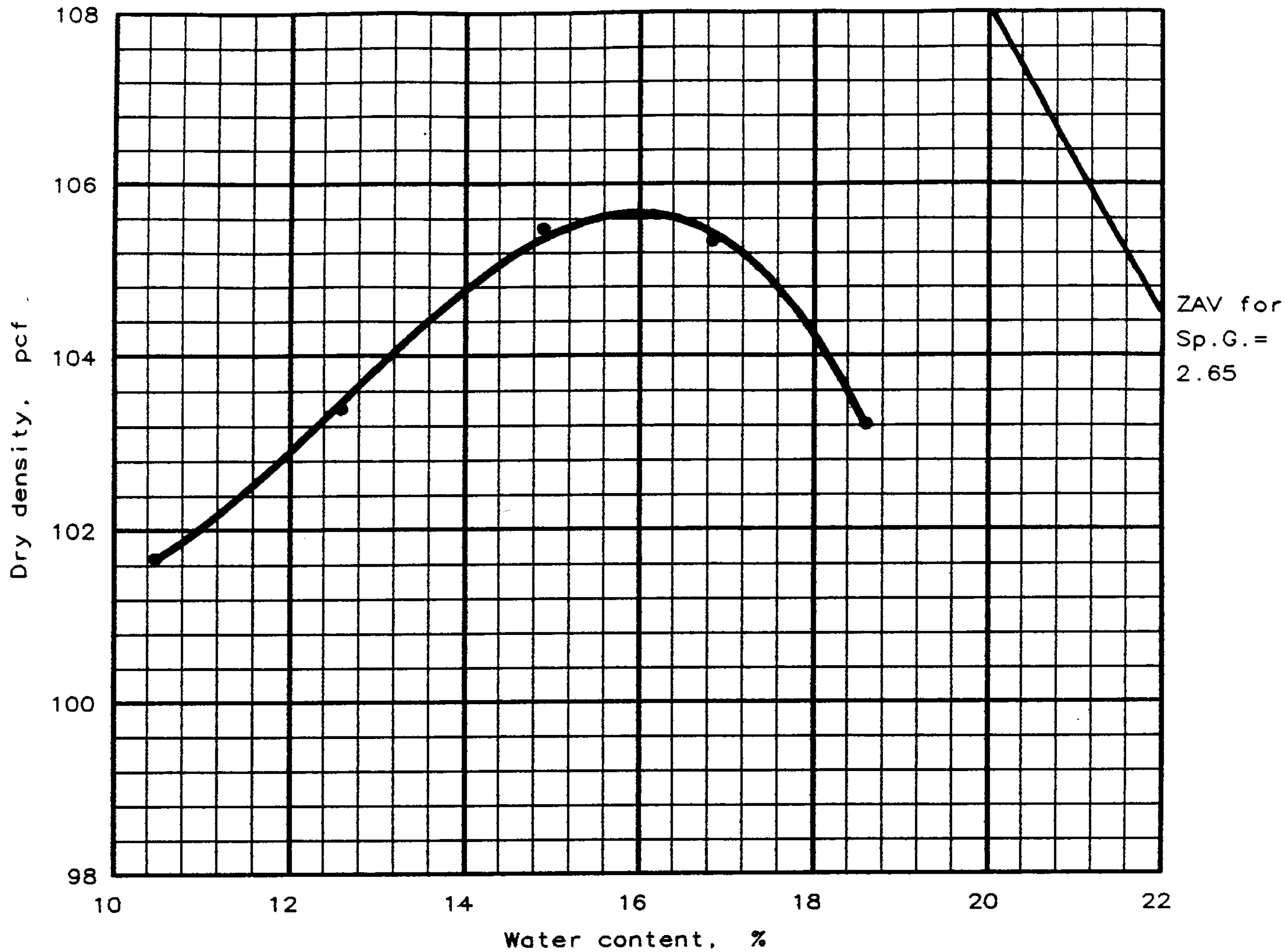
Client: International Uranium Corporation

Project: Soil Sample Testing

Project No.: 804899

Figure 35

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure A, Standard

Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
			N/A %	2.65				

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 105.7 pcf Optimum moisture = 16.0 %	105.7 pcf 16.0 %	C3-TS1

Project No.: 804899

Project: International Uranium Corporation

Location: Soil Sample Testing

Date: 4/27/99

Remarks:

SUBMITTED BY: Client

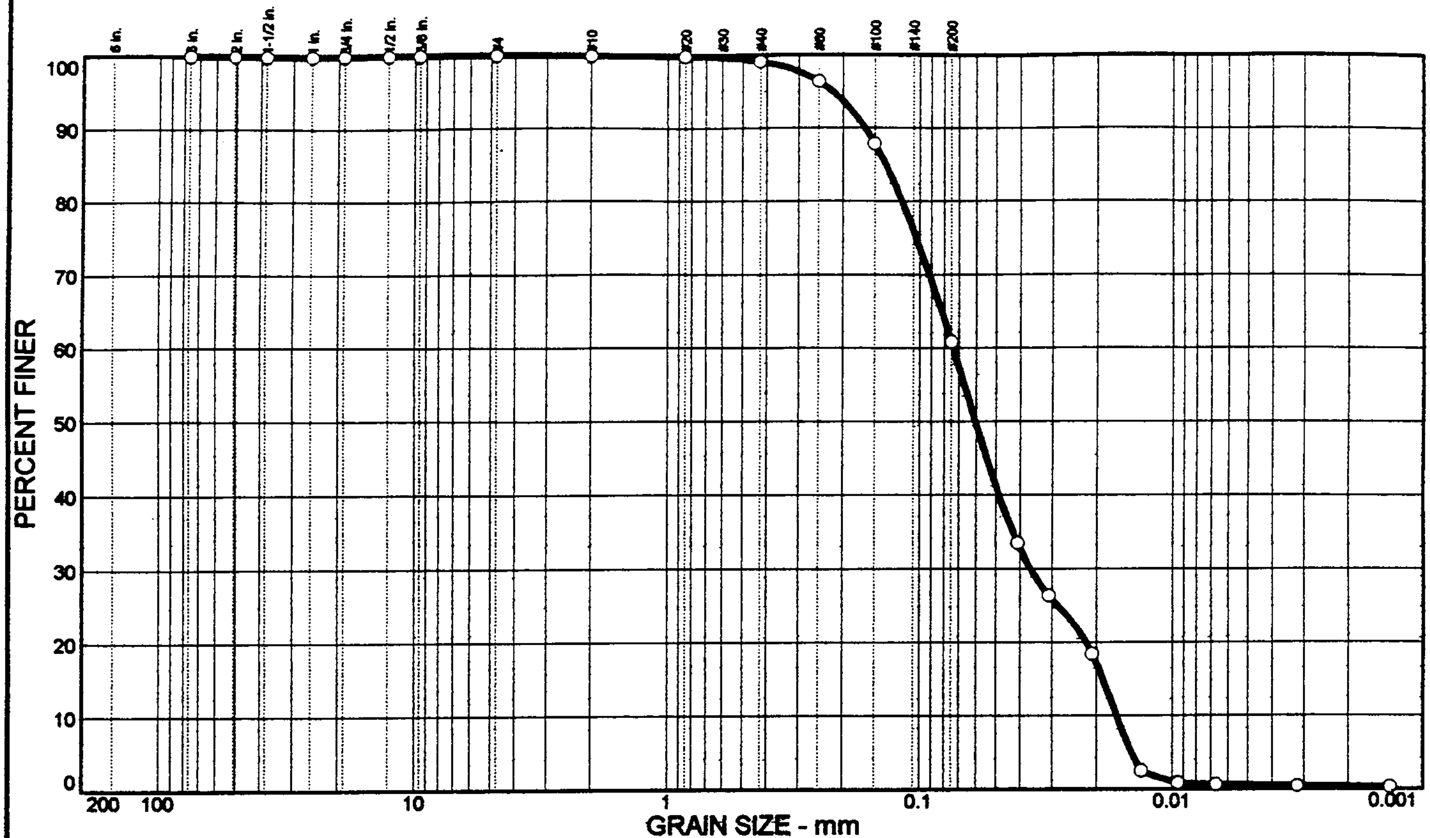
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST

WESTERN COLORADO TESTING, INC.

Fig. No. 5

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		0.0	39.2	60.3	0.5	ML	A-4(0)	NP	NP

SIEVE inches size	PERCENT FINER ○		
3	100.0		
2	100.0		
1.5	100.0		
1	100.0		
3/4	100.0		
1/2	100.0		
3/8	100.0		
	GRAIN SIZE		
D_{60}	0.0738		
D_{30}	0.0364		
D_{10}	0.0166		
	COEFFICIENTS		
C_c	1.08		
C_u	4.45		

SIEVE number size	PERCENT FINER ○		
#4	100.0		
#10	100.0		
#20	99.9		
#40	99.1		
#60	96.3		
#100	87.8		
#200	60.8		

SOIL DESCRIPTION

○ Silt, sandy, brown

REMARKS:

○ Tested By: JH

○ Source:

Sample No.: C3-TS1

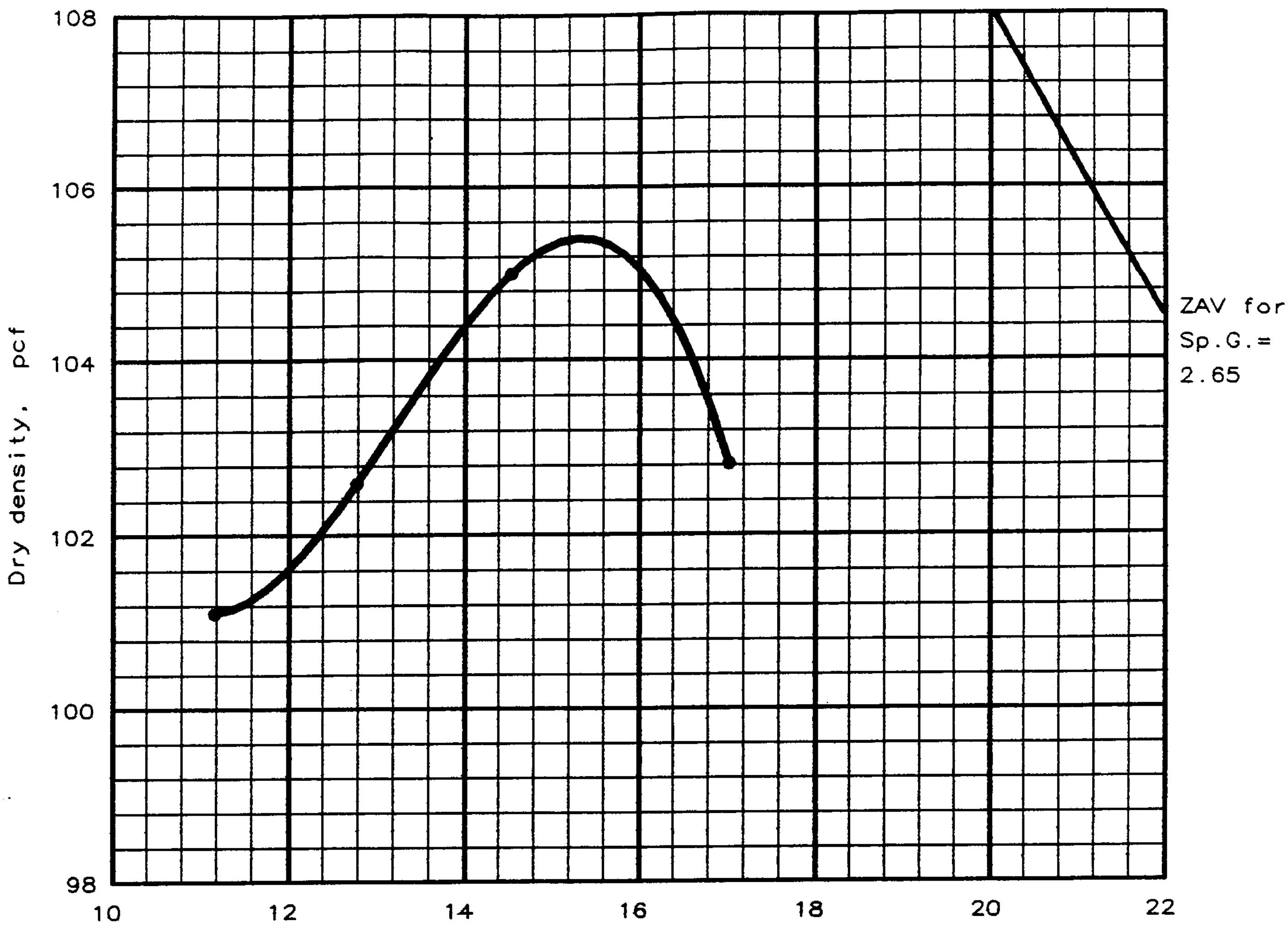
WESTERN COLORADO TESTING, INC.

Client: International Uranium Corporation

Project: Soil Sample Testing

Project No.: 804899

MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure A, Standard
Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
			N/A %	2.65				

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 105.4 pcf Optimum moisture = 15.3 %	105.4 pcf 15.3 %	C3-TS2

Project No.: 804899
Project: International Uranium Corporation
Location: Soil Sample Testing

Date: 4/27/99

Remarks:
SUBMITTED BY: Client
TESTED BY: JH

MOISTURE-DENSITY RELATIONSHIP TEST
WESTERN COLORADO TESTING, INC.

Fig. No. 6

PARTICLE SIZE DISTRIBUTION TEST REPORT

	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
O		0.0	77.0	16.9	6.1	SM	A-2-4(0)	NP	NP

SIEVE inches size	PERCENT FINER O		
3	100.0		
2	100.0		
1.5	100.0		
1	100.0		
3/4	100.0		
1/2	100.0		
3/8	100.0		
	GRAIN SIZE		
D_{60}	0.185		
D_{30}	0.102		
D_{10}	0.0260		
	COEFFICIENTS		
C_c	2.16		
C_u	7.12		

SIEVE number size	PERCENT FINER O		
#4	100.0		
#10	99.9		
#20	99.0		
#40	94.6		
#60	78.1		
#100	46.9		
#200	23.0		

SOIL DESCRIPTION

O Sand, silty, gray/brown

REMARKS:

O Tested By: JH

O Source:

Sample No.: C3-TS2

WESTERN COLORADO TESTING, INC.

Client: International Uranium Corporation

Project: Soil Sample Testing

Project No.: 804899

Figure 37

APPENDIX A.2

ADVANCED TERRA TESTING, INC.

2010

MOISTURE CONTENT
ASTM D 2216

Moisture Content Determinations
ASTM D 2216

CLIENT: MWH JOB NO.: 2521-53
LOCATION: Denison White Mesa Project

BORING	Stockpile 1	Stockpile 1	Stockpile 2	Stockpile 3
SAMPLE DEPTH	5.0'	12.0'	5.0'	6.0'
SAMPLE NO.	A South	B South	A	A
DATE SAMPLED	10/12/10	10/12/10	10/12/10	10/12/10
DATE TESTED	10/23/10 LB	10/23/10 LB	10/23/10 LB	10/23/10 LB
SOIL DESCRIPTION	1009740	1009740	1009740	1009740
MOISTURE DETERMINATIONS				
Wt. of Wet Soil & Dish (gms)	168.75	189.58	140.80	159.75
Wt. of Dry Soil & Dish (gms)	161.67	179.59	129.88	146.78
Net Loss of Moisture (gms)	7.08	9.99	10.92	12.97
Wt. of Dish (gms)	3.04	3.16	3.08	3.02
Wt. of Dry Soil (gms)	158.63	176.43	126.80	143.76
Moisture Content (%)	4.5	5.7	8.6	9.0

BORING	Stockpile 4	Stockpile 5	Stockpile 6	Stockpile 7
SAMPLE DEPTH	5.0'	6.0'	2.0'	0
SAMPLE NO.	A	A	A	A
DATE SAMPLED	10/12/10	10/12/10	10/12/10	10/12/10
DATE TESTED	10/23/10 LB	10/23/10 LB	10/23/10 LB	10/23/10 LB
SOIL DESCRIPTION	1009740	1009740	1009740	1009740
MOISTURE DETERMINATIONS				
Wt. of Wet Soil & Dish (gms)	124.09	129.19	176.52	135.98
Wt. of Dry Soil & Dish (gms)	108.90	122.37	164.58	130.35
Net Loss of Moisture (gms)	15.19	6.82	11.94	5.63
Wt. of Dish (gms)	3.14	3.07	3.30	3.04
Wt. of Dry Soil (gms)	105.76	119.30	161.28	127.31
Moisture Content (%)	14.4	5.7	7.4	4.4

Data entered by: BKL Date: 10/26/2010
Data checked by: DPM Date: 10/26/10
FileName: MHN053AA

ADVANCED TERRA TESTING, INC. ATT

Moisture Content Determinations
ASTM D 2216

CLIENT: MWH
JOB NO.: 2512-53
LOCATION: Denison White Mesa Project

BORING	Stockpile 8	Stockpile 9	Stockpile 10	Stockpile 11
SAMPLE DEPTH	5.0'	0'	5.0'	0'
SAMPLE NO.	A	A	A	A
DATE SAMPLED	10/12/10	10/12/10	10/12/10	10/12/10
DATE TESTED	10/23/10 LB	10/23/10 LB	10/23/10 LB	10/23/10 LB
SOIL DESCRIPTION	1009740	1009740	1009740	1009740
MOISTURE DETERMINATIONS				
Wt. of Wet Soil & Dish (gms)	151.72	156.77	120.43	161.56
Wt. of Dry Soil & Dish (gms)	139.81	151.93	114.57	154.98
Net Loss of Moisture (gms)	11.91	4.84	5.86	6.58
Wt. of Dish (gms)	3.04	3.04	3.11	3.29
Wt. of Dry Soil (gms)	136.77	148.89	111.46	151.69
Moisture Content (%)	8.7	3.3	5.3	4.3

BORING	Stockpile 12	Stockpile 13
SAMPLE DEPTH	5.0'	0'
SAMPLE NO.	A	A
DATE SAMPLED	10/12/10	10/12/10
DATE TESTED	10/23/10 LB	10/23/10 LB
SOIL DESCRIPTION	1009740	1009740
MOISTURE DETERMINATIONS		
Wt. of Wet Soil & Dish (gms)	138.36	155.25
Wt. of Dry Soil & Dish (gms)	127.42	143.36
Net Loss of Moisture (gms)	10.94	11.89
Wt. of Dish (gms)	3.11	3.28
Wt. of Dry Soil (gms)	124.31	140.08
Moisture Content (%)	8.8	8.5

Data entered by: BKL Date: 10/26/2010
Data checked by: DM Date: 10/26/10
FileName: MHN053AB

Advanced Terra Testing, Inc. ATT

SPECIFIC GRAVITY TEST
ASTM D 854

SPECIFIC GRAVITY TESTS ASTM D 854

CLIENT:	MWH	JOB NO.	2512-53
SOIL DESCR.	1009740	LOCATION	Denison White Mesa Mill Project

BORING NO.	Stockpile 8	Stockpile 1	Stockpile 4
DEPTH	5.0'	5.0'	5.0'
SAMPLE NO.	A	A-South	A
DATE SAMPLED			
DATE TESTED	11/17/10 MLM	11/17/10 MLM	11/17/10 MLM
Pycnometer #	Big 1	Big 9	Big 10
Weight of oven dry soil (g) (Wo)	108.770	105.460	91.720
Weight of flask, soil, and water. (g) (Wb)	739.740	740.170	730.080
Temperature (deg. C) (Tx)	25.3	25.3	25.4
Weight of water & flask at Tx (from cal. curve)(Wa)	671.632	674.591	671.815
Specific Gravity*	2.67	2.64	2.74

*Specific Gravity = Wo/[Wo+(Wa-Wb)]

Data entry by: MLM Date: 11/18/2010
Data checked by: BKC Date: 11/8/10
FileName: MHE0S814

ADVANCED TERRA TESTING, Inc. ATT

ATTERBERG LIMITS
ASTM D 4318

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 1	DATE SAMPLED	10/12/10 --
DEPTH	5.0'	DATE TESTED	11/08/10 MLM
SAMPLE NO.	A South		
SOIL DESCR.	1009740		
LOCATION	Denison White Mesa Mill Project		

Plastic Limit
Determination

Wt Dish & Wet Soil
Wt Dish & Dry Soil
Wt of Moisture
Wt of Dish — NON-PLASTIC
Wt of Dry Soil
Moisture Content

Liquid Limit Determination — Device Number 1075

Number of Blows

Wt Dish & Wet Soil
Wt Dish & Dry Soil
Wt of Moisture
Wt of Dish — NON-PLASTIC
Wt of Dry Soil
Moisture Content

Liquid Limit	NP
Plastic Limit	NP
Plasticity Index	NP

Atterberg Classification NP

Data entry by: MLM Date: 11/08/2010
Checked by: LB Date: 10-09-10
FileName: MHG0S15A

ADVANCED TERRA TESTING, INC. ATT

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 1	DATE SAMPLED	10/12/10
DEPTH	12.0'	DATE TESTED	11/08/10 MLM
SAMPLE NO.	B South		
SOIL DESCR.	1009740		
LOCATION	Denison White Mesa Mill Project		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	12.25	12.02	11.89
Wt Dish & Dry Soil	11.15	10.92	10.80
Wt of Moisture	1.10	1.10	1.09
Wt of Dish	1.14	1.14	1.14
Wt of Dry Soil	10.01	9.78	9.66
Moisture Content	10.99	11.25	11.28

Liquid Limit Determination — Device Number 1075

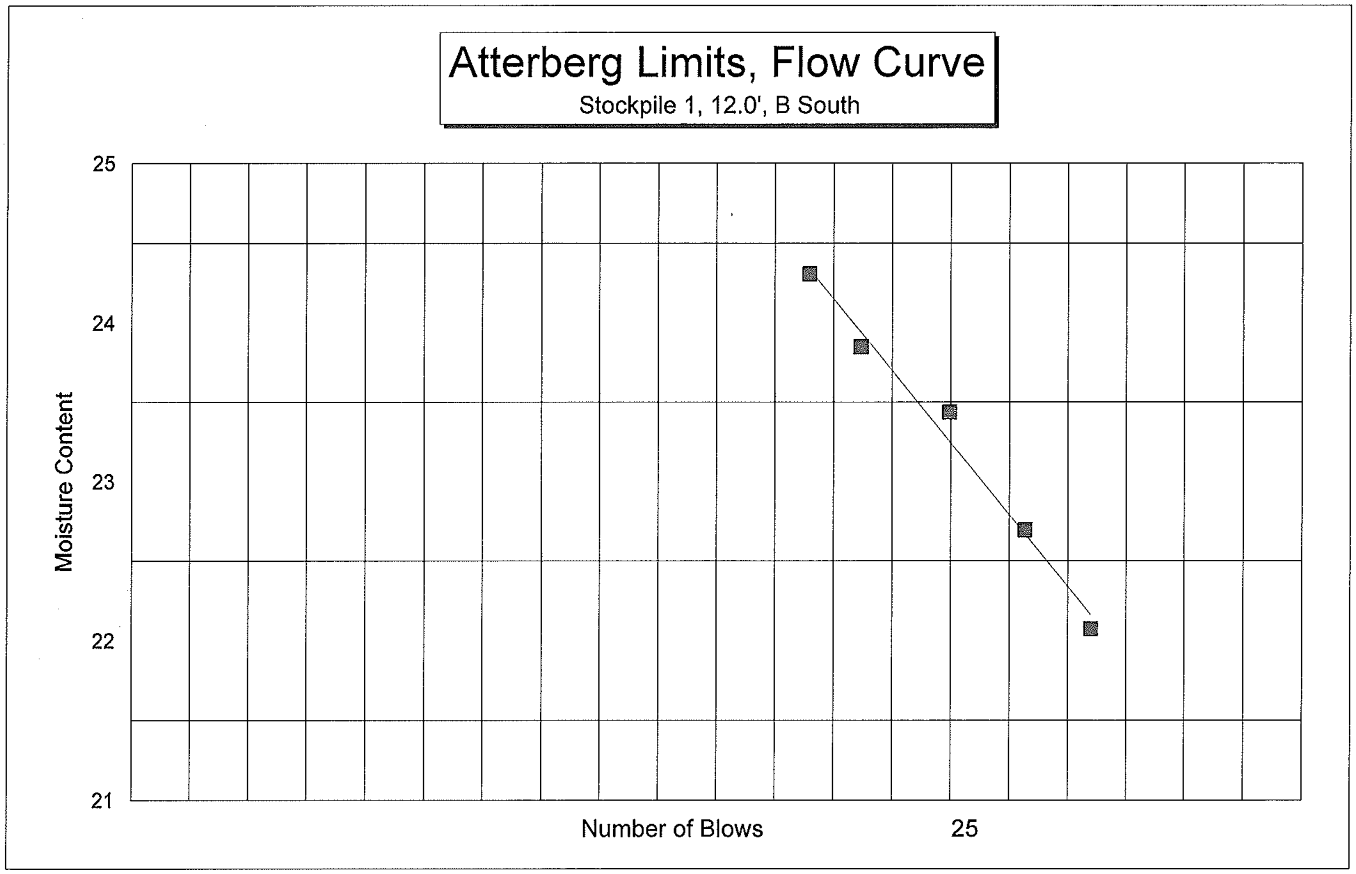
	1	2	3	4	5
Number of Blows	33	29	25	21	19
Wt Dish & Wet Soil	12.90	11.80	12.19	11.65	12.34
Wt Dish & Dry Soil	10.77	9.83	10.09	9.63	10.15
Wt of Moisture	2.13	1.97	2.10	2.02	2.19
Wt of Dish	1.12	1.15	1.13	1.16	1.14
Wt of Dry Soil	9.65	8.68	8.96	8.47	9.01
Moisture Content	22.07	22.70	23.44	23.85	24.31

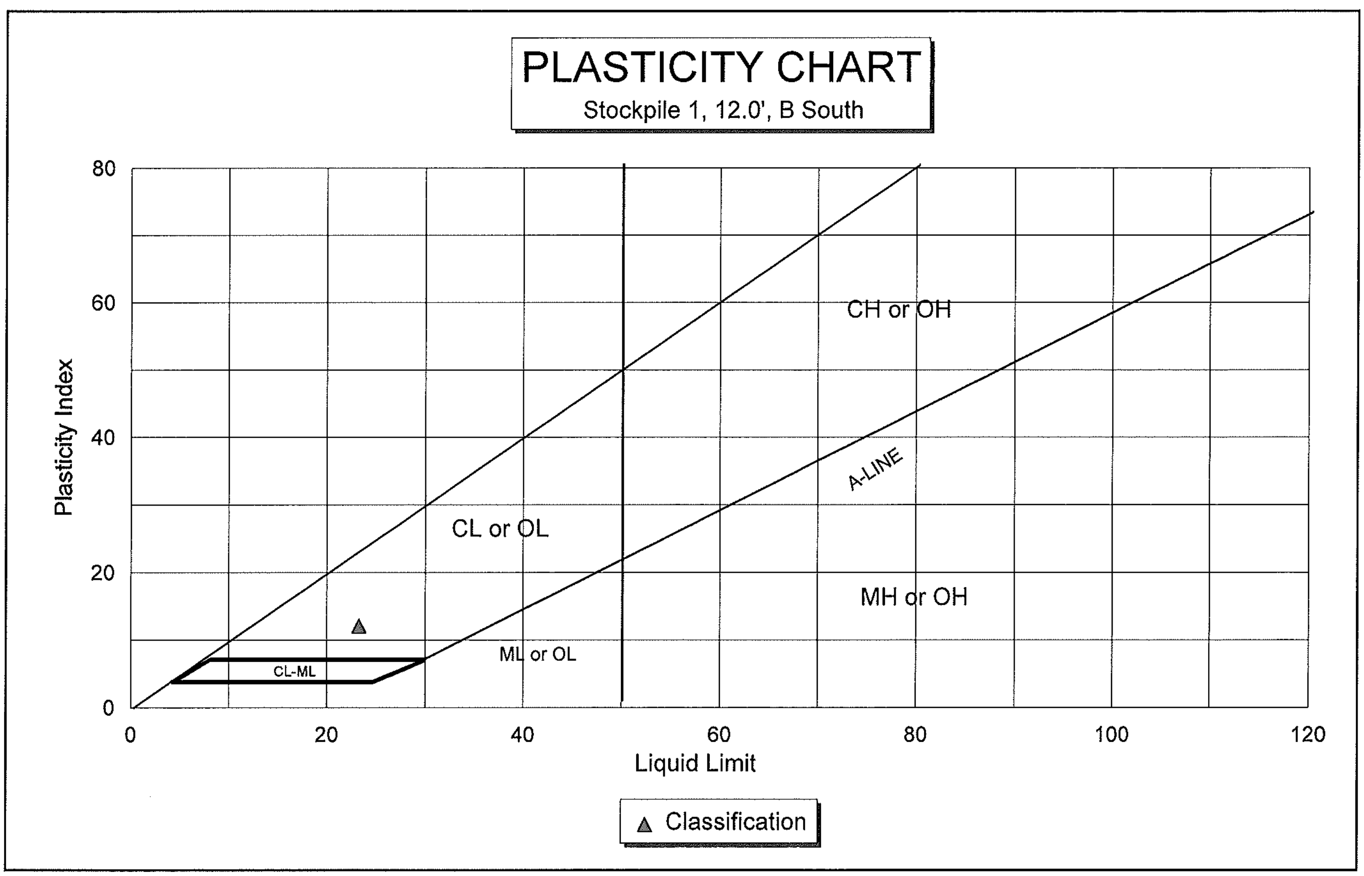
Liquid Limit 23.3
Plastic Limit 11.2
Plasticity Index 12.1

Atterberg Classification CL

Data entry by: MLM Date: 11/09/2010
Checked by: BKL Date: 11/9/10
FileName: MHG0S1BS

ADVANCED TERRA TESTING, Inc. ATT


Atterberg Limits, Flow Curve
Stockpile 1, 12.0', B South
25
24
23
22
21
Moisture Content
Number of Blows
25


PLASTICITY CHART
Stockpile 1, 12.0', B South
80
60
40
20
0
Plasticity Index
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 2	DATE SAMPLED	10/12/10
DEPTH	5.0'	DATE TESTED	10/27/10 MLM
SAMPLE NO.	A		
SOIL DESCR.	1009740		
LOCATION	Denison White Mesa Mill Project		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	10.04	11.59	11.84
Wt Dish & Dry Soil	8.91	10.25	10.53
Wt of Moisture	1.13	1.34	1.31
Wt of Dish	1.14	1.15	1.15
Wt of Dry Soil	7.77	9.10	9.38
Moisture Content	14.54	14.73	13.97

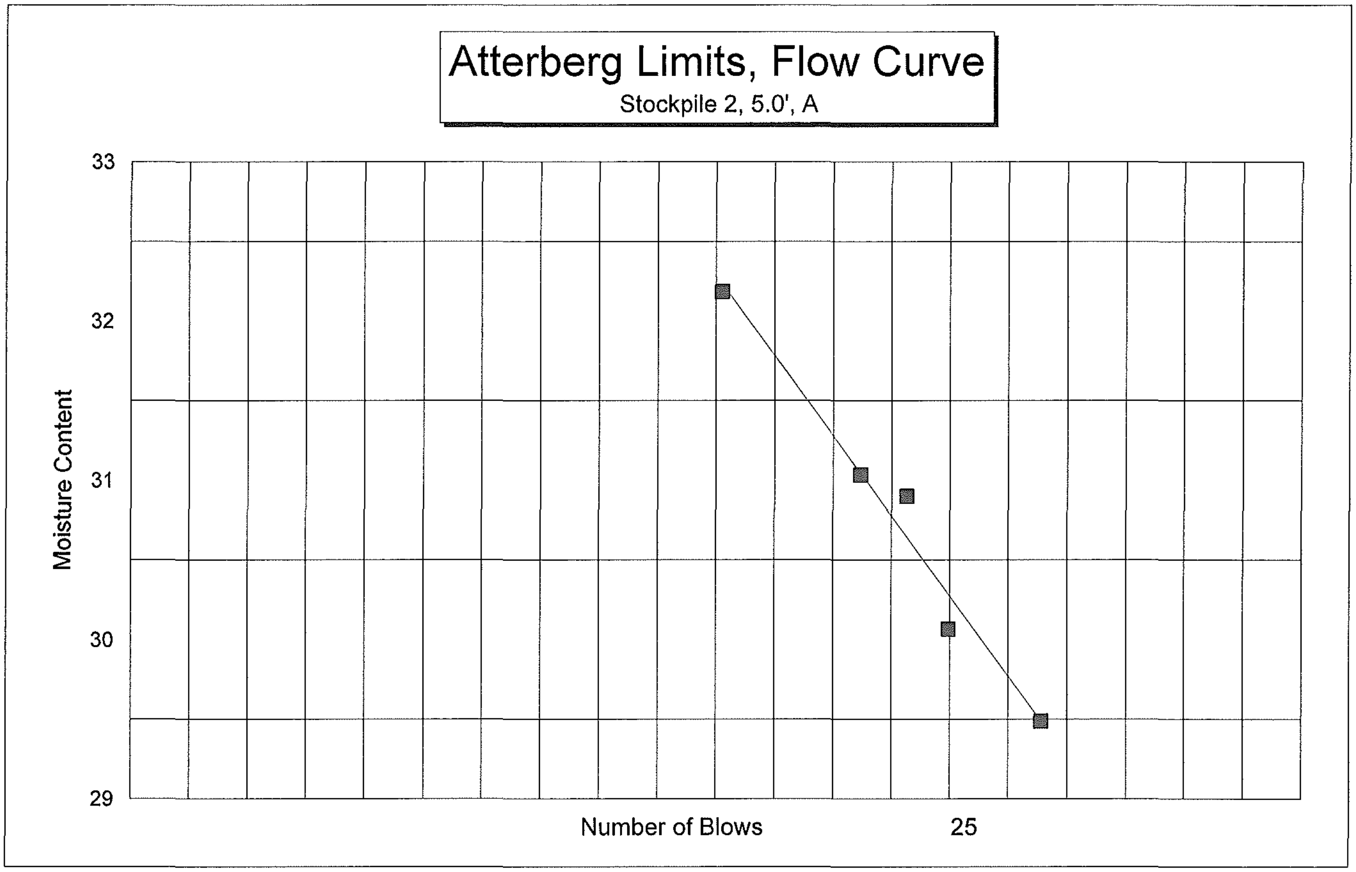
Liquid Limit Determination   Device Number 1080

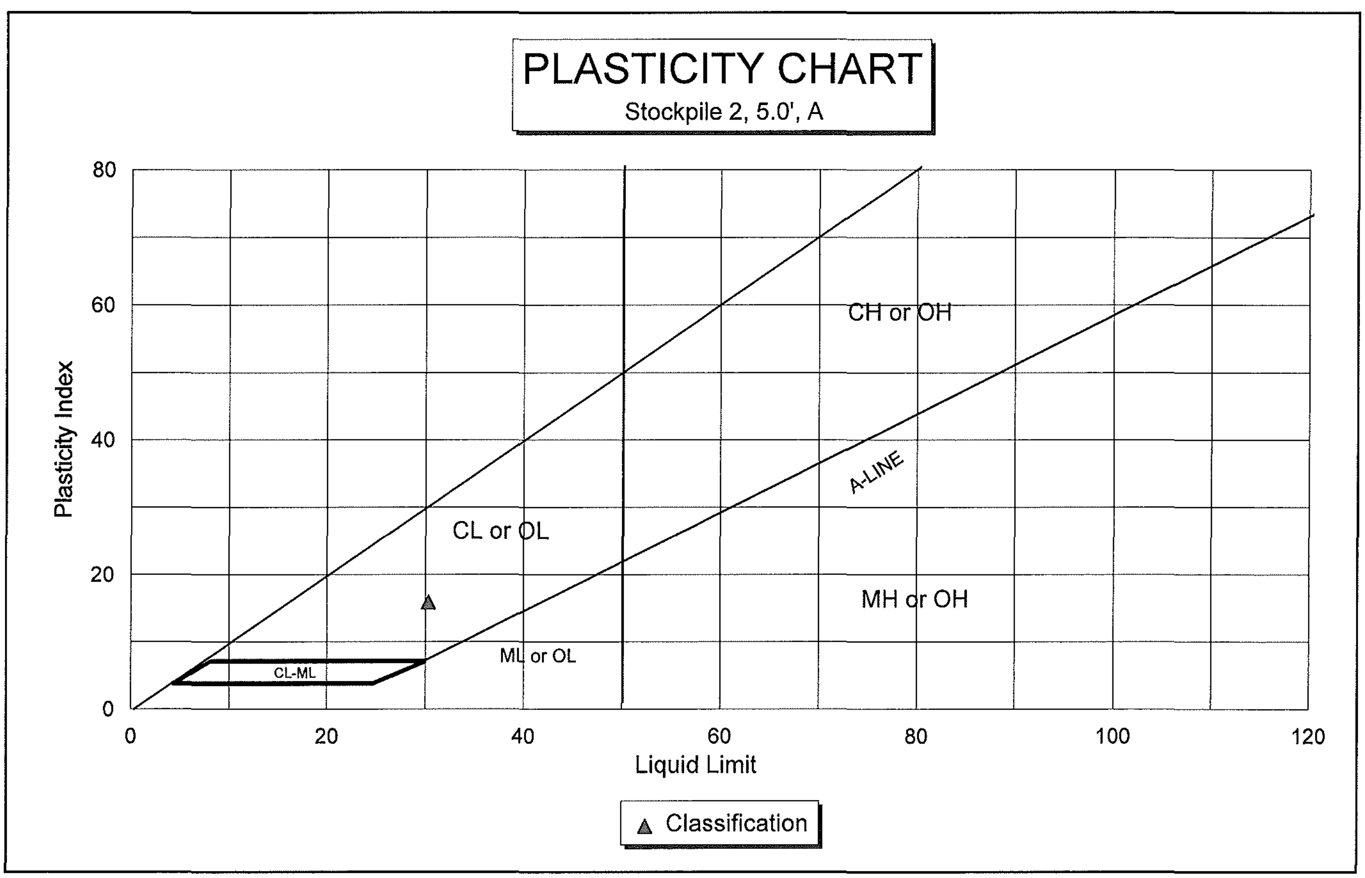
	1	2	3	4	5
Number of Blows	30	25	23	21	16
Wt Dish & Wet Soil	11.02	10.83	10.45	10.66	11.50
Wt Dish & Dry Soil	8.77	8.59	8.25	8.41	8.98
Wt of Moisture	2.25	2.24	2.20	2.25	2.52
Wt of Dish	1.14	1.14	1.13	1.16	1.15
Wt of Dry Soil	7.63	7.45	7.12	7.25	7.83
Moisture Content	29.49	30.07	30.90	31.03	32.18

Liquid Limit	30.3
Plastic Limit	14.4
Plasticity Index	15.9

Atterberg Classification CL

Data entry by: MLM Date: 10/28/2010
Checked by: BKL Date: 10/28/10
FileName: MHG0250A


Atterberg Limits, Flow Curve
Stockpile 2, 5.0', A
33
32
31
30
29
Moisture Content
Number of Blows
25


PLASTICITY CHART
Stockpile 2, 5.0', A
80
60
40
20
0
Plasticity Index
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 3	DATE SAMPLED	10/12/10
DEPTH	6.0'	DATE TESTED	10/27/10 PW
SAMPLE NO.	A		
SOIL DESCR.	1009740		
LOCATION	Denison White Mesa Mill Project		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	10.49	10.76	10.76
Wt Dish & Dry Soil	9.36	9.55	9.53
Wt of Moisture	1.13	1.21	1.23
Wt of Dish	1.13	1.14	1.15
Wt of Dry Soil	8.23	8.41	8.38
Moisture Content	13.73	14.39	14.68

Liquid Limit Determination   Device Number   0860

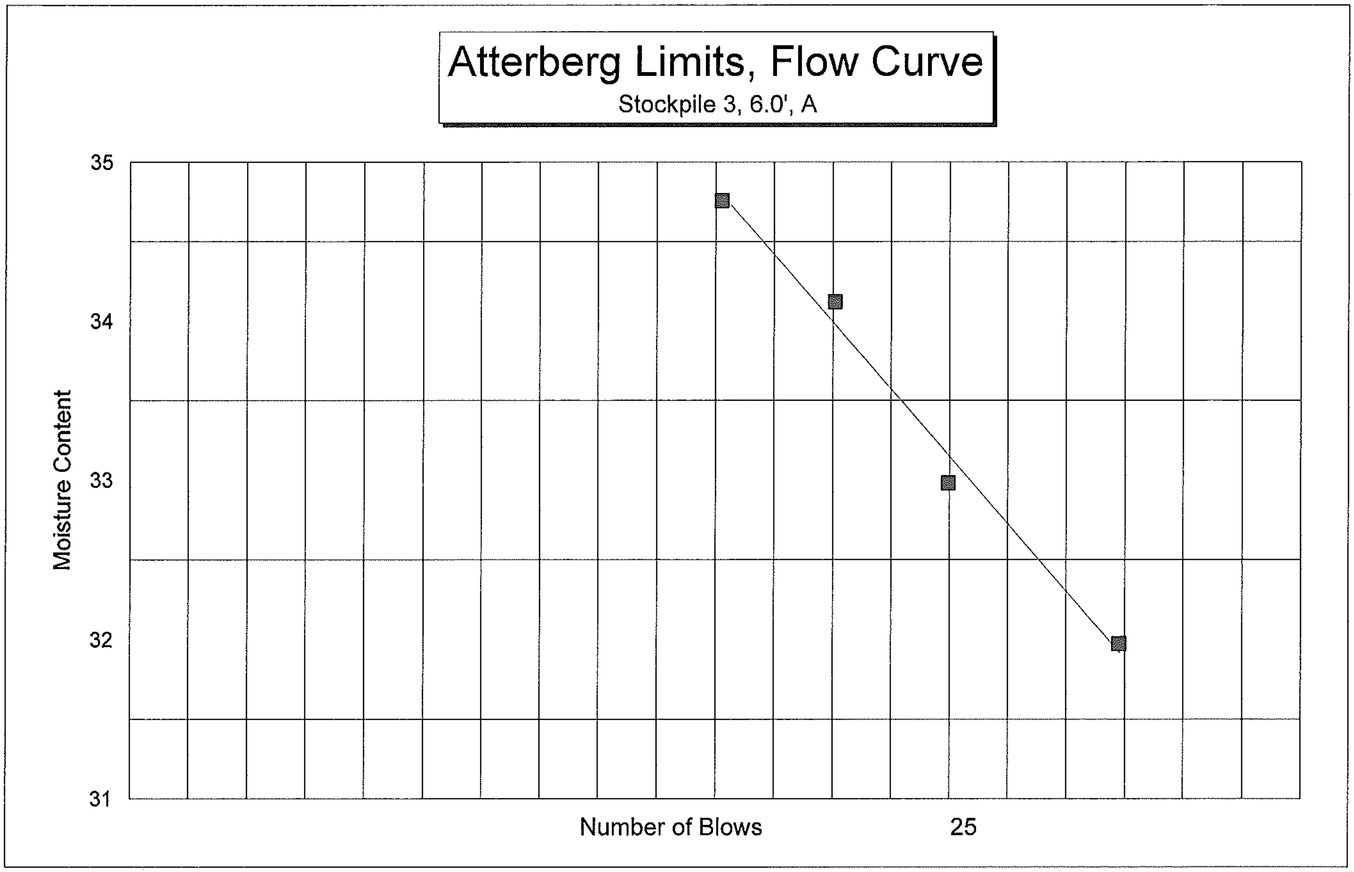
	1	2	3	4
Number of Blows	35	16	25	20
Wt Dish & Wet Soil	14.74	15.36	14.95	17.60
Wt Dish & Dry Soil	11.45	11.70	11.53	13.41
Wt of Moisture	3.29	3.66	3.42	4.19
Wt of Dish	1.16	1.17	1.16	1.13
Wt of Dry Soil	10.29	10.53	10.37	12.28
Moisture Content	31.97	34.76	32.98	34.12

Liquid Limit	33.2
Plastic Limit	14.3
Plasticity Index	18.9

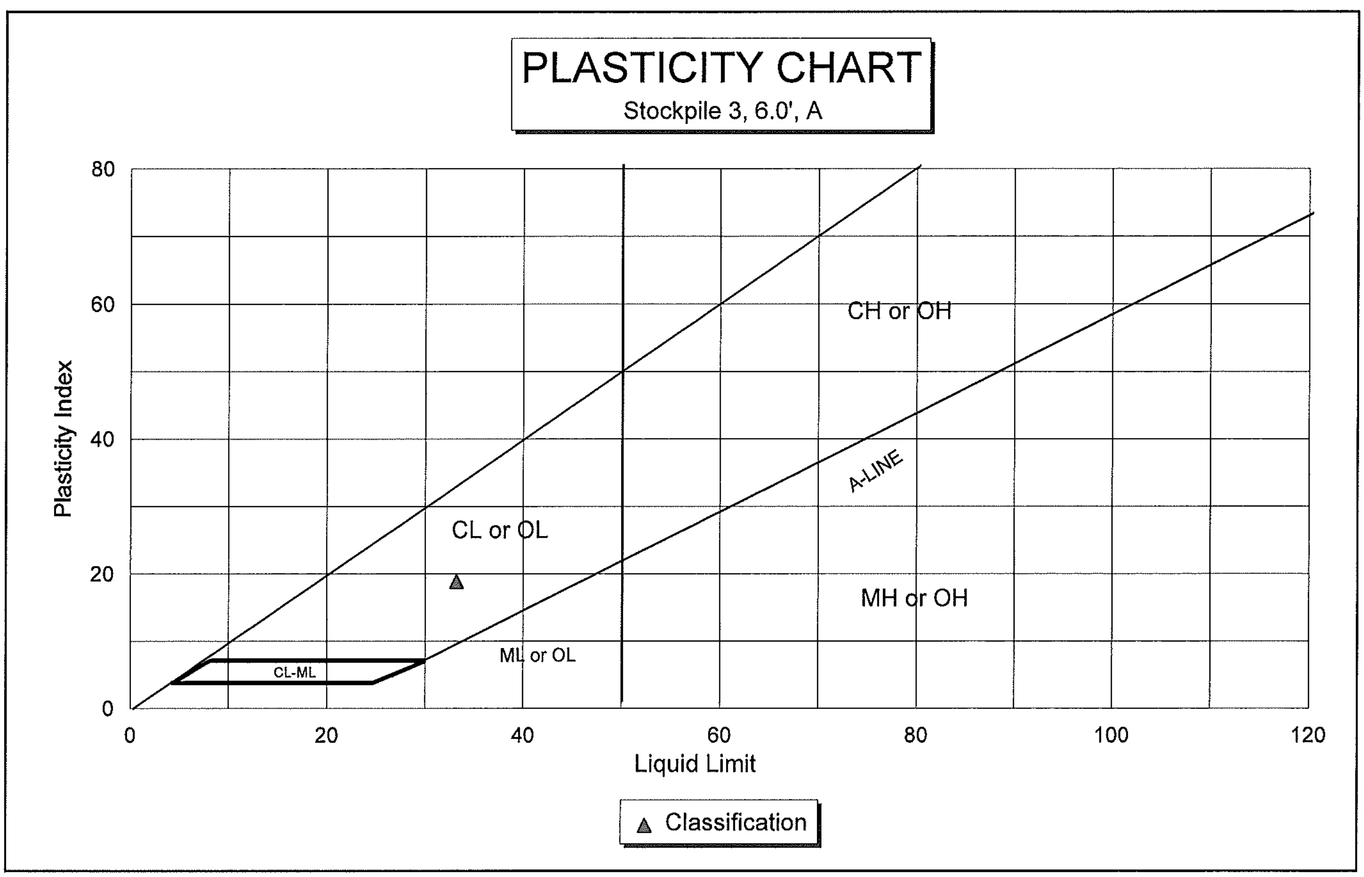
Atterberg Classification   CL

Data entry by: MLM   Date: 10/28/2010
Checked by: BKL   Date: 10/28/10
FileName: MHG0360A

ADVANCED TERRA TESTING, Inc. ATT



Atterberg Limits, Flow Curve
Stockpile 3, 6.0', A
35
34
33
32
31
Moisture Content
Number of Blows
25



PLASTICITY CHART
Stockpile 3, 6.0', A
80
60
40
20
0
Plasticity Index
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 4	DATE SAMPLED	10/12/10
DEPTH	5.0'	DATE TESTED	11/03/10 PW
SAMPLE NO.	A		
SOIL DESCR.	1009740		
LOCATION	Denison White Mesa Mill Project		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	10.11	10.31	10.26
Wt Dish & Dry Soil	8.88	9.06	9.02
Wt of Moisture	1.23	1.25	1.24
Wt of Dish	1.14	1.16	1.14
Wt of Dry Soil	7.74	7.90	7.88
Moisture Content	15.89	15.82	15.74

Liquid Limit Determination — Device Number 0860

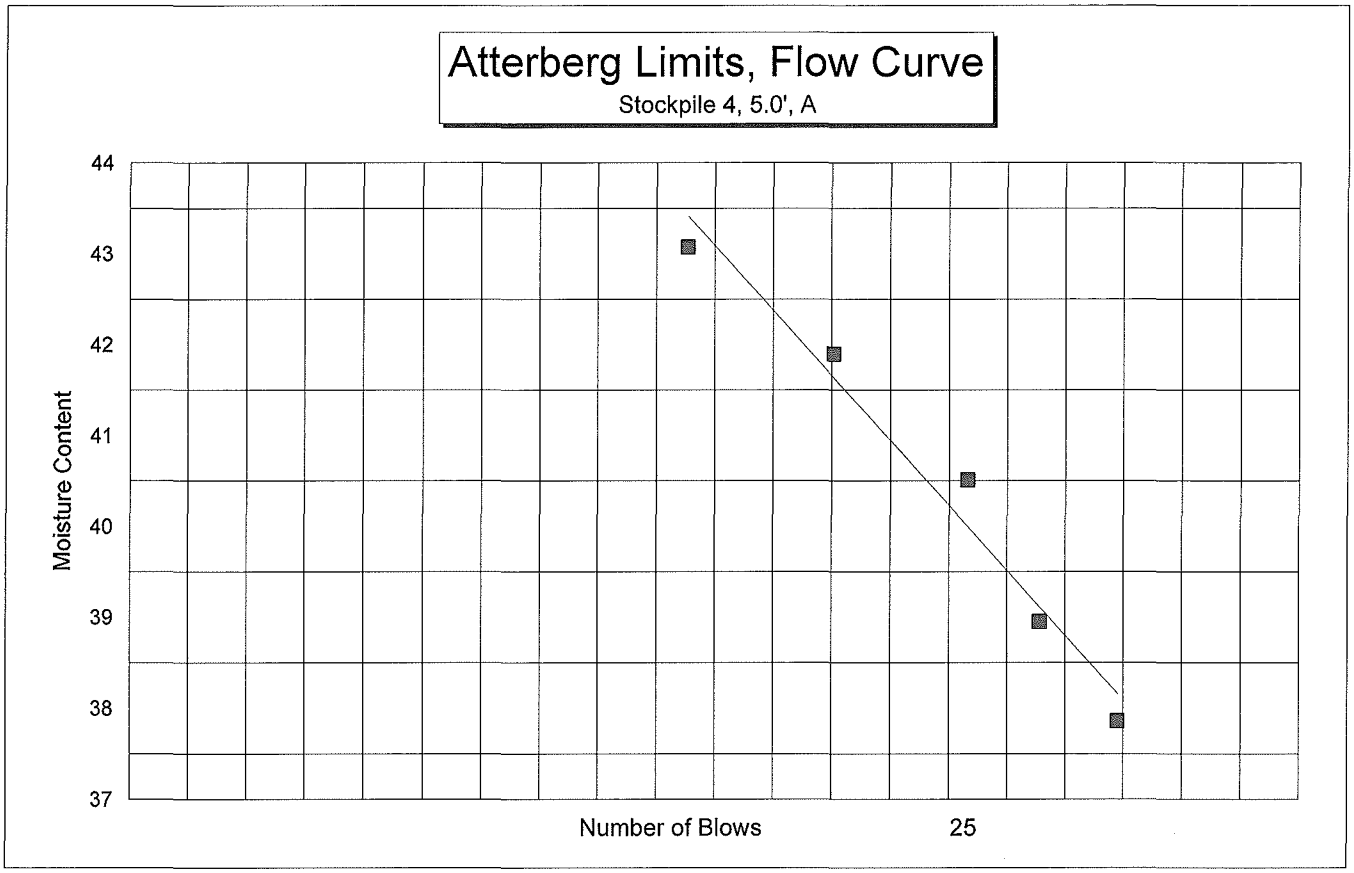
	1	2	3	4	5
Number of Blows	35	30	26	20	15
Wt Dish & Wet Soil	16.36	18.13	17.07	16.99	15.30
Wt Dish & Dry Soil	12.18	13.37	12.48	12.31	11.04
Wt of Moisture	4.18	4.76	4.59	4.68	4.26
Wt of Dish	1.14	1.15	1.15	1.14	1.15
Wt of Dry Soil	11.04	12.22	11.33	11.17	9.89
Moisture Content	37.86	38.95	40.51	41.90	43.07

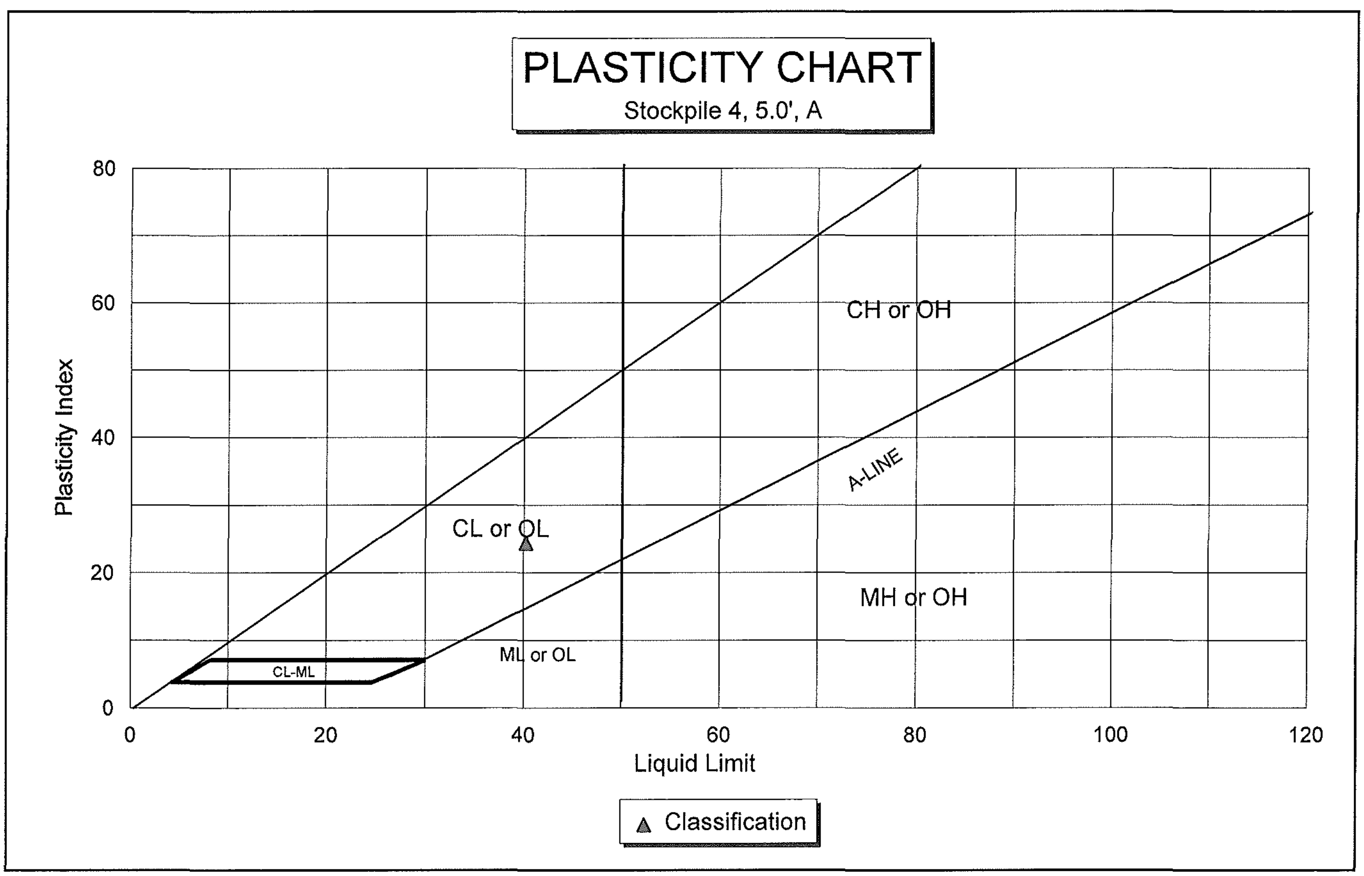
Liquid Limit	40.2
Plastic Limit	15.8
Plasticity Index	24.4

Atterberg Classification CL

Data entry by: MLM Date: 11/04/2010
Checked by: BKL Date: 11/4/10
FileName: MHG0S45A

ADVANCED TERRA TESTING, Inc. ATT


Atterberg Limits, Flow Curve
Stockpile 4, 5.0', A
44
43
42
41
40
39
38
37
Moisture Content
Number of Blows
25


PLASTICITY CHART
Stockpile 4, 5.0', A
80
60
40
20
0
Plasticity Index
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 5	DATE SAMPLED	10/12/10
DEPTH	6.0'	DATE TESTED	10/27/10 MLM
SAMPLE NO.	A		
SOIL DESCR.	1009740		
LOCATION	Denison White Mesa Mill Project		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	9.49	11.27	9.56
Wt Dish & Dry Soil	8.31	9.85	8.39
Wt of Moisture	1.18	1.42	1.17
Wt of Dish	1.14	1.14	1.13
Wt of Dry Soil	7.17	8.71	7.26
Moisture Content	16.46	16.30	16.12

Liquid Limit Determination   Device Number   1080

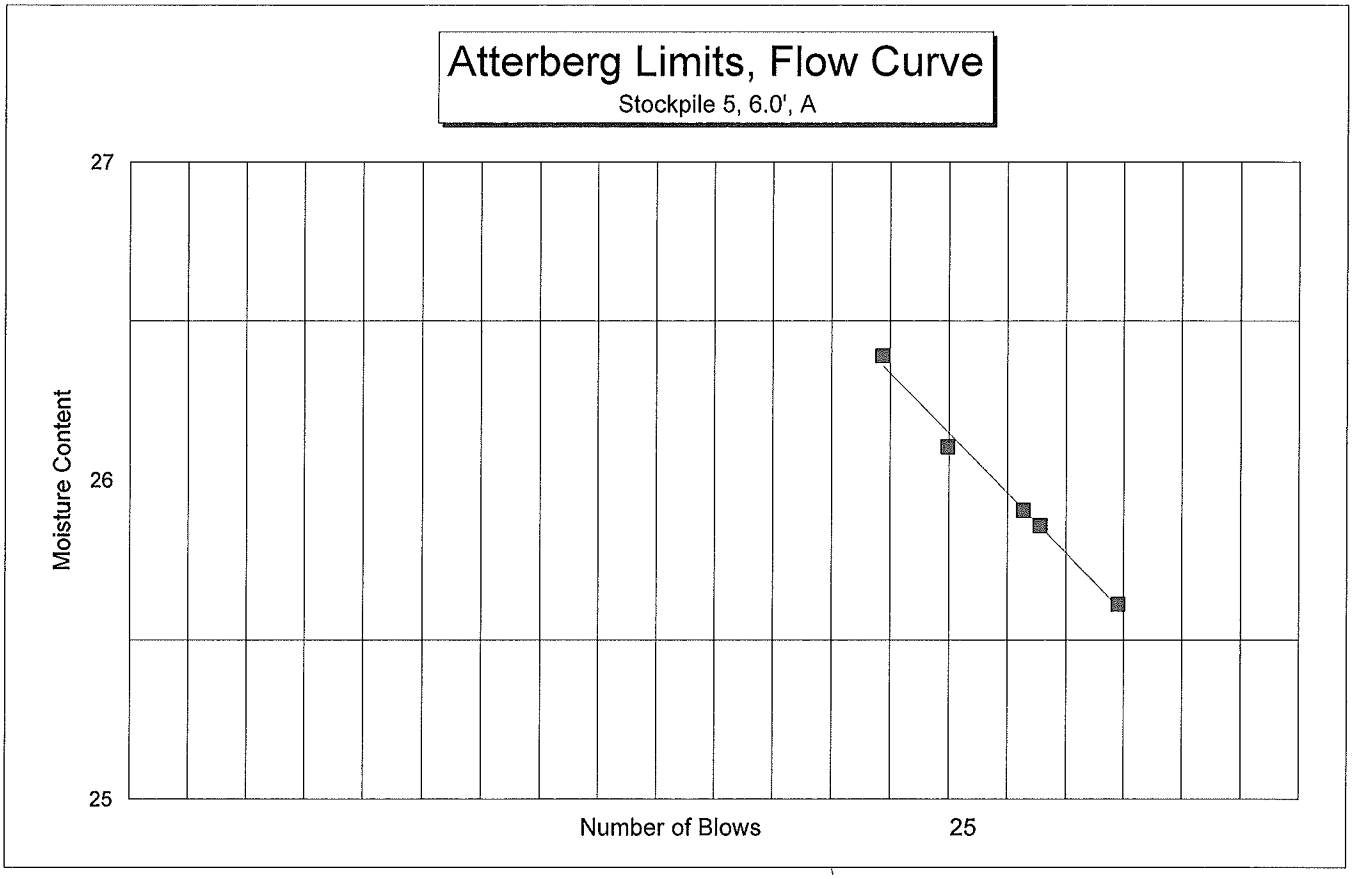
	1	2	3	4	5
Number of Blows	35	22	25	29	30
Wt Dish & Wet Soil	11.37	10.88	10.57	10.50	11.34
Wt Dish & Dry Soil	9.28	8.84	8.62	8.57	9.23
Wt of Moisture	2.09	2.04	1.95	1.93	2.11
Wt of Dish	1.12	1.11	1.15	1.12	1.07
Wt of Dry Soil	8.16	7.73	7.47	7.45	8.16
Moisture Content	25.61	26.39	26.10	25.91	25.86

Liquid Limit	26.2
Plastic Limit	16.3
Plasticity Index	9.9

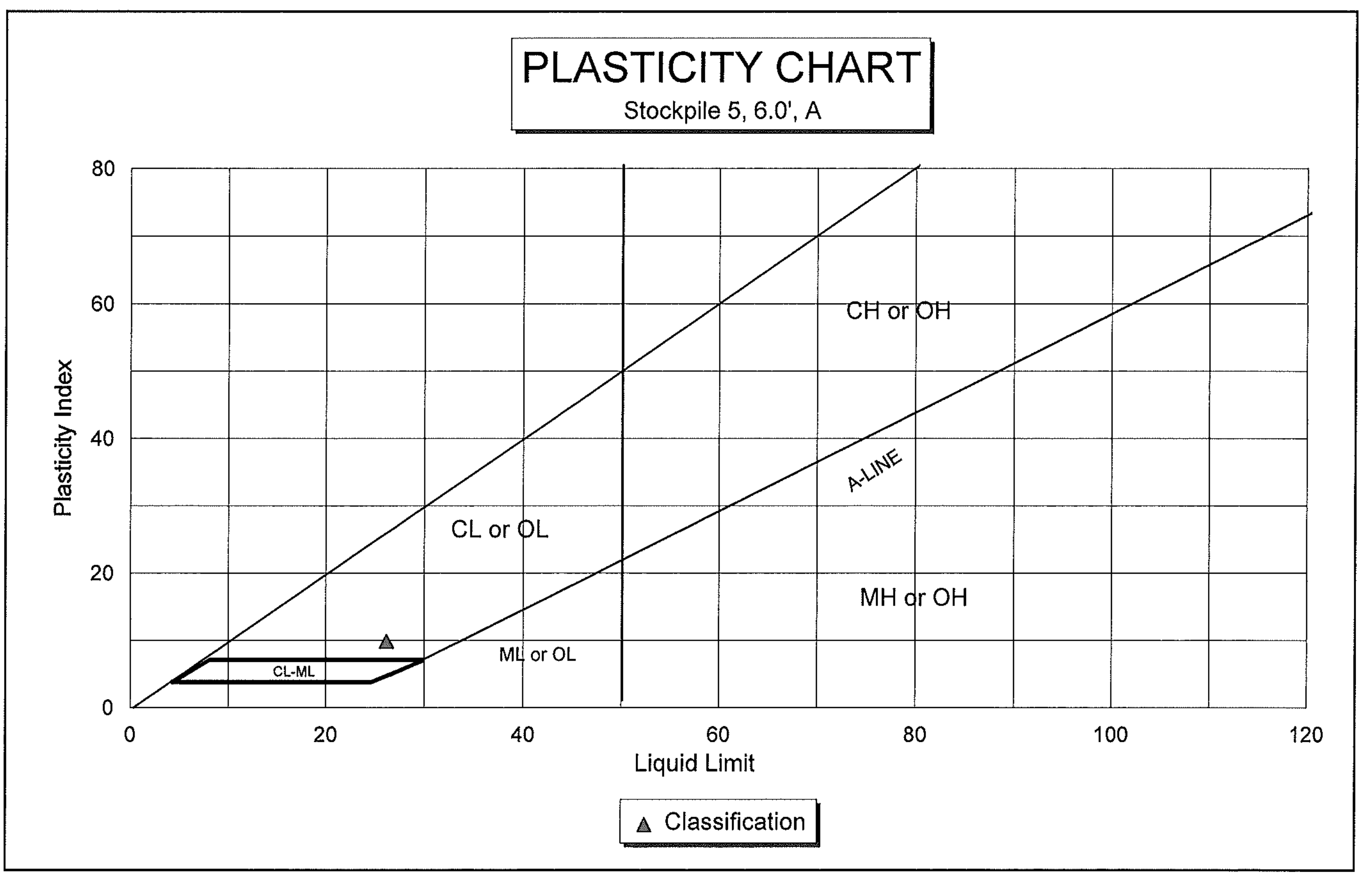
Atterberg Classification   CL

Data entry by: MLM   Date: 10/28/2010
Checked by: BKL   Date: 10/28/10
FileName: MHG0560A

ADVANCED TERRA TESTING, INC. ATT



Atterberg Limits, Flow Curve
Stockpile 5, 6.0', A
27
26
25
Moisture Content
Number of Blows
25



PLASTICITY CHART
Stockpile 5, 6.0', A
80
60
40
20
0
Plasticity Index
0
20
40
60
80
100
120
Liquid Limit
CH or OH
A-LINE
CL or OL
MH or OH
CL-ML
ML or OL
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 6	DATE SAMPLED	
DEPTH	2.0'	DATE TESTED	11/03/10 LB
SAMPLE NO.	A		
SOIL DESCR.	1009740		
LOCATION	Denison White Mesa Mill Project		

Plastic Limit Determination

	1	2
Wt Dish & Wet Soil	7.04	7.01
Wt Dish & Dry Soil	6.40	6.39
Wt of Moisture	0.64	0.62
Wt of Dish	1.15	1.12
Wt of Dry Soil	5.25	5.27
Moisture Content	12.19	11.76

Liquid Limit Determination — Device Number 1075

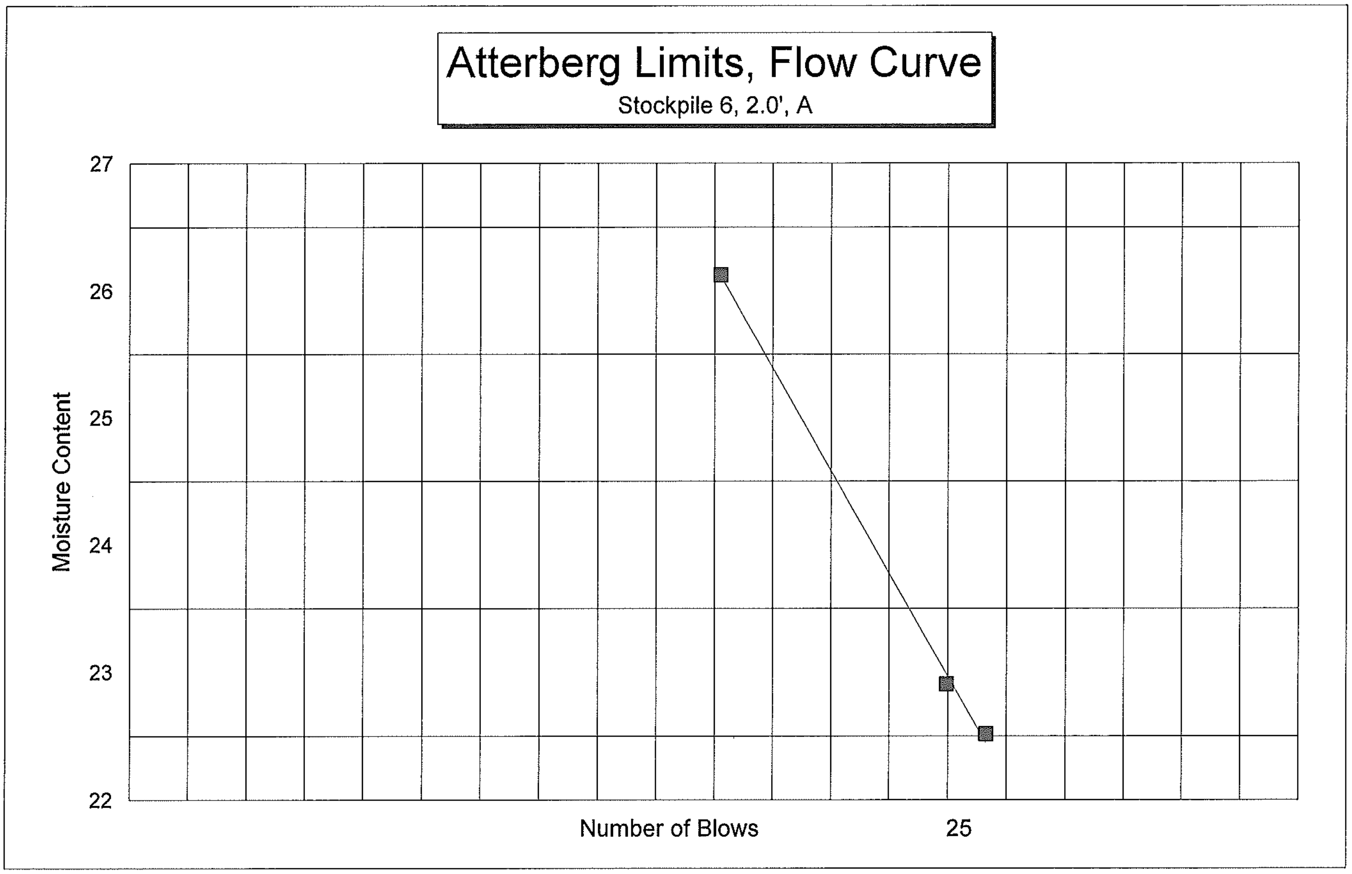
	1	2	3
Number of Blows	25	16	27
Wt Dish & Wet Soil	16.70	21.03	20.01
Wt Dish & Dry Soil	13.80	16.91	16.54
Wt of Moisture	2.90	4.12	3.47
Wt of Dish	1.14	1.14	1.13
Wt of Dry Soil	12.66	15.77	15.41
Moisture Content	22.91	26.13	22.52

Liquid Limit	23.0
Plastic Limit	12.0
Plasticity Index	11.0

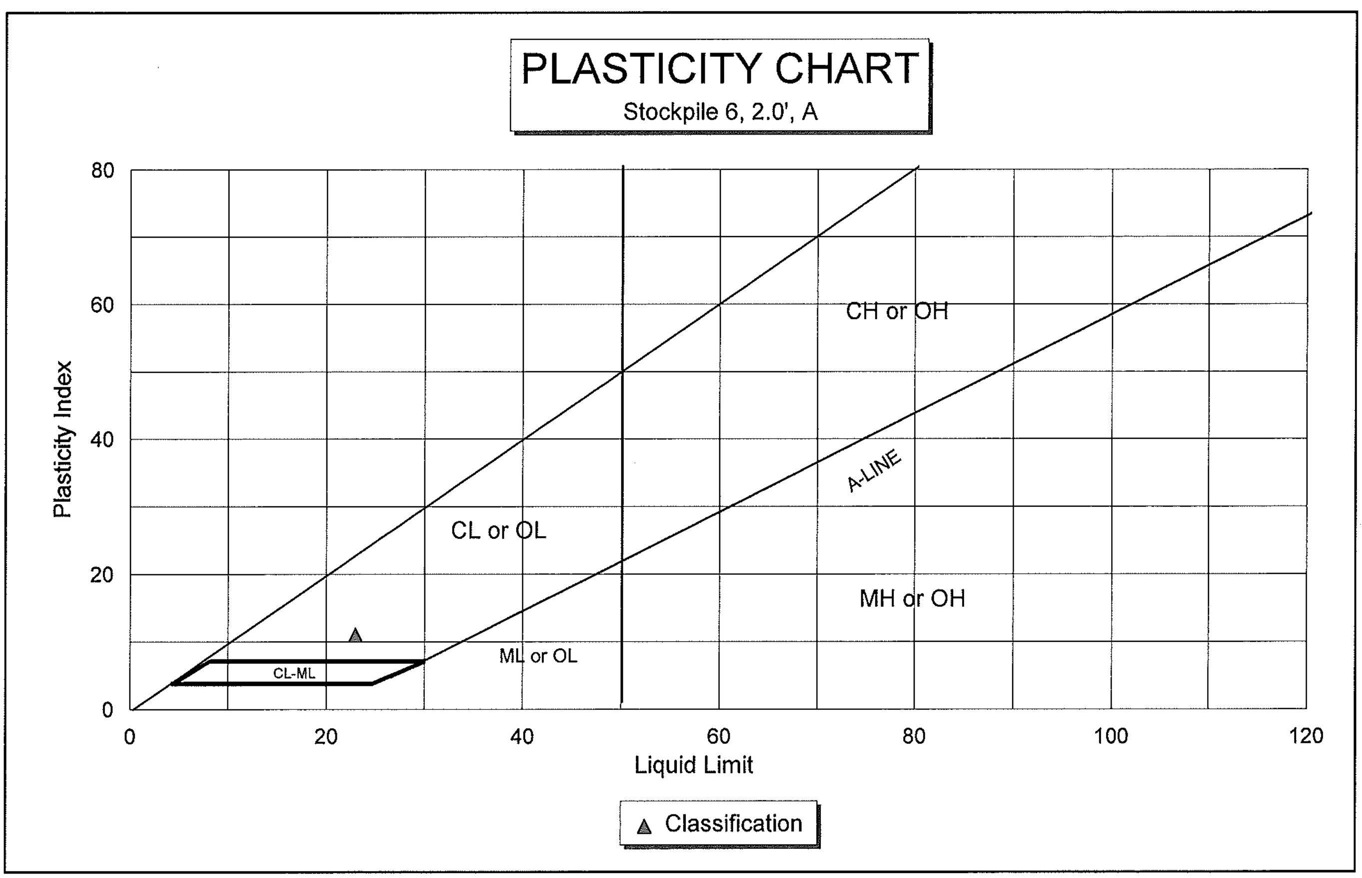
Atterberg Classification CL

Data entry by: LB Date: 11/04/2010
Checked by: _[signature]_ Date: 11/04/10
FileName: MHG0CKP6

ADVANCED TERRA TESTING, INC. ATT



Atterberg Limits, Flow Curve
Stockpile 6, 2.0', A
Moisture Content
27
26
25
24
23
22
Number of Blows
25



PLASTICITY CHART
Stockpile 6, 2.0', A
Plasticity Index
80
60
40
20
0
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 7	DATE SAMPLED	10/12/10
DEPTH	0.0	DATE TESTED	11/05/10 BKL
SAMPLE NO.	A		
SOIL DESCR.	1009740		
LOCATION	Denison White Mesa Mill Project		

Plastic Limit
Determination

	1	2
Wt Dish & Wet Soil	7.12	7.12
Wt Dish & Dry Soil	6.46	6.47
Wt of Moisture	0.66	0.65
Wt of Dish	1.16	1.16
Wt of Dry Soil	5.30	5.31
Moisture Content	12.45	12.24

Liquid Limit Determination   Device Number   1075

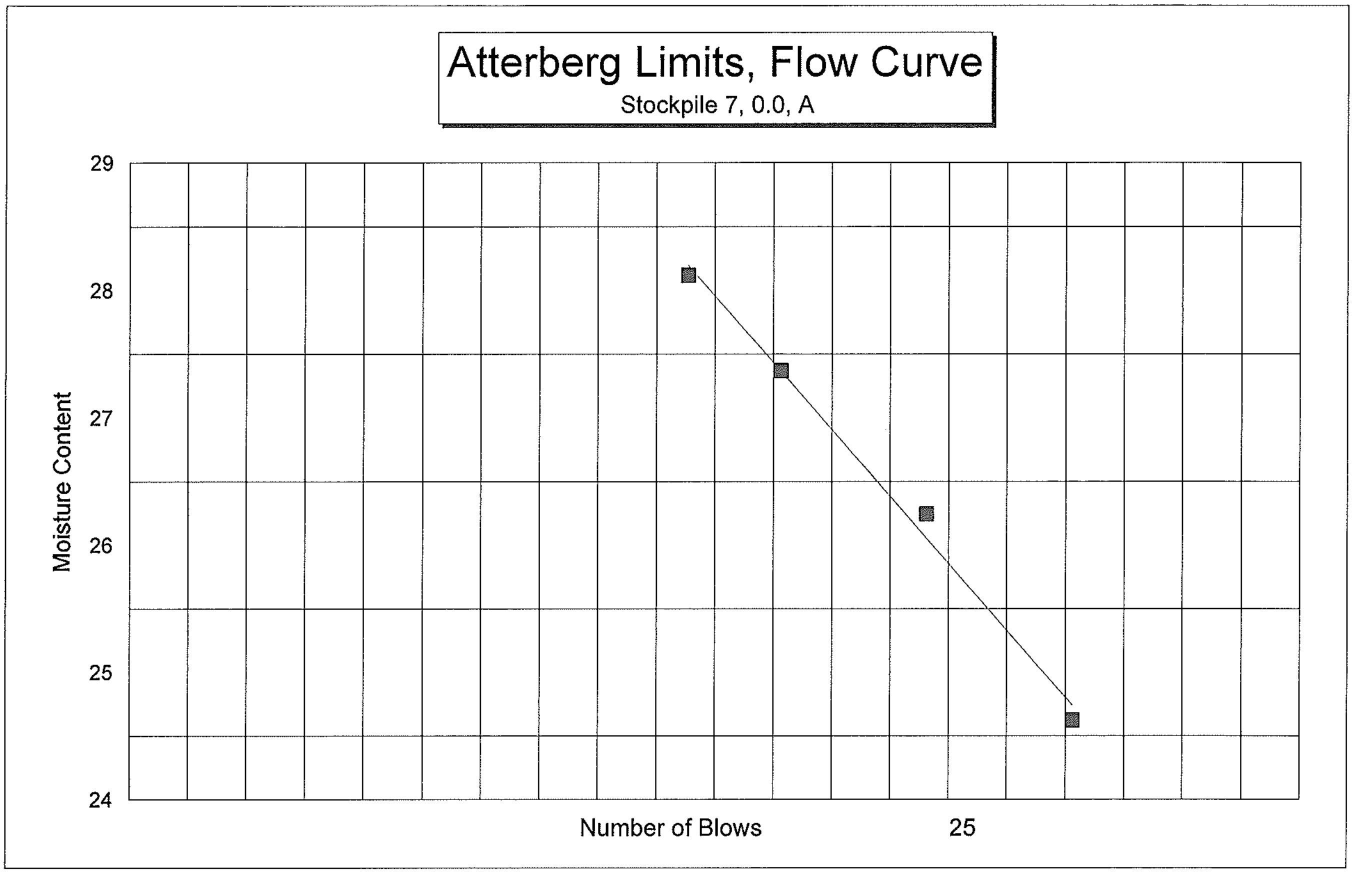
	1	2	3	4
Number of Blows	15	18	24	32
Wt Dish & Wet Soil	10.39	10.65	10.74	10.21
Wt Dish & Dry Soil	8.36	8.60	8.74	8.42
Wt of Moisture	2.03	2.05	2.00	1.79
Wt of Dish	1.14	1.11	1.12	1.15
Wt of Dry Soil	7.22	7.49	7.62	7.27
Moisture Content	28.12	27.37	26.25	24.62

Liquid Limit	25.9
Plastic Limit	12.3
Plasticity Index	13.5

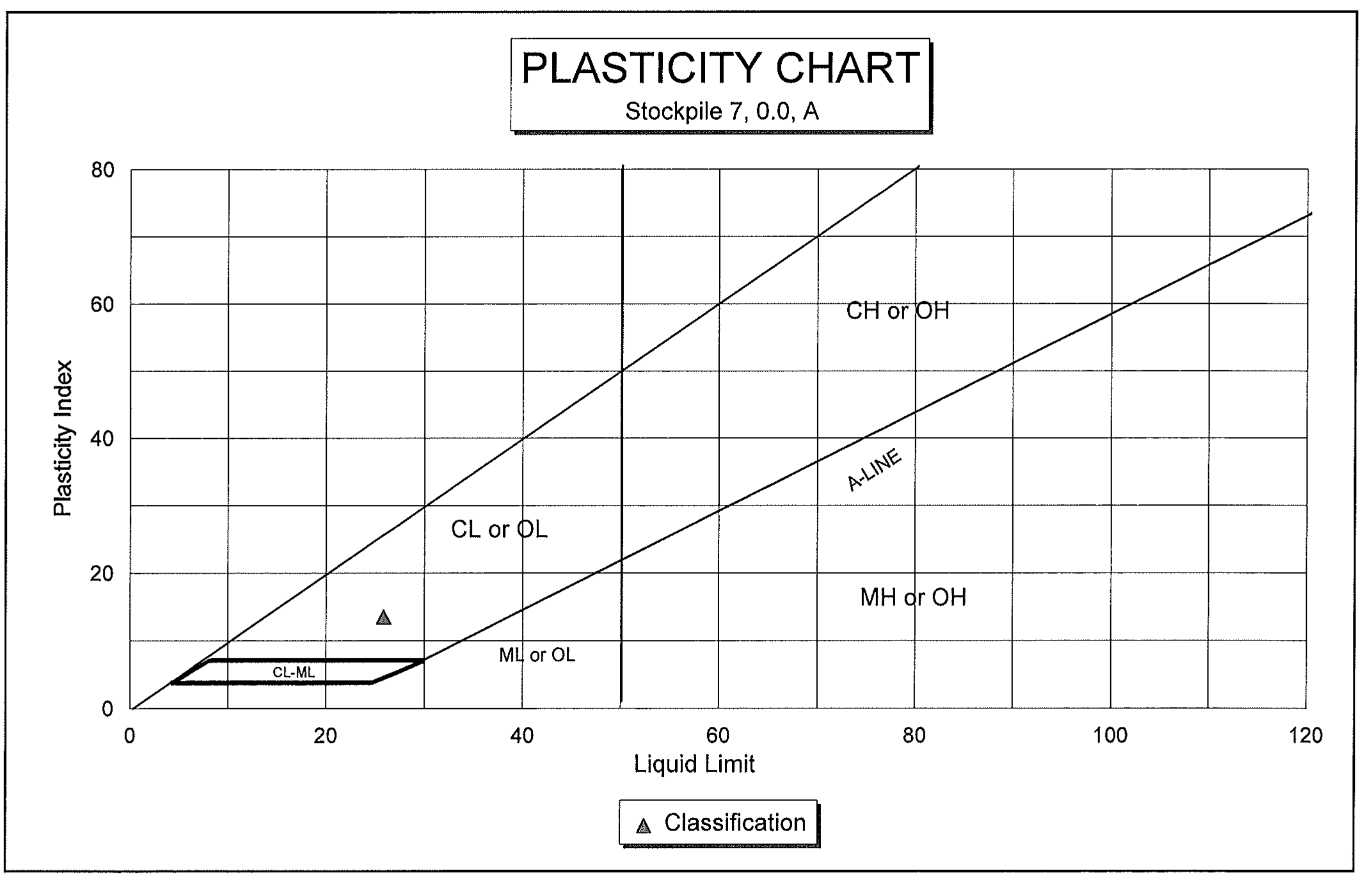
Atterberg Classification   CL

Data entry by: MLM   Date: 11/08/2010
Checked by: LB   Date: 11-09-10
FileName: MHG0S70A

ADVANCED TERRA TESTING, INC. ATT



Atterberg Limits, Flow Curve
Stockpile 7, 0.0, A
29
28
27
26
25
24
Moisture Content
Number of Blows
25



PLASTICITY CHART
Stockpile 7, 0.0, A
80
60
40
20
0
Plasticity Index
0
20
40
60
80
100
120
Liquid Limit
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 8	DATE SAMPLED	10/12/10
DEPTH	5.0'	DATE TESTED	11/08/10 TMR
SAMPLE NO.	A		
SOIL DESCR.	1009740		
LOCATION	Denison White Mesa Mill Project		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	8.47	8.40	8.40
Wt Dish & Dry Soil	7.74	7.73	7.70
Wt of Moisture	0.73	0.67	0.70
Wt of Dish	1.15	1.14	1.15
Wt of Dry Soil	6.59	6.59	6.55
Moisture Content	11.08	10.17	10.69

Liquid Limit Determination — Device Number 1080

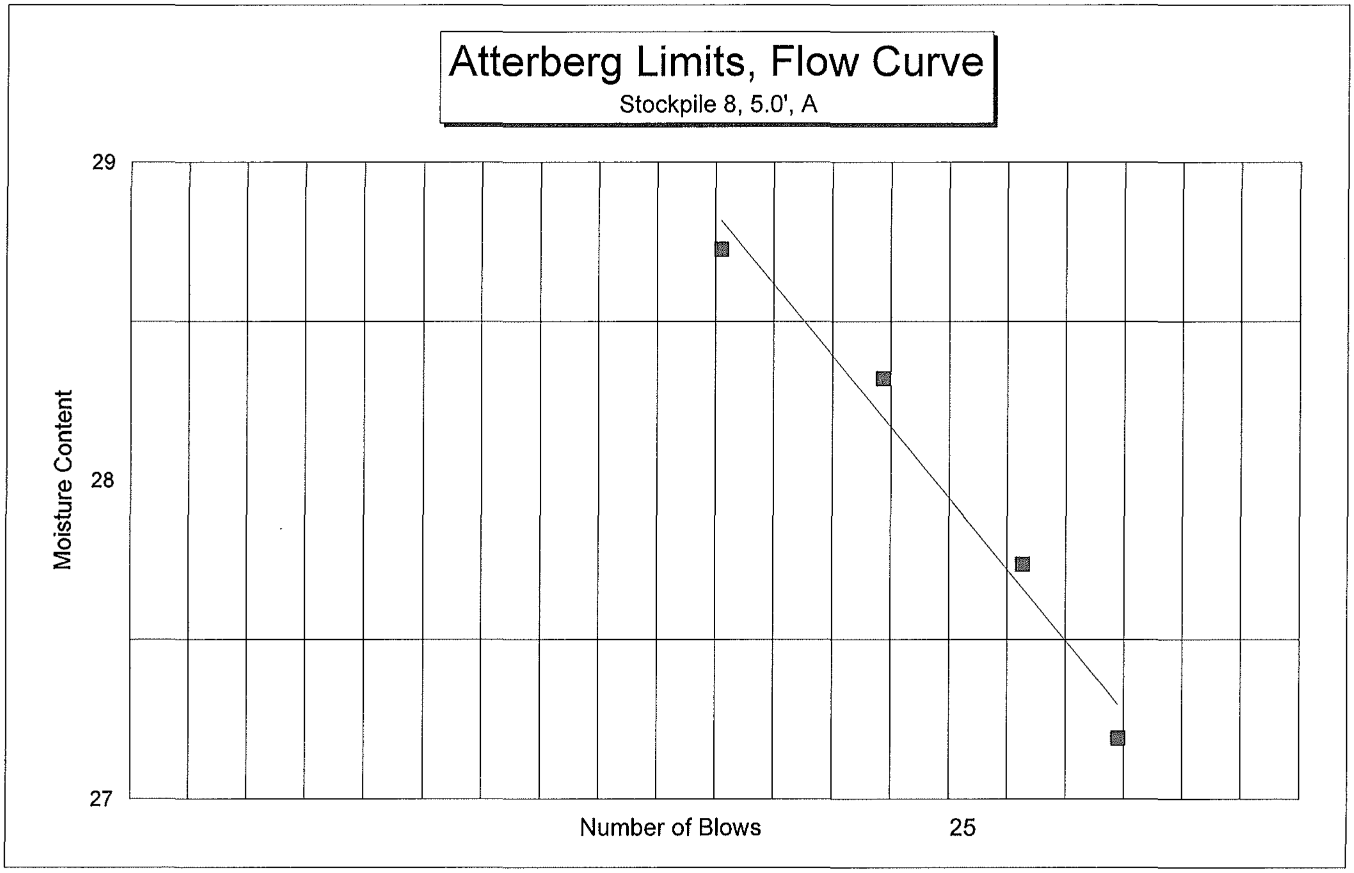
	1	2	3	4
Number of Blows	16	22	29	35
Wt Dish & Wet Soil	10.61	9.91	7.88	13.93
Wt Dish & Dry Soil	8.49	7.97	6.41	11.20
Wt of Moisture	2.12	1.94	1.47	2.73
Wt of Dish	1.11	1.12	1.11	1.16
Wt of Dry Soil	7.38	6.85	5.30	10.04
Moisture Content	28.73	28.32	27.74	27.19

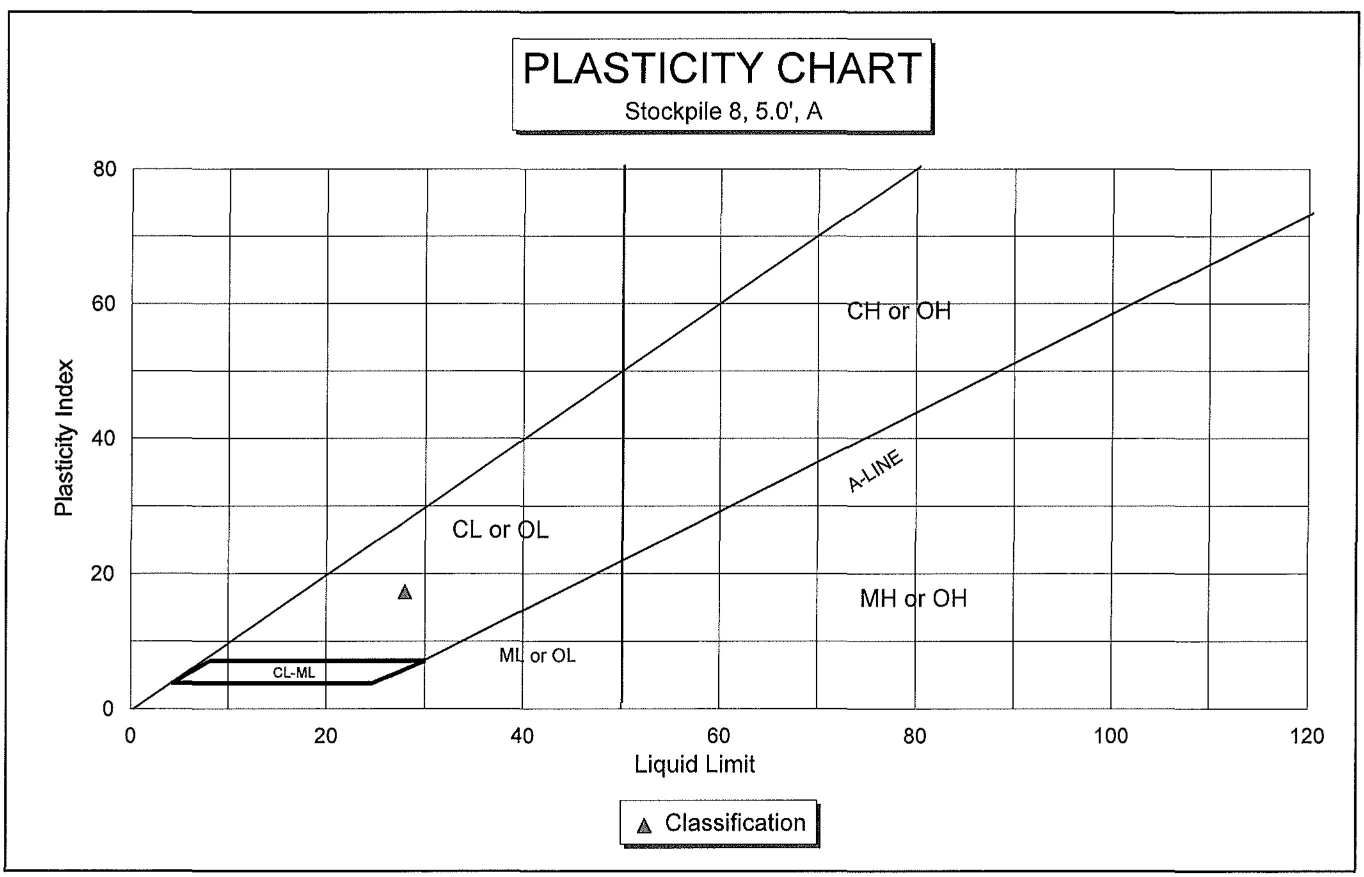
Liquid Limit	28.0
Plastic Limit	10.6
Plasticity Index	17.3

Atterberg Classification CL

Data entry by: MLM Date: 11/09/2010
Checked by: BKC Date: 11/9/10
FileName: MHG0S850

ADVANCED TERRA TESTING, INC. ATT


Atterberg Limits, Flow Curve
Stockpile 8, 5.0', A
29
28
27
Moisture Content
Number of Blows
25


PLASTICITY CHART
Stockpile 8, 5.0', A
80
60
40
20
0
Plasticity Index
0
20
40
60
80
100
120
Liquid Limit
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 9	DATE SAMPLED	10/12/10
DEPTH	0.0'	DATE TESTED	10/27/10 MLM
SAMPLE NO.	A		
SOIL DESCR.	1009740		
LOCATION	Denison White Mesa Mill Project		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	10.28	10.65	12.42
Wt Dish & Dry Soil	8.97	9.31	10.83
Wt of Moisture	1.31	1.34	1.59
Wt of Dish	1.14	1.13	1.14
Wt of Dry Soil	7.83	8.18	9.69
Moisture Content	16.73	16.38	16.41

Liquid Limit Determination — Device Number 1080

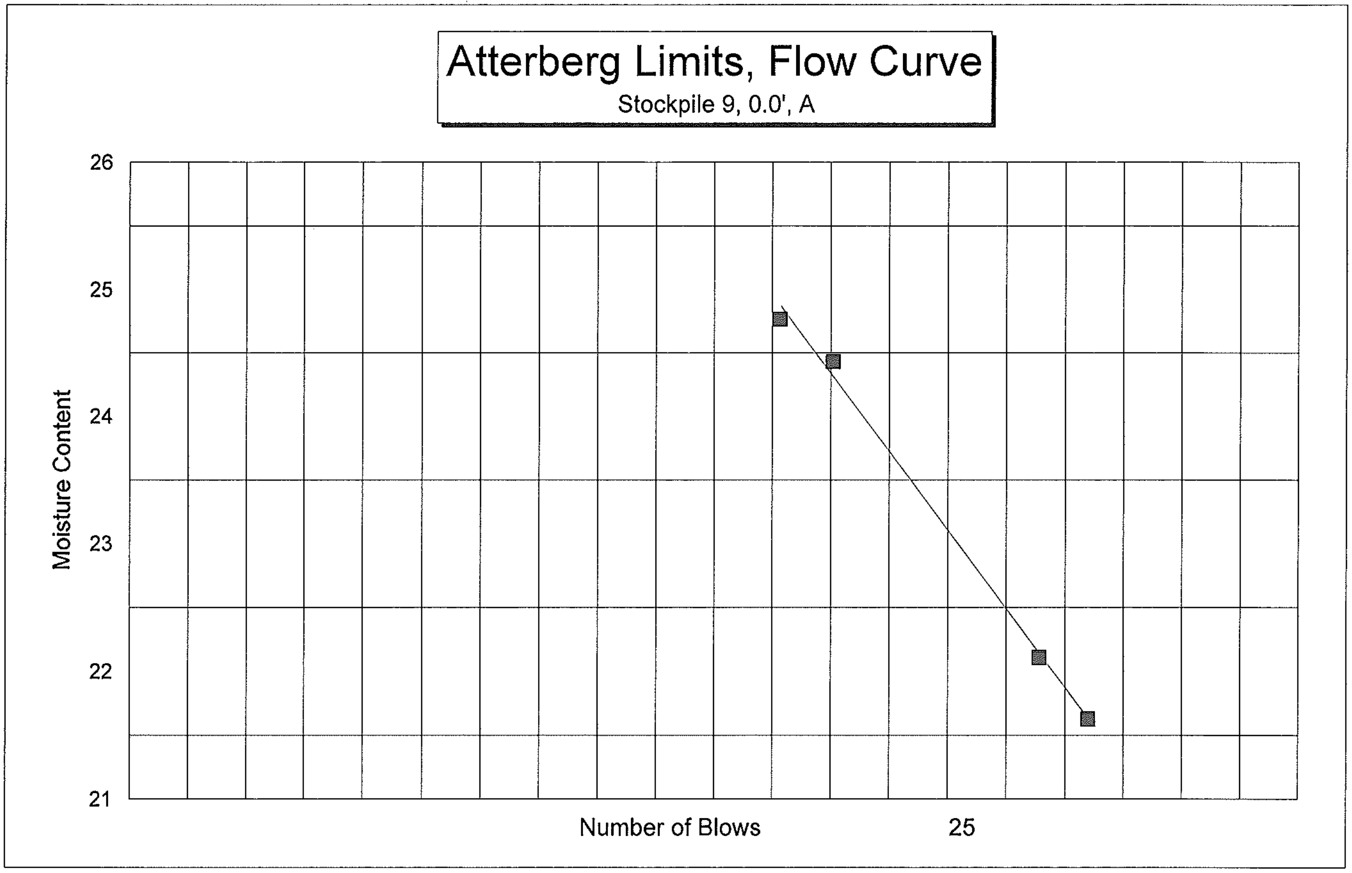
	1	2	3	4
Number of Blows	33	30	18	20
Wt Dish & Wet Soil	12.52	11.80	11.75	10.46
Wt Dish & Dry Soil	10.50	9.87	9.64	8.63
Wt of Moisture	2.02	1.93	2.11	1.83
Wt of Dish	1.16	1.14	1.12	1.14
Wt of Dry Soil	9.34	8.73	8.52	7.49
Moisture Content	21.63	22.11	24.77	24.43

Liquid Limit	23.1
Plastic Limit	16.5
Plasticity Index	6.6

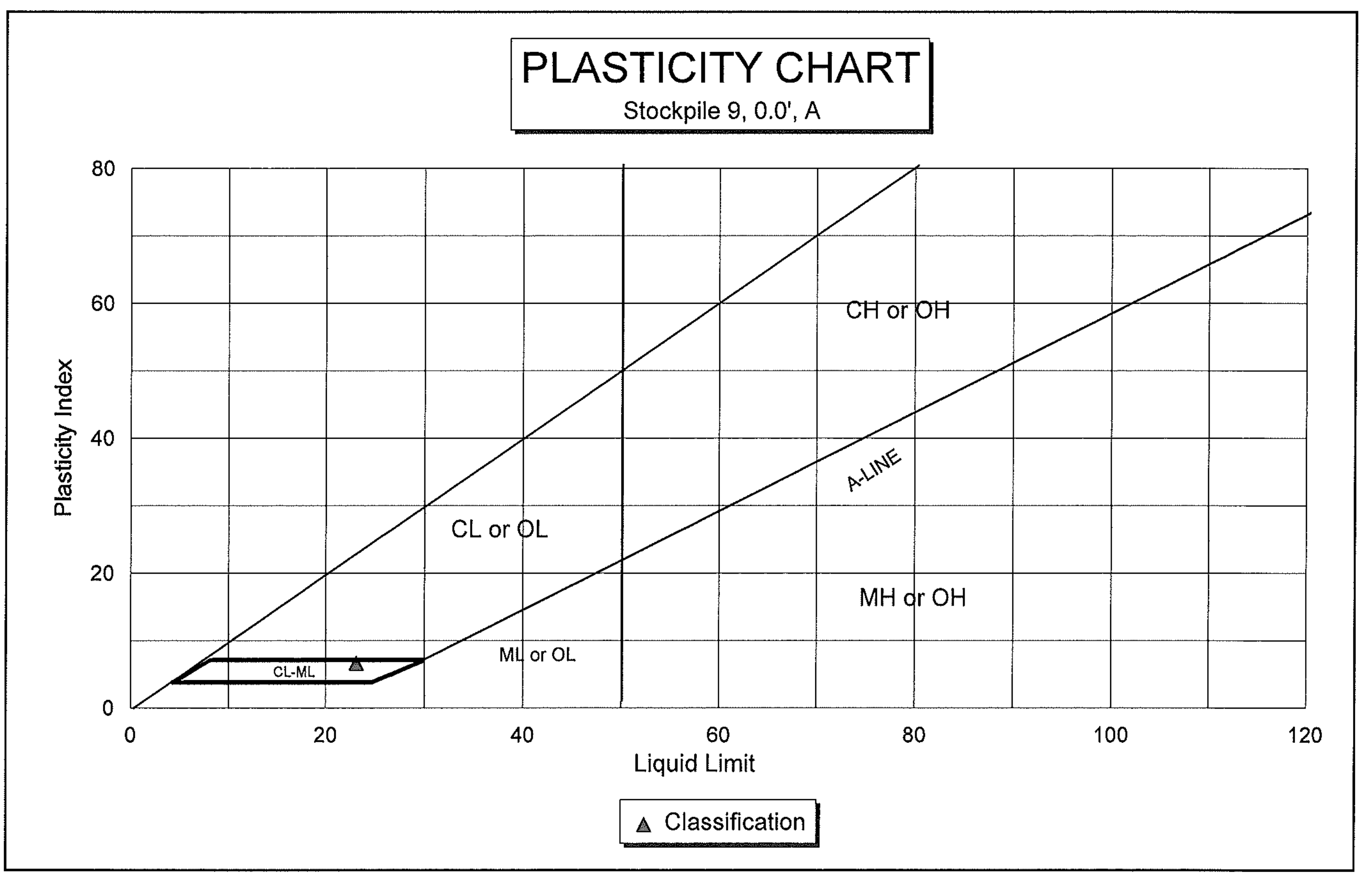
Atterberg Classification CL-ML

Data entry by: MLM Date: 10/28/2010
Checked by: BKL Date: 10/28/10
FileName: MHG090A

ADVANCED TERRA TESTING, INC. ATT



Atterberg Limits, Flow Curve
Stockpile 9, 0.0', A
Moisture Content
26
25
24
23
22
21
Number of Blows
25



PLASTICITY CHART
Stockpile 9, 0.0', A
Plasticity Index
80
60
40
20
0
0
20
40
60
80
100
120
Liquid Limit
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 10	DATE SAMPLED	10/12/10
DEPTH	5.0'	DATE TESTED	10/28/10 PW
SAMPLE NO.	A		
SOIL DESCR.	1009740		
LOCATION	Denison White Mesa Mill Project		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	11.61	12.10	11.57
Wt Dish & Dry Soil	10.05	10.40	9.95
Wt of Moisture	1.56	1.70	1.62
Wt of Dish	1.15	1.08	1.06
Wt of Dry Soil	8.90	9.32	8.89
Moisture Content	17.53	18.24	18.17

Liquid Limit Determination — Device Number 0860

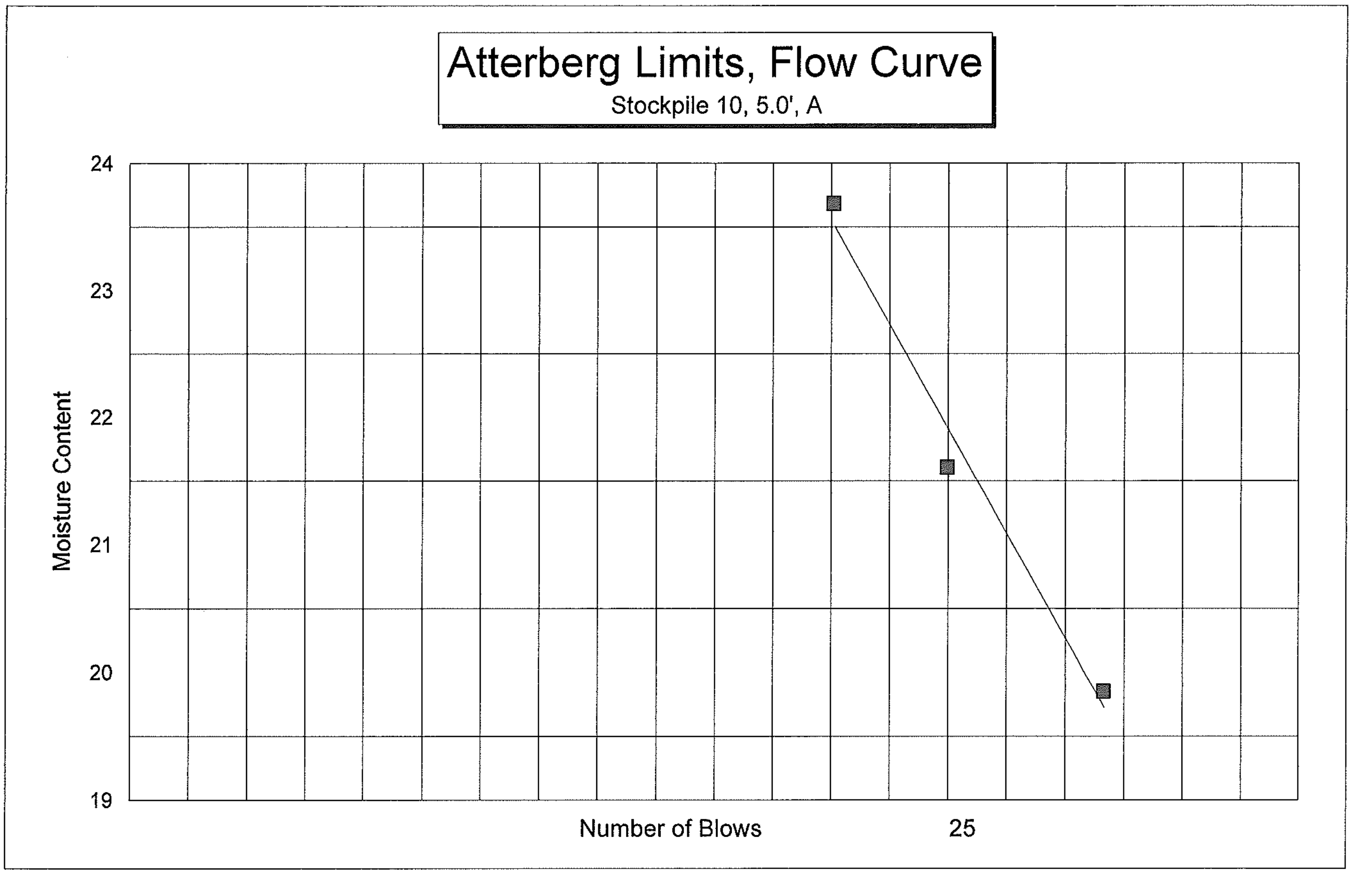
	1	2	3
Number of Blows	34	20	25
Wt Dish & Wet Soil	14.92	15.72	17.87
Wt Dish & Dry Soil	12.64	12.93	14.89
Wt of Moisture	2.28	2.79	2.99
Wt of Dish	1.15	1.15	1.07
Wt of Dry Soil	11.49	11.78	13.82
Moisture Content	19.85	23.68	21.61

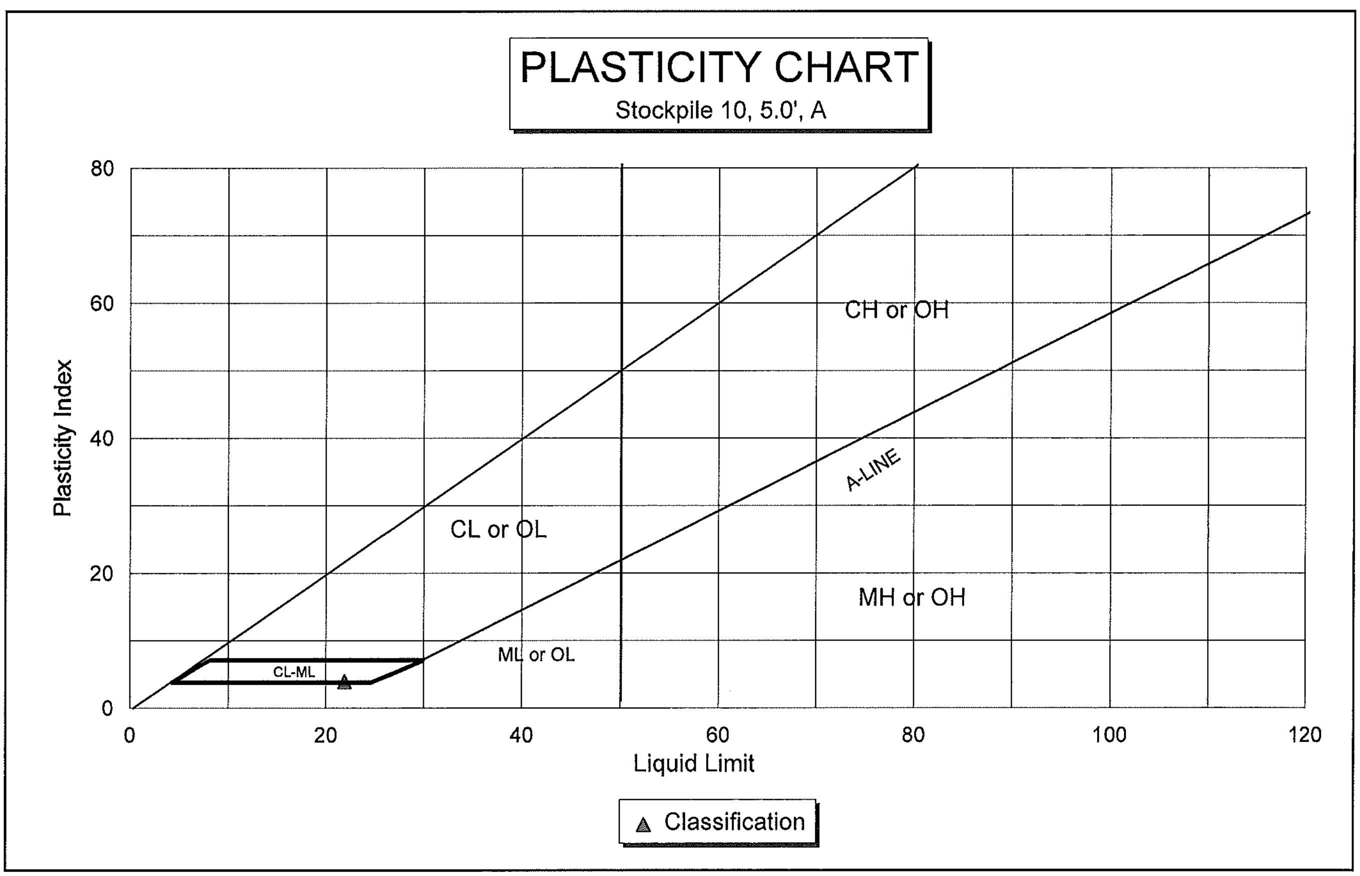
Liquid Limit	21.9
Plastic Limit	18.0
Plasticity Index	3.9

Atterberg Classification ML

Data entry by: MLM Date: 10/29/2010
Checked by: BKL Date: 10/29/10
FileName: MHG0105A

ADVANCED TERRA TESTING, Inc. ATT


Atterberg Limits, Flow Curve
Stockpile 10, 5.0', A
24
23
22
21
20
19
Moisture Content
Number of Blows
25


PLASTICITY CHART
Stockpile 10, 5.0', A
80
60
40
20
0
Plasticity Index
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 11	DATE SAMPLED	10/12/10
DEPTH	0.0'	DATE TESTED	11/05/10 MLM
SAMPLE NO.	A		
SOIL DESCR.	1009740		
LOCATION	Denison White Mesa Mill Project		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	11.41	13.44	12.03
Wt Dish & Dry Soil	9.95	11.71	10.55
Wt of Moisture	1.46	1.73	1.48
Wt of Dish	1.14	1.12	1.15
Wt of Dry Soil	8.81	10.59	9.40
Moisture Content	16.57	16.34	15.74

Liquid Limit Determination — Device Number 1080

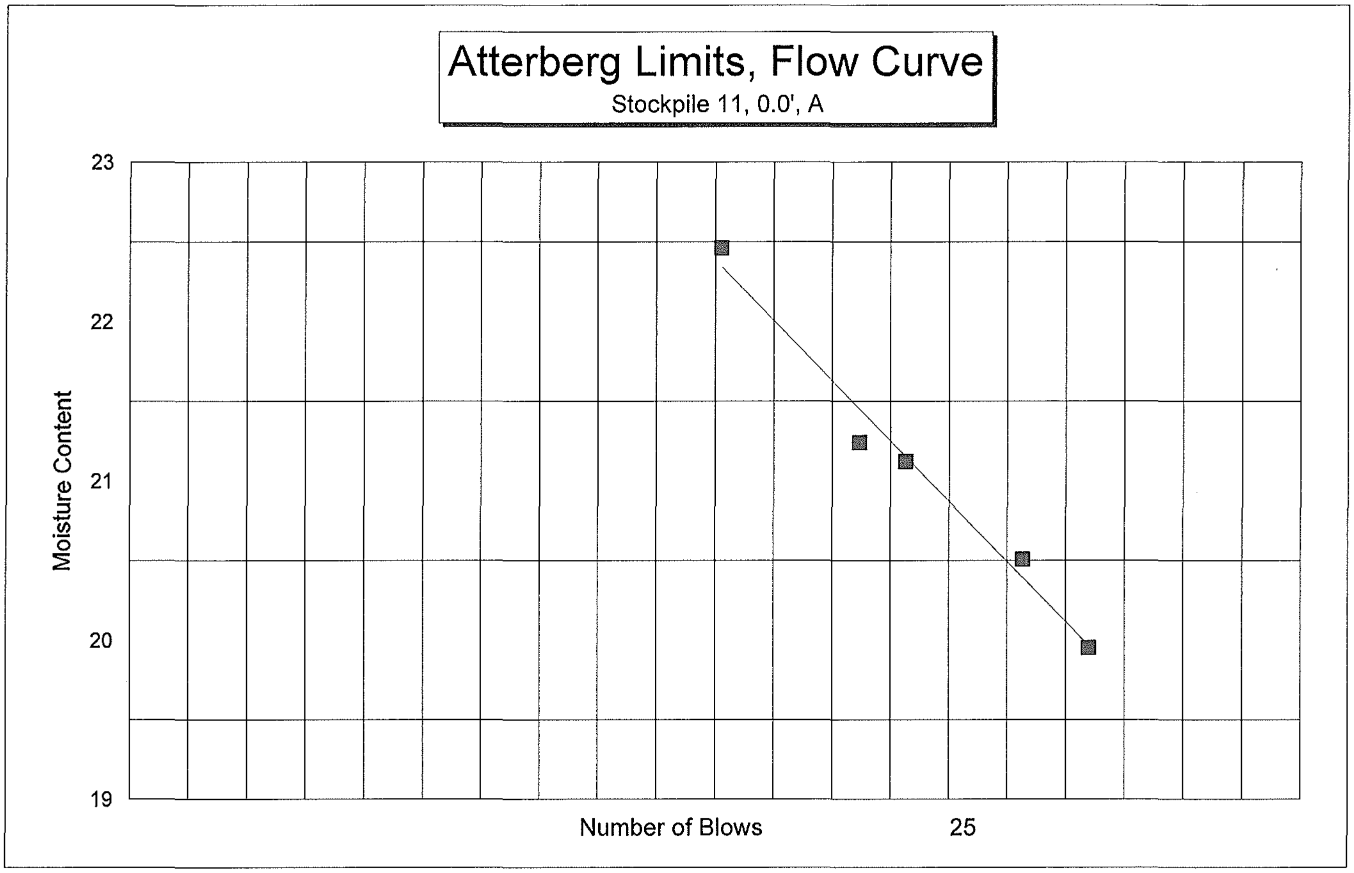
	1	2	3	4	5
Number of Blows	33	29	23	21	16
Wt Dish & Wet Soil	16.83	14.89	14.74	14.62	14.29
Wt Dish & Dry Soil	14.22	12.55	12.37	12.26	11.88
Wt of Moisture	2.61	2.34	2.37	2.36	2.41
Wt of Dish	1.14	1.14	1.15	1.15	1.15
Wt of Dry Soil	13.08	11.41	11.22	11.11	10.73
Moisture Content	19.95	20.51	21.12	21.24	22.46

Liquid Limit	20.9
Plastic Limit	16.2
Plasticity Index	4.7

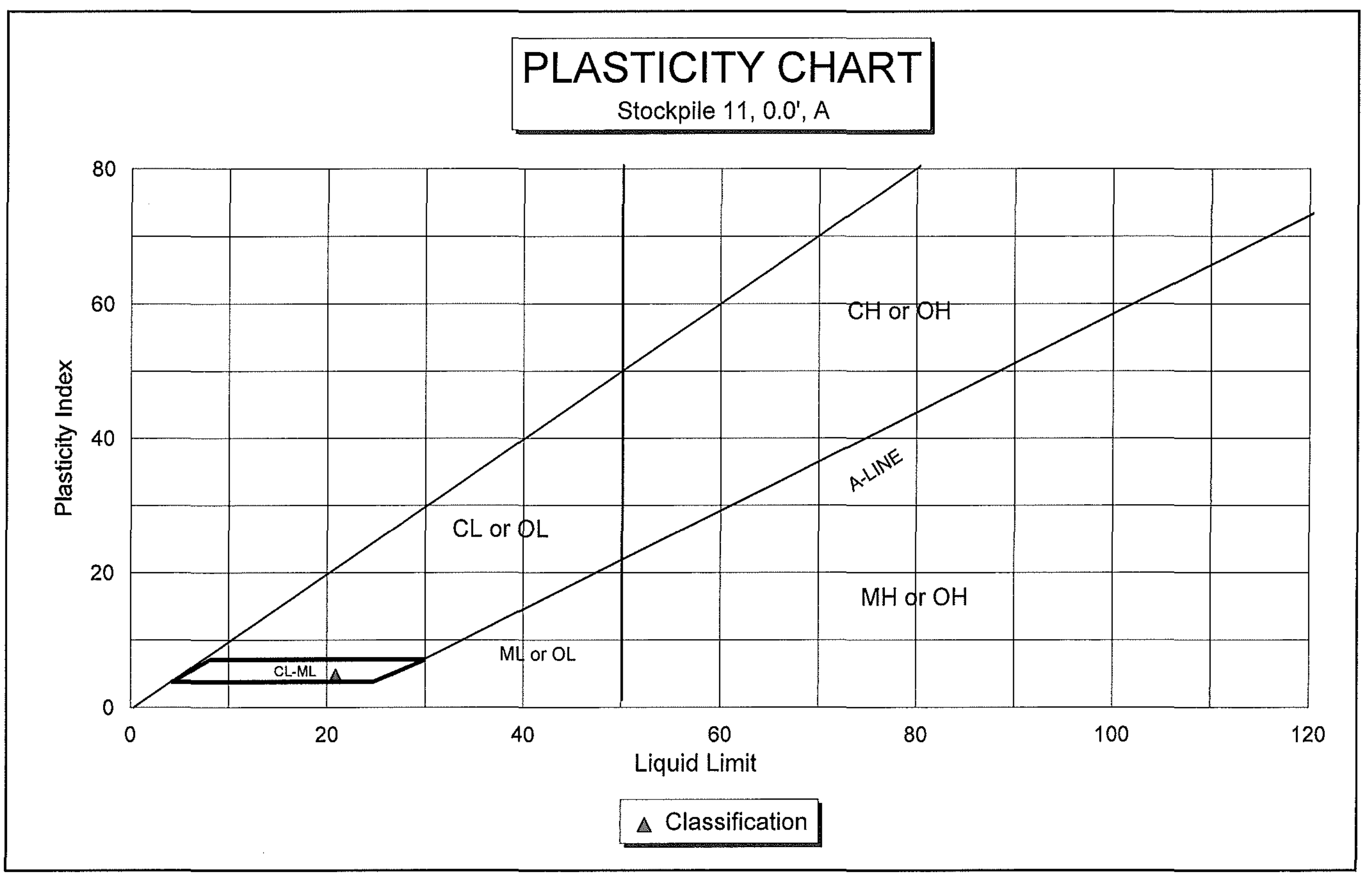
Atterberg Classification CL-ML

Data entry by: MLM Date: 11/08/2010
Checked by: LB Date: 11-09-10
FileName: MHG0S11A

ADVANCED TERRA TESTING, Inc. ATT



Atterberg Limits, Flow Curve
Stockpile 11, 0.0', A
Moisture Content
23
22
21
20
19
Number of Blows
25



PLASTICITY CHART
Stockpile 11, 0.0', A
Plasticity Index
80
60
40
20
0
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 12	DATE SAMPLED	10/12/10
DEPTH	5.0'	DATE TESTED	10/27/10 MLM
SAMPLE NO.	A		
SOIL DESCR.	1009740		
LOCATION	Denison White Mesa Mill Project		

Plastic Limit Determination

	1	2
Wt Dish & Wet Soil	13.07	15.00
Wt Dish & Dry Soil	11.56	13.25
Wt of Moisture	1.51	1.75
Wt of Dish	1.13	1.12
Wt of Dry Soil	10.43	12.13
Moisture Content	14.48	14.43

Liquid Limit Determination — Device Number 1080

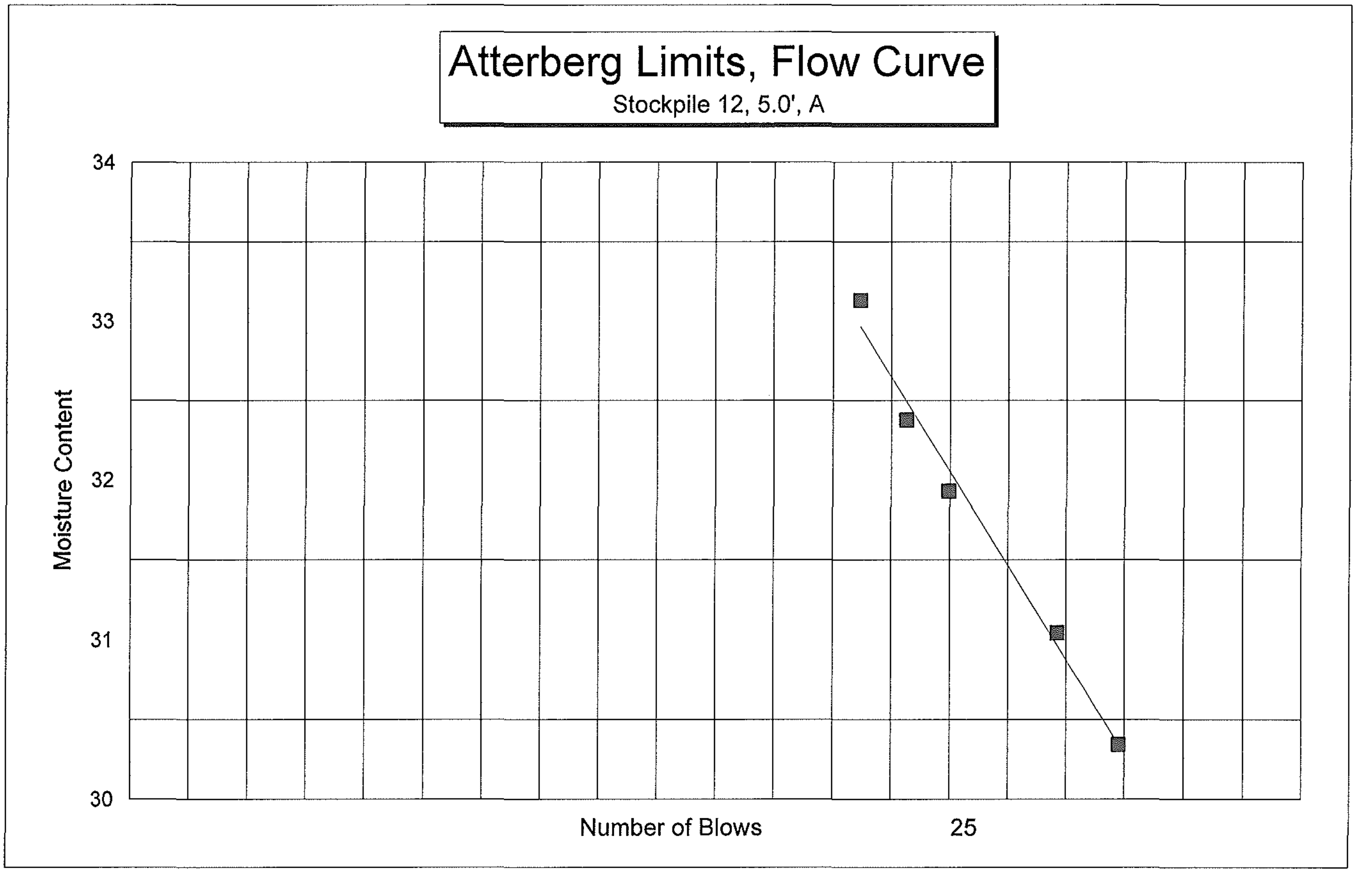
	1	2	3	4	5
Number of Blows	35	31	25	23	21
Wt Dish & Wet Soil	10.60	10.67	10.86	10.85	9.88
Wt Dish & Dry Soil	8.40	8.41	8.51	8.48	7.71
Wt of Moisture	2.20	2.26	2.35	2.37	2.17
Wt of Dish	1.15	1.13	1.15	1.16	1.16
Wt of Dry Soil	7.25	7.28	7.36	7.32	6.55
Moisture Content	30.34	31.04	31.93	32.38	33.13

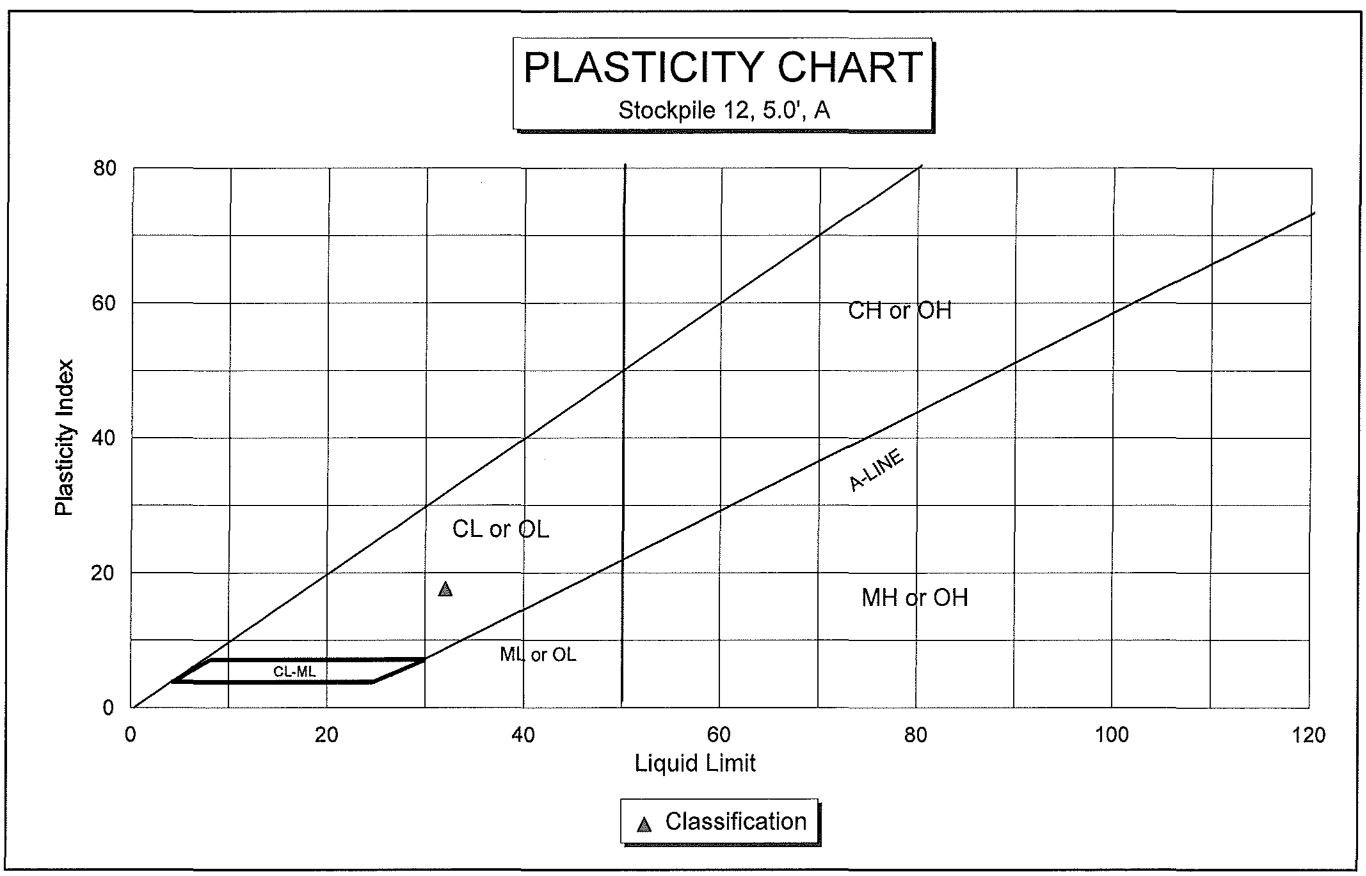
Liquid Limit	32.1
Plastic Limit	14.5
Plasticity Index	17.6

Atterberg Classification CL

Data entry by: MLM Date: 10/28/2010
Checked by: BKL Date: 10/28/10
FileName: MHG01250

ADVANCED TERRA TESTING, INC. ATT


Atterberg Limits, Flow Curve
Stockpile 12, 5.0', A
34
33
32
31
30
Moisture Content
Number of Blows
25


PLASTICITY CHART
Stockpile 12, 5.0', A
80
60
40
20
0
Plasticity Index
0
20
40
60
80
100
120
Liquid Limit
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 13	DATE SAMPLED	10/12/10
DEPTH	0.0'	DATE TESTED	10/27/10 MLM
SAMPLE NO.	A		
SOIL DESCR.	1009740		
LOCATION	Denison White Mesa Mill Project		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	10.58	11.06	10.25
Wt Dish & Dry Soil	9.48	9.93	9.18
Wt of Moisture	1.10	1.13	1.07
Wt of Dish	1.12	1.14	1.12
Wt of Dry Soil	8.36	8.79	8.06
Moisture Content	13.16	12.86	13.28

Liquid Limit Determination — Device Number 1080

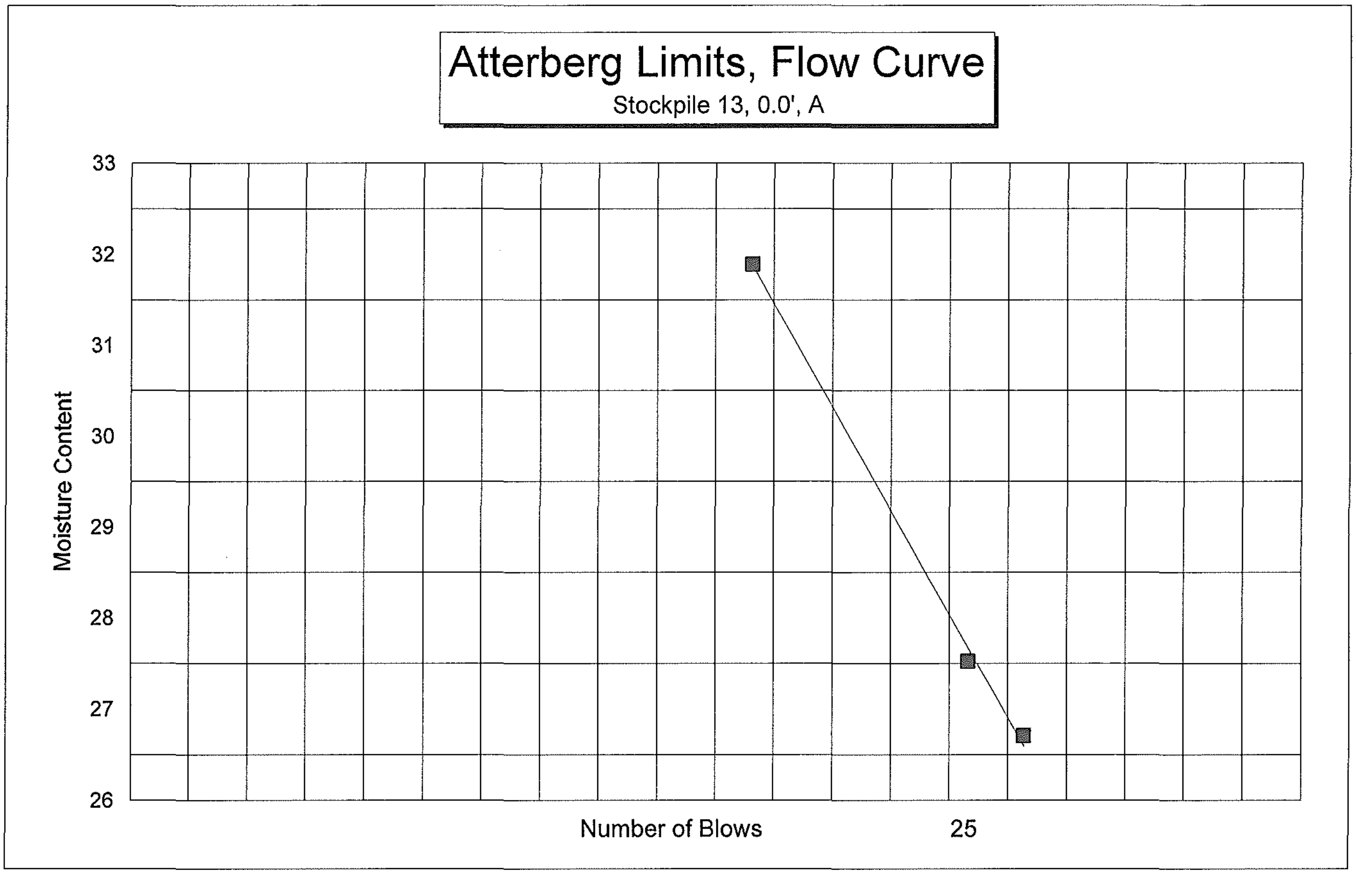
	1	2	3
Number of Blows	29	26	17
Wt Dish & Wet Soil	11.35	11.77	11.20
Wt Dish & Dry Soil	9.20	9.48	8.77
Wt of Moisture	2.15	2.29	2.43
Wt of Dish	1.15	1.16	1.15
Wt of Dry Soil	8.05	8.32	7.62
Moisture Content	26.71	27.52	31.89

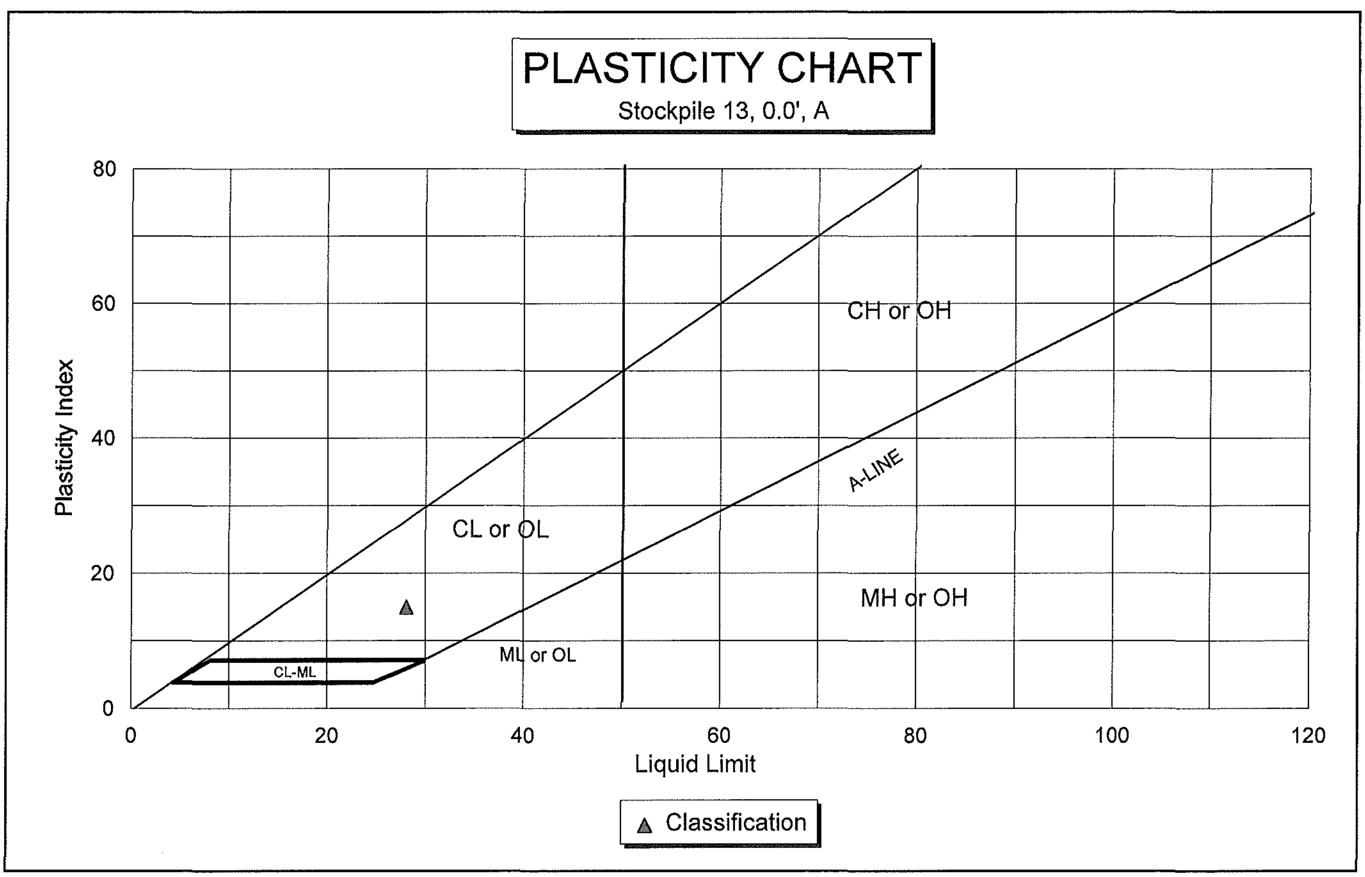
Liquid Limit	28.1
Plastic Limit	13.1
Plasticity Index	15.0

Atterberg Classification CL

Data entry by: MLM Date: 10/28/2010
Checked by: BKL Date: 10/28/10
FileName: MHG0130A

ADVANCED TERRA TESTING, Inc. ATT


Atterberg Limits, Flow Curve
Stockpile 13, 0.0', A
33
32
31
30
29
28
27
26
Moisture Content
Number of Blows
25


PLASTICITY CHART
Stockpile 13, 0.0', A
80
60
40
20
0
Plasticity Index
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

MECHANICAL ANALYSIS
WITH HYDROMETER
ASTM D 422

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 1
DEPTH	5.0'
SAMPLE NO.	A South
SOIL DESCR.	1009740
LOCATION	Denison White Mesa Mill Project

SAMPLED	10/12/10 --
DATE TESTED	10/26/10 DPM
WASH SIEVE	Yes
DRY SIEVE	No

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No
Wt. Wet Soil & Pan (g)	112.71
Wt. Dry Soil & Pan (g)	111.29
Wt. Lost Moisture (g)	1.42
Wt. of Pan Only (g)	3.23
Wt. of Dry Soil (g)	108.06
Moisture Content %	1.3
Wt. Hydrom. Sample Wet (g)	69.24
Wt. Hydrom. Sample Dry (g)	68.34

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	2215.88
Weight of + #10 Before Washing (g)	20.38
Weight of + #10 After Washing (g)	18.67
Weight of - #10 Wet (g)	2195.50
Weight of - #10 Dry (g)	2168.71
Wt. Total Sample Dry (g)	2187.38
Calc. Wt. "W" (g)	68.93
Calc. Mass + #10	0.59

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	6.84	6.84	6.84	0.3	99.7
#4	0.00	3.97	3.97	10.81	0.5	99.5
#10	0.00	7.86	7.86	18.67	0.9	99.1
#20	1.76	4.38	2.62	2.62	4.7	95.3
#40	1.79	13.48	11.69	14.31	21.6	78.4
#60	1.74	25.97	24.23	38.54	56.8	43.2
#100	1.77	11.13	9.36	47.90	70.3	29.7
#200	1.77	6.76	4.99	52.89	77.6	22.4

Data entered by: MLM Date: 11/04/2010
Data checked by: KR Date: 11/4/10
FileName: MHHYS1AS

ADVANCED TERRA TESTING, Inc. ATT

HYDROMETER ANALYSIS - SEDIMENTATION DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 1	SAMPLED	10/12/10 --
DEPTH	5.0'	DATE TESTED	10/26/10 DPM
SAMPLE NO.	A South	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

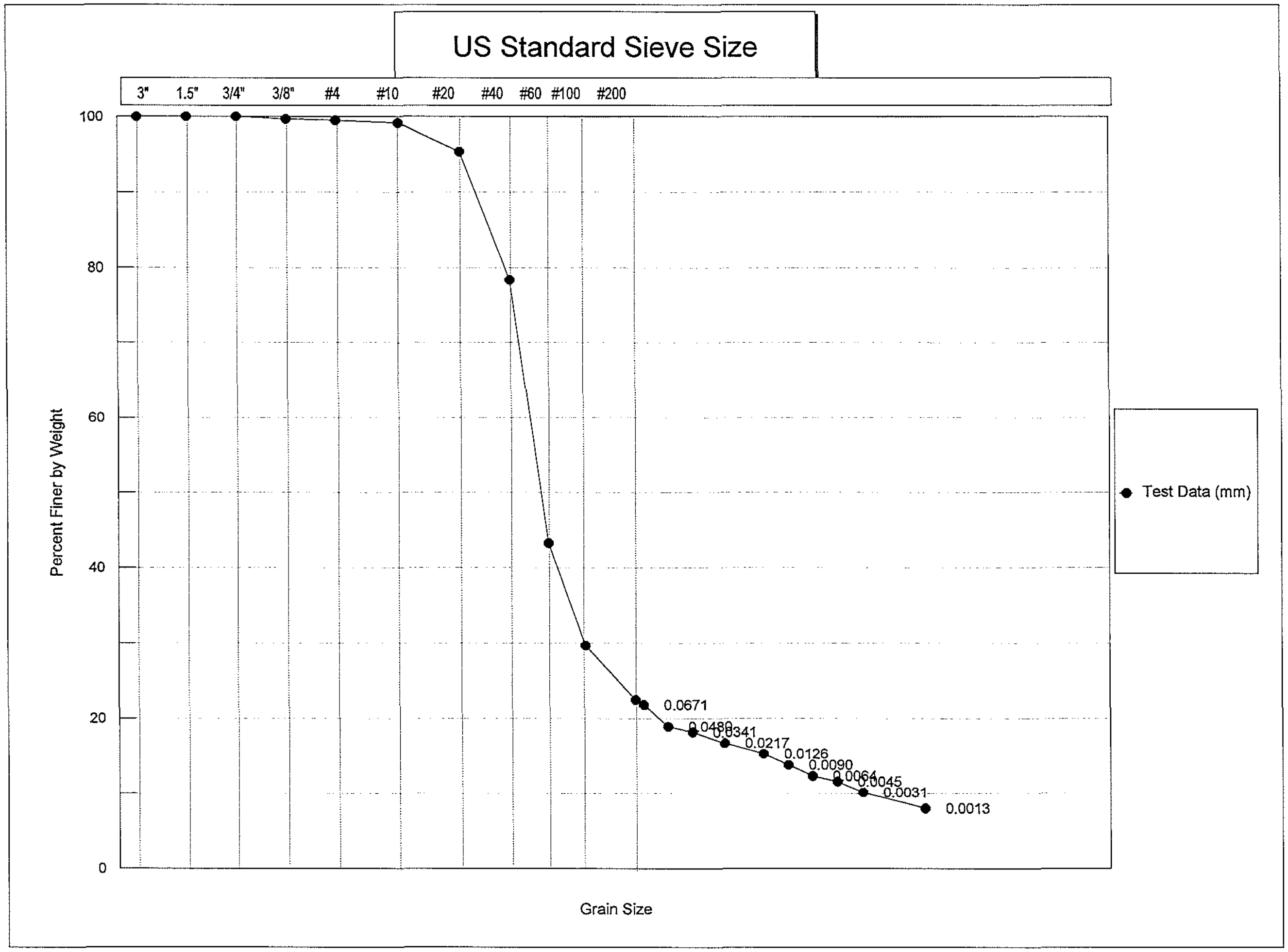
Hydrometer #	ASTM 152 H	Temp., Deg. C	23.1
Sp. Gr. of Soil	2.65	Temp. Coef. K	0.01315
Value of "alpha"	1.00	Wt. Dry Sample "W"	68.930
Deflocculant	Sodium Hexametaphosphate	% of Total Sample	100.0
Defloc. Corr'n	5.5		
Meniscus Corr'n	0.5		

T Elapsed Time (min)	Hydrometer Reading Original	Corrected "R"	100Ra/W	% Total Sample	Effective Depth L	Grain Diameter (mm)
0.0	--	--	--	--	--	--
0.5	20.00	15.00	21.8	21.8	13.01	0.0671
1.0	18.00	13.00	18.9	18.9	13.34	0.0480
2.0	17.50	12.50	18.1	18.1	13.42	0.0341
5.0	16.50	11.50	16.7	16.7	13.58	0.0217
15.0	15.50	10.50	15.2	15.2	13.75	0.0126
30.0	14.50	9.50	13.8	13.8	13.91	0.0090
60.0	13.50	8.50	12.3	12.3	14.08	0.0064
120.0	13.00	8.00	11.6	11.6	14.16	0.0045
250.0	12.00	7.00	10.2	10.2	14.32	0.0031
1440.0	10.50	5.50	8.0	8.0	14.57	0.0013

Grain Diameter = K*(SQRT(L/T))

Data entered by: MLM Date: 11/04/2010
Data checked by:______ Date:________
FileName: MHHYS1AS

ADVANCED TERRA TESTING, Inc. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY (mm)	USCS
	COARSE	FINE	CRS	MEDIUM	FINE		

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY	WENTWORTH
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE			

Client: MWH
Job Number: 2512-53
Boring No.: Stockpile 1
Depth: 5.0'
Sample No.: A South
Classification: **Classification Not Performed**

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 1	SAMPLED	10/12/10 --
DEPTH	12.0'	DATE TESTED	10/26/10 DPM
SAMPLE NO.	B South	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No
Wt. Wet Soil & Pan (g)	104.78
Wt. Dry Soil & Pan (g)	102.31
Wt. Lost Moisture (g)	2.47
Wt. of Pan Only (g)	3.07
Wt. of Dry Soil (g)	99.24
Moisture Content %	2.5
Wt. Hydrom. Sample Wet (g)	63.26
Wt. Hydrom. Sample Dry (g)	61.72

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	2715.20
Weight of + #10 Before Washing (g)	373.00
Weight of + #10 After Washing (g)	355.13
Weight of - #10 Wet (g)	2342.20
Weight of - #10 Dry (g)	2302.76
Wt. Total Sample Dry (g)	2657.89
Calc. Wt. "W" (g)	71.24
Calc. Mass + #10	9.52

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	177.82	177.82	177.82	6.7	93.3
3/4"	0.00	165.87	165.87	343.69	12.9	87.1
3/8"	0.00	2.41	2.41	346.10	13.0	87.0
#4	0.00	1.85	1.85	347.95	13.1	86.9
#10	0.00	7.18	7.18	355.13	13.4	86.6
#20	1.78	2.64	0.86	0.86	14.6	85.4
#40	1.83	6.50	4.67	5.53	21.1	78.9
#60	1.78	15.80	14.02	19.55	40.8	59.2
#100	1.78	9.73	7.95	27.50	52.0	48.0
#200	1.74	9.87	8.13	35.63	63.4	36.6

Data entered by: MLM Date: 11/04/2010
Data checked by: KR Date: 11/4/10
FileName: MHHYS112

ADVANCED TERRA TESTING, INC. ATT

HYDROMETER ANALYSIS - SEDIMENTATION DATA
ASTM D 422

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 1	SAMPLED	10/12/10 --
DEPTH	12.0'	DATE TESTED	10/26/10 DPM
SAMPLE NO.	B South	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

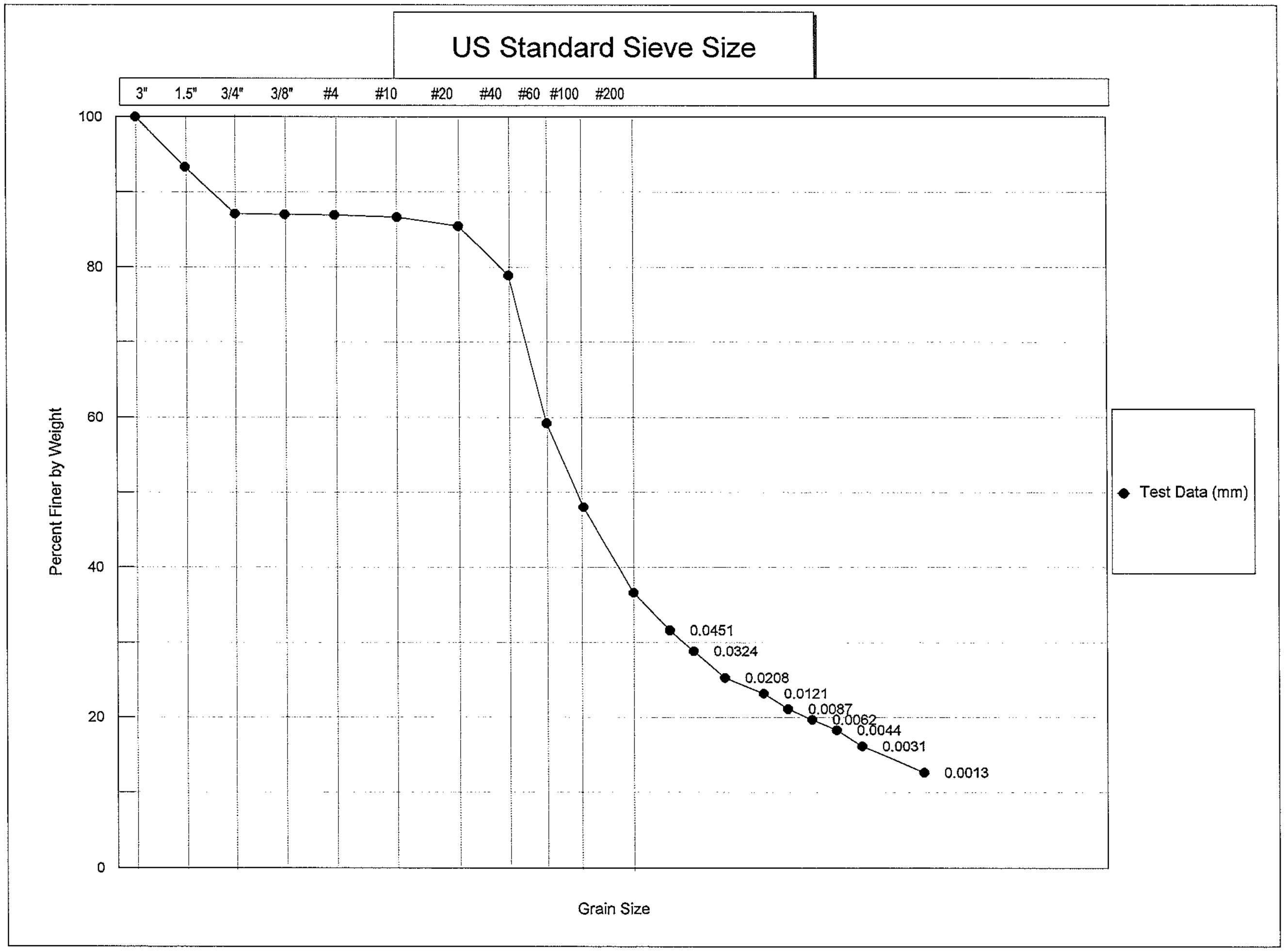
Hydrometer #	ASTM 152 H	Temp., Deg. C	23.1
Sp. Gr. of Soil	2.65	Temp. Coef. K	0.01315
Value of "alpha"	1.00	Wt. Dry Sample "W"	71.241
Deflocculant	Sodium Hexametaphosphate	% of Total Sample	100.0
Defloc. Corr'n	5.5		
Meniscus Corr'n	0.5		

T Elapsed Time (min)	Hydrometer Reading Original	Corrected "R"	100Ra/W	% Total Sample	Effective Depth L	Grain Diameter (mm)
0.0	--	--	--	--	--	--
0.5	--	--	--	--	--	--
1.0	27.50	22.50	31.6	31.6	11.78	0.0451
2.0	25.50	20.50	28.8	28.8	12.11	0.0324
5.0	23.00	18.00	25.3	25.3	12.52	0.0208
15.0	21.50	16.50	23.2	23.2	12.76	0.0121
30.0	20.00	15.00	21.1	21.1	13.01	0.0087
60.0	19.00	14.00	19.7	19.7	13.17	0.0062
120.0	18.00	13.00	18.2	18.2	13.34	0.0044
250.0	16.50	11.50	16.1	16.1	13.58	0.0031
1440.0	14.00	9.00	12.6	12.6	13.99	0.0013

Grain Diameter = K*(SQRT(L/T))

Data entered by: MLM Date: 11/04/2010
Data checked by:______ Date:________
FileName: MHHYS112

ADVANCED TERRA TESTING, Inc. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY (mm)	USCS
	COARSE	FINE	CRS	MEDIUM	FINE		

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY	WENTWORTH
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE			

Client: MWH   Boring No.: Stockpile 1   Sample No.: B South
Job Number: 2512-53   Depth: 12.0'
Classification: **Classification Not Performed**

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 2	SAMPLED	10/12/10 --
DEPTH	5.0'	DATE TESTED	10/26/10 DPM
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No
Wt. Wet Soil & Pan (g)	101.41
Wt. Dry Soil & Pan (g)	97.96
Wt. Lost Moisture (g)	3.45
Wt. of Pan Only (g)	3.14
Wt. of Dry Soil (g)	94.82
Moisture Content %	3.6
Wt. Hydrom. Sample Wet (g)	60.53
Wt. Hydrom. Sample Dry (g)	58.40

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	1717.36
Weight of + #10 Before Washing (g)	2.66
Weight of + #10 After Washing (g)	2.52
Weight of - #10 Wet (g)	1714.70
Weight of - #10 Dry (g)	1654.64
Wt. Total Sample Dry (g)	1657.16
Calc. Wt. "W" (g)	58.49
Calc. Mass + #10	0.09

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	0.00	0.00	0.00	0.0	100.0
#4	0.00	0.99	0.99	0.99	0.1	99.9
#10	0.00	1.53	1.53	2.52	0.2	99.8
#20	1.79	2.37	0.58	0.58	1.1	98.9
#40	1.74	2.41	0.67	1.25	2.3	97.7
#60	1.77	3.27	1.50	2.75	4.9	95.1
#100	1.76	4.29	2.53	5.28	9.2	90.8
#200	1.78	20.51	18.73	24.01	41.2	58.8

Data entered by: MLM Date: 11/04/2010
Data checked by: KR Date: 11/4/10
FileName: MHHYS25A

ADVANCED TERRA TESTING, Inc. ATT

HYDROMETER ANALYSIS - SEDIMENTATION DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 2	SAMPLED	10/12/10 --
DEPTH	5.0'	DATE TESTED	10/26/10 DPM
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

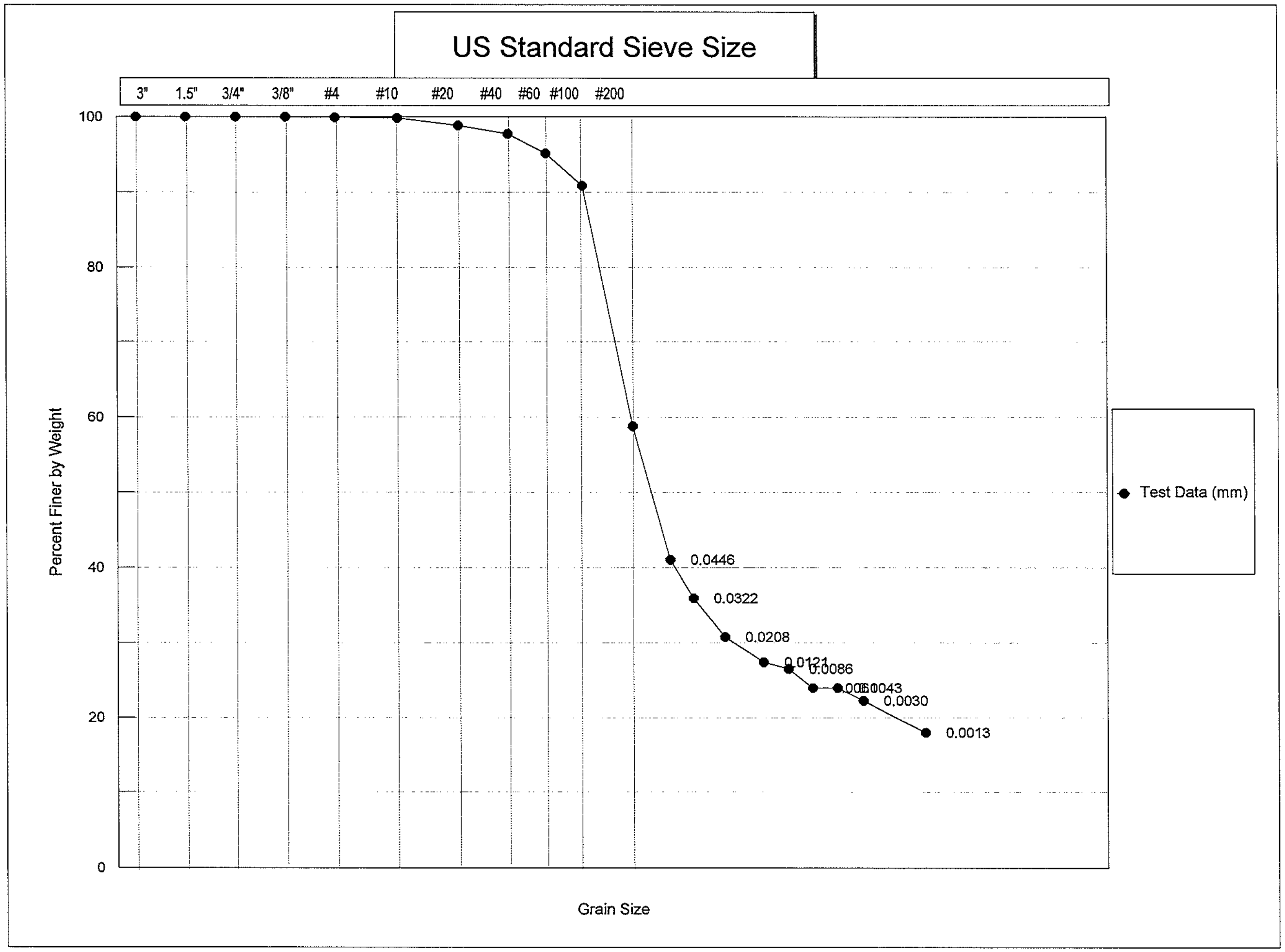
Hydrometer #	ASTM 152 H	Temp., Deg. C	23.3
Sp. Gr. of Soil	2.65	Temp. Coef. K	0.01312
Value of "alpha"	1.00	Wt. Dry Sample "W"	58.489
Deflocculant	Sodium Hexametaphosphate	% of Total Sample	100.0
Defloc. Corr'n	5.5		
Meniscus Corr'n	0.5		

T Elapsed Time (min)	Hydrometer Reading Original	Corrected "R"	100Ra/W	% Total Sample	Effective Depth L	Grain Diameter (mm)
0.0	--	--	--	--	--	--
0.5	--	--	--	--	--	--
1.0	29.00	24.00	41.0	41.0	11.53	0.0446
2.0	26.00	21.00	35.9	35.9	12.03	0.0322
5.0	23.00	18.00	30.8	30.8	12.52	0.0208
15.0	21.00	16.00	27.4	27.4	12.85	0.0121
30.0	20.50	15.50	26.5	26.5	12.93	0.0086
60.0	19.00	14.00	23.9	23.9	13.17	0.0061
120.0	19.00	14.00	23.9	23.9	13.17	0.0043
250.0	18.00	13.00	22.2	22.2	13.34	0.0030
1451.0	15.50	10.50	18.0	18.0	13.75	0.0013

Grain Diameter = K*(SQRT(L/T))

Data entered by: MLM Date: 11/04/2010
Data checked by: KR Date: 11/4/10
FileName: MHHYS25A

ADVANCED TERRA TESTING, Inc.



COBBLES	GRAVEL		SAND			SILT OR CLAY (mm)	USCS
	COARSE	FINE	CRS	MEDIUM	FINE		

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY	WENTWORTH
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE			

Client: MWH
Job Number: 2512-53
Boring No.: Stockpile 2
Depth: 5.0'
Sample No.: A
Classification: **Classification Not Performed**

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 3	SAMPLED	10/12/10 --
DEPTH	6.0'	DATE TESTED	10/26/10 DPM
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No
Wt. Wet Soil & Pan (g)	83.64
Wt. Dry Soil & Pan (g)	80.02
Wt. Lost Moisture (g)	3.62
Wt. of Pan Only (g)	2.99
Wt. of Dry Soil (g)	77.03
Moisture Content %	4.7
Wt. Hydrom. Sample Wet (g)	63.20
Wt. Hydrom. Sample Dry (g)	60.36

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	2309.30
Weight of + #10 Before Washing (g)	2.80
Weight of + #10 After Washing (g)	2.03
Weight of - #10 Wet (g)	2306.50
Weight of - #10 Dry (g)	2203.71
Wt. Total Sample Dry (g)	2205.74
Calc. Wt. "W" (g)	60.42
Calc. Mass + #10	0.06

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	0.00	0.00	0.00	0.0	100.0
#4	0.00	0.73	0.73	0.73	0.0	100.0
#10	0.00	1.30	1.30	2.03	0.1	99.9
#20	1.77	2.20	0.43	0.43	0.8	99.2
#40	1.77	2.58	0.81	1.24	2.1	97.9
#60	1.81	4.70	2.89	4.13	6.9	93.1
#100	1.73	9.08	7.35	11.48	19.1	80.9
#200	1.78	11.67	9.89	21.37	35.5	64.5

Data entered by: MLM Date: 11/04/2010
Data checked by: KR Date: 11/4/10
FileName: MHHYS36A

ADVANCED TERRA TESTING, Inc. ATT

HYDROMETER ANALYSIS - SEDIMENTATION DATA
ASTM D 422

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 3	SAMPLED	10/12/10 --
DEPTH	6.0'	DATE TESTED	10/26/10 DPM
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

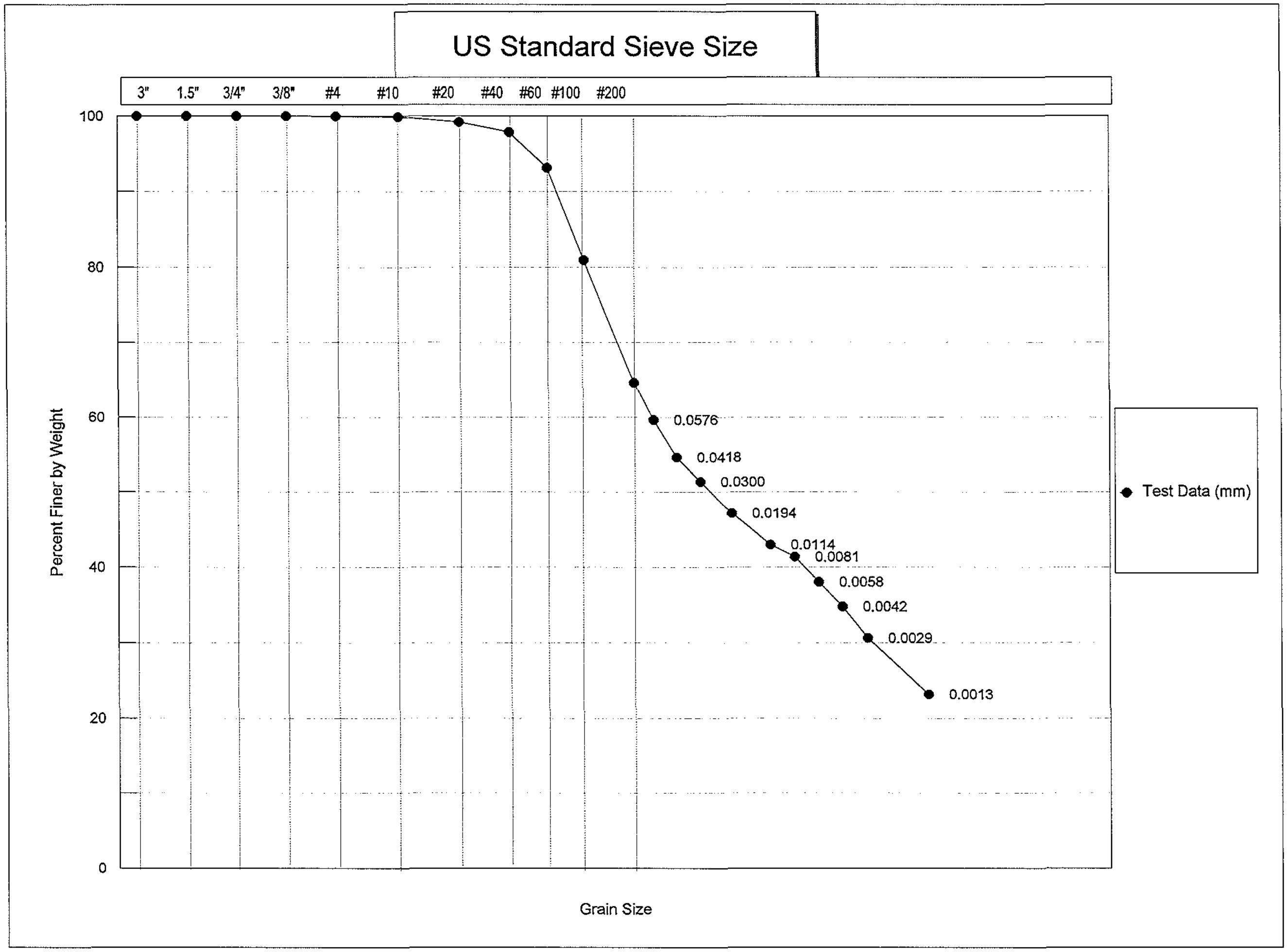
Hydrometer #	ASTM 152 H	Temp., Deg. C	23.0
Sp. Gr. of Soil	2.65	Temp. Coef. K	0.01317
Value of "alpha"	1.00	Wt. Dry Sample "W"	60.420
Deflocculant	Sodium Hexametaphosphate	% of Total Sample	100.0
Defloc. Corr'n	5.5		
Meniscus Corr'n	0.5		

T Elapsed Time (min)	Hydrometer Reading Original	Corrected "R"	100Ra/W	% Total Sample	Effective Depth L	Grain Diameter (mm)
0.0	--	--	--	--	--	--
0.5	41.00	36.00	59.6	59.6	9.57	0.0576
1.0	38.00	33.00	54.6	54.6	10.06	0.0418
2.0	36.00	31.00	51.3	51.3	10.39	0.0300
5.0	33.50	28.50	47.2	47.2	10.80	0.0194
15.0	31.00	26.00	43.0	43.0	11.21	0.0114
30.0	30.00	25.00	41.4	41.4	11.37	0.0081
60.0	28.00	23.00	38.1	38.1	11.70	0.0058
120.0	26.00	21.00	34.8	34.8	12.03	0.0042
250.0	23.50	18.50	30.6	30.6	12.44	0.0029
1440.0	19.00	14.00	23.2	23.2	13.17	0.0013

Grain Diameter = K*(SQRT(L/T))

Data entered by: MLM Date: 11/04/2010
Data checked by: KR Date: 11/4/10
FileName: MHHYS36A

ADVANCED TERRA TESTING, Inc. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY (mm)	USCS
	COARSE	FINE	CRS	MEDIUM	FINE		

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY	WENTWORTH
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE			

Client: MWH
Job Number: 2512-53
Boring No.: Stockpile 3
Depth: 6.0'
Sample No.: A
Classification: **Classification Not Performed**

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 4	SAMPLED	10/12/10
DEPTH	5.0'	DATE TESTED	10/26/10 DPM
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No
Wt. Wet Soil & Pan (g)	103.65
Wt. Dry Soil & Pan (g)	97.39
Wt. Lost Moisture (g)	6.26
Wt. of Pan Only (g)	3.14
Wt. of Dry Soil (g)	94.25
Moisture Content %	6.6
Wt. Hydrom. Sample Wet (g)	60.83
Wt. Hydrom. Sample Dry (g)	57.04

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	1447.32
Weight of + #10 Before Washing (g)	2.12
Weight of + #10 After Washing (g)	1.76
Weight of - #10 Wet (g)	1445.20
Weight of - #10 Dry (g)	1355.53
Wt. Total Sample Dry (g)	1357.29
Calc. Wt. "W" (g)	57.12
Calc. Mass + #10	0.07

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	0.00	0.00	0.00	0.0	100.0
#4	0.00	0.95	0.95	0.95	0.1	99.9
#10	0.00	0.81	0.81	1.76	0.1	99.9
#20	3.06	3.44	0.38	0.38	0.8	99.2
#40	3.02	4.36	1.34	1.72	3.1	96.9
#60	3.11	5.57	2.46	4.18	7.4	92.6
#100	3.05	5.21	2.16	6.34	11.2	88.8
#200	2.97	6.74	3.77	10.11	17.8	82.2

Data entered by: MLM Date: 10/29/2010
Data checked by: VR Date: 11/1/10
FileName: MHHY450A

ADVANCED TERRA TESTING, INC. ATT

HYDROMETER ANALYSIS - SEDIMENTATION DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 4	SAMPLED	10/12/10
DEPTH	5.0'	DATE TESTED	10/26/10 DPM
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

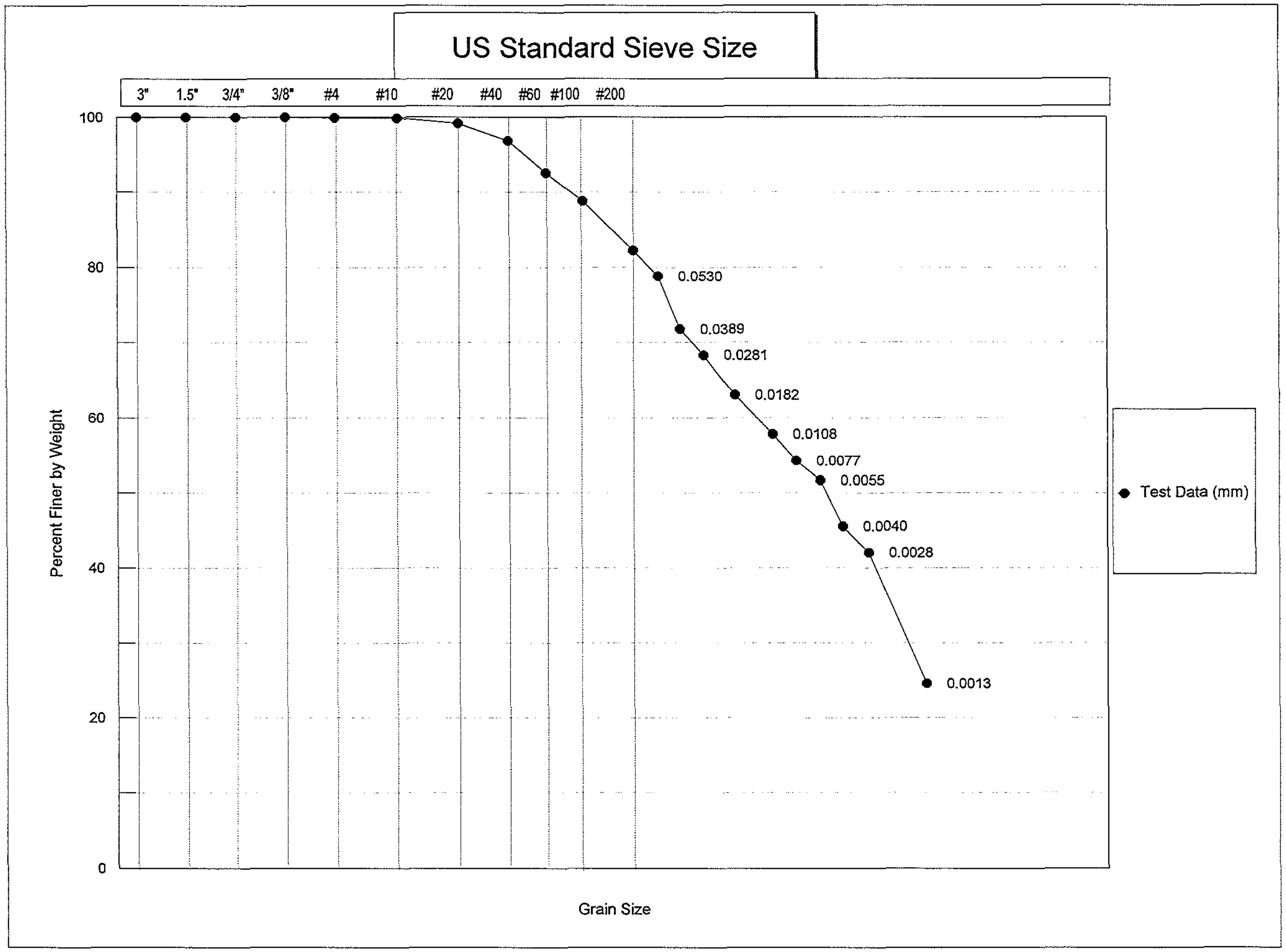
Hydrometer #	ASTM 152 H	Temp., Deg. C	23.0
Sp. Gr. of Soil	2.65	Temp. Coef. K	0.01317
Value of "alpha"	1.00	Wt. Dry Sample "W"	57.118
Deflocculant	Sodium Hexametaphosphate	% of Total Sample	100.0
Defloc. Corr'n	5.5		
Meniscus Corr'n	0.5		

T Elapsed Time (min)	Hydrometer Reading Original	Corrected "R"	100Ra/W	% Total Sample	Effective Depth L	Grain Diameter (mm)
0.0	--	--	--	--	--	--
0.5	50.00	45.00	78.8	78.8	8.09	0.0530
1.0	46.00	41.00	71.8	71.8	8.75	0.0389
2.0	44.00	39.00	68.3	68.3	9.07	0.0281
5.0	41.00	36.00	63.0	63.0	9.57	0.0182
15.0	38.00	33.00	57.8	57.8	10.06	0.0108
30.0	36.00	31.00	54.3	54.3	10.39	0.0077
60.0	34.50	29.50	51.6	51.6	10.63	0.0055
120.0	31.00	26.00	45.5	45.5	11.21	0.0040
250.0	29.00	24.00	42.0	42.0	11.53	0.0028
1440.0	19.00	14.00	24.5	24.5	13.17	0.0013

Grain Diameter = K*(SQRT(L/T))

Data entered by: MLM Date: 10/29/2010
Data checked by: [signature] Date: 11/1/10
FileName: MHHY450A

ADVANCED TERRA TESTING, INC. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY (mm)	USCS
	COARSE	FINE	CRS	MEDIUM	FINE		

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY	WENTWORTH
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE			

Client: MWH   Boring No.: Stockpile 4   Sample No.: A
Job Number: 2512-53   Depth: 5.0'
Classification: **Classification Not Performed**

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 5	SAMPLED	
DEPTH	6.0'	DATE TESTED	11/15/10 WAR
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No
Wt. Wet Soil & Pan (g)	262.62
Wt. Dry Soil & Pan (g)	256.89
Wt. Lost Moisture (g)	5.73
Wt. of Pan Only (g)	6.60
Wt. of Dry Soil (g)	250.29
Moisture Content %	2.3
Wt. Hydrom. Sample Wet (g)	66.35
Wt. Hydrom. Sample Dry (g)	64.87

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	66.35
Weight of + #10 Before Washing (g)	0.00
Weight of + #10 After Washing (g)	0.00
Weight of - #10 Wet (g)	66.35
Weight of - #10 Dry (g)	64.87
Wt. Total Sample Dry (g)	64.87
Calc. Wt. "W" (g)	64.87
Calc. Mass + #10	0.00

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	0.00	0.00	0.00	0.0	100.0
#4	0.00	0.00	0.00	0.00	0.0	100.0
#10	0.00	0.00	0.00	0.00	0.0	100.0
#20	3.03	3.06	0.03	0.03	0.0	100.0
#40	3.00	3.15	0.15	0.18	0.3	99.7
#60	3.08	3.71	0.63	0.81	1.2	98.8
#100	2.99	4.29	1.30	2.11	3.3	96.7
#200	3.13	20.58	17.45	19.56	30.2	69.8

Data entered by: MLM Date: 11/19/2010
Data checked by: BK Date: 11/19/10
FileName: MHHYS66A

ADVANCED TERRA TESTING, INC.
ATT

HYDROMETER ANALYSIS - SEDIMENTATION DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO. Stockpile 5
DEPTH 6.0'
SAMPLE NO. A
SOIL DESCR. 1009740
LOCATION Denison White Mesa Mill Project

SAMPLED
DATE TESTED 11/15/10 WAR
WASH SIEVE Yes
DRY SIEVE No

Hydrometer # ASTM 152 H
Sp. Gr. of Soil 2.65
Value of "alpha" 1.00
Deflocculant Sodium Hexametaphosphate
Defloc. Corr'n 5.0
Meniscus Corr'n -1.5

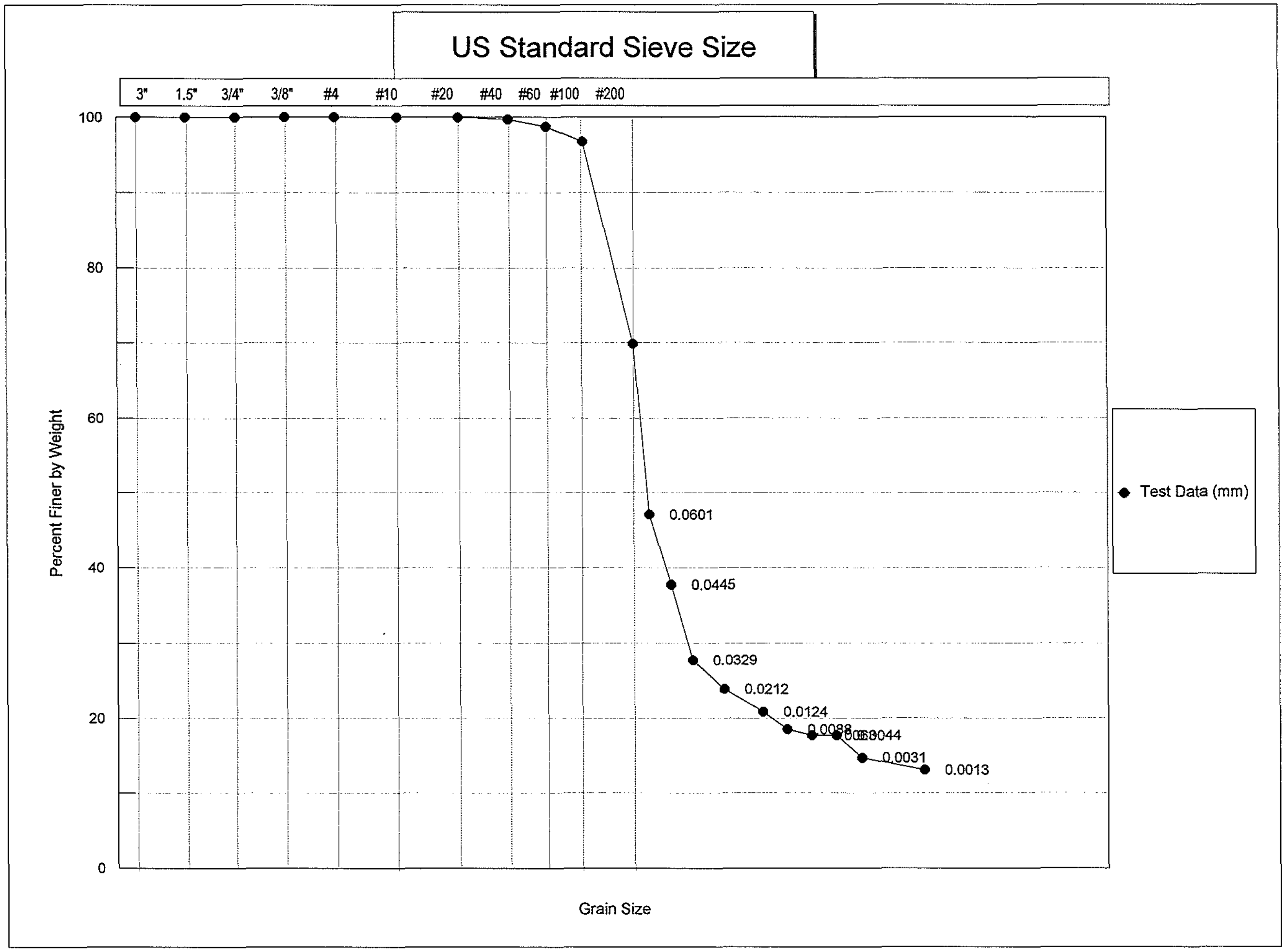
Temp., Deg. C 22.2
Temp. Coef. K 0.01329
Wt. Dry Sample "W" 64.865
% of Total Sample 100.0

T Elapsed Time (min)	Hydrometer Reading Original	Corrected "R"	100Ra/W	% Total Sample	Effective Depth L	Grain Diameter (mm)
0.0	--	--	--	--	--	--
0.5	37.00	30.50	47.0	47.0	10.22	0.0601
1.0	31.00	24.50	37.8	37.8	11.21	0.0445
2.0	24.50	18.00	27.7	27.7	12.27	0.0329
5.0	22.00	15.50	23.9	23.9	12.68	0.0212
15.0	20.00	13.50	20.8	20.8	13.01	0.0124
30.0	18.50	12.00	18.5	18.5	13.26	0.0088
60.0	18.00	11.50	17.7	17.7	13.34	0.0063
120.0	18.00	11.50	17.7	17.7	13.34	0.0044
250.0	16.00	9.50	14.6	14.6	13.67	0.0031
1440.0	15.00	8.50	13.1	13.1	13.83	0.0013

Grain Diameter = K*(SQRT(L/T))

Data entered by: MLM Date: 11/19/2010
Data checked by: BRC Date: 11/19/10
FileName: MHHYS66A

ADVANCED TERRA TESTING, INC. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY (mm)	USCS
	COARSE	FINE	CRS	MEDIUM	FINE		

COBBLES	PEBBLE GRAVEL				SAND			SILT	CLAY	WENTWORTH
TO BOULDERS	COARSE	MED	FINE	GRAN	COARSE	MED	FINE			

Client: MWH　　Boring No.: Stockpile 5　　Sample No.: A

Job Number: 2512-53　　Depth: 6.0'

Classification: **Classification Not Performed**

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 6	SAMPLED	
DEPTH	2.0'	DATE TESTED	11/15/10 WAR
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No
Wt. Wet Soil & Pan (g)	383.02
Wt. Dry Soil & Pan (g)	374.28
Wt. Lost Moisture (g)	8.74
Wt. of Pan Only (g)	6.73
Wt. of Dry Soil (g)	367.55
Moisture Content %	2.4
Wt. Hydrom. Sample Wet (g)	65.22
Wt. Hydrom. Sample Dry (g)	63.71

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	65.22
Weight of + #10 Before Washing (g)	0.00
Weight of + #10 After Washing (g)	0.00
Weight of - #10 Wet (g)	65.22
Weight of - #10 Dry (g)	63.71
Wt. Total Sample Dry (g)	63.71
Calc. Wt. "W" (g)	63.71
Calc. Mass + #10	0.00

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	0.00	0.00	0.00	0.0	100.0
#4	0.00	0.00	0.00	0.00	0.0	100.0
#10	0.00	0.00	0.00	0.00	0.0	100.0
#20	3.29	3.94	0.65	0.65	1.0	99.0
#40	3.04	4.05	1.01	1.66	2.6	97.4
#60	3.03	6.51	3.48	5.14	8.1	91.9
#100	3.26	14.22	10.96	16.10	25.3	74.7
#200	3.21	17.03	13.82	29.92	47.0	53.0

Data entered by: MLM Date: 11/18/2010
Data checked by: BKL Date: 11/18/10
FileName: MHHYS62A

ADVANCED TERRA TESTING, Inc. ATT

HYDROMETER ANALYSIS - SEDIMENTATION DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 6	SAMPLED	
DEPTH	2.0'	DATE TESTED	11/15/10 WAR
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

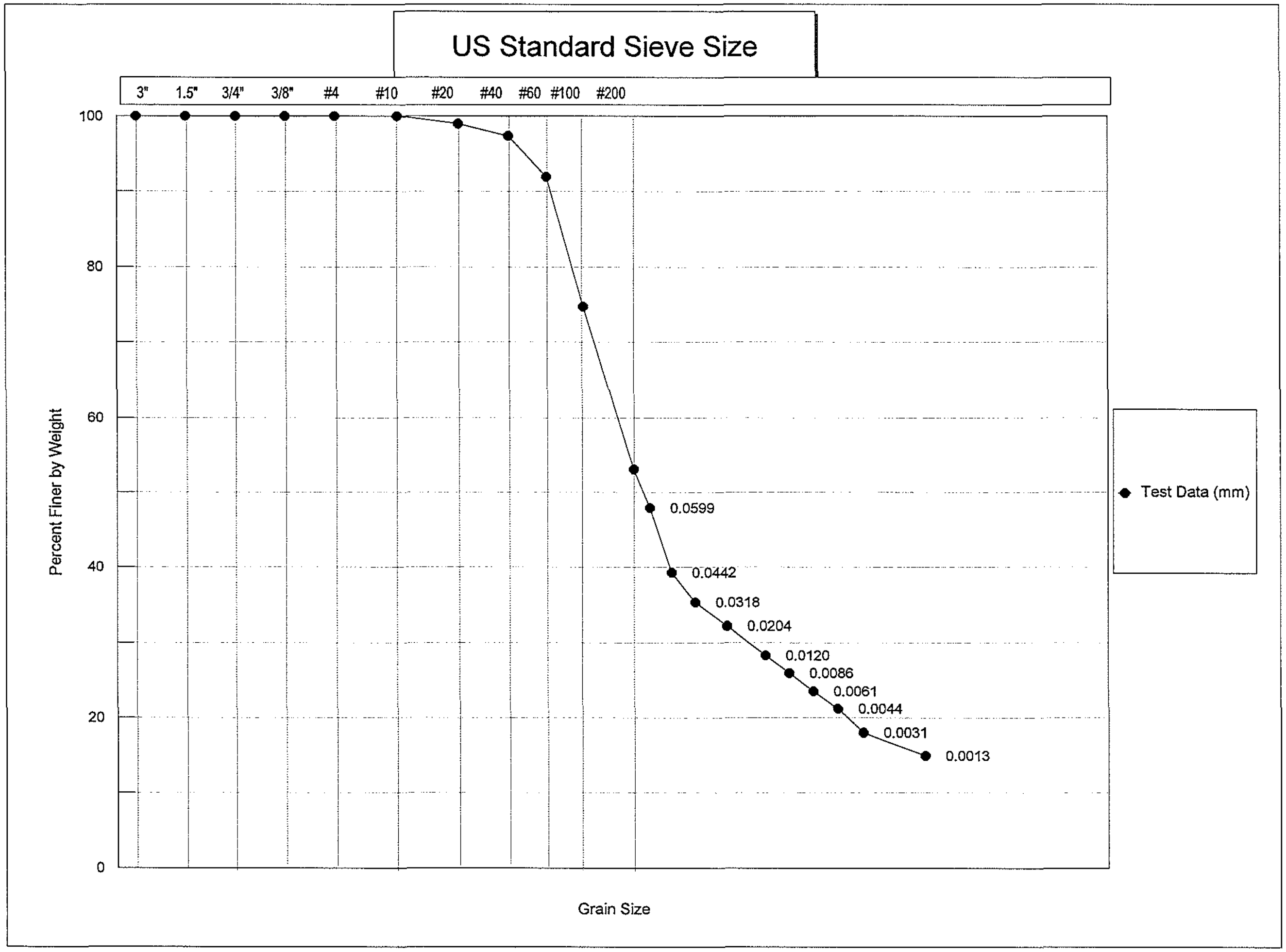
Hydrometer #	ASTM 152 H	Temp., Deg. C	22.5
Sp. Gr. of Soil	2.65	Temp. Coef. K	0.01325
Value of "alpha"	1.00	Wt. Dry Sample "W"	63.705
Deflocculant	Sodium Hexametaphosphate	% of Total Sample	100.0
Defloc. Corr'n	5.0		
Meniscus Corr'n	-1.5		

T Elapsed Time (min)	Hydrometer Reading Original	Corrected "R"	100Ra/W	% Total Sample	Effective Depth L	Grain Diameter (mm)
0.0	--	--	--	--	--	--
0.5	37.00	30.50	47.9	47.9	10.22	0.0599
1.0	31.50	25.00	39.2	39.2	11.12	0.0442
2.0	29.00	22.50	35.3	35.3	11.53	0.0318
5.0	27.00	20.50	32.2	32.2	11.86	0.0204
15.0	24.50	18.00	28.3	28.3	12.27	0.0120
30.0	23.00	16.50	25.9	25.9	12.52	0.0086
60.0	21.50	15.00	23.5	23.5	12.76	0.0061
120.0	20.00	13.50	21.2	21.2	13.01	0.0044
250.0	18.00	11.50	18.1	18.1	13.34	0.0031
1440.0	16.00	9.50	14.9	14.9	13.67	0.0013

Grain Diameter = K*(SQRT(L/T))

Data entered by: MLM Date: 11/18/2010
Data checked by: BKL Date: 11/18/10
FileName: MHHYS62A

ADVANCED TERRA TESTING, Inc. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY (mm)	
	COARSE	FINE	CRS	MEDIUM	FINE		USCS

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY	
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE			WENTWORTH

Client: MWH
Job Number: 2512-53
Boring No.: Stockpile 6
Depth: 2.0'
Sample No.: A
Classification: **Classification Not Performed**

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 7
DEPTH	0.0'
SAMPLE NO.	A
SOIL DESCR.	1009740
LOCATION	Denison White Mesa Mill Project

SAMPLED	
DATE TESTED	11/15/10 WAR
WASH SIEVE	Yes
DRY SIEVE	No

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No
Wt. Wet Soil & Pan (g)	262.38
Wt. Dry Soil & Pan (g)	257.88
Wt. Lost Moisture (g)	4.50
Wt. of Pan Only (g)	8.59
Wt. of Dry Soil (g)	249.29
Moisture Content %	1.8
Wt. Hydrom. Sample Wet (g)	64.62
Wt. Hydrom. Sample Dry (g)	63.47

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	64.62
Weight of + #10 Before Washing (g)	0.00
Weight of + #10 After Washing (g)	0.00
Weight of - #10 Wet (g)	64.62
Weight of - #10 Dry (g)	63.47
Wt. Total Sample Dry (g)	63.47
Calc. Wt. "W" (g)	63.47
Calc. Mass + #10	0.00

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	0.00	0.00	0.00	0.0	100.0
#4	0.00	0.00	0.00	0.00	0.0	100.0
#10	0.00	0.00	0.00	0.00	0.0	100.0
#20	3.08	3.53	0.45	0.45	0.7	99.3
#40	3.25	3.89	0.64	1.09	1.7	98.3
#60	3.08	4.48	1.40	2.49	3.9	96.1
#100	3.14	5.55	2.41	4.90	7.7	92.3
#200	3.10	21.95	18.85	23.75	37.4	62.6

Data entered by: MLM Date: 11/19/2010
Data checked by: BKL Date: 11/19/10
FileName: MHHYS70A

ADVANCED TERRA TESTING, Inc.
ATT

HYDROMETER ANALYSIS - SEDIMENTATION DATA
ASTM D 422

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 7	SAMPLED	
DEPTH	0.0'	DATE TESTED	11/15/10 WAR
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

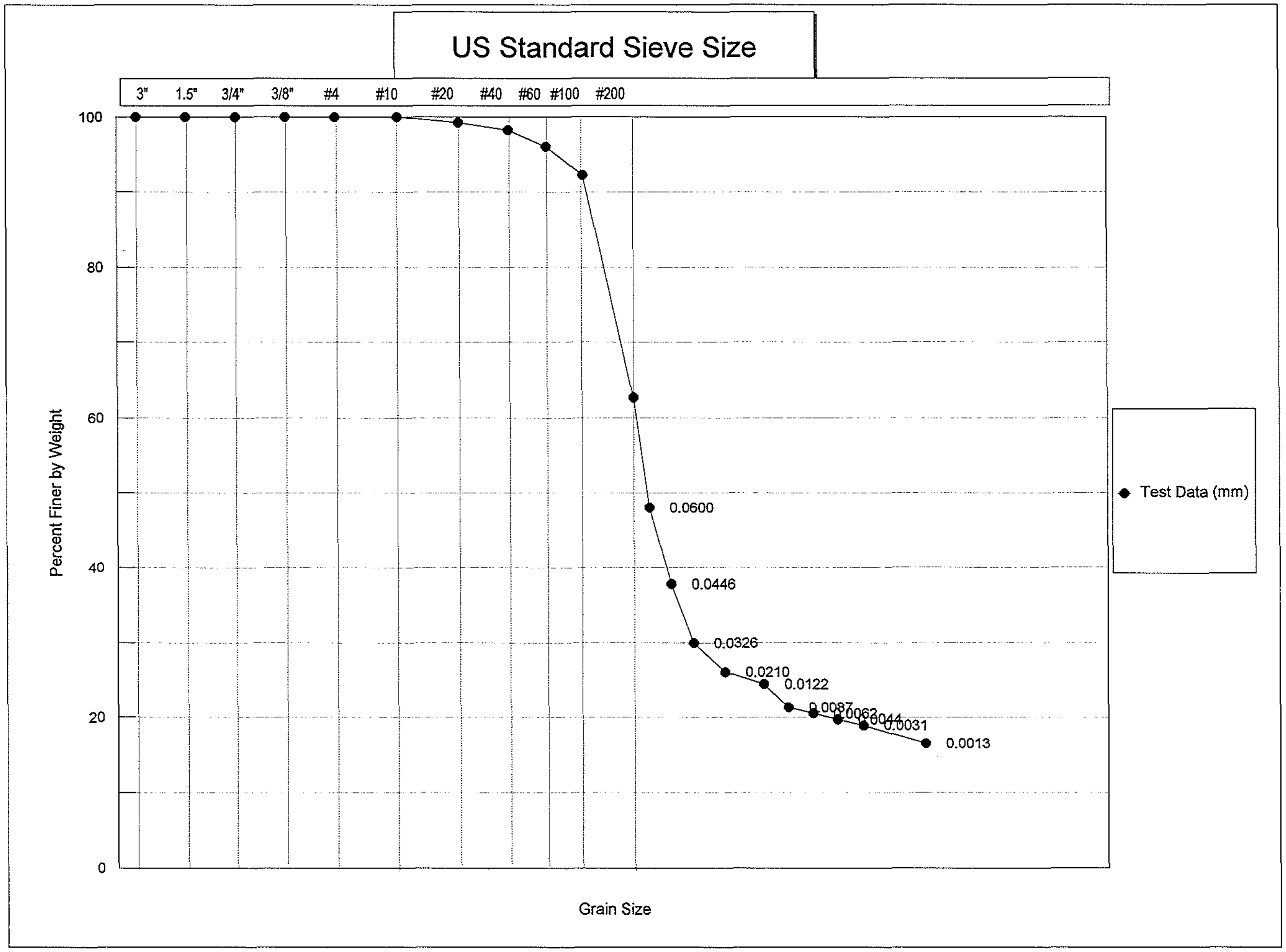
Hydrometer #	ASTM 152 H	Temp., Deg. C	22.4
Sp. Gr. of Soil	2.65	Temp. Coef. K	0.01326
Value of "alpha"	1.00	Wt. Dry Sample "W"	63.474
Deflocculant	Sodium Hexametaphosphate	% of Total Sample	100.0
Defloc. Corr'n	5.0		
Meniscus Corr'n	-1.5		

T Elapsed Time (min)	Hydrometer Reading Original	Corrected "R"	100Ra/W	% Total Sample	Effective Depth L	Grain Diameter (mm)
0.0	--	--	--	--	--	--
0.5	37.00	30.50	48.1	48.1	10.22	0.0600
1.0	30.50	24.00	37.8	37.8	11.29	0.0446
2.0	25.50	19.00	29.9	29.9	12.11	0.0326
5.0	23.00	16.50	26.0	26.0	12.52	0.0210
15.0	22.00	15.50	24.4	24.4	12.68	0.0122
30.0	20.00	13.50	21.3	21.3	13.01	0.0087
60.0	19.50	13.00	20.5	20.5	13.09	0.0062
120.0	19.00	12.50	19.7	19.7	13.17	0.0044
250.0	18.50	12.00	18.9	18.9	13.26	0.0031
1440.0	17.00	10.50	16.5	16.5	13.50	0.0013

Grain Diameter = K*(SQRT(L/T))

Data entered by: MLM Date: 11/18/2010
Data checked by: BKL Date: 11/18/10
FileName: MHHYS70A

ADVANCED TERRA TESTING, INC. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY (mm)	USCS
	COARSE	FINE	CRS	MEDIUM	FINE		

COBBLES	PEBBLE GRAVEL				SAND			SILT	CLAY	WENTWORTH
TO BOULDERS	COARSE	MED	FINE	GRAN	COARSE	MED	FINE			

Client: MWH Boring No.: Stockpile 7 Sample No.: A
Job Number: 2512-53 Depth: 0.0'
Classification: **Classification Not Performed**

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 8	SAMPLED	10/12/10 --
DEPTH	5.0'	DATE TESTED	10/26/10 DPM
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

MOISTURE DATA

HYGROSCOPIC	Yes	
NATURAL	No	
Wt. Wet Soil & Pan (g)		110.10
Wt. Dry Soil & Pan (g)		108.82
Wt. Lost Moisture (g)		1.28
Wt. of Pan Only (g)		2.99
Wt. of Dry Soil (g)		105.83
Moisture Content %		1.2
Wt. Hydrom. Sample Wet (g)		68.19
Wt. Hydrom. Sample Dry (g)		67.37

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	2051.90
Weight of + #10 Before Washing (g)	40.60
Weight of + #10 After Washing (g)	14.13
Weight of - #10 Wet (g)	2011.30
Weight of - #10 Dry (g)	2013.42
Wt. Total Sample Dry (g)	2027.55
Calc. Wt. "W" (g)	67.85
Calc. Mass + #10	0.47

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	0.00	0.00	0.00	0.0	100.0
#4	0.00	0.69	0.69	0.69	0.0	100.0
#10	0.00	13.44	13.44	14.13	0.7	99.3
#20	1.77	2.13	0.36	0.36	1.2	98.8
#40	1.81	2.30	0.49	0.85	1.9	98.1
#60	1.83	4.28	2.45	3.30	5.6	94.4
#100	1.77	12.00	10.23	13.53	20.6	79.4
#200	1.79	17.51	15.72	29.25	43.8	56.2

Data entered by: MLM Date: 11/04/2010
Data checked by: KR Date: 11/4/10
FileName: MHHYS85A

ADVANCED TERRA TESTING, Inc. ATT

HYDROMETER ANALYSIS - SEDIMENTATION DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 8	SAMPLED	10/12/10 --
DEPTH	5.0'	DATE TESTED	10/26/10 DPM
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

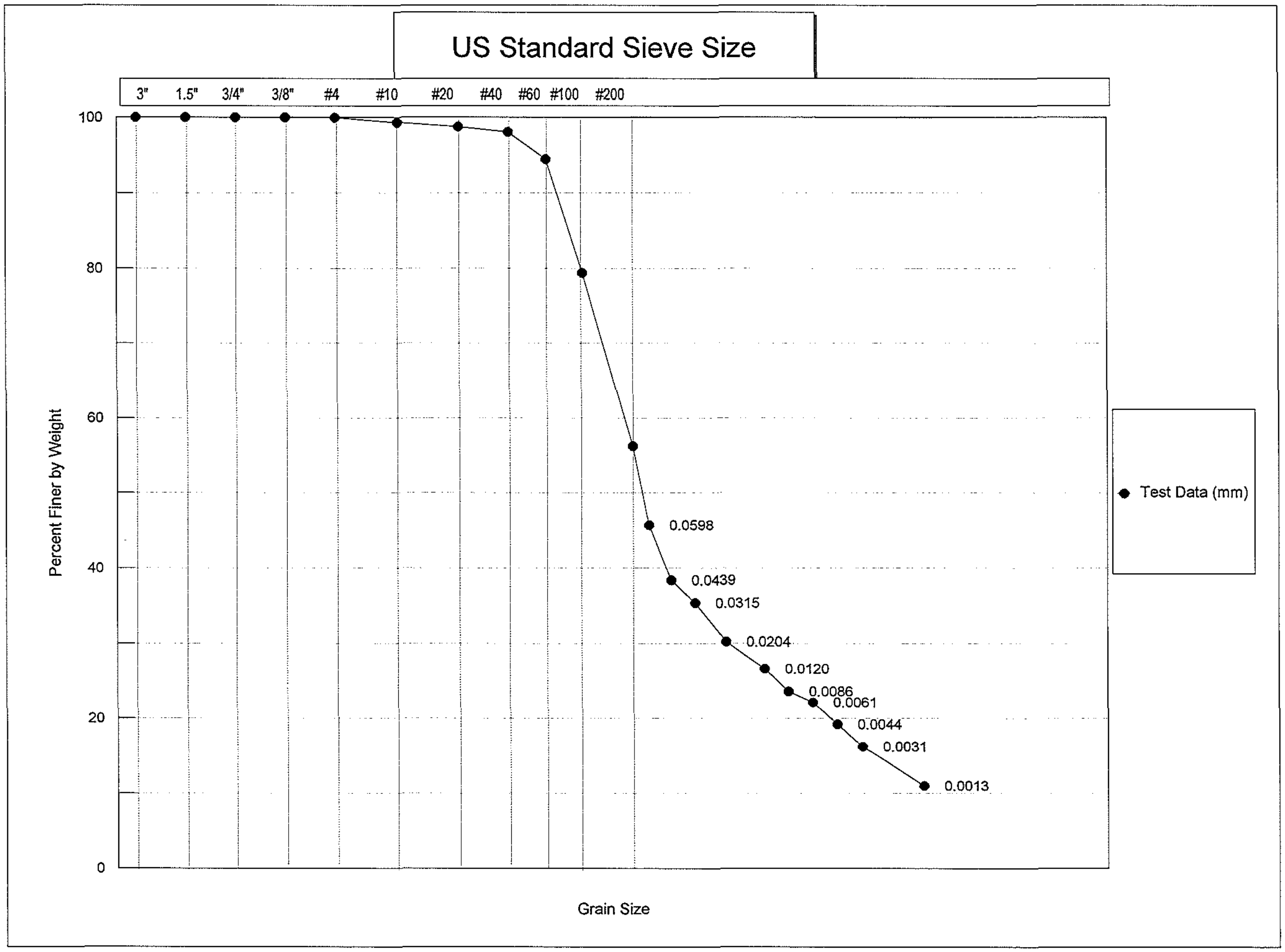
Hydrometer #	ASTM 152 H	Temp., Deg. C	23.3
Sp. Gr. of Soil	2.65	Temp. Coef. K	0.01312
Value of "alpha"	1.00	Wt. Dry Sample "W"	67.847
Deflocculant	Sodium Hexametaphosphate	% of Total Sample	100.0
Defloc. Corr'n	5.5		
Meniscus Corr'n	0.5		

T Elapsed Time (min)	Hydrometer Reading Original	Corrected "R"	100Ra/W	% Total Sample	Effective Depth L	Grain Diameter (mm)
0.0	--	--	--	--	--	--
0.5	36.00	31.00	45.7	45.7	10.39	0.0598
1.0	31.00	26.00	38.3	38.3	11.21	0.0439
2.0	29.00	24.00	35.4	35.4	11.53	0.0315
5.0	25.50	20.50	30.2	30.2	12.11	0.0204
15.0	23.00	18.00	26.5	26.5	12.52	0.0120
30.0	21.00	16.00	23.6	23.6	12.85	0.0086
60.0	20.00	15.00	22.1	22.1	13.01	0.0061
120.0	18.00	13.00	19.2	19.2	13.34	0.0044
250.0	16.00	11.00	16.2	16.2	13.67	0.0031
1442.0	12.50	7.50	11.1	11.1	14.24	0.0013

Grain Diameter = K*(SQRT(L/T))

Data entered by: MLM Date: 11/04/2010
Data checked by: KR Date: 11/4/10
FileName: MHHYS85A

ADVANCED TERRA TESTING, Inc. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY (mm)	USCS
	COARSE	FINE	CRS	MEDIUM	FINE		

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY	WENTWORTH
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE			

Client: MWH
Job Number: 2512-53
Boring No.: Stockpile 8
Depth: 5.0'
Sample No.: A
Classification: **Classification Not Performed**

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 9	SAMPLED	
DEPTH	0.0'	DATE TESTED	11/15/10 WAR
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No
Wt. Wet Soil & Pan (g)	305.13
Wt. Dry Soil & Pan (g)	299.78
Wt. Lost Moisture (g)	5.35
Wt. of Pan Only (g)	6.79
Wt. of Dry Soil (g)	292.99
Moisture Content %	1.8
Wt. Hydrom. Sample Wet (g)	71.63
Wt. Hydrom. Sample Dry (g)	70.35

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	71.63
Weight of + #10 Before Washing (g)	0.00
Weight of + #10 After Washing (g)	0.00
Weight of - #10 Wet (g)	71.63
Weight of - #10 Dry (g)	70.35
Wt. Total Sample Dry (g)	70.35
Calc. Wt. "W" (g)	70.35
Calc. Mass + #10	0.00

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	0.00	0.00	0.00	0.0	100.0
#4	0.00	0.00	0.00	0.00	0.0	100.0
#10	0.00	0.00	0.00	0.00	0.0	100.0
#20	2.99	3.03	0.04	0.04	0.1	99.9
#40	3.05	3.09	0.04	0.08	0.1	99.9
#60	3.27	3.55	0.28	0.36	0.5	99.5
#100	3.04	4.04	1.00	1.36	1.9	98.1
#200	3.11	25.90	22.79	24.15	34.3	65.7

Data entered by: MLM Date: 11/18/2010
Data checked by: BKL Date: 11/19/10
FileName: MHHYS90A

ADVANCED TERRA TESTING, Inc. ATT

HYDROMETER ANALYSIS - SEDIMENTATION DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 9	SAMPLED	
DEPTH	0.0'	DATE TESTED	11/15/10 WAR
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

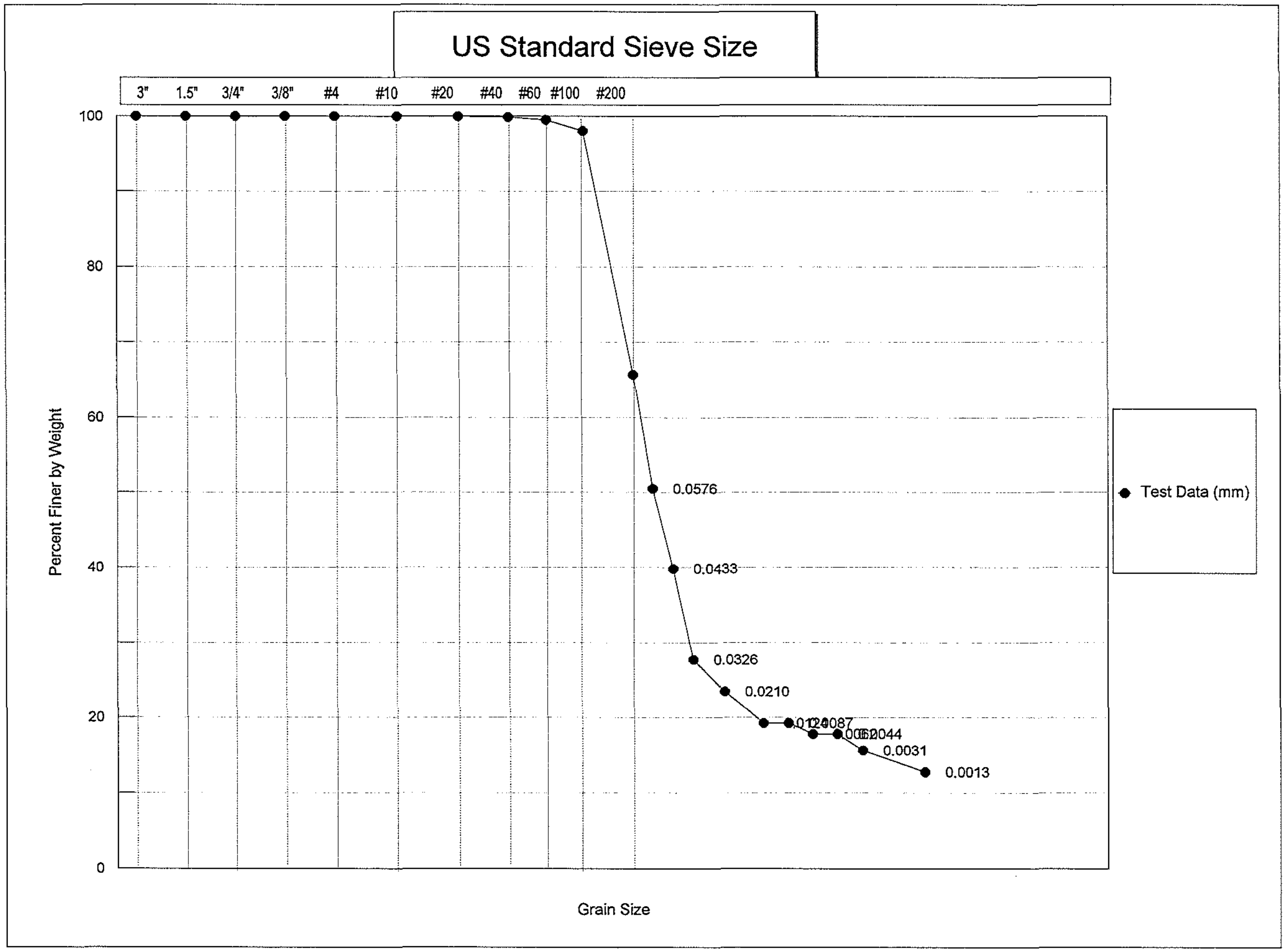
Hydrometer #	ASTM 152 H	Temp., Deg. C	22.3
Sp. Gr. of Soil	2.65	Temp. Coef. K	0.01328
Value of "alpha"	1.00	Wt. Dry Sample "W"	70.345
Deflocculant	Sodium Hexametaphosphate	% of Total Sample	100.0
Defloc. Corr'n	5.0		
Meniscus Corr'n	-1.5		

T Elapsed Time (min)	Hydrometer Reading Original	Corrected "R"	100Ra/W	% Total Sample	Effective Depth L	Grain Diameter (mm)
0.0	--	--	--	--	--	--
0.5	42.00	35.50	50.5	50.5	9.40	0.0576
1.0	34.50	28.00	39.8	39.8	10.63	0.0433
2.0	26.00	19.50	27.7	27.7	12.03	0.0326
5.0	23.00	16.50	23.5	23.5	12.52	0.0210
15.0	20.00	13.50	19.2	19.2	13.01	0.0124
30.0	20.00	13.50	19.2	19.2	13.01	0.0087
60.0	19.00	12.50	17.8	17.8	13.17	0.0062
120.0	19.00	12.50	17.8	17.8	13.17	0.0044
250.0	17.50	11.00	15.6	15.6	13.42	0.0031
1440.0	15.50	9.00	12.8	12.8	13.75	0.0013

Grain Diameter = K*(SQRT(L/T))

Data entered by: MLM Date: 11/19/2010
Data checked by: BKL Date: 11/19/10
FileName: MHHYS90A

ADVANCED TERRA TESTING, Inc. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY (mm)	USCS
	COARSE	FINE	CRS	MEDIUM	FINE		

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY	WENTWORTH
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE			

Client: MWH
Job Number: 2512-53
Boring No.: Stockpile 9
Depth: 0.0'
Sample No.: A
Classification: **Classification Not Performed**

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 10	SAMPLED	
DEPTH	5.0'	DATE TESTED	11/15/10 WAR
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No
Wt. Wet Soil & Pan (g)	256.44
Wt. Dry Soil & Pan (g)	251.58
Wt. Lost Moisture (g)	4.86
Wt. of Pan Only (g)	8.35
Wt. of Dry Soil (g)	243.23
Moisture Content %	2.0
Wt. Hydrom. Sample Wet (g)	61.57
Wt. Hydrom. Sample Dry (g)	60.36

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	61.57
Weight of + #10 Before Washing (g)	0.00
Weight of + #10 After Washing (g)	0.00
Weight of - #10 Wet (g)	61.57
Weight of - #10 Dry (g)	60.36
Wt. Total Sample Dry (g)	60.36
Calc. Wt. "W" (g)	60.36
Calc. Mass + #10	0.00

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	0.00	0.00	0.00	0.0	100.0
#4	0.00	0.00	0.00	0.00	0.0	100.0
#10	0.00	0.00	0.00	0.00	0.0	100.0
#20	3.04	3.07	0.03	0.03	0.0	100.0
#40	3.10	3.21	0.11	0.14	0.2	99.8
#60	3.10	3.67	0.57	0.71	1.2	98.8
#100	3.07	4.13	1.06	1.77	2.9	97.1
#200	3.21	21.12	17.91	19.68	32.6	67.4

Data entered by: MLM Date: 11/18/2010
Data checked by: BKL Date: 11/18/10
FileName: MHHYS10A

ADVANCED TERRA TESTING, Inc. ATT

HYDROMETER ANALYSIS - SEDIMENTATION DATA
ASTM D 422

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 10	SAMPLED	
DEPTH	5.0'	DATE TESTED	11/15/10 WAR
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

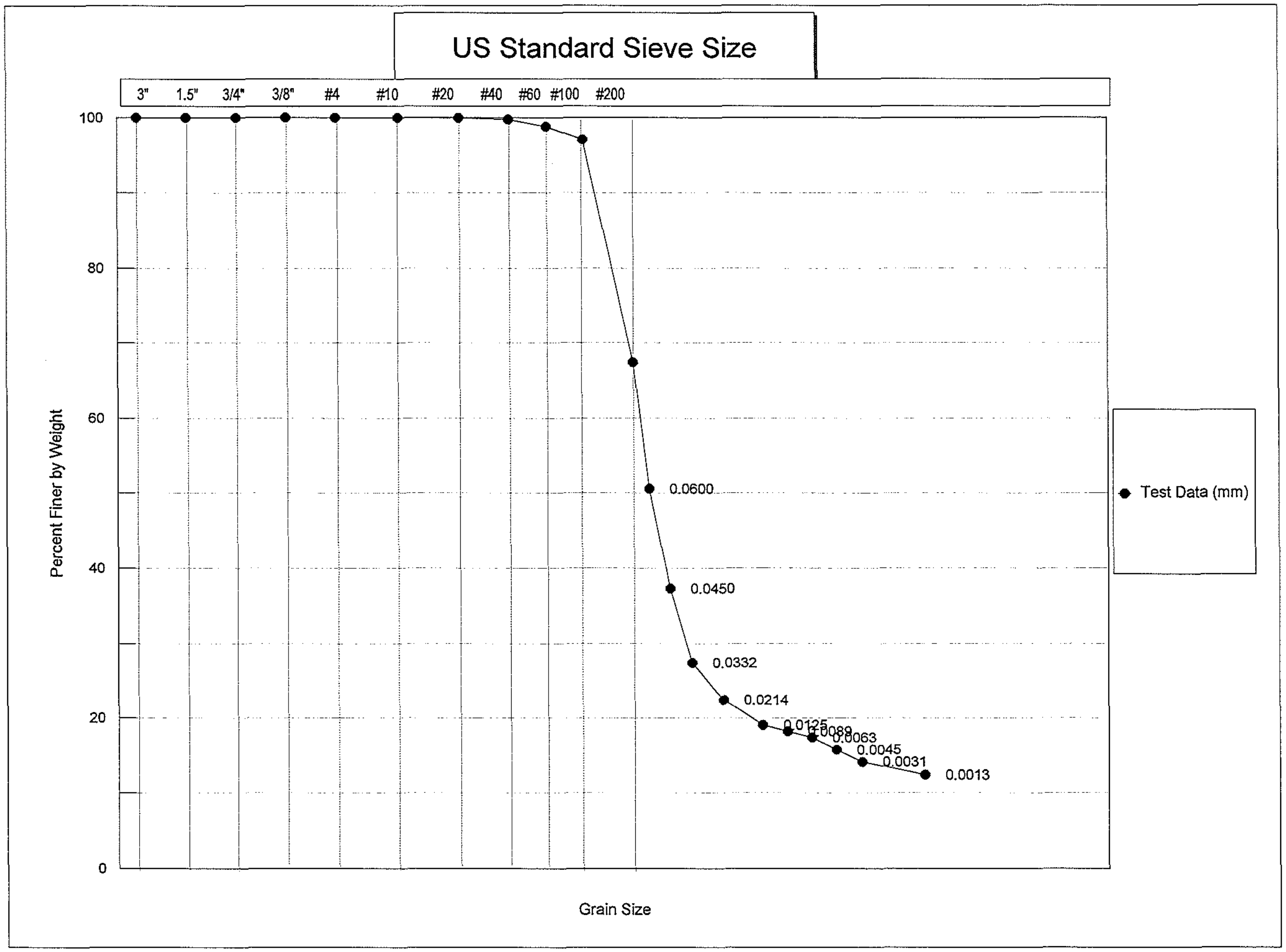
Hydrometer #	ASTM 152 H	Temp., Deg. C	22.4
Sp. Gr. of Soil	2.65	Temp. Coef. K	0.01326
Value of "alpha"	1.00	Wt. Dry Sample "W"	60.364
Deflocculant	Sodium Hexametaphosphate	% of Total Sample	100.0
Defloc. Corr'n	5.0		
Meniscus Corr'n	-1.5		

T Elapsed Time (min)	Hydrometer Reading Original	 Corrected "R"	100Ra/W	% Total Sample	Effective Depth L	Grain Diameter (mm)
0.0	--	--	--	--	--	--
0.5	37.00	30.50	50.5	50.5	10.22	0.0600
1.0	29.00	22.50	37.3	37.3	11.53	0.0450
2.0	23.00	16.50	27.3	27.3	12.52	0.0332
5.0	20.00	13.50	22.4	22.4	13.01	0.0214
15.0	18.00	11.50	19.1	19.1	13.34	0.0125
30.0	17.50	11.00	18.2	18.2	13.42	0.0089
60.0	17.00	10.50	17.4	17.4	13.50	0.0063
120.0	16.00	9.50	15.7	15.7	13.67	0.0045
250.0	15.00	8.50	14.1	14.1	13.83	0.0031
1440.0	14.00	7.50	12.4	12.4	13.99	0.0013

Grain Diameter = K*(SQRT(L/T))

Data entered by: MLM Date: 11/18/2010
Data checked by: MLL Date: 11/18/10
FileName: MHHYS10A

ADVANCED TERRA TESTING, Inc. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY (mm)	USCS
	COARSE	FINE	CRS	MEDIUM	FINE		

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY	WENTWORTH
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE			

Client: MWH
Job Number: 2512-53
Classification: **Classification Not Performed**

Boring No.: Stockpile 10
Depth: 5.0'

Sample No.: A

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 11	SAMPLED	10/12/10
DEPTH	0.0'	DATE TESTED	10/26/10 DPM
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No
Wt. Wet Soil & Pan (g)	103.39
Wt. Dry Soil & Pan (g)	101.41
Wt. Lost Moisture (g)	1.98
Wt. of Pan Only (g)	3.13
Wt. of Dry Soil (g)	98.28
Moisture Content %	2.0
Wt. Hydrom. Sample Wet (g)	66.77
Wt. Hydrom. Sample Dry (g)	65.46

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	2472.51
Weight of + #10 Before Washing (g)	7.41
Weight of + #10 After Washing (g)	6.93
Weight of - #10 Wet (g)	2465.10
Weight of - #10 Dry (g)	2416.89
Wt. Total Sample Dry (g)	2423.82
Calc. Wt. "W" (g)	65.64
Calc. Mass + #10	0.19

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	1.89	1.89	1.89	0.1	99.9
#4	0.00	3.87	3.87	5.76	0.2	99.8
#10	0.00	1.17	1.17	6.93	0.3	99.7
#20	2.96	3.19	0.23	0.23	0.6	99.4
#40	3.08	3.75	0.67	0.90	1.7	98.3
#60	3.17	7.63	4.46	5.36	8.5	91.5
#100	3.06	8.85	5.80	11.16	17.3	82.7
#200	2.99	20.77	17.78	28.93	44.4	55.6

Data entered by: MLM Date: 10/29/2010
Data checked by: *[signature]* Date: 11/1/10
FileName: MHHY110A

ADVANCED TERRA TESTING, INC. ATT

HYDROMETER ANALYSIS - SEDIMENTATION DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 11	SAMPLED	10/12/10
DEPTH	0.0'	DATE TESTED	10/26/10 DPM
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

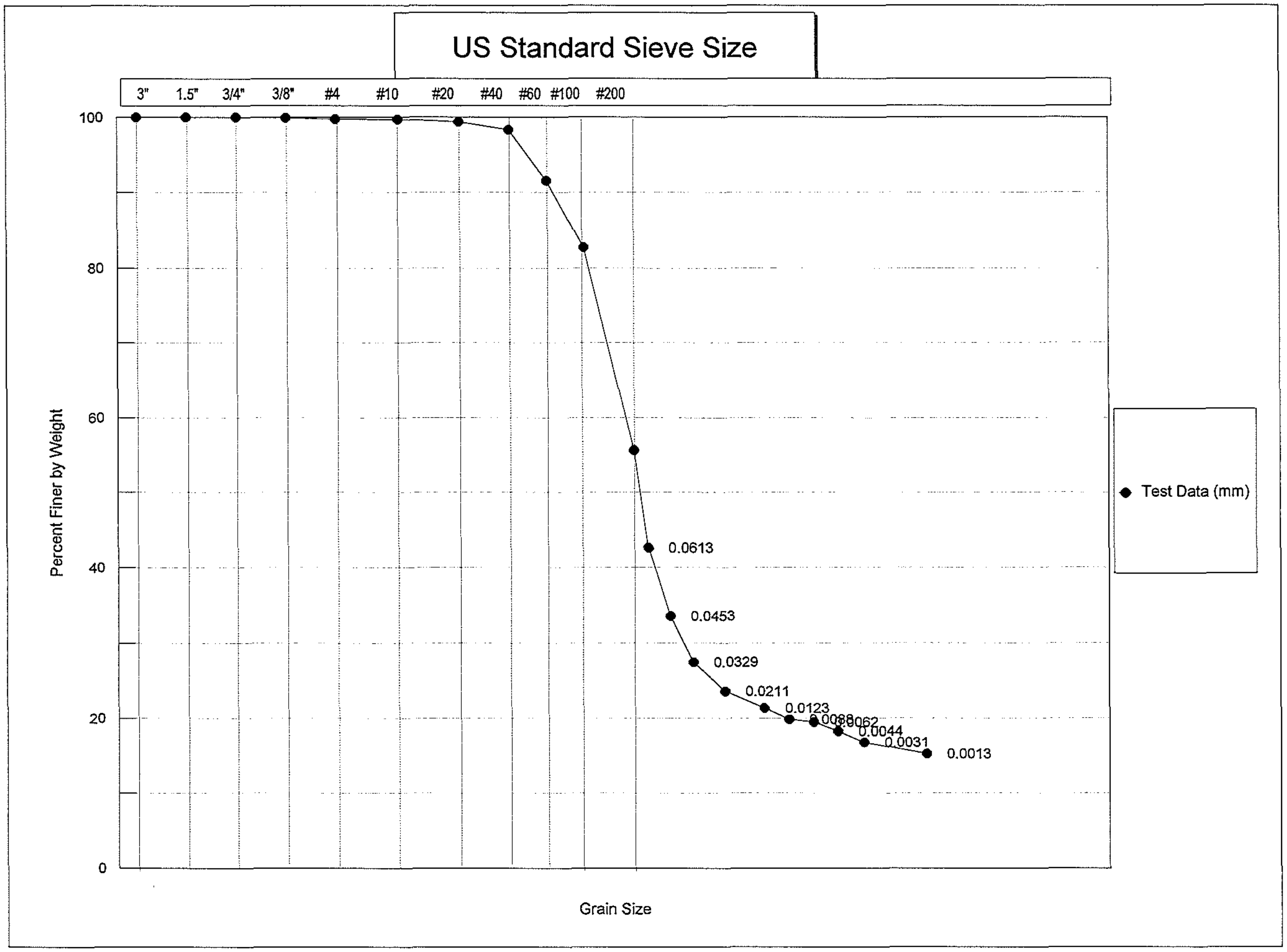
Hydrometer #	ASTM 152 H	Temp., Deg. C	23.2
Sp. Gr. of Soil	2.65	Temp. Coef. K	0.01314
Value of "alpha"	1.00	Wt. Dry Sample "W"	65.643
Deflocculant	Sodium Hexametaphosphate	% of Total Sample	100.0
Defloc. Corr'n	5.5		
Meniscus Corr'n	0.5		

T Elapsed Time (min)	Hydrometer Reading Original	Corrected "R"	100Ra/W	% Total Sample	Effective Depth L	Grain Diameter (mm)
0.0	--	--	--	--	--	--
0.5	33.00	28.00	42.7	42.7	10.88	0.0613
1.0	27.00	22.00	33.5	33.5	11.86	0.0453
2.0	23.00	18.00	27.4	27.4	12.52	0.0329
5.0	20.50	15.50	23.6	23.6	12.93	0.0211
15.0	19.00	14.00	21.3	21.3	13.17	0.0123
30.0	18.00	13.00	19.8	19.8	13.34	0.0088
60.0	17.75	12.75	19.4	19.4	13.38	0.0062
120.0	17.00	12.00	18.3	18.3	13.50	0.0044
250.0	16.00	11.00	16.8	16.8	13.67	0.0031
1440.0	15.00	10.00	15.2	15.2	13.83	0.0013

Grain Diameter = K*(SQRT(L/T))

Data entered by: MLM Date: 10/29/2010
Data checked by: KL Date: 11/1/10
FileName: MHHY110A

ADVANCED TERRA TESTING, Inc. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY (mm)	USCS
	COARSE	FINE	CRS	MEDIUM	FINE		

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY	WENTWORTH
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE			

Client: MWH
Job Number: 2512-53
Classification: **Classification Not Performed**

Boring No.: Stockpile 11
Depth: 0.0'

Sample No.: A

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 12	SAMPLED	10/12/10 --
DEPTH	5.0'	DATE TESTED	10/25/10 DPM
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No
Wt. Wet Soil & Pan (g)	95.32
Wt. Dry Soil & Pan (g)	91.82
Wt. Lost Moisture (g)	3.50
Wt. of Pan Only (g)	3.16
Wt. of Dry Soil (g)	88.66
Moisture Content %	4.0
Wt. Hydrom. Sample Wet (g)	61.16
Wt. Hydrom. Sample Dry (g)	58.84

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	1732.46
Weight of + #10 Before Washing (g)	0.36
Weight of + #10 After Washing (g)	0.33
Weight of - #10 Wet (g)	1732.10
Weight of - #10 Dry (g)	1666.29
Wt. Total Sample Dry (g)	1666.62
Calc. Wt. "W" (g)	58.85
Calc. Mass + #10	0.01

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	0.00	0.00	0.00	0.0	100.0
#4	0.00	0.00	0.00	0.00	0.0	100.0
#10	0.00	0.33	0.33	0.33	0.0	100.0
#20	1.79	2.05	0.26	0.26	0.5	99.5
#40	1.83	2.28	0.45	0.71	1.2	98.8
#60	1.77	2.33	0.56	1.27	2.2	97.8
#100	1.78	3.32	1.54	2.81	4.8	95.2
#200	1.78	22.86	21.08	23.89	40.6	59.4

Data entered by: MLM Date: 11/04/2010
Data checked by: VR Date: 11/4/10
FileName: MHHYS12A

ADVANCED TERRA TESTING, Inc. ATT

HYDROMETER ANALYSIS - SEDIMENTATION DATA
ASTM D 422

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 12	SAMPLED	10/12/10 --
DEPTH	5.0'	DATE TESTED	10/25/10 DPM
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

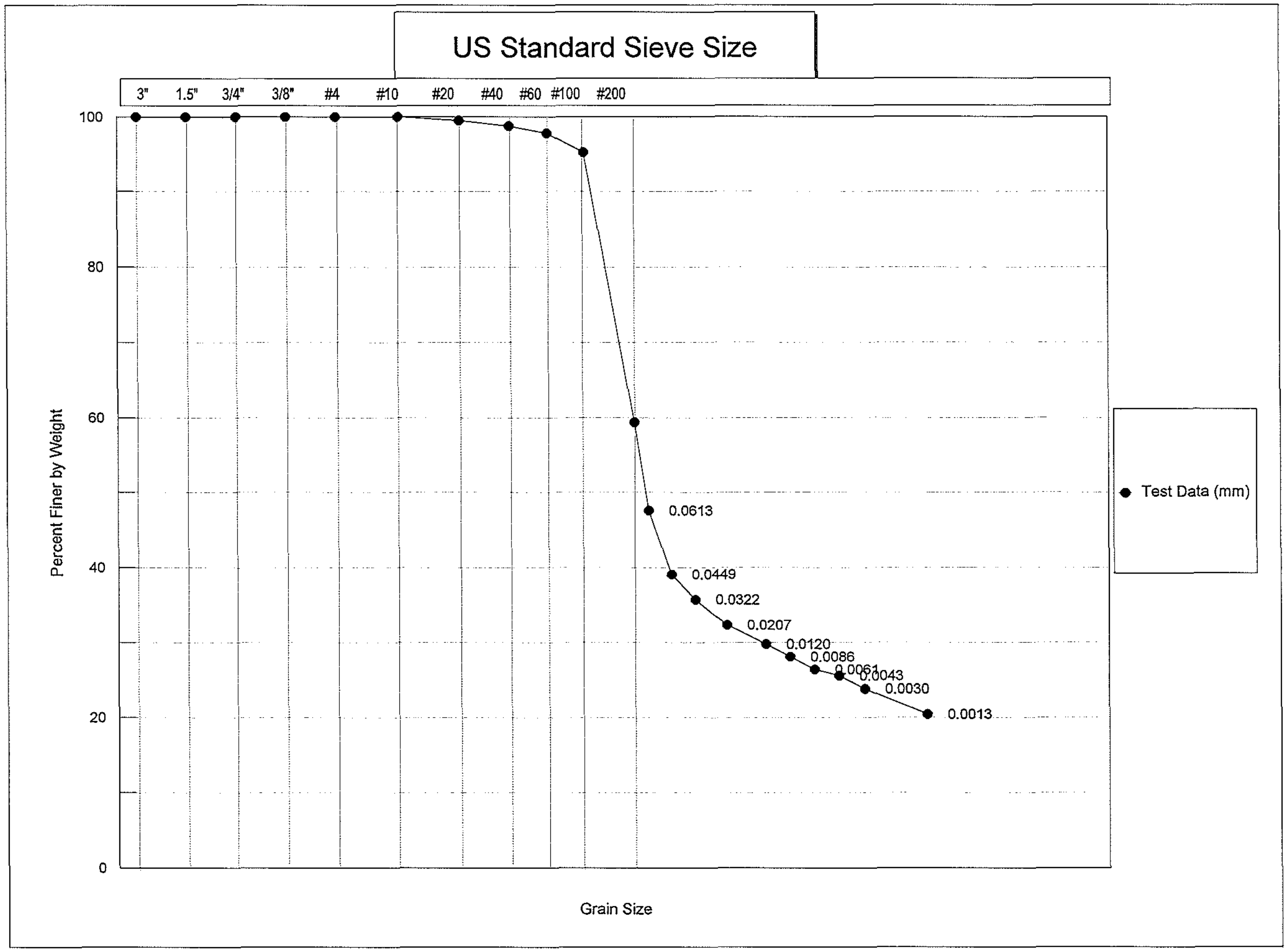
Hydrometer #	ASTM 152 H	Temp., Deg. C	23.2
Sp. Gr. of Soil	2.65	Temp. Coef. K	0.01314
Value of "alpha"	1.00	Wt. Dry Sample "W"	58.850
Deflocculant	Sodium Hexametaphosphate	% of Total Sample	100.0
Defloc. Corr'n	5.5		
Meniscus Corr'n	0.5		

T Elapsed Time (min)	Hydrometer Reading Original	Corrected "R"	100Ra/W	% Total Sample	Effective Depth L	Grain Diameter (mm)
0.0	--	--	--	--	--	--
0.5	33.00	28.00	47.6	47.6	10.88	0.0613
1.0	28.00	23.00	39.1	39.1	11.70	0.0449
2.0	26.00	21.00	35.7	35.7	12.03	0.0322
5.0	24.00	19.00	32.3	32.3	12.35	0.0207
15.0	22.50	17.50	29.7	29.7	12.60	0.0120
30.0	21.50	16.50	28.0	28.0	12.76	0.0086
60.0	20.50	15.50	26.3	26.3	12.93	0.0061
120.0	20.00	15.00	25.5	25.5	13.01	0.0043
250.0	19.00	14.00	23.8	23.8	13.17	0.0030
1440.0	17.00	12.00	20.4	20.4	13.50	0.0013

Grain Diameter = K*(SQRT(L/T))

Data entered by: MLM Date: 11/04/2010
Data checked by: KR Date: 11/4/10
FileName: MHHYS12A

ADVANCED TERRA TESTING, Inc. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY (mm)	USCS
	COARSE	FINE	CRS	MEDIUM	FINE		

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY	WENTWORTH
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE			

Client: MWH   Boring No.: Stockpile 12   Sample No.: A
Job Number: 2512-53   Depth: 5.0'
Classification: **Classification Not Performed**

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT MWH

JOB NO. 2512-53

BORING NO.	Stockpile 13	SAMPLED	10/12/10
DEPTH	0.0'	DATE TESTED	11/09/10 WAR
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No
Wt. Wet Soil & Pan (g)	103.51
Wt. Dry Soil & Pan (g)	99.73
Wt. Lost Moisture (g)	3.78
Wt. of Pan Only (g)	3.13
Wt. of Dry Soil (g)	96.60
Moisture Content %	3.9
Wt. Hydrom. Sample Wet (g)	62.53
Wt. Hydrom. Sample Dry (g)	60.18

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	1684.57
Weight of + #10 Before Washing (g)	4.67
Weight of + #10 After Washing (g)	4.12
Weight of - #10 Wet (g)	1679.90
Weight of - #10 Dry (g)	1617.17
Wt. Total Sample Dry (g)	1621.29
Calc. Wt. "W" (g)	60.33
Calc. Mass + #10	0.15

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	0.00	0.00	0.00	0.0	100.0
#4	0.00	2.47	2.47	2.47	0.2	99.8
#10	0.00	1.65	1.65	4.12	0.3	99.7
#20	3.00	4.45	1.45	1.45	2.6	97.4
#40	3.09	4.72	1.63	3.07	5.3	94.7
#60	3.08	6.97	3.89	6.96	11.8	88.2
#100	3.03	10.05	7.02	13.98	23.4	76.6
#200	3.00	14.05	11.05	25.03	41.7	58.3

Data entered by: MLM Date: 11/12/2010
Data checked by: *[signature]* Date: *11/13/10*
FileName: MHHYS13A

ADVANCED TERRA TESTING, Inc. ATT

HYDROMETER ANALYSIS - SEDIMENTATION DATA
ASTM D 422

CLIENT	MWH	JOB NO.	2512-53
BORING NO.	Stockpile 13	SAMPLED	10/12/10
DEPTH	0.0'	DATE TESTED	11/09/10 WAR
SAMPLE NO.	A	WASH SIEVE	Yes
SOIL DESCR.	1009740	DRY SIEVE	No
LOCATION	Denison White Mesa Mill Project		

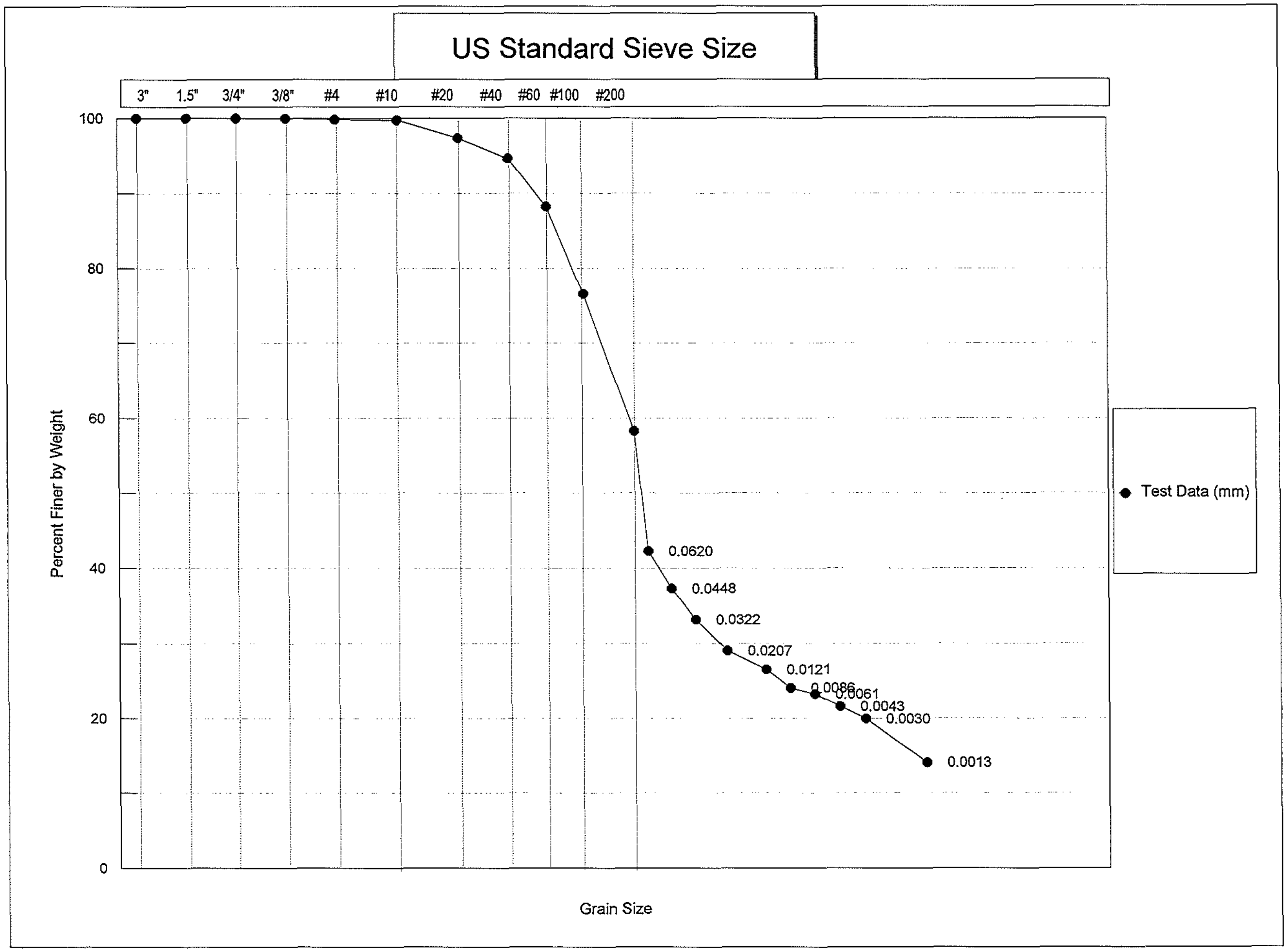
Hydrometer #	ASTM 152 H	Temp., Deg. C	23.8
Sp. Gr. of Soil	2.65	Temp. Coef. K	0.01304
Value of "alpha"	1.00	Wt. Dry Sample "W"	60.329
Deflocculant	Sodium Hexametaphosphate	% of Total Sample	100.0
Defloc. Corr'n	5.0		
Meniscus Corr'n	0.0		

T Elapsed Time (min)	Hydrometer Reading Original	Corrected "R"	100Ra/W	% Total Sample	Effective Depth L	Grain Diameter (mm)
0.0	--	--	--	--	--	--
0.5	30.50	25.50	42.3	42.3	11.29	0.0620
1.0	27.50	22.50	37.3	37.3	11.78	0.0448
2.0	25.00	20.00	33.2	33.2	12.19	0.0322
5.0	22.50	17.50	29.0	29.0	12.60	0.0207
15.0	21.00	16.00	26.5	26.5	12.85	0.0121
30.0	19.50	14.50	24.0	24.0	13.09	0.0086
60.0	19.00	14.00	23.2	23.2	13.17	0.0061
120.0	18.00	13.00	21.5	21.5	13.34	0.0043
250.0	17.00	12.00	19.9	19.9	13.50	0.0030
1440.0	13.50	8.50	14.1	14.1	14.08	0.0013

Grain Diameter = K*(SQRT(L/T))

Data entered by: MLM Date: 11/12/2010
Data checked by: Cal Date: 11/13/10
FileName: MHHYS13A

ADVANCED TERRA TESTING, INC. ATT



COBBLES	GRAVEL		SAND			SILT OR CLAY (mm)	USCS
	COARSE	FINE	CRS	MEDIUM	FINE		

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY	WENTWORTH
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE			

Client: MWH Boring No.: Stockpile 13 Sample No.: A
Job Number: 2512-53 Depth: 0.0'
Classification: **Classification Not Performed**

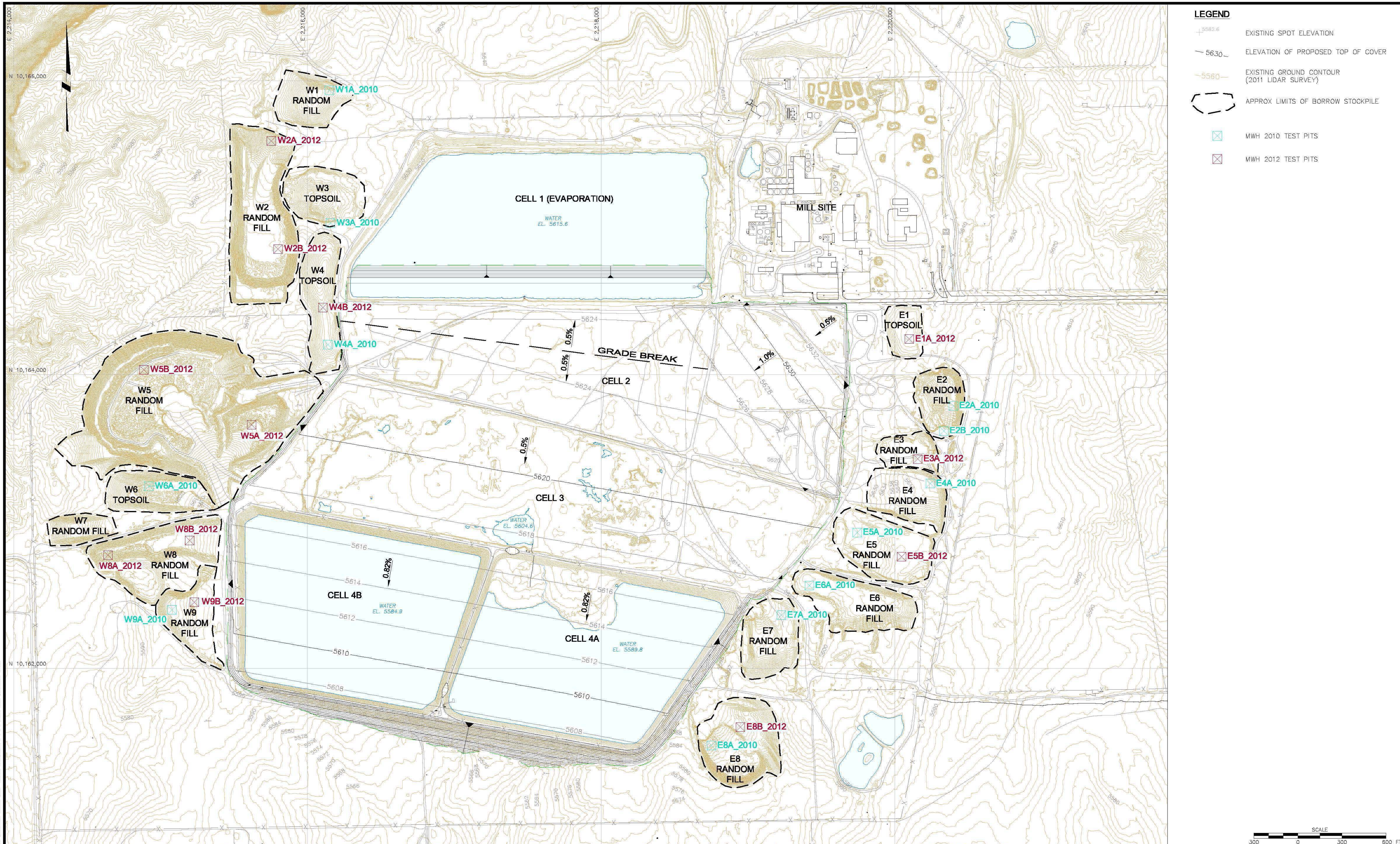
APPENDIX A.3

APRIL 2012 COVER MATERIAL FIELD INVESTIGATION

AND LABORATORY TESTING RESULTS

APPENDIX A.3.1

APRIL 2012 COVER MATERIAL FIELD INVESTIGATION



D:\DESIGN-DRAFTING\CLIENTS A-H\DENISON MINES\013-Sheet Set\2012-08-10 TEST PITS\1009740 BRW

DENISON MINES
Denison Mines (USA) Corp

PROJECT
WHITE MESA MILL TAILINGS RECLAMATION

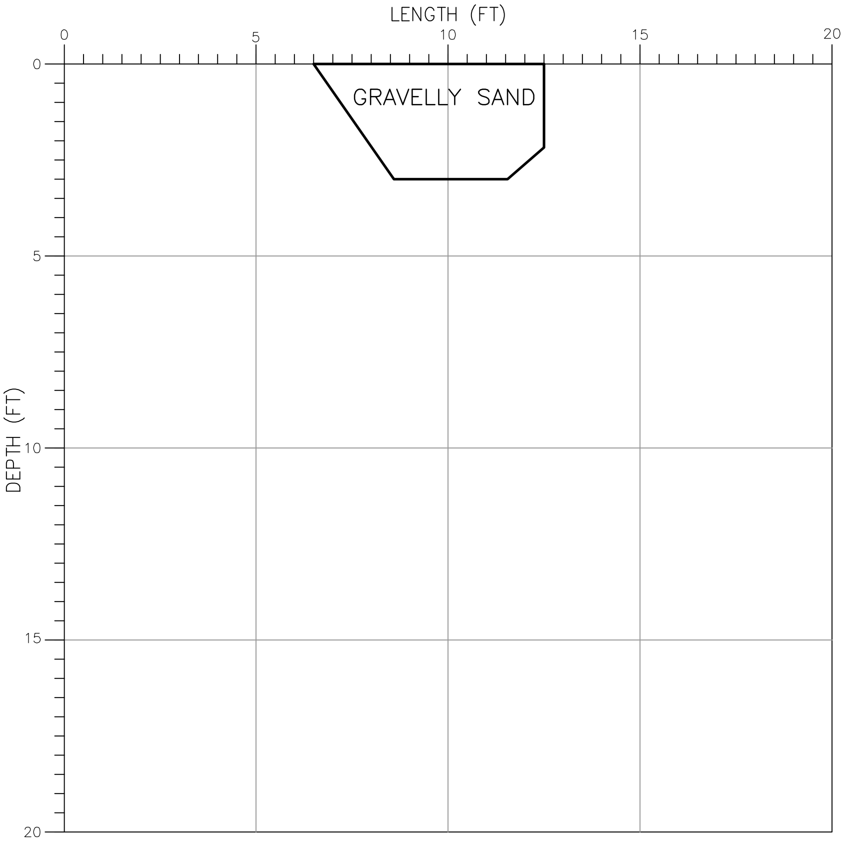
TITLE
COVER MATERIAL BORROW STOCKPILES
TEST PIT LOCATIONS

MWH

DATE AUG 2012
FIGURE 1
FILE NAME 1009740 BRW

PROJECT: DENISON WHITE MESA RECLAMATION
PIT NAME: W2A_2012
GENERAL LOCATION: SEE BORROW LOCATIONS MAP
PIT TREND: WEST–EAST
PIT FACED LOGGED: NORTH

DATE: 04/19/2012 0835–0900
FIELD ENGINEER: CAB ESPOSITO, MWH
EXCAVATOR: JOHN DEERE BACKHOE
CONTRACTOR: DENISON WHITE MESA



TEST PIT LOG

LEGEND

— — CONTACT

SAMPLE No.	DEPTH	TIME
DWM_W2A1_2012	0'–3'	0845
DWM_W2A2_2012	0'–3'	0855
–	–	–
–	–	–

PIT WIDTH: 2'
PIT LENGTH: 6'
PIT DEPTH: 3'

SOIL UNIT	SOIL DESCRIPTION AND EXCAVATION NOTES
GRAVELLY SAND	0'–3' SLIGHTLY MOIST, BROWN–LIGHT BROWN SUBANGULAR COARSE SAND, 10–20% DARK GRAY ANGULAR GRAVEL

SPECIAL NOTES:

REV	REVISIONS	DATE	DES BY	DWN BY	REVIEWED AND SIGNED BY

MWH

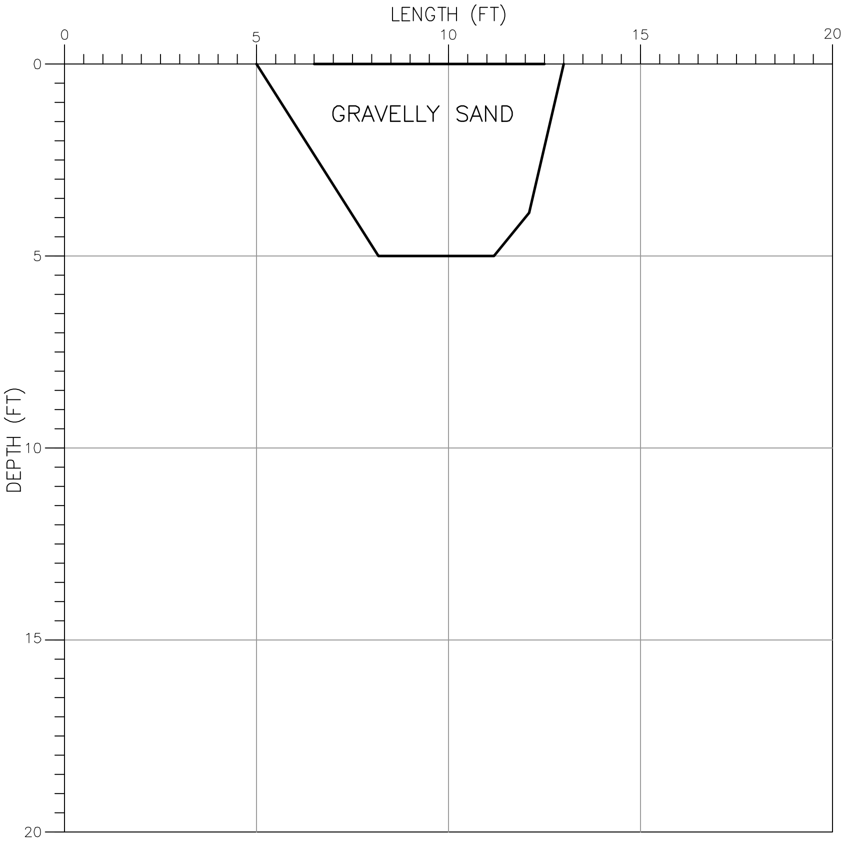
PROJECT No. 1011332
FILENAME: 1009740 TEST PIT.DWG
SCALE NOT TO SCALE
FIGURE No

1009740 TEST PIT.DWG

PROJECT: DENISON WHITE MESA RECLAMATION
PIT NAME: W2B_2012
GENERAL LOCATION: SEE BORROW LOCATIONS MAP
PIT TREND: WEST–EAST
PIT FACED LOGGED: NORTH

DATE: 04/19/2012 0910
FIELD ENGINEER: CAB ESPOSITO, MWH
EXCAVATOR: JOHN DEERE BACKHOE
CONTRACTOR: DENISON WHITE MESA

TEST PIT LOG



LEGEND

— — CONTACT

SAMPLE No.	DEPTH	TIME
DWM_W2B1_2012	0'–5'	0910
DWM_W2B2_2012	0'–5'	0910
–	–	–
–	–	–

PIT WIDTH: 3'
PIT LENGTH: 8'
PIT DEPTH: 5'

SOIL UNIT	SOIL DESCRIPTION AND EXCAVATION NOTES
GRAVELLY SAND	0'–5' SLIGHTLY MOIST, BROWN SUBANGULAR SAND, 10–15% DARK GRAY ANGULAR GRAVEL

SPECIAL NOTES:

REV	REVISIONS	DATE	DES BY	DWN BY	REVIEWED AND SIGNED BY

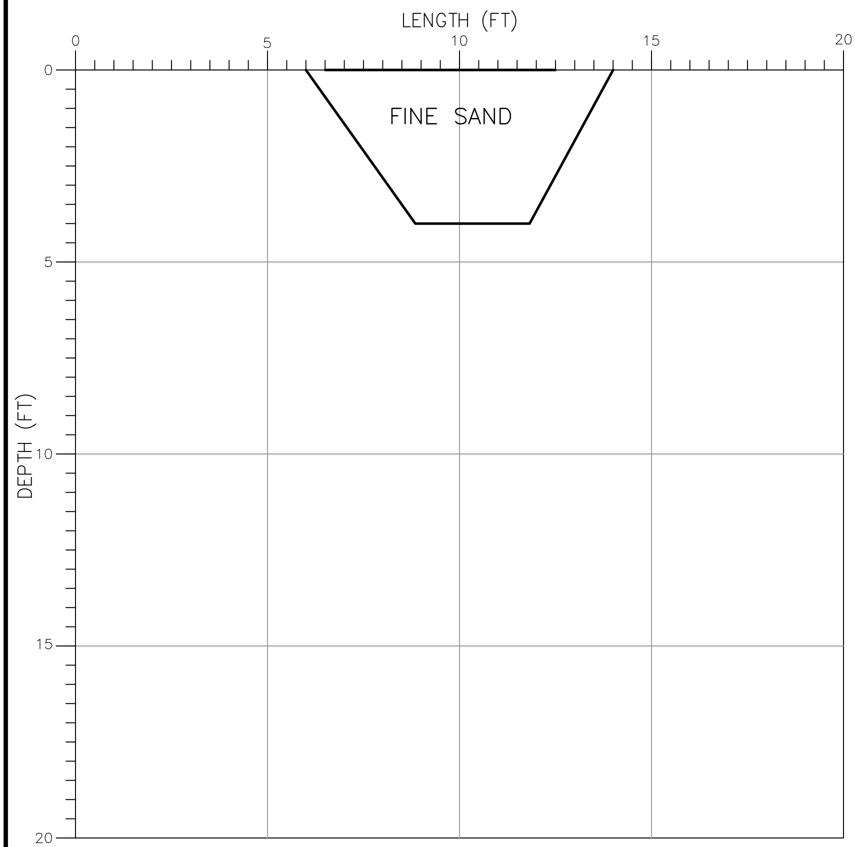
MWH

PROJECT No. 1011332
FILENAME: 1009740 TEST PIT.DWG
SCALE NOT TO SCALE
FIGURE No

1009740 TEST PIT.DWG

PROJECT: DENISON WHITE MESA RECLAMATION
PIT NAME: W4B_2012
GENERAL LOCATION: SEE BORROW LOCATIONS MAP
PIT TREND: NORTH–SOUTH
PIT FACED LOGGED: WEST

DATE: 04/19/2012 0930
FIELD ENGINEER: CAB ESPOSITO, MWH
EXCAVATOR: JOHN DEERE BACKHOE
CONTRACTOR: DENISON WHITE MESA



TEST PIT LOG

LEGEND

— — CONTACT

SAMPLE No.	DEPTH	TIME
DWM_W4B1_2012	0'–4'	0930
DWM_W4B2_2012	0'–4'	0930
–	–	–
–	–	–

PIT WIDTH: 3'
PIT LENGTH: 8'
PIT DEPTH: 4'

SOIL UNIT	SOIL DESCRIPTION AND EXCAVATION NOTES
FINE SAND	0'–4' DRY, RED, FINE SAND, 40–50% FRIABLE CLAY FRAGMENTS

SPECIAL NOTES:

REV	REVISIONS	DATE	DES BY	DWN BY	REVIEWED AND SIGNED BY

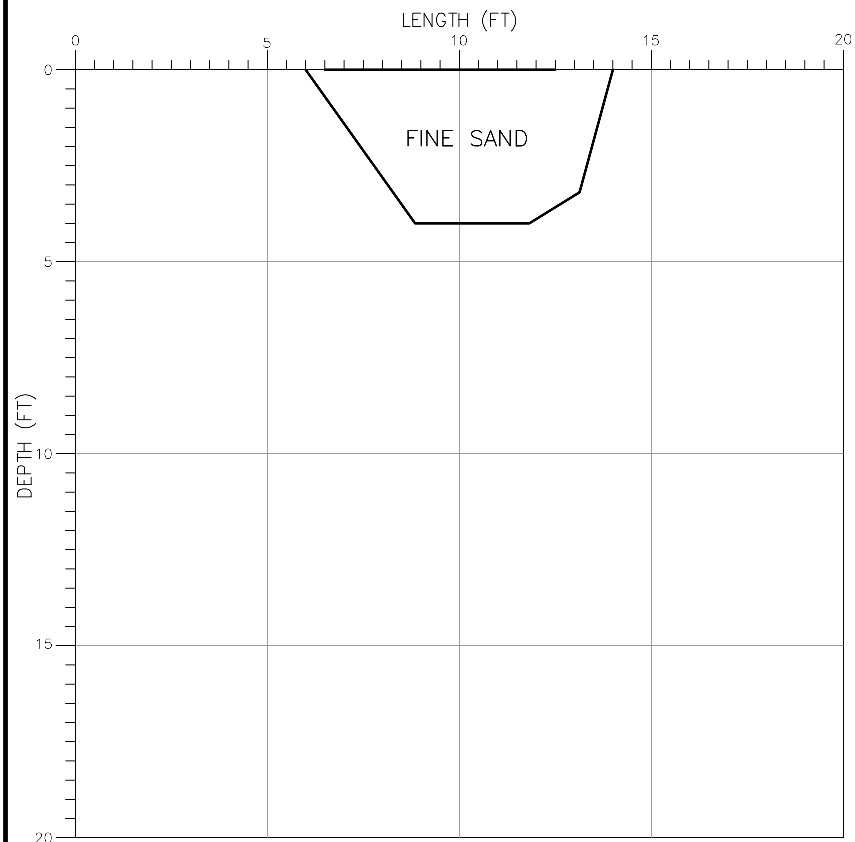
MWH

PROJECT No. 1011332
FILENAME: 1009740 TEST PIT.DWG
SCALE NOT TO SCALE
FIGURE No

1009740 TEST PIT.DWG

PROJECT: DENISON WHITE MESA RECLAMATION
PIT NAME: W5A_2012
GENERAL LOCATION: SEE BORROW LOCATIONS MAP
PIT TREND: WEST-EAST
PIT FACED LOGGED: NORTH

DATE: 04/19/2012 0950
FIELD ENGINEER: CAB ESPOSITO, MWH
EXCAVATOR: JOHN DEERE BACKHOE
CONTRACTOR: DENISON WHITE MESA



TEST PIT LOG

LEGEND

—— —— CONTACT

SAMPLE No.	DEPTH	TIME
DWM_W5A1_2012	0'-4'	0950
DWM_W5A2_2012	0'-4'	0950
-	-	-
-	-	-

PIT WIDTH: 3'
PIT LENGTH: 8'
PIT DEPTH: 4'

SOIL UNIT	SOIL DESCRIPTION AND EXCAVATION NOTES
FINE SAND	0'-4' SLIGHTLY MOIST-MOIST, LIGHT GRAY-BROWN, FINE SAND, 10% FRIABLE CLAY FRAGMENTS

SPECIAL NOTES:

REV	REVISIONS	DATE	DES BY	DWN BY	REVIEWED AND SIGNED BY

MWH

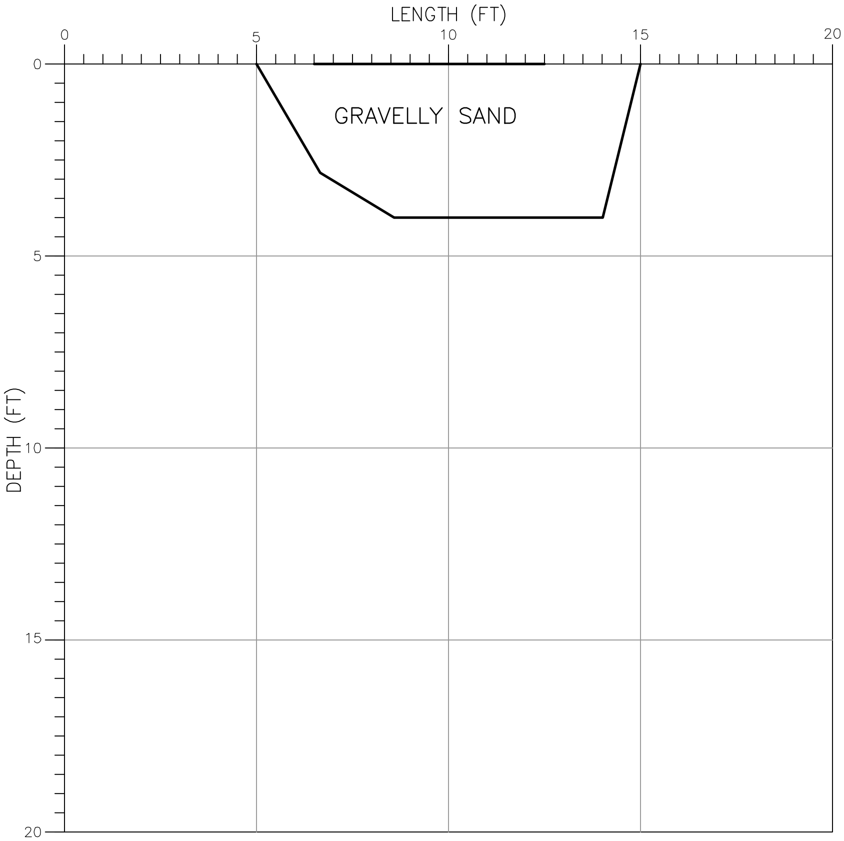
PROJECT No. 1011332
FILENAME: 1009740 TEST PIT.DWG
SCALE NOT TO SCALE
FIGURE No

1009740 TEST PIT.DWG

PROJECT: DENISON WHITE MESA RECLAMATION
PIT NAME: W5B_2012
GENERAL LOCATION: SEE BORROW LOCATIONS MAP
PIT TREND: WEST–EAST
PIT FACED LOGGED: NORTH

DATE: 04/19/2012 1005
FIELD ENGINEER: CAB ESPOSITO, MWH
EXCAVATOR: JOHN DEERE BACKHOE
CONTRACTOR: DENISON WHITE MESA

TEST PIT LOG



LEGEND

— — CONTACT

SAMPLE No.	DEPTH	TIME
DWM_W5B1_2012	0'–4'	1005
DWM_W5B2_2012	0'–4'	1005
–	–	–
–	–	–

PIT WIDTH: 3'
PIT LENGTH: 10'
PIT DEPTH: 4'

SOIL UNIT	SOIL DESCRIPTION AND EXCAVATION NOTES
GRAVELLY SAND	0'–4' DRY, LIGHT GRAY, VERY FINE SAND TO LARGE GRAVEL, 20% GRAVEL. GRAVEL CONSISTING OF WEAKLY CEMENTED SANDSTONE

SPECIAL NOTES:

REV	REVISIONS	DATE	DES BY	DWN BY	REVIEWED AND SIGNED BY

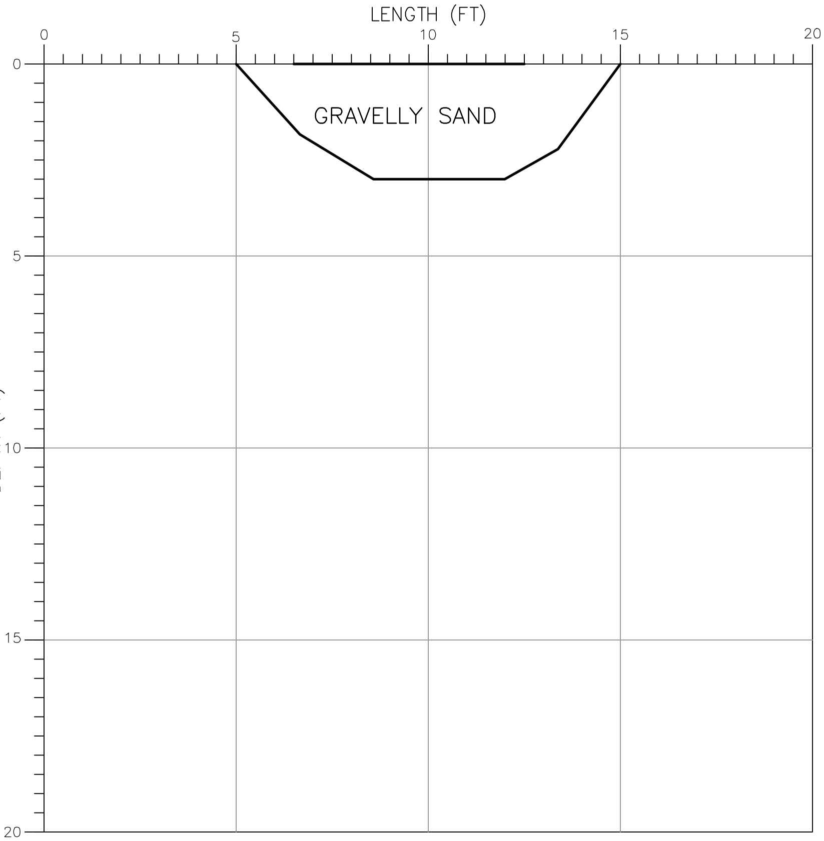
MWH

PROJECT No. 1011332
FILENAME: 1009740 TEST PIT.DWG
SCALE NOT TO SCALE
FIGURE No

1009740 TEST PIT.DWG

PROJECT: DENISON WHITE MESA RECLAMATION
PIT NAME: W8A_2012
GENERAL LOCATION: SEE BORROW LOCATIONS MAP
PIT TREND: WEST–EAST
PIT FACED LOGGED: NORTH

DATE: 04/19/2012 1025
FIELD ENGINEER: CAB ESPOSITO, MWH
EXCAVATOR: JOHN DEERE BACKHOE
CONTRACTOR: DENISON WHITE MESA



TEST PIT LOG

LEGEND

—— —— CONTACT

SAMPLE No.	DEPTH	TIME
DWM_W8A1_2012	0'–3'	1025
DWM_W8A2_2012	0'–3'	1025
–	–	–
–	–	–

PIT WIDTH: 6'
PIT LENGTH: 10'
PIT DEPTH: 3'

SOIL UNIT	SOIL DESCRIPTION AND EXCAVATION NOTES
GRAVELLY SAND	0'–3' SLIGHTLY MOIST, LIGHT TAN–LIGHT BROWN, SAND, 10% SUB–ANGULAR GRAVEL, 5% ANGULAR BOULDERS. GRAVEL AND BOULDERS CONSISTING OF QUARTZ SANDSTONE

SPECIAL NOTES:

REV	REVISIONS	DATE	DES BY	DWN BY	REVIEWED AND SIGNED BY

MWH

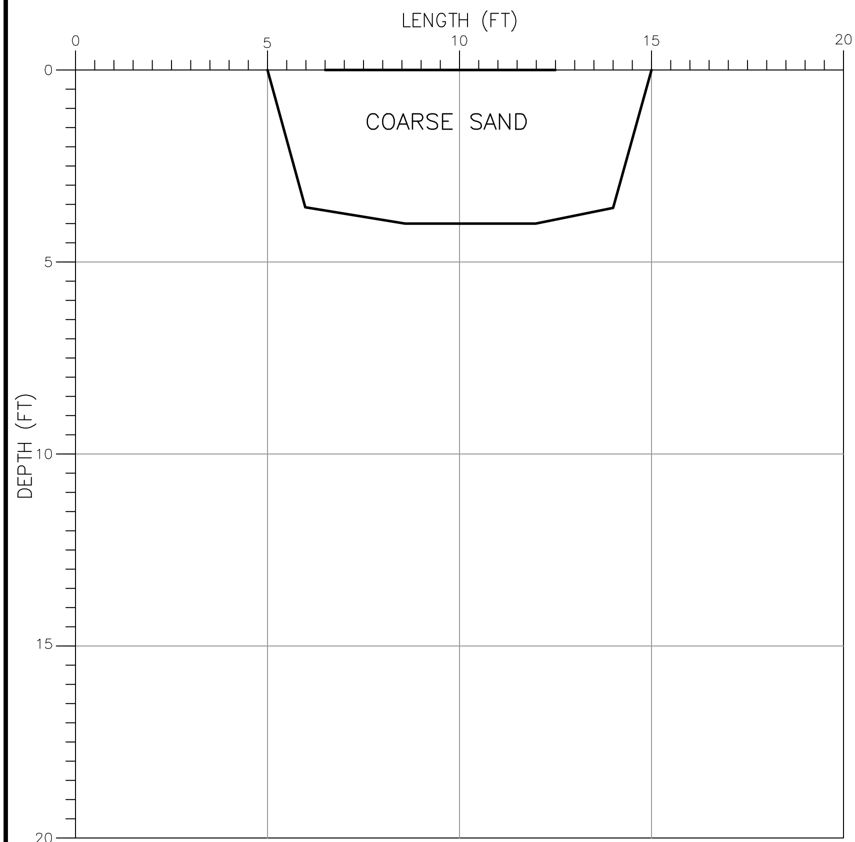
PROJECT No. 1011332
FILENAME: 1009740 TEST PIT.DWG
SCALE NOT TO SCALE
FIGURE No

1009740 TEST PIT.DWG

PROJECT: DENISON WHITE MESA RECLAMATION
PIT NAME: W8B_2012
GENERAL LOCATION: SEE BORROW LOCATIONS MAP
PIT TREND: WEST–EAST
PIT FACED LOGGED: NORTH

DATE: 04/19/2012 1035
FIELD ENGINEER: CAB ESPOSITO, MWH
EXCAVATOR: JOHN DEERE BACKHOE
CONTRACTOR: DENISON WHITE MESA

TEST PIT LOG



LEGEND

— — CONTACT

SAMPLE No.	DEPTH	TIME
DWM_W8B1_2012	0'–4'	1035
DWM_W8B2_2012	0'–4'	1035
–	–	–
–	–	–

PIT WIDTH: 3'
PIT LENGTH: 10'
PIT DEPTH: 4'

SOIL UNIT	SOIL DESCRIPTION AND EXCAVATION NOTES
COARSE SAND	0'–4' MOIST, BROWN–LIGHT BROWN, COARSE–FINE SAND, 5% CLAYS, 10% GRAVEL, 2% COBBLES

SPECIAL NOTES:

REV	REVISIONS	DATE	DES BY	DWN BY	REVIEWED AND SIGNED BY

MWH

PROJECT No. 1011332
FILENAME: 1009740 TEST PIT.DWG
SCALE NOT TO SCALE
FIGURE No

1009740 TEST PIT.DWG

PROJECT: DENISON WHITE MESA RECLAMATION

PIT NAME: W9B_2012

GENERAL LOCATION: SEE BORROW LOCATIONS MAP

PIT TREND: NORTH–SOUTH

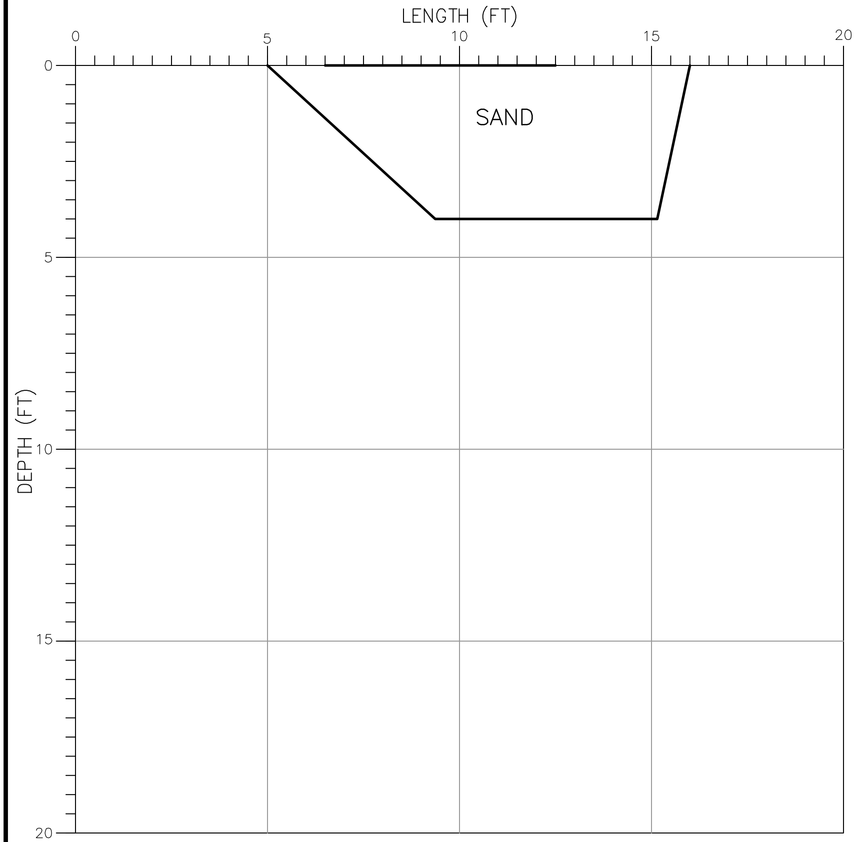
PIT FACED LOGGED: WEST

DATE: 04/19/2012 1055

FIELD ENGINEER: CAB ESPOSITO, MWH

EXCAVATOR: JOHN DEERE BACKHOE

CONTRACTOR: DENISON WHITE MESA



TEST PIT LOG

LEGEND

— — CONTACT

SAMPLE No.	DEPTH	TIME
DWM_W9B1_2012	0'–4'	1055
DWM_W9B2_2012	0'–4'	1055
–	–	–
–	–	–

PIT WIDTH: 2'

PIT LENGTH: 11'

PIT DEPTH: 4'

SOIL UNIT	SOIL DESCRIPTION AND EXCAVATION NOTES
SAND	0'–4' SLIGHT MOIST–MOIST, TAN–RED, MEDIUM SAND, 10% GRAVEL, 2% COBBLES

SPECIAL NOTES:

REV	REVISIONS	DATE	DES BY	DWN BY	REVIEWED AND SIGNED BY

MWH

PROJECT No. 1011332

FILENAME: 1009740 TEST PIT.DWG

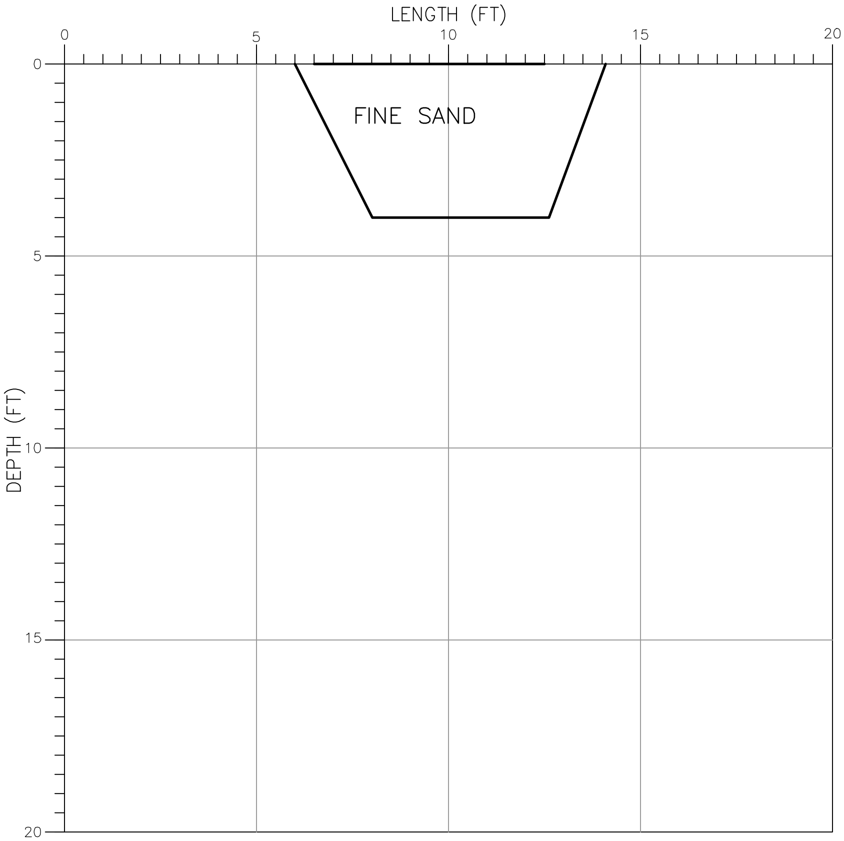
SCALE NOT TO SCALE

FIGURE No

1009740 TEST PIT.DWG

PROJECT: DENISON WHITE MESA RECLAMATION
PIT NAME: E1A_2012
GENERAL LOCATION: SEE BORROW LOCATIONS MAP
PIT TREND: NORTH–SOUTH
PIT FACED LOGGED: WEST

DATE: 04/19/2012 1310
FIELD ENGINEER: CAB ESPOSITO, MWH
EXCAVATOR: JOHN DEERE BACKHOE
CONTRACTOR: DENISON WHITE MESA



TEST PIT LOG

LEGEND

— — CONTACT

SAMPLE No.	DEPTH	TIME
DWM_E1A1_2012	0'–4'	1310
DWM_E1A2_2012	0'–4'	1310
–	–	–
–	–	–

PIT WIDTH: 3'
PIT LENGTH: 8'
PIT DEPTH: 4'

SOIL UNIT	SOIL DESCRIPTION AND EXCAVATION NOTES
FINE SAND	0'–4' DRY, RED, FINE SAND, TRACE PEBBLES, TRACE ORGANICS (ROOTS)

SPECIAL NOTES:

REV	REVISIONS	DATE	DES BY	DWN BY	REVIEWED AND SIGNED BY

MWH

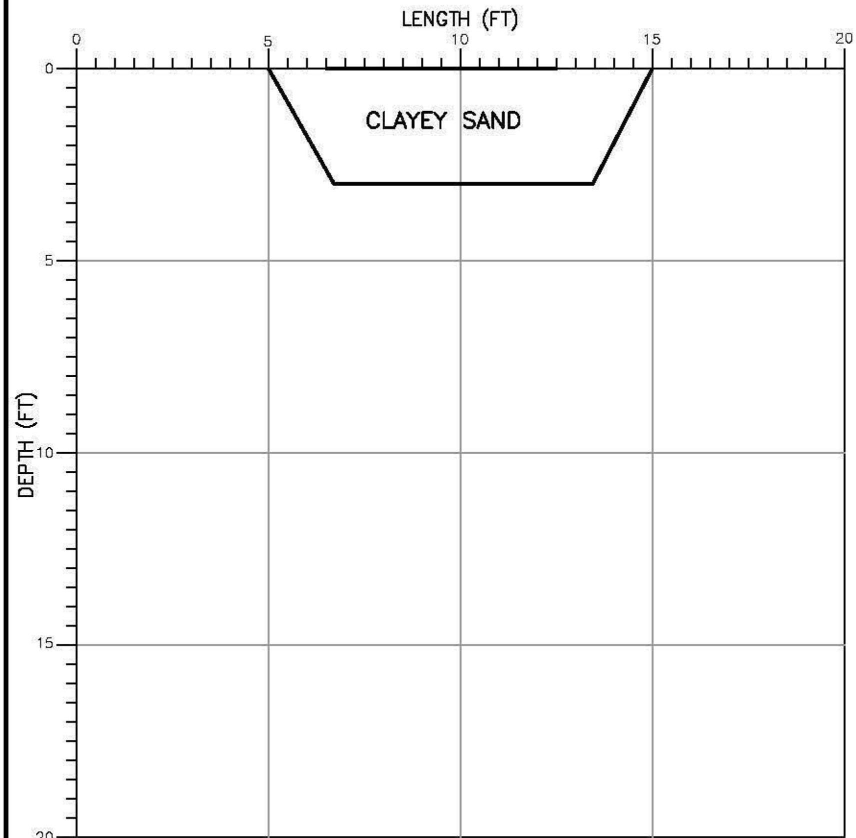
PROJECT No. 1011332
FILENAME: 1009740 TEST PIT.DWG
SCALE NOT TO SCALE
FIGURE No

1009740 TEST PIT.DWG

PROJECT: DENISON WHITE MESA RECLAMATION
PIT NAME: E3A_2012
GENERAL LOCATION: SEE BORROW LOCATIONS MAP
PIT TREND: NORTH-SOUTH
PIT FACED LOGGED: EAST

DATE: 04/19/2012 1255
FIELD ENGINEER: CAB ESPOSITO, MWH
EXCAVATOR: TULLEY LAMENAN
CONTRACTOR: DENISON WHITE MESA

TEST PIT LOG



LEGEND

— — CONTACT

SAMPLE No.	DEPTH	TIME
DWM_E3A1_2012	0'-3'	1255
DWM_E3A2_2012	0'-3'	1255
–	–	–
–	–	–

PIT WIDTH: 2'
PIT LENGTH: 10'
PIT DEPTH: 3'

SOIL UNIT	SOIL DESCRIPTION AND EXCAVATION NOTES
CLAYEY SAND	0'-3' SLIGHTLY MOIST, LIGHT BROWN, CLAYEY SAND, 5-10% GRAVEL (PINK-WHITE)

SPECIAL NOTES:

REV	REVISIONS	DATE	DES BY	DWN BY	REVIEWED AND SIGNED BY

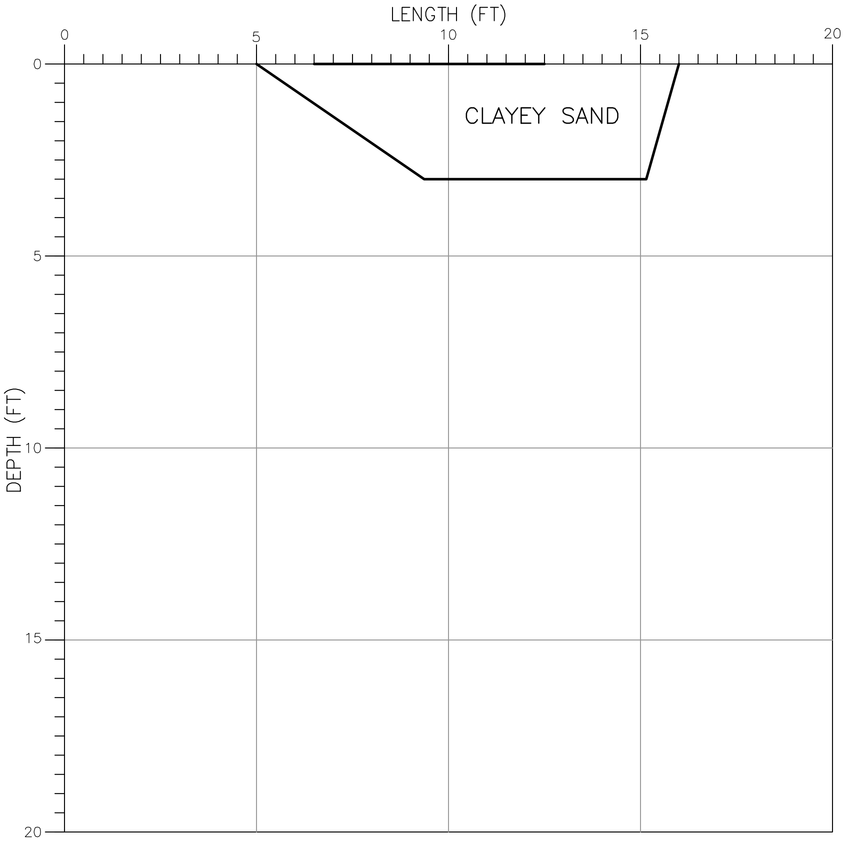
MWH

PROJECT No. 1011332
FILENAME: 2012-04-25 TEST PIT LOGS.DWG
SCALE NOT TO SCALE
FIGURE No

2012-04-25 TEST PIT LOGS.DWG

PROJECT: DENISON WHITE MESA RECLAMATION
PIT NAME: E5B_2012
GENERAL LOCATION: SEE BORROW LOCATIONS MAP
PIT TREND: EAST-WEST
PIT FACED LOGGED: SOUTH

DATE: 04/19/2012 1240
FIELD ENGINEER: CAB ESPOSITO, MWH
EXCAVATOR: JOHN DEERE BACKHOE
CONTRACTOR: DENISON WHITE MESA



TEST PIT LOG

LEGEND

— — CONTACT

SAMPLE No.	DEPTH	TIME
DWM_E5B1_2012	0'–3'	1240
DWM_E5B2_2012	0'–3'	1240
–	–	–
–	–	–

PIT WIDTH: 2'
PIT LENGTH: 8'
PIT DEPTH: 3'

SOIL UNIT	SOIL DESCRIPTION AND EXCAVATION NOTES
CLAYEY SAND	0'–3' DRY–SLIGHTLY MOIST, LIGHT TAN, CLAYEY SAND, 5% DARK GRAY GRAVEL

SPECIAL NOTES:

REV	REVISIONS	DATE	DES BY	DWN BY	REVIEWED AND SIGNED BY

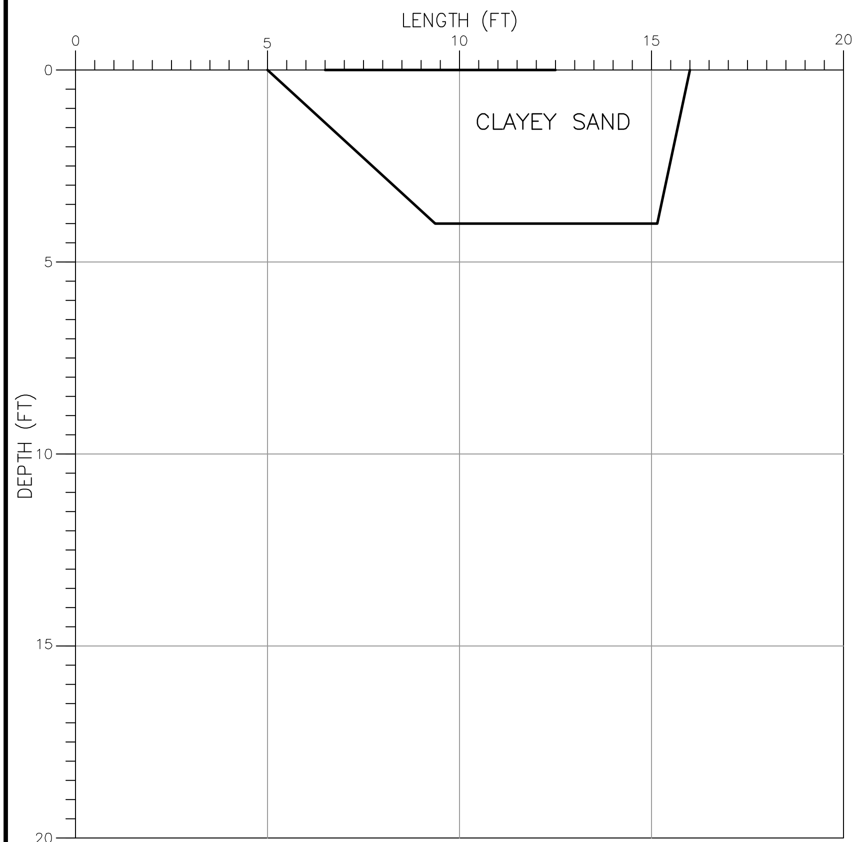
MWH

PROJECT No. 1011332
FILENAME: 1009740 TEST PIT.DWG
SCALE NOT TO SCALE
FIGURE No

1009740 TEST PIT.DWG

PROJECT: DENISON WHITE MESA RECLAMATION
PIT NAME: E8B_2012
GENERAL LOCATION: SEE BORROW LOCATIONS MAP
PIT TREND: NORTH–SOUTH
PIT FACED LOGGED: WEST

DATE: 04/19/2012 1115
FIELD ENGINEER: CAB ESPOSITO, MWH
EXCAVATOR: JOHN DEERE BACKHOE
CONTRACTOR: DENISON WHITE MESA



TEST PIT LOG

LEGEND

— — CONTACT

SAMPLE No.	DEPTH	TIME
DWM_E8B1_2012	0'–4'	1115
DWM_E8B2_2012	0'–4'	1115
–	–	–
–	–	–

PIT WIDTH: 3'
PIT LENGTH: 11'
PIT DEPTH: 4'

SOIL UNIT	SOIL DESCRIPTION AND EXCAVATION NOTES
CLAYEY SAND	0'–4' MOIST, DARK BROWN, COARSE CLAYEY SAND, 2–5% WHITE SUBROUNDED COBBLES

SPECIAL NOTES:

REV	REVISIONS	DATE	DES BY	DWN BY	REVIEWED AND SIGNED BY

MWH

PROJECT No. 1011332
FILENAME: 1009740 TEST PIT.DWG
SCALE NOT TO SCALE
FIGURE No

1009740 TEST PIT.DWG

APPENDIX A.3.2

APRIL 2012 COVER MATERIAL FIELD INVESTIGATION

LABORATORY TESTING RESULTS

DENISON MINES WHITE MESA MILL

Table 1. Summary of Laboratory Testing Results for Borrow Stockpiles

Borrow Stockpile ID	Estimated Stockpile Volume[1] (cy)	Field Investigation Date	Material Description	USCS	Sample ID	Sample Depth (ft)	Gravimetric Water Content (%)	Atterberg Limits[2] LL/PL/PI (%)	PI	Specific Gravity	Particle Size[3]					Max. Density (pcf)	Opt. Moist. Cont. (%)	Sat. Hyd. Conc. (cm/s)	15 Bar Grav. Moist. Cont. (%)	Gravimetric Water Content Est. using Rawls Eqn.3 (%)	Soil Group[4]
											% Gravel	%Sand	%Silt	% Clay	% Fines						
E1	15,900	Apr-2012	Topsoil (Sandy Silty Clay)	CL-ML	E1-A	0 - 3	--	23/18/5	5	2.61	0	41	43	16	59	118	11	1.3×10^{-4}	5.2	6.6	Topsoil
E2	92,000	Oct-2010	Silty Sand/Clayey Sand	SM	A	5	4.5	NP	NP	--	0.5	77.1	13.5	8.9	22					4.4	B
				SC	B	12	5.7	23.3/11.2/12.1	12.1	2.64	13.1	50.3	22.6	14.0	37					6.0	U
E3	16,800	Apr-2012	Clay with Sand	CH	E3-A	0 - 3	--	54/24/30	30	2.53	0	23	29	48	77	105	19	9.5×10^{-5}	13.6	16.5	F
E4	66,600	Oct-2010	Sandy Clay	CL	A	5	8.6	30.3/14.4/15.9	15.9	--	0.0	41.2	39.1	19.7	59					7.7	U
E5	68,800	Oct-2010	Sandy Clay	CL	A	6	9.0	33.2/14.3/18.9	18.9	--	0.0	35.5	38.1	26.4	65					9.8	F
		Apr-2012	Clay with Sand	CH	E5-B	0 - 3	--	51/24/27	27	2.56	2	15	36	47	83					16.2	F
E6	100,700	Oct-2010	Clay	CL	A	5	14.4	40.2/15.8/24.4	24.4	2.74	0.1	17.7	49.5	32.7	82					11.8	F
E7	74,900	Oct-2010	Sandy Clay	CL	A	6	5.7	26.2/16.3/9.9	9.9	--	0.0	30.2	56.1	13.7	70					5.9	U
E8	227,300	Oct-2010	Sandy Clay	CL	A	2	7.4	23.0/12.0/11.0	11.0	--	0.0	47.0	36.9	16.1	53					6.6	U
		Apr-2012	Gravel with Clay and Sand	GW-GC	E8-B	0 - 4	--	27/16/11	11	2.63	40.0	31.0	18.0	11.0	29	125	11		6.0	5.0	B
W1	85,700	Oct-2010	Sandy Clay	CL	A	5	8.8	32.1/14.5/17.6	17.6	--	0.0	40.6	37.6	21.8	59					8.4	U
W2	584,500	Oct-2010	Sandy Clay	CL	A	surface	8.5	28.1/13.1/15.0	15.0	--	0.2	41.5	42.5	15.8	58					6.5	U
		Apr-2012	Clayey Sand with Gravel	SC	W2-A	0 - 3	--	24/14/10	10	2.62	30	45	15.0	10.0	25				6.9	4.7	B
		Apr-2012	Silty Clayey Sand with Gravel	SC-SM	W2-B	0 - 5	--	18/13/5	5	2.63	41	45	9.0	5.0	14	128	9	1.5×10^{-3}	3.5	3.2	B
W3	84,800	Oct-2010	Topsoil (Sandy Silty Clay)	CL-ML	A	surface	4.3	20.9/16.2/4.7	4.7	--	0.2	44.2	39.2	16.4	56					6.7	Topsoil
W4	90,000	Oct-2010	Topsoil (Sandy Silt)	ML	A	5	5.3	21.9/18.0/3.9	3.9	--	0.0	32.6	54.3	13.1	67					5.7	Topsoil
		Apr-2012	Topsoil (Sandy Silty Clay)	CL-ML	W4-B	0 - 4	--	26/19/7	7	2.60	0	38	44	18	62					7.2	Topsoil
W5	2,001,160	Apr-2012	Sandy Clay	CL	W5-A	0 - 4	--	27/18/9	9	2.61	1	49	32	18	50				7.0	7.2	U
			Clayey Sand with Gravel	SC	W5-B	0 - 4	--	24/15/9	9	2.63	29	44	19	8	27	122	10	1.1×10^{-3}	3.6	4.1	B
W6	93,400	Oct-2010	Topsoil (Sandy Silty Clay)	CL-ML	A	surface	3.3	23.1/16.5/6.6	6.6	--	0.0	34.3	51.8	13.9	66					5.9	Topsoil
W7	39,500	Oct-2010	Sandy Clay	CL	A	5	8.7	28.0/10.6/17.3	17.3	2.67	0.0	43.8	43.1	13.1	56					5.7	U
W8	178,411	Apr-2012	Silty Sand with Gravel	SM	W8-A	0 - 3	--	NP	NP	2.64	35	51	9	5	14	117	13	1.2×10^{-3}	5.0	3.2	B
			Silty Sand with Gravel	SM	W8-B	0 - 4	--	NP	NP	2.66	32	40	18	10	28				6.4	4.7	B
W9	60,250	Oct-2010	Sandy Clay	CL	A	surface	4.4	25.9/12.3/13.5	13.5	--	0.0	37.4	45.2	17.4	63					7.0	U
		Apr-2012	Sandy Clay	CL	W9-B	0 - 4	--	28/16/12	12	2.63	6	44	35	15	50	115	14	4.1×10^{-4}	7.7	6.3	U

14.0

Notes:

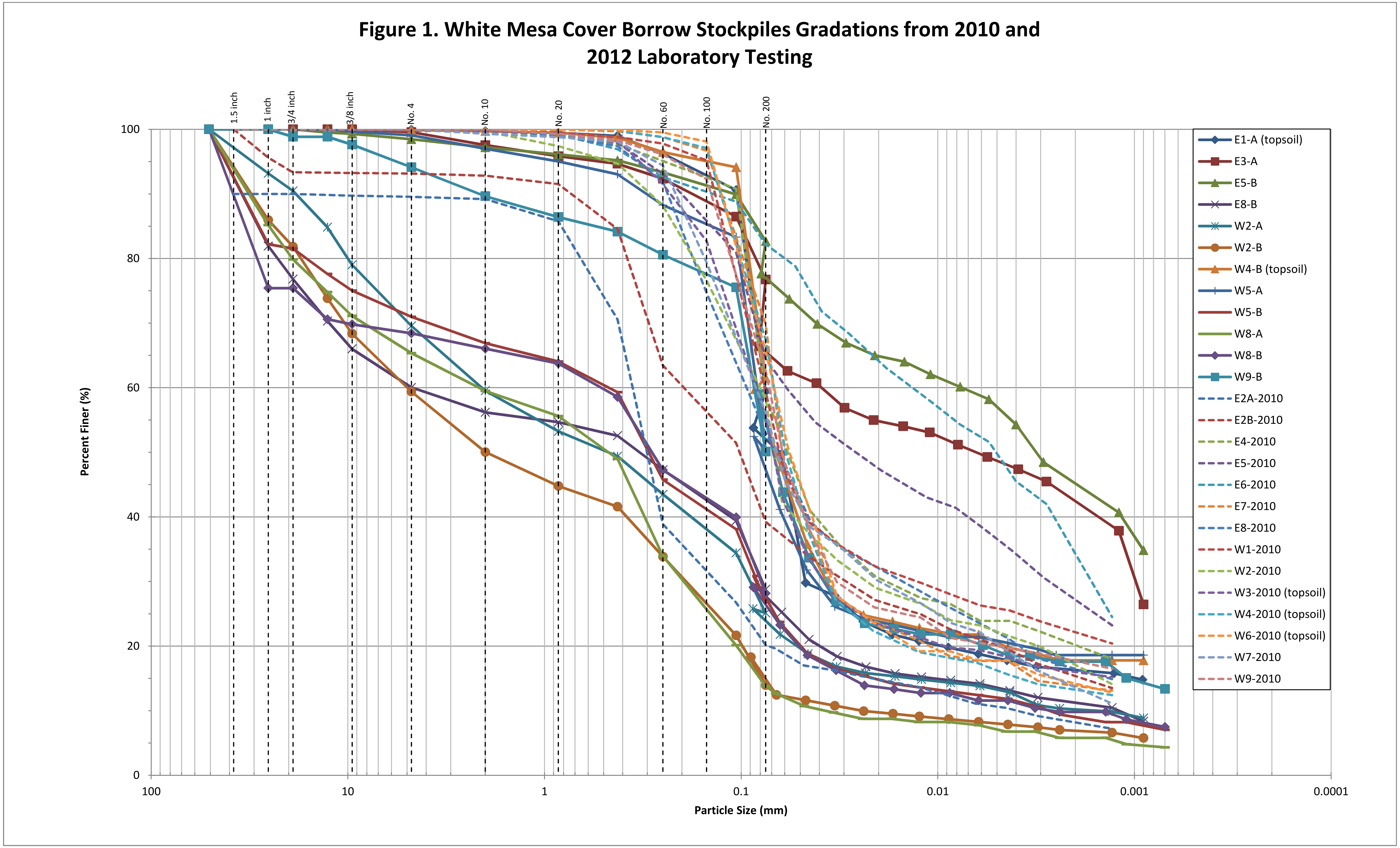
1. Volumes estimated using 2009 topography and assuming a relatively flat bottom surface, except for stockpiles W5, W8 and W9. The volumes for stockpiles W8 and W9 were estimated by comparing the 2011 versus 2009 topography.
The volume for stockpile W5 was estimated using a combination of both methods.

2. LL = Liquid Limt, PL = Plastic Limit, PI = Plasticity Index (PI = LL-PL)

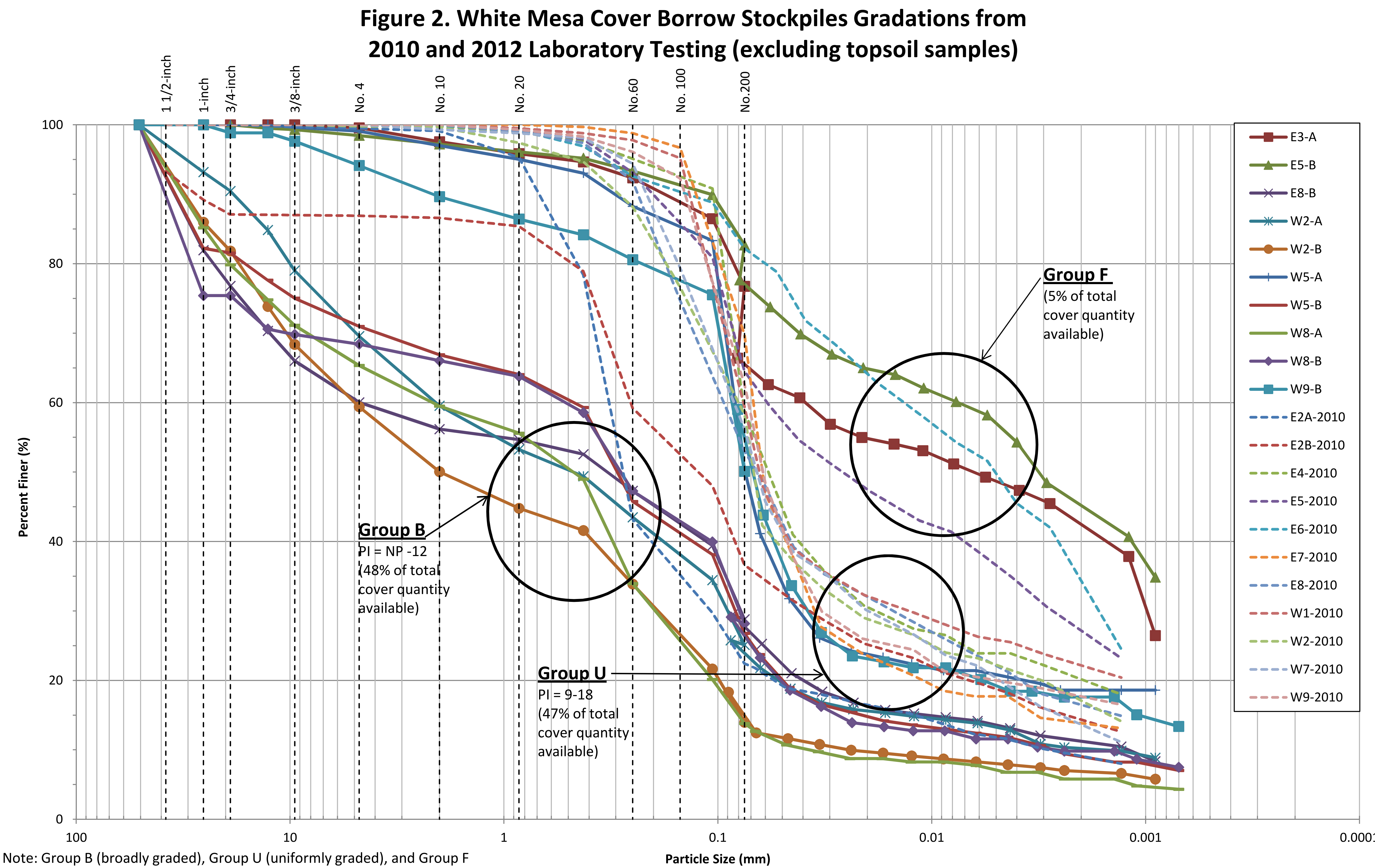
3. Gravel = 4.75 mm to 75 mm, Sand = 0.075 mm to 4.75 mm, Fines: Silt = 0 .075 mm to 0.002 mm, Clay = less than 0.002 mm

4. Group B (broadly graded), Group U (uniformly graded), and Group F (fine textured) based on evaluation of gradations and Benson (2012)*.

*Benson, C., 2012. Electronic communication from Craig Benson, University of Wisconsin-Madison, to Melanie Davis, MWH Americas, Inc., regarding evaluation of gradations performed for potential cover soils for White Mesa, May 20.



2010 and 2012 Cover Soil Gradations_mmd.xlsx



Note: Group B (broadly graded), Group U (uniformly graded), and Group F (fine textured) based on evaluation of gradations and Benson (2012)*.

*Benson, C., 2012. Electronic communication from Craig Benson, University of Wisconsin-Madison, to Melanie Davis, MWH Americas, Inc., regarding evaluation of gradations performed for potential cover soils for White Mesa, May 20.

INDEX PROPERTIES OF SOILS FROM BLANDING, UTAH

by

C.H. Benson and X. Wang

Geotechnics Report No. 12-37

Wisconsin Geotechnics Laboratory

University of Wisconsin-Madison
Madison, Wisconsin 53706
USA

20 May 2012

1. SCOPE

This report describes results of laboratory tests conducted to determine the specific gravity of solids, Atterberg Limits, and particle size distribution of twelve (12) soil samples from Blanding, Utah. The soils were delivered to the Wisconsin Geotechnics Laboratory as disturbed samples in 20-L buckets (2 buckets per soil).

2. METHODS

The two buckets of soil for each sample were inspected, thoroughly blended by hand, and then tested to determine the specific gravity of solids, Atterberg Limits, and particle size distribution. The following ASTM methods were employed on the blended samples:

D 422 Standard Test Method for Particle-Size Analysis of Soils

D 854 Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

D 4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

3. RESULTS

A summary of the index properties is provided in Table 1. The particle size distribution curves are summarized in Fig. 1. Data recorded from the tests are in the appendix.

Table 1. Summary of index properties for soils from Blanding, Utah.

Sample ID	Liquid Limit	Plastic Limit	Plasticity Index	Specific Gravity	Gravel (%)	Sand (%)	Fines (%)
E1-A	23	18	5	2.61	0	41	59
E3-A	54	24	30	2.53	0	23	77
E5-B	51	24	27	2.56	2	15	83
E8-B	27	16	11	2.63	40	31	29
W2-A	24	14	10	2.62	30	45	25
W4-A	26	19	7	2.60	0	38	62
W2-B	18	13	5	2.63	41	45	14
W5-A	27	18	9	2.61	1	49	50
W5-B	24	15	9	2.63	29	44	27
W8-A	17	NP	NP	2.64	35	51	14
W8-B	15	NP	NP	2.66	32	40	28
W9-B	28	16	12	2.63	6	44	50

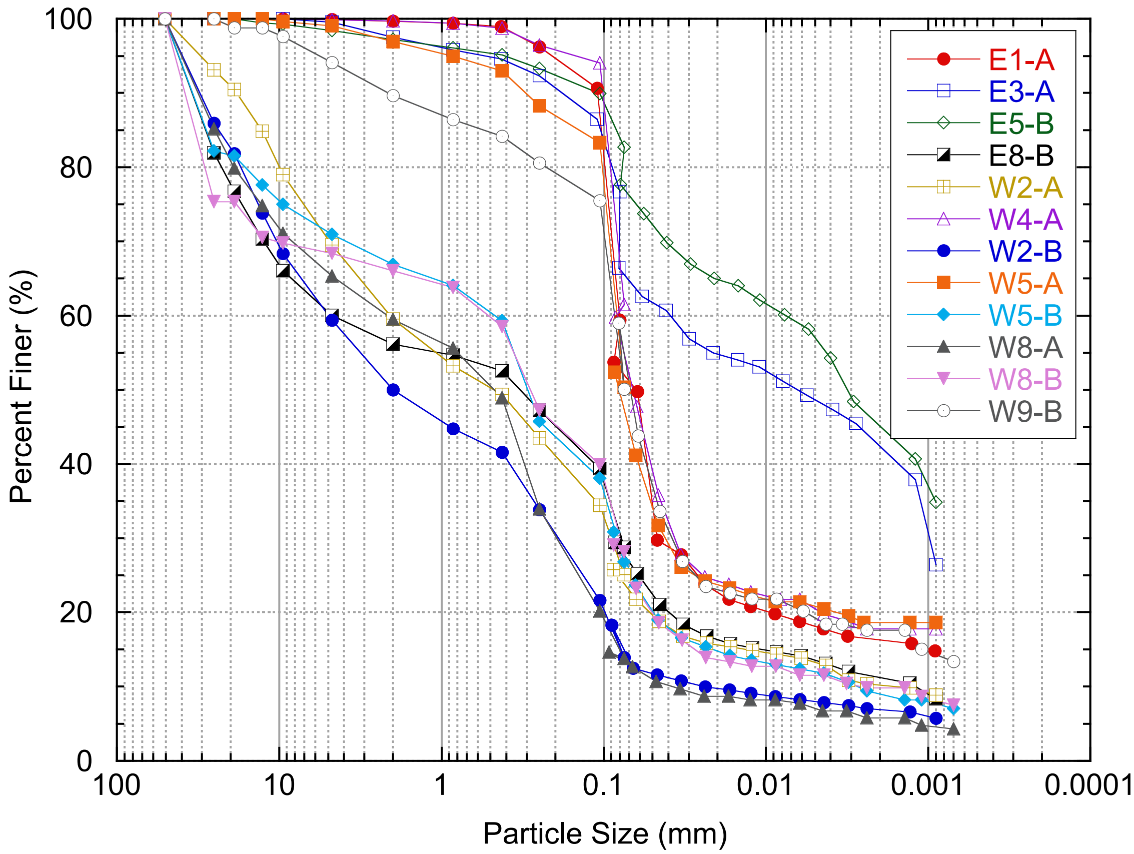


Fig. 1. Particle size distribution curves for soils from Blanding, Utah.

APPENDIX:

DATA SHEETS

Wisconsin Geotechnics Laboratory
COLLEGE OF ENGINEERING
UNIVERSITY OF WISCONSIN–MADISON

Wisconsin Geotechnics Laboratory

Specific Gravity ASTM D854

Test No.		E1-A	E3-A	E5-B	E8-B	W2-A	W4-A	W2-B	W5-A	W5-B	W8-A	W8-B	W9-B
Volumetric Flask No.		500	500	500	500	500	500	500	500	500	500	500	500
Weight of Flask (g)	W_1	170.7	170.7	170.7	170.7	170.7	170.7	170.7	170.7	170.7	170.7	170.7	170.7
Dry Soil (g)	W_2	92.7	127.3	117.6	132.9	131.5	138.9	127.6	124.8	132.3	96.8	116.5	91.6
Weight of Flask + Dry Soil (g)	$W_1 + W_2$	263.4	298	288.3	303.6	302.2	309.6	298.3	295.5	303	267.5	287.2	262.3
Weight of Flask + Dry Soil + Water (g)	$W_1 + W_2 + W_3$	727.2	747.1	741.7	752.5	751.4	755.6	749.2	747.1	752.1	730.2	742.8	726.8
Temperature	T_1	23	23	23	23	23	23	23	23	23	23	23	23
Weight of Flask + Water (g)	$W_1 + W_4$	670	670	670	670	670	670	670	670	670	670	670	670
Temperature	T_2	23	23	23	23	23	23	23	23	23	23	23	23
Weight of Equal Volume of Water	$W_4 - W_3$	35.5	50.2	45.9	50.4	50.1	53.3	48.4	47.7	50.2	36.6	43.7	34.8
G_s at Temperature	$W_2 / (W_4 - W_3)$	2.611	2.536	2.562	2.637	2.625	2.606	2.636	2.616	2.635	2.645	2.666	2.632
A		0.9982	0.9982	0.9982	0.9982	0.9982	0.9982	0.9982	0.9982	0.9982	0.9982	0.9982	0.9982
G_s at Temperature of 20°C	$A\ G_s$	**2.61**	**2.53**	**2.56**	**2.63**	**2.62**	**2.60**	**2.63**	**2.61**	**2.63**	**2.64**	**2.66**	**2.63**

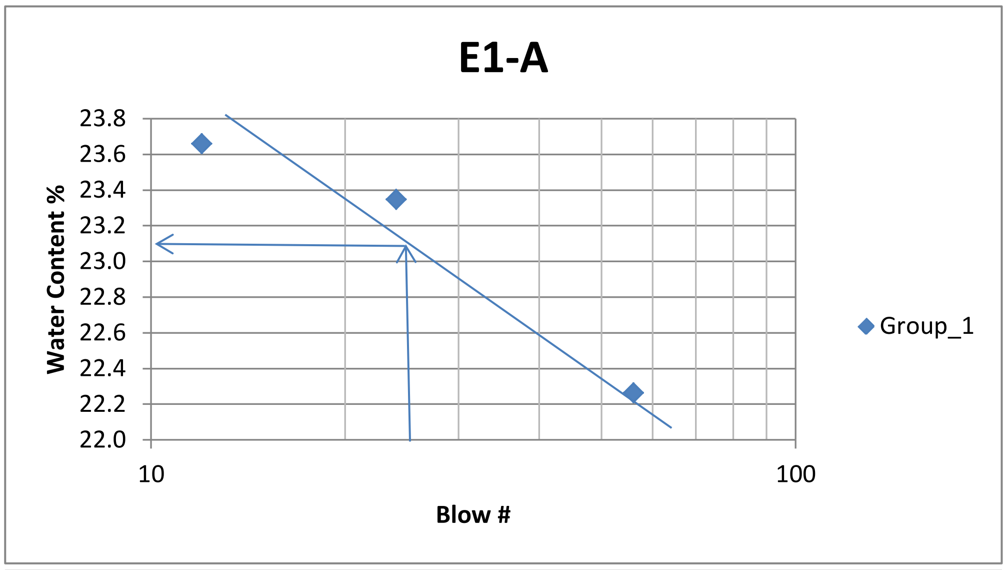
Wisconsin Geotechnics Laboratory

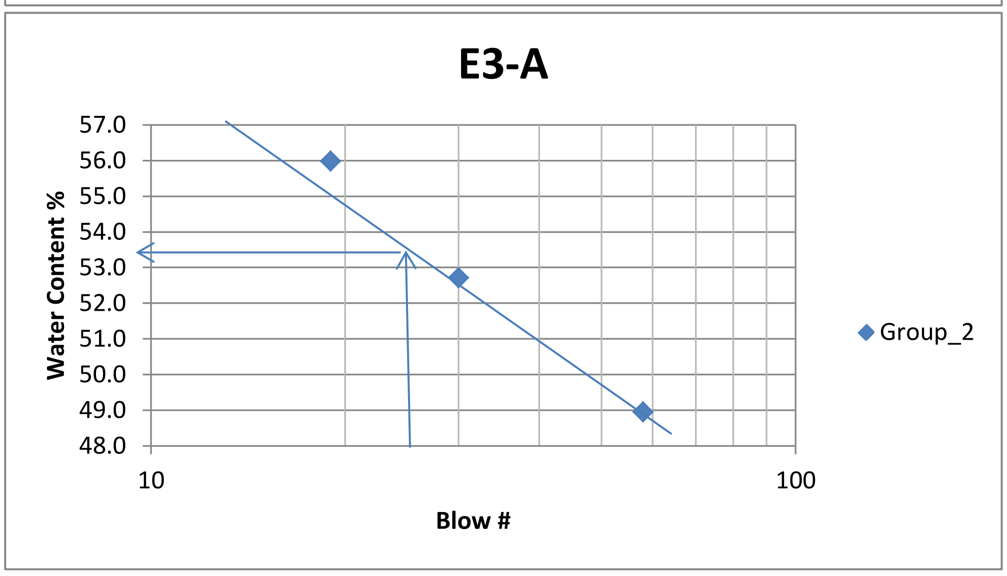
Liquid Limit Test (ASTM D 4318)

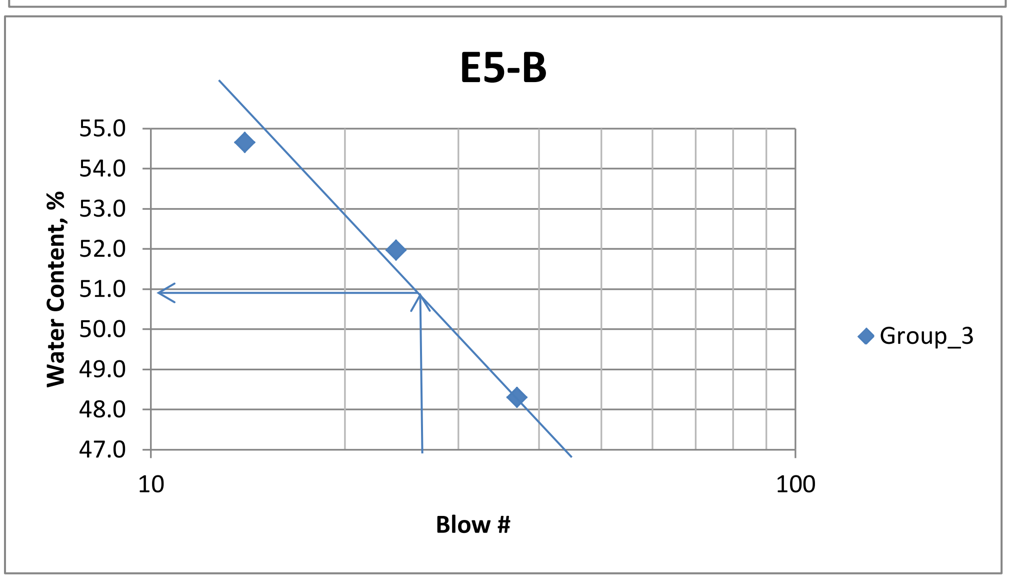
Group #	Target N	Moisture Can #	WT of Moisture Can (G)	WT of Wet Soil + Moisture Can (g)	WT of Dry Soil + Moisture Can (g)	Water Content (%)	Actual Blow Number N	**Liquid Limit**
E1-A	30 - 40	3	23.7	57.2	51.1	22.3	56	**23**
	20 - 30	1	31.6	63.3	57.3	23.3	24	
	10 - 20	2	31.4	70.6	63.1	23.7	12	
E3-A	30 - 40	22	31.2	59.5	50.2	48.9	58	**54**
	20 - 30	7	31.4	73.7	59.1	52.7	30	
	10 - 20	h	31.7	68.2	55.1	56.0	19	
E5-B	30 - 40	j	31.4	66.4	55	48.3	37	**51**
	20 - 30	2,4	31.7	70.3	57.1	52.0	24	
	10 - 20	1	29.6	67.8	54.3	54.7	14	
E8-B	30 - 40	b	31.9	70.2	62.8	23.9	55	**27**
	20 - 30	5	31.1	78.9	69.1	25.8	30	
	10 - 20	d1	28.7	78.8	67.6	28.8	14	

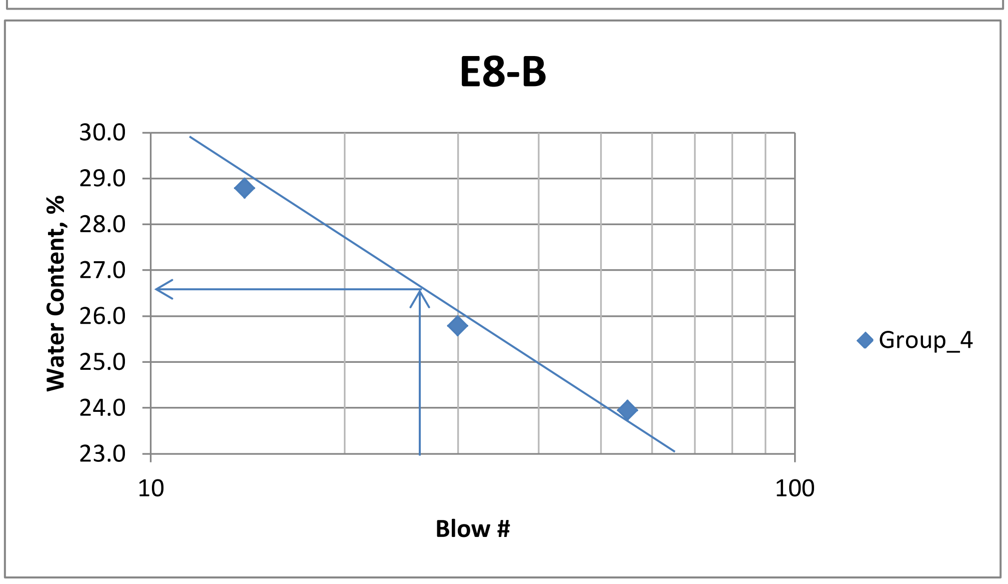
Plastic Limit Test (ASTM D 4318)

Group #	Moisture Can #	WT of Moisture Can (G)	WT of Wet Soil + Moisture Can (g)	WT of Dry Soil + Moisture Can (g)	Water Content (%)	**Plastic Limit**
E1-A	1	31.6	40.1	38.8	18.1	**18**
E3-A	6	31.3	49.4	45.9	24.0	**24**
E5-B	10	26.5	48.2	44	24.0	**24**
E8-B	3	28.9	49	46.3	15.5	**16**


E1-A
Water Content %
23.8
23.6
23.4
23.2
23.0
22.8
22.6
22.4
22.2
22.0
10
100
Blow #
Group_1


E3-A
Water Content %
57.0
56.0
55.0
54.0
53.0
52.0
51.0
50.0
49.0
48.0
10
100
Blow #
Group_2


E5-B
Water Content, %
55.0
54.0
53.0
52.0
51.0
50.0
49.0
48.0
47.0
10
100
Blow #
Group_3


E8-B
Water Content, %
30.0
29.0
28.0
27.0
26.0
25.0
24.0
23.0
10
100
Blow #
Group_4

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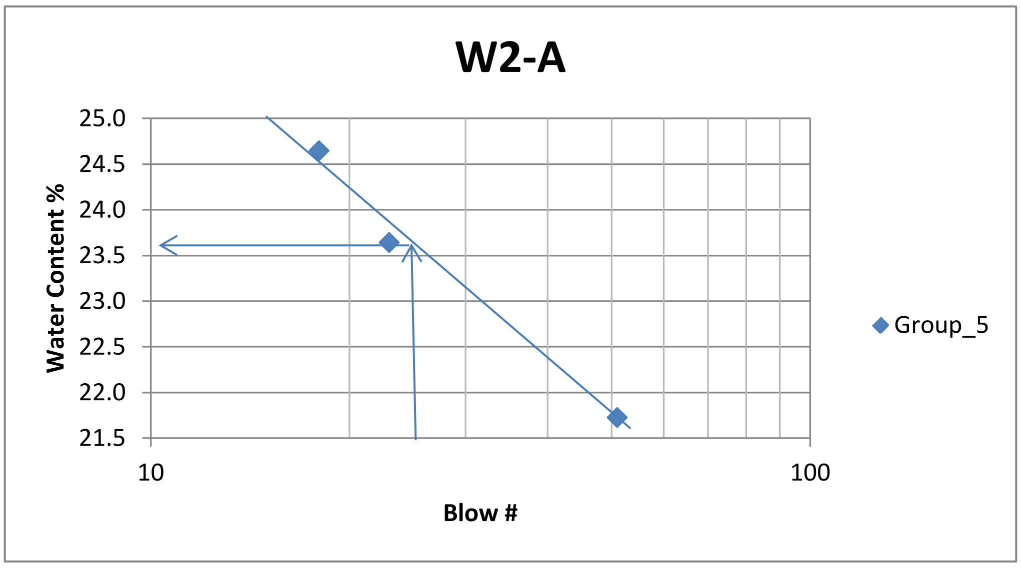
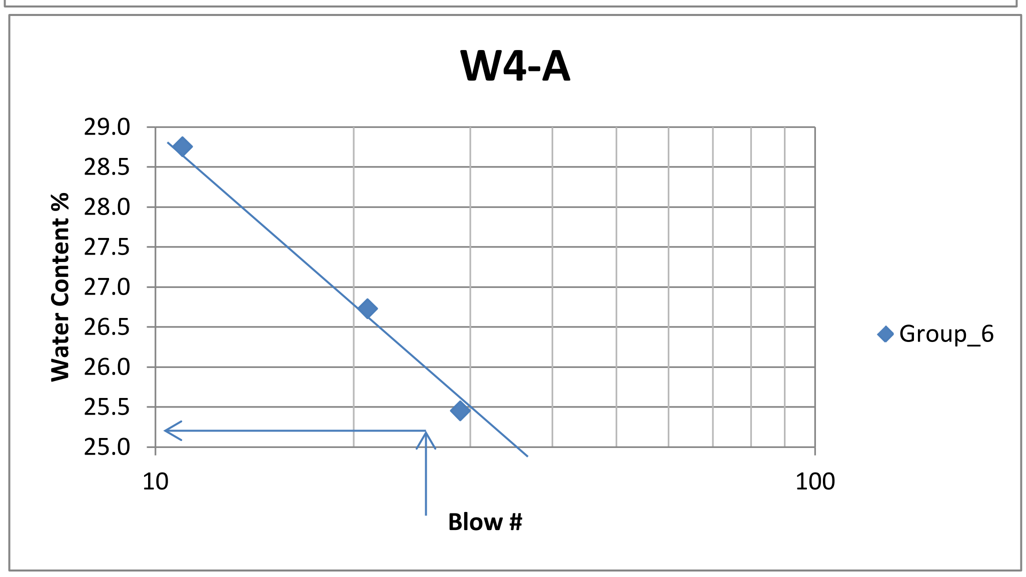
Liquid Limit Test (ASTM D 4318)

Group #	Target N	Moisture Can #	WT of Moisture Can (G)	WT of Wet Soil + Moisture Can (g)	WT of Dry Soil + Moisture Can (g)	Water Content (%)	Actual Blow Number N	**Liquid Limit**
W2-A	30 - 40	b	31.9	78.4	70.1	21.7	51	**24**
	20 - 30	5	31.1	83.4	73.4	23.6	23	
	10 - 20	10	26.5	79.1	68.7	24.6	18	
W4-A	30 - 40	3	28.9	91.5	78.8	25.5	29	**26**
	20 - 30	9	31.5	84.6	73.4	26.7	21	
	10 - 20	d	28.7	78.4	67.3	28.8	11	
W2-B	30 - 40	h	31.7	68.1	62.2	19.3	12	**18**
	20 - 30	j	31.4	85.5	77	18.6	20	
	10 - 20	7	31.4	88.7	80	17.9	33	
W5-A	30 - 40	1	31.5	81.8	71.8	24.8	45	**27**
	20 - 30	6	31.3	87.1	75.1	27.4	19	
	10 - 20	2	31.4	78.5	67.7	29.8	12	

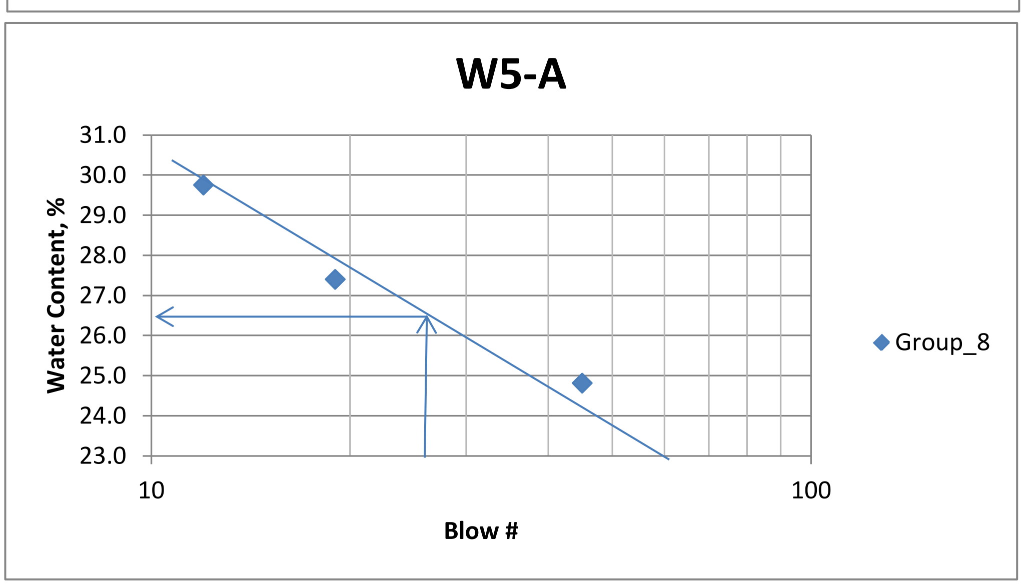
Plastic Limit Test (ASTM D 4318)

Group #	Moisture Can #	WT of Moisture Can (G)	WT of Wet Soil + Moisture Can (g)	WT of Dry Soil + Moisture Can (g)	Water Content (%)	**Plastic Limit**
W2-A	1	29.6	42.3	40.7	14.4	**14**
W4-A	22	31.2	49.4	46.5	19.0	**19**
W2-B	3	23.7	37.4	35.8	13.2	**13**
W5-A	2	31.7	52.5	49.4	17.5	**18**


W2-A
Water Content %
25.0
24.5
24.0
23.5
23.0
22.5
22.0
21.5
10
100
Blow #
Group_5


W4-A
Water Content %
29.0
28.5
28.0
27.5
27.0
26.5
26.0
25.5
25.0
10
100
Blow #
Group_6


W2-B
Water Content, %
19.6
19.4
19.2
19.0
18.8
18.6
18.4
18.2
18.0
17.8
10
100
Blow #
Group_7


W5-A
Water Content, %
31.0
30.0
29.0
28.0
27.0
26.0
25.0
24.0
23.0
10
100
Blow #
Group_8

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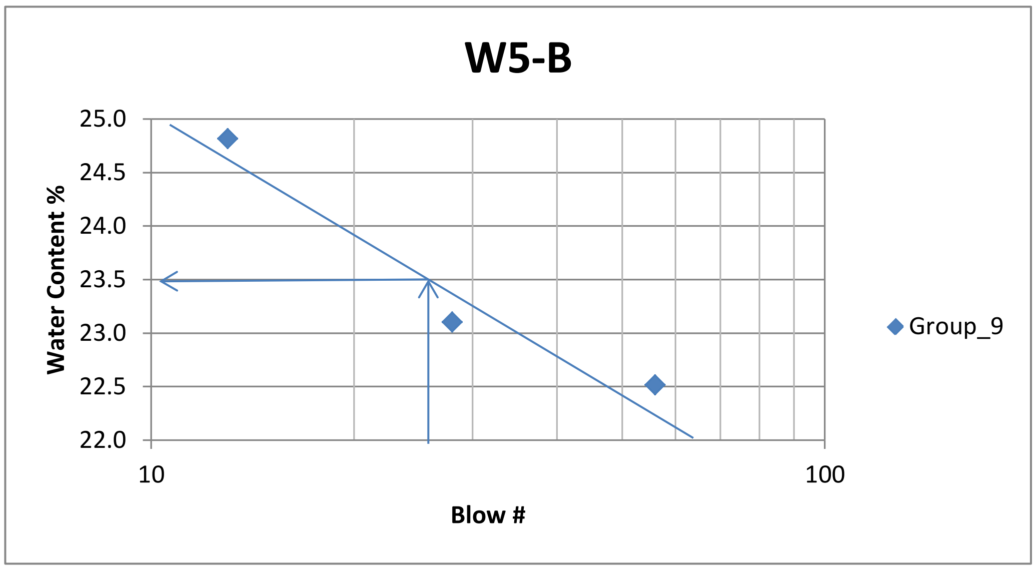
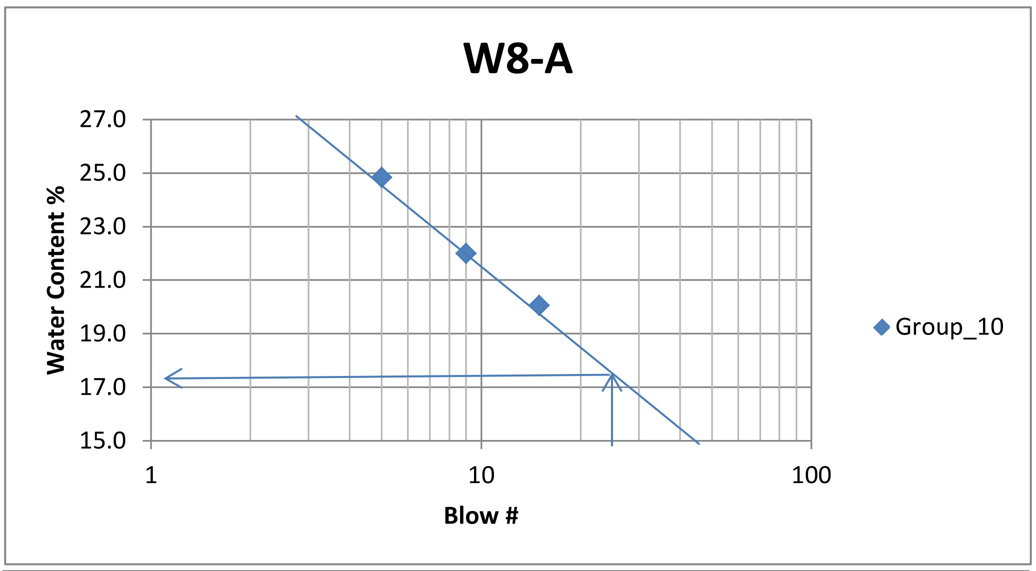
Liquid Limit Test (ASTM D 4318)

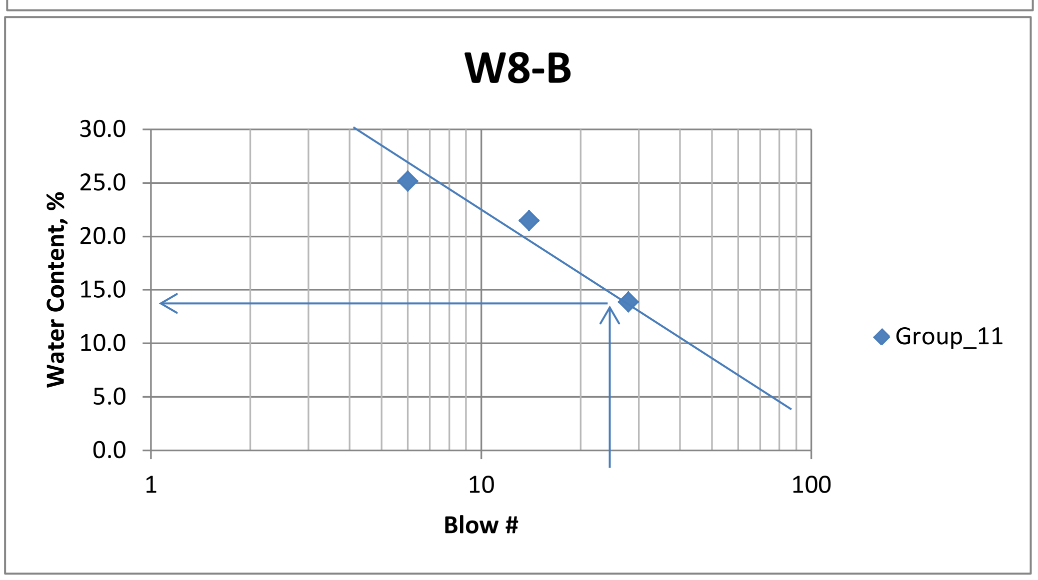
Group #	Target N	Moisture Can #	WT of Moisture Can (G)	WT of Wet Soil + Moisture Can (g)	WT of Dry Soil + Moisture Can (g)	Water Content (%)	Actual Blow Number N	**Liquid Limit**
9	30 - 40	f1	31.5	68.5	61.7	22.5	56	**24**
	20 - 30	2	31.7	67.4	60.7	23.1	28	
	10 - 20	9	31.5	65.2	58.5	24.8	13	
10	30 - 40	6	31.3	70.2	63.7	20.1	15	**17**
	20 - 30	5	31.1	73.8	66.1	22.0	9	
	10 - 20	d	28.7	86	74.6	24.8	5	
11	30 - 40	1	31.5	71.7	64.6	21.5	14	**15**
	20 - 30	2	31.4	73.2	64.8	25.1	6	
	10 - 20	b	31.9	81.2	75.2	13.9	28	
12	30 - 40	j	31.4	75.8	66.9	25.1	47	**28**
	20 - 30	1	29.5	85.9	73.6	27.9	21	
	10 - 20	10	26.5	81.1	68.3	30.6	12	

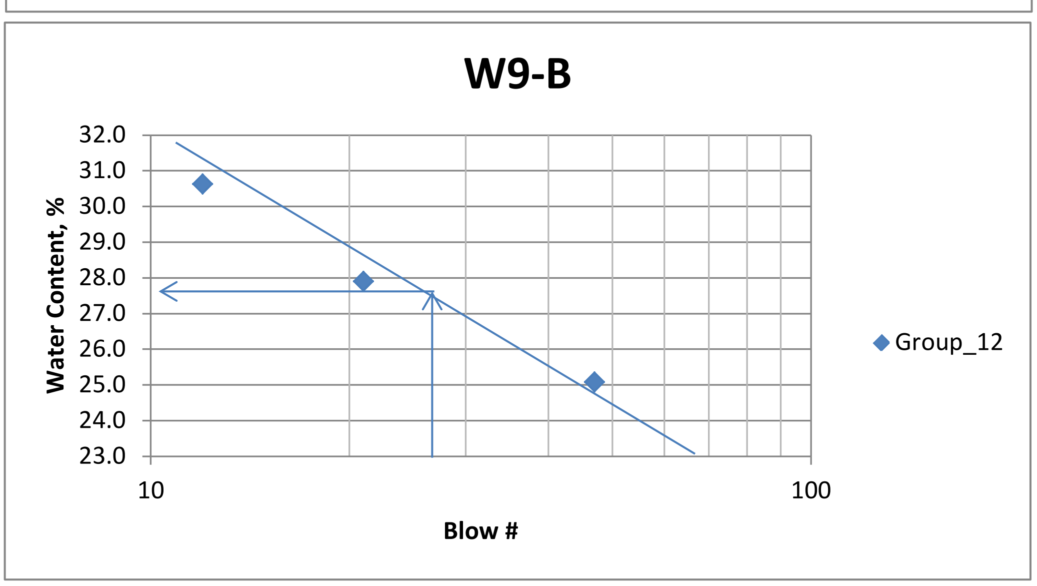
Plastic Limit Test (ASTM D 4318)

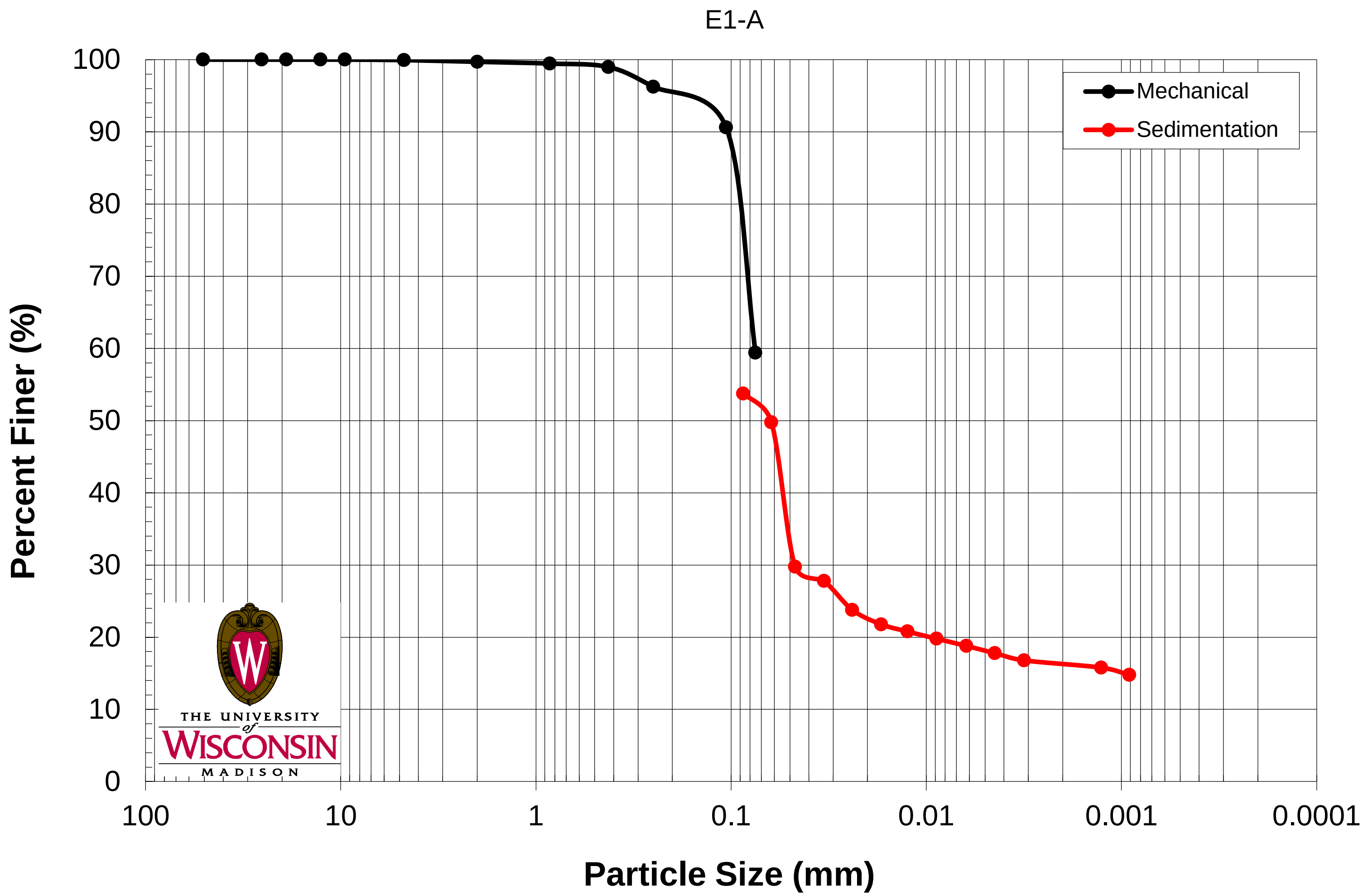
Group #	Moisture Can #	WT of Moisture Can (G)	WT of Wet Soil + Moisture Can (g)	WT of Dry Soil + Moisture Can (g)	Water Content (%)	**Plastic Limit**
9	7	31.3	54.3	51.3	15.0	**15**
10						**NP**
11	3	23.7	37.4	35.5	16.1	**16**
12	h	31.7	52.8	49.9	15.9	**16**


W5-B
Water Content %
25.0
24.5
24.0
23.5
23.0
22.5
22.0
10
100
Blow #
Group_9


W8-A
Water Content %
27.0
25.0
23.0
21.0
19.0
17.0
15.0
1
10
100
Blow #
Group_10


W8-B
Water Content, %
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1
10
100
Blow #
Group_11


W9-B
Water Content, %
32.0
31.0
30.0
29.0
28.0
27.0
26.0
25.0
24.0
23.0
10
100
Blow #
Group_12


E1-A
Percent Finer (%)
Particle Size (mm)
Mechanical
Sedimentation
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
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Mechanical Particle Size Analysis - ASTM D 422

Sample ID: **E1-A** Test Date:

Weight of Air Dry Sample = 791 g Initials:

Sieve No.	Sieve Opening	Weight Retained on Each Sieve	Percent Retained on Each Sieve	Cumulative Percent Retained	Percent Finer
	(mm)	(g)	(%)	(%)	(%)
2"	50.8	0.00	0	0	100
1"	25.4	0.00	0.00	0.00	100.00
3/4"	19.0	0.00	0.00	0.00	100.00
1/2"	12.7	0.00	0.00	0.00	100.00
3/8"	9.52	0.00	0.00	0.00	100.00
4	4.75	0.51	0.06	0.06	99.94
10	2.00	1.87	0.24	0.30	99.70
20	0.85	1.93	0.24	0.55	99.45
40	0.425	3.79	0.48	1.02	98.98
60	0.250	21.63	2.74	3.76	96.24
100	0.106	44.60	5.64	9.40	90.60
200	0.075	246.73	31.21	40.61	59.39
Pan		469.53	59.39	100.00	0.00

Total Weight (g) = 791

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Sedimentation Particle Size Analysis - ASTM D 422

Sample ID:	**E1-A**		Temp. Correction, A	0.0130
Specific Gravity, G_s =	2.61		Hydrometer Type:	ASTM 152H
Dry Weight of Soil, W (g) =	50		Temperature of Test, C	23
Meniscus Correction, F_m =	0.5		Zero Correction, F_z	6
Temperature Correction, F_T =	0.9		a	1.010
Material Max. Size and Percentage (%)	40 98.98			

Time (min)	Hydrometer Reading, R	R_{cp}	R_{cl}	L (cm)	D (mm)	Final Percent Finer (%)	Percent Finer
0					0.425	98.98	
0.3	32	26.90	40.90	11.05	0.086619	53.76	54.32
0.5	30	24.90	38.90	11.38	0.062149	49.77	50.28
1.0	20	14.90	28.90	13.01	0.046998	29.78	30.09
2.0	19	13.90	27.90	13.18	0.033441	27.78	28.07
4.0	17	11.90	25.90	13.50	0.023938	23.78	24.03
8.0	16	10.90	24.90	13.67	0.017029	21.79	22.01
15.0	15.5	10.40	24.40	13.75	0.012473	20.79	21.00
30.0	15	9.90	23.90	13.83	0.008846	19.79	19.99
61.0	14.5	9.40	23.40	13.91	0.006222	18.79	18.98
120.0	14	8.90	22.90	13.99	0.004449	17.79	17.97
240.0	13.5	8.40	22.40	14.08	0.003155	16.79	16.96
1486.0	13	7.90	21.90	14.16	0.001272	15.79	15.95
2921.0	12.5	7.40	21.40	14.24	0.000910	14.79	14.94

Formulas:

$F_T = -4.85 + 0.25\,T$

$R_{cp} = R + F_T - F_Z$

$L = f(R) = 16.3 - 0.1641\,R_{cl}$

$a = f(G_s) = 1.65\,G_s / (2.65\,(G_s - 1))$

$R_{cl} = R + F_m$

$$D(mm) = A\sqrt{\frac{L(cm)}{t(min)}}$$

$$A = f(G_s, T) = \sqrt{\frac{30\eta}{(G_s - 1)\gamma_\omega}}$$

$$\text{Percent Finer} = \frac{aR_{cp}}{50}100$$

$\eta = 0.0911 \times 10^{-4}$ (g-s/cm^2) (if T = 25 ^{o}C)

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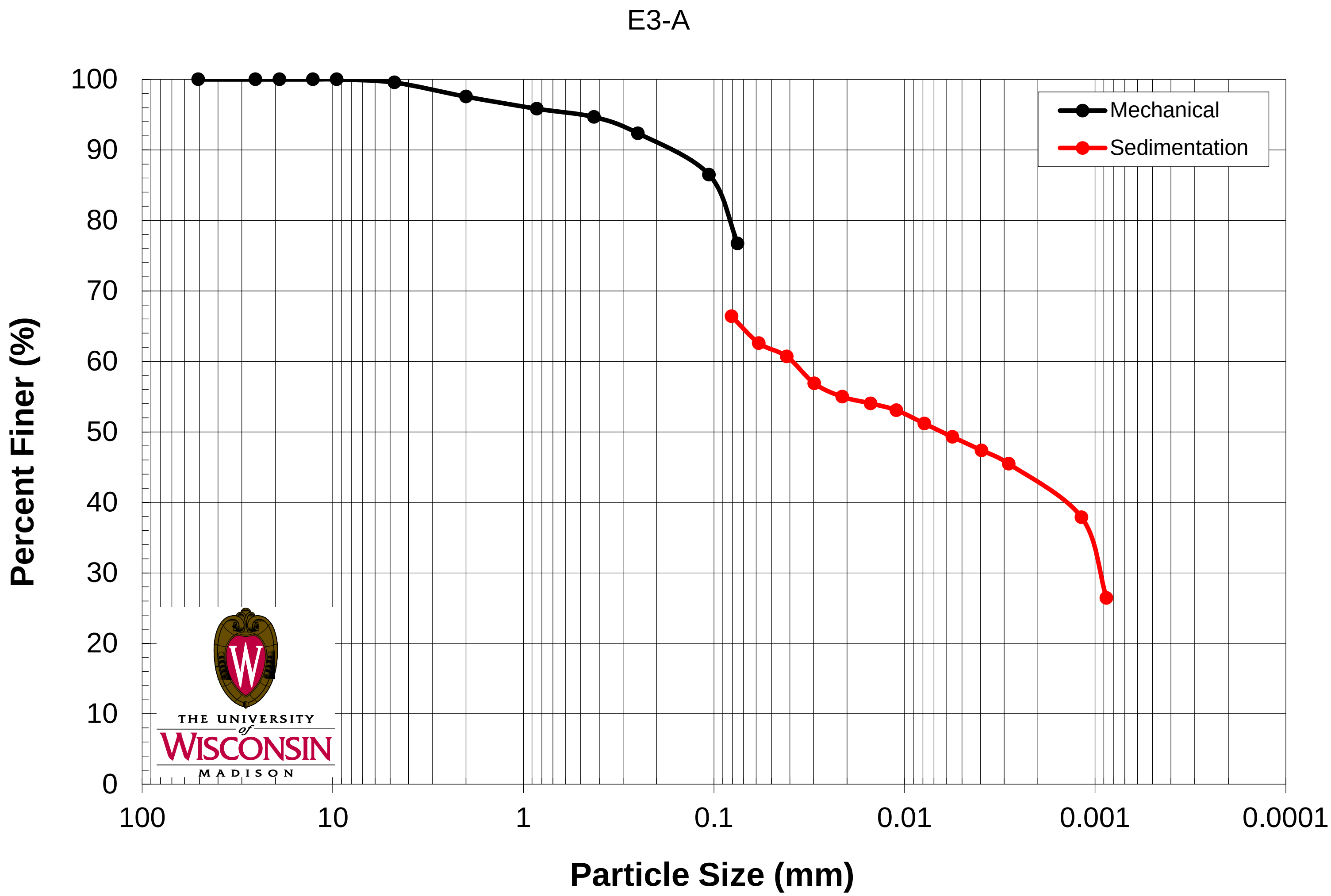

E3-A
Percent Finer (%)
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
Particle Size (mm)
Mechanical
Sedimentation
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Mechanical Particle Size Analysis - ASTM D 422

Sample ID: **E3-A** Test Date:

Weight of Air Dry Sample = 929 g Initials:

Sieve No.	Sieve Opening	Weight Retained on Each Sieve	Percent Retained on Each Sieve	Cumulative Percent Retained	Percent Finer
	(mm)	(g)	(%)	(%)	(%)
2"	50.8	0.00	0	0	100
1"	25.4	0.00	0.00	0.00	100.00
3/4"	19	0.00	0.00	0.00	100.00
1/2"	12.7	0.00	0.00	0.00	100.00
3/8"	9.52	0.00	0.00	0.00	100.00
4	4.75	4.08	0.44	0.44	99.56
10	2.00	18.60	2.00	2.44	97.56
20	0.85	15.91	1.71	4.16	95.84
40	0.43	10.95	1.18	5.34	94.66
60	0.25	21.46	2.31	7.65	92.35
100	0.11	54.56	5.88	13.52	86.48
200	0.08	90.46	9.74	23.26	76.74
Pan		712.52	76.74	100.00	0.00

Total Weight (g) = 929

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Sedimentation Particle Size Analysis - ASTM D 422

Sample ID:	**E3-A**	Temp. Correction, A	0.0129
Specific Gravity, G_s =	2.63	Hydrometer Type:	ASTM 152H
Dry Weight of Soil, W (g) =	50	Temperature of Test, C	23
Meniscus Correction, F_m =	0.5	Zero Correction, F_z	6
Temperature Correction, F_T =	0.9	a	1.005
Material Max. Size and Percentage (%)	200 94.66		

Time (min)	Hydrometer Reading, R	R_{cp}	R_{cl}	L (cm)	D (mm)	Final Percent Finer (%)	Percent Finer
0					0.425	94.66	
0.2	40	34.90	64.90	9.74	0.0808	66.40	70.14
0.5	38	32.90	62.90	10.07	0.0581	62.59	66.12
1.0	37	31.90	61.90	10.23	0.0414	60.69	64.11
2.0	35	29.90	59.90	10.56	0.0298	56.88	60.09
4.0	34	28.90	58.90	10.72	0.0212	54.98	58.08
8.0	33.5	28.40	58.40	10.80	0.0150	54.03	57.07
15.0	33	27.90	57.90	10.89	0.0110	53.08	56.07
30.0	32	26.90	56.90	11.05	0.0079	51.18	54.06
60.0	31	25.90	55.90	11.21	0.0056	49.27	52.05
123.0	30	24.90	54.90	11.38	0.0039	47.37	50.04
240.0	29	23.90	53.90	11.54	0.0028	45.47	48.03
1475.0	25	19.90	49.90	12.19	0.0012	37.86	39.99
2910.0	19	13.90	43.90	13.18	0.0009	26.44	27.93

Formulas:

$F_T = -4.85 + 0.25\,T$

$R_{cp} = R + F_T - F_Z$

$L = f(R) = 16.3 - 0.1641\,R_{cl}$

$a = f(G_s) = 1.65\,G_s / (2.65\,(G_s - 1))$

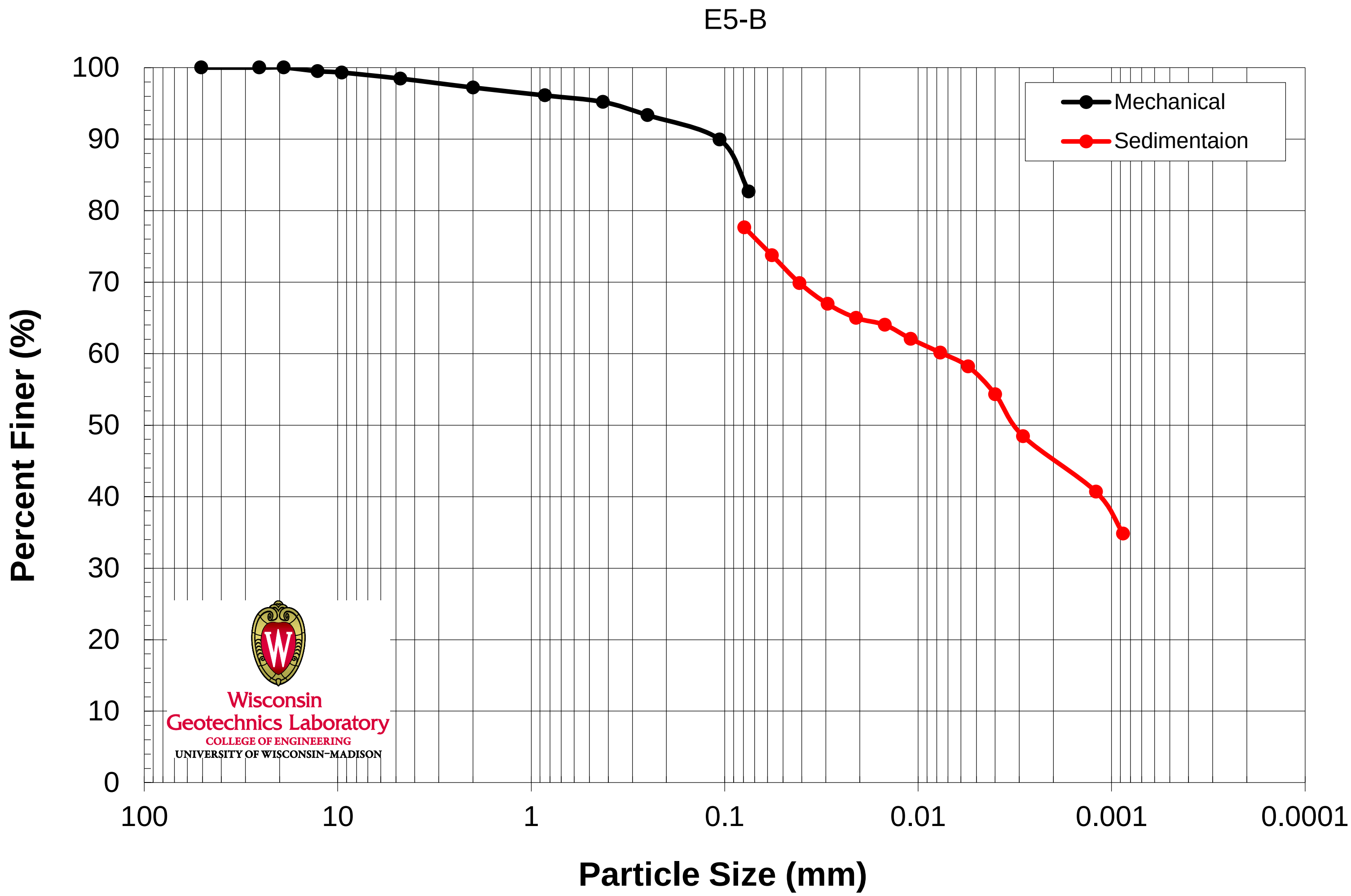
$R_{cl} = R + F_m$

$$D(mm) = A\sqrt{\frac{L(cm)}{t(min)}}$$

$$A = f(G_s, T) = \sqrt{\frac{30\eta}{(G_s - 1)\gamma_\omega}}$$

$$\text{Percent Finer} = \frac{aR_{cp}}{50}100$$

$\eta = 0.0911 \times 10^{-4}$ (g-s/cm^2) (if T = 25 ^{o}C)


E5-B
Mechanical
Sedimentaion
Percent Finer (%)
Particle Size (mm)
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
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Mechanical Particle Size Analysis - ASTM D 422

Sample ID: **E5-B** Test Date:

Weight of Air Dry Sample = 890 g Initials:

Sieve No.	Sieve Opening	Weight Retained on Each Sieve	Percent Retained on Each Sieve	Cumulative Percent Retained	Percent Finer
	(mm)	(g)	(%)	(%)	(%)
2"	50.800	0.00	0	0	100
1"	25.400	0.00	0.00	0.00	100.00
3/4"	19.000	0.00	0.00	0.00	100.00
1/2"	12.700	4.48	0.50	0.50	99.50
3/8"	9.520	1.70	0.19	0.69	99.31
4	4.750	7.51	0.84	1.54	98.46
10	2.000	11.13	1.25	2.79	97.21
20	0.850	9.82	1.10	3.89	96.11
40	0.425	8.19	0.92	4.81	95.19
60	0.250	16.44	1.85	6.66	93.34
100	0.106	30.31	3.41	10.07	89.93
200	0.075	64.45	7.25	17.32	82.68
Pan		735.52	82.68	100.00	0.00
	Total Weight (g) =	**890**			

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Sedimentation Particle Size Analysis - ASTM D 422

Sample ID:	**E5-B**
Specific Gravity, G_s =	2.56
Dry Weight of Soil, W (g) =	50
Meniscus Correction, F_m =	0.5
Temperature Correction, F_T =	0.9
Material Max. Size and Percentage (%)	40 95.19

Temp. Correction, A	0.0132
Hydrometer Type:	ASTM 152H
Temperature of Test, C	23
Zero Correction, F_z	6
a	1.022

Time (min)	Hydrometer Reading, R	R_{cp}	R_{cl}	L (cm)	D (mm)	Final Percent Finer (%)	Percent Finer
0.0					0.425	95.19	
0.2	45	39.90	72.90	8.92	0.0791	77.64	81.57
0.5	43	37.90	70.90	9.25	0.0569	73.75	77.48
1.0	41	35.90	68.90	9.58	0.0410	69.86	73.39
2.0	39.5	34.40	67.40	9.82	0.0293	66.94	70.33
4.0	38.5	33.40	66.40	9.99	0.0209	64.99	68.28
8.0	38	32.90	65.90	10.07	0.0148	64.02	67.26
15.0	37	31.90	64.90	10.23	0.0109	62.07	65.21
31.0	36	30.90	63.90	10.40	0.0077	60.13	63.17
61.0	35	29.90	62.90	10.56	0.0055	58.18	61.13
120.0	33	27.90	60.90	10.89	0.0040	54.29	57.04
243.0	30	24.90	57.90	11.38	0.0029	48.45	50.90
1455.0	26	20.90	53.90	12.03	0.0012	40.67	42.73
2890.0	23	17.90	50.90	12.52	0.0009	34.83	36.59

Formulas:

$F_T = -4.85 + 0.25\,T$

$R_{cp} = R + F_T - F_Z$

$L = f(R) = 16.3 - 0.1641\,R_{cl}$

$a = f(G_s) = 1.65\,G_s / (2.65\,(G_s - 1))$

$R_{cl} = R + F_m$

$$D(mm) = A\sqrt{\frac{L(cm)}{t(min)}}$$

$$A = f(G_s, T) = \sqrt{\frac{30\eta}{(G_s - 1)\gamma_\omega}}$$

$$\text{Percent Finer} = \frac{aR_{cp}}{50}100$$

$\eta = 0.0911 \times 10^{-4}$ (g-s/cm^2) (if T = 25 ^{o}C)

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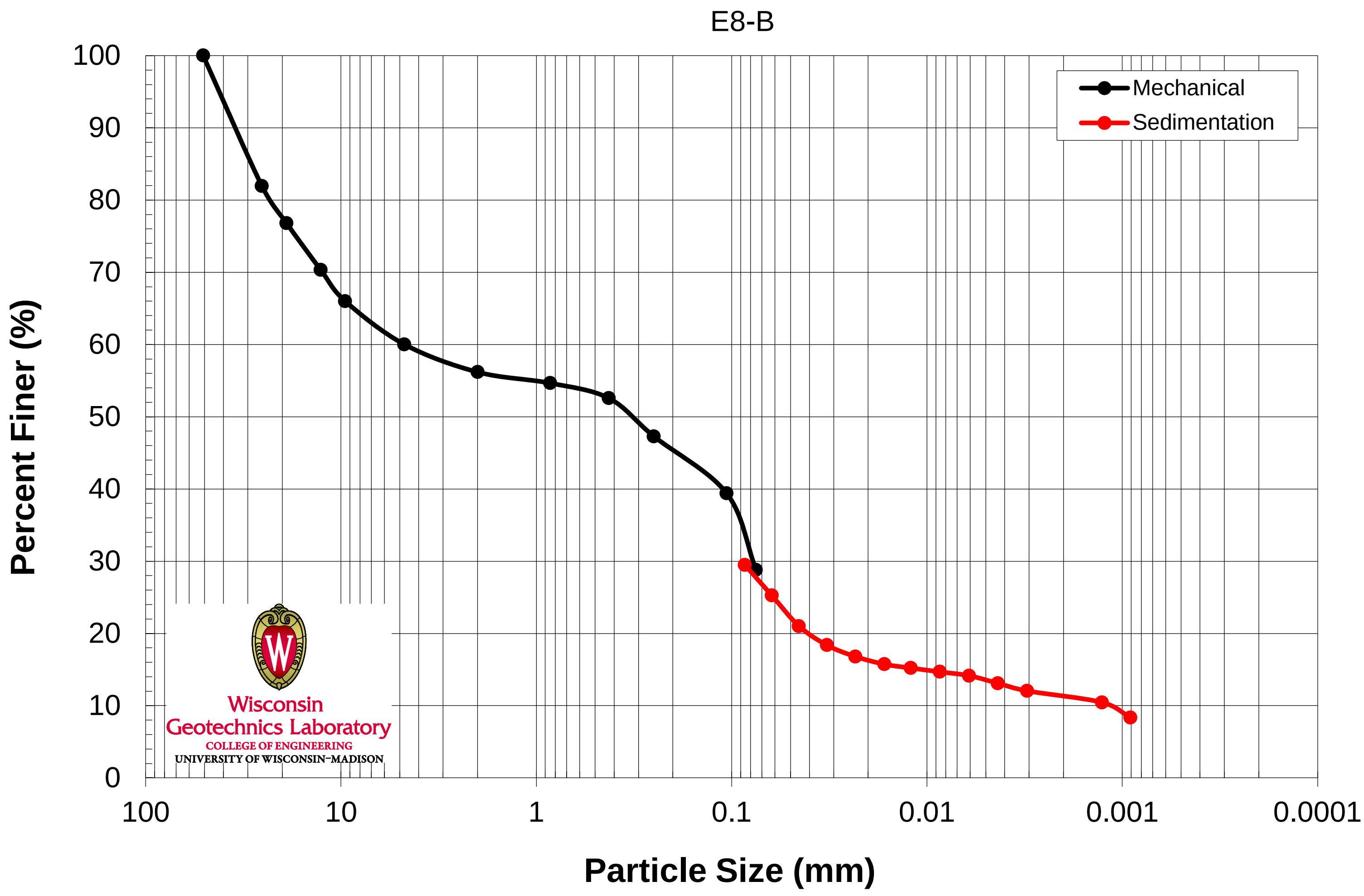
E8-B
Percent Finer (%)
Particle Size (mm)
Mechanical
Sedimentation
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
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Mechanical Particle Size Analysis - ASTM D 422

Sample ID: **E8-B** Test Date:

Weight of Air Dry Sample = 1639 g Initials:

Sieve No.	Sieve Opening	Weight Retained on Each Sieve	Percent Retained on Each Sieve	Cumulative Percent Retained	Percent Finer
	(mm)	(g)	(%)	(%)	(%)
2"	50.800	0.00	0	0	100
1"	25.400	296.07	18.07	18.07	81.93
3/4"	19.000	84.17	5.14	23.20	76.80
1/2"	12.700	106.06	6.47	29.68	70.32
3/8"	9.520	70.74	4.32	33.99	66.01
4	4.750	98.02	5.98	39.97	60.03
10	2.000	63.00	3.84	43.82	56.18
20	0.850	25.01	1.53	45.34	54.66
40	0.425	34.36	2.10	47.44	52.56
60	0.250	86.55	5.28	52.72	47.28
100	0.106	129.17	7.88	60.60	39.40
200	0.075	173.98	10.62	71.22	28.78
Pan		471.62	28.78	100.00	0.00
	Total Weight (g) =	**1639**			

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Sedimentation Particle Size Analysis - ASTM D 422

Sample ID:	**E8-B**
Specific Gravity, G_s =	2.63
Dry Weight of Soil, W (g) =	50
Meniscus Correction, F_m =	0.5
Temperature Correction, F_T =	0.9
Material Max. Size and Percentage (%)	40 52.56

Temp. Correction, A	0.0129
Hydrometer Type:	ASTM 152H
Temperature of Test, C	23
Zero Correction, F_z	6
a	1.005

Time (min)	Hydrometer Reading, R	R_{cp}	R_{cl}	L (cm)	D (mm)	Final Percent Finer (%)	Percent Finer
0.0					0.425	52.56	
0.2	33	27.90	45.40	10.89	0.0854	29.47	56.07
0.5	29	23.90	41.40	11.54	0.0622	25.24	48.03
1.0	25	19.90	37.40	12.19	0.0452	21.02	39.99
2.0	22.5	17.40	34.90	12.60	0.0325	18.38	34.97
4.0	21	15.90	33.40	12.85	0.0232	16.79	31.95
8.0	20	14.90	32.40	13.01	0.0165	15.74	29.94
15.0	19.5	14.40	31.90	13.09	0.0121	15.21	28.94
30.0	19	13.90	31.40	13.18	0.0086	14.68	27.93
60.0	18.5	13.40	30.90	13.26	0.0061	14.15	26.93
120.0	17.5	12.40	29.90	13.42	0.0043	13.10	24.92
242.0	16.5	11.40	28.90	13.58	0.0031	12.04	22.91
1438.0	15	9.90	27.40	13.83	0.0013	10.46	19.90
2873.0	13	7.90	25.40	14.16	0.0009	8.34	15.88

Formulas:

$F_T = -4.85 + 0.25\ T$

$R_{cp} = R + F_T - F_Z$

$L = f(R) = 16.3 - 0.1641\ R_{cl}$

$a = f(G_s) = 1.65\ G_s / (2.65\ (G_s - 1))$

$R_{cl} = R + F_m$

$$D(mm) = A\sqrt{\frac{L(cm)}{t(min)}}$$

$$A = f(G_s, T) = \sqrt{\frac{30\eta}{(G_s - 1)\gamma_\omega}}$$

$$\text{Percent Finer} = \frac{aR_{cp}}{50}100$$

$\eta = 0.0911 \times 10^{-4}$ (g-s/cm^2) (if T = 25 ^{o}C)

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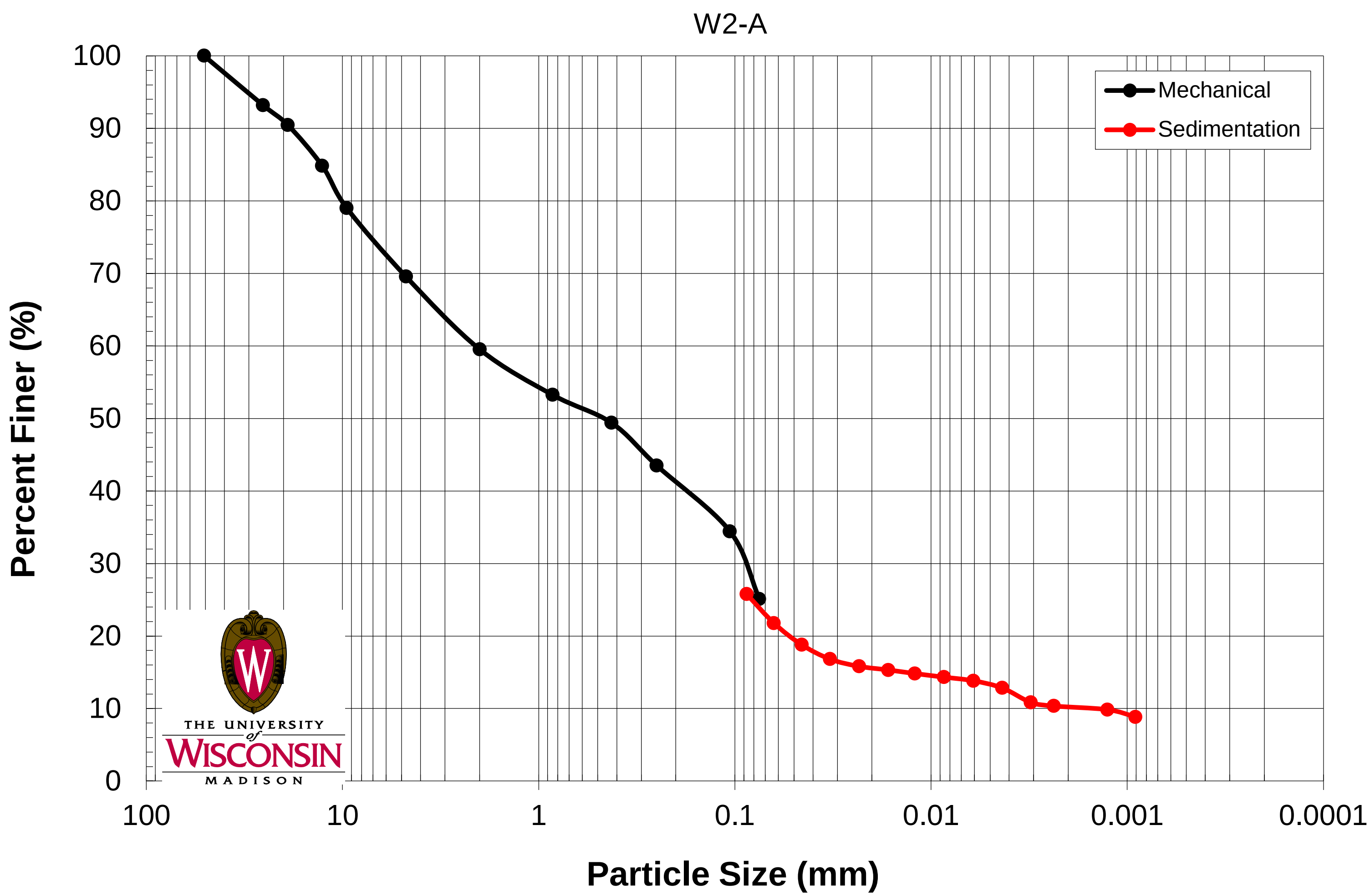

W2-A
Percent Finer (%)
Particle Size (mm)
Mechanical
Sedimentation
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
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Mechanical Particle Size Analysis - ASTM D 422

Sample ID: **W2-A** Test Date:

Weight of Air Dry Sample = 1766 g Initials:

Sieve No.	Sieve Opening	Weight Retained on Each Sieve	Percent Retained on Each Sieve	Cumulative Percent Retained	Percent Finer
	(mm)	(g)	(%)	(%)	(%)
2"	50.800	0.00	0	0	100
1"	25.400	120.36	6.82	6.82	93.18
3/4"	19.000	48.06	2.72	9.54	90.46
1/2"	12.700	99.19	5.62	15.16	84.84
3/8"	9.520	102.84	5.82	20.98	79.02
4	4.750	167.06	9.46	30.44	69.56
10	2.000	177.05	10.03	40.47	59.53
20	0.850	110.90	6.28	46.75	53.25
40	0.425	68.17	3.86	50.61	49.39
60	0.250	104.06	5.89	56.51	43.49
100	0.106	159.98	9.06	65.57	34.43
200	0.075	164.67	9.33	74.89	25.11
Pan		443.32	25.11	100.00	0.00
	Total Weight (g) =	**1766**			

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Sedimentation Particle Size Analysis - ASTM D 422

Sample ID:	**W2-A**
Specific Gravity, G_s =	2.62
Dry Weight of Soil, W (g) =	50
Meniscus Correction, F_m =	0.5
Temperature Correction, F_T =	0.9
Material Max. Size and Percentage (%)	40 49.39

Temp. Correction, A	0.0130
Hydrometer Type:	ASTM 152H
Temperature of Test, C	23
Zero Correction, F_z	6
a	1.007

Time (min)	Hydrometer Reading, R	R_{cp}	R_{cl}	L (cm)	D (mm)	Final Percent Finer (%)	Percent Finer
0.0					0.425	49.39	
0.3	31	25.90	43.90	11.21	0.0870	25.77	52.17
0.5	27	21.90	39.90	11.87	0.0633	21.79	44.12
1.0	24	18.90	36.90	12.36	0.0457	18.80	38.07
2.0	22	16.90	34.90	12.69	0.0327	16.81	34.04
4.0	21	15.90	33.90	12.85	0.0233	15.82	32.03
8.0	20.5	15.40	33.40	12.93	0.0165	15.32	31.02
15.0	20	14.90	32.90	13.01	0.0121	14.82	30.02
30.0	19.5	14.40	32.40	13.09	0.0086	14.33	29.01
60.0	19	13.90	31.90	13.18	0.0061	13.83	28.00
120.0	18	12.90	30.90	13.34	0.0043	12.83	25.99
240.0	16	10.90	28.90	13.67	0.0031	10.84	21.96
415.0	15.5	10.40	28.40	13.75	0.0024	10.35	20.95
1465.0	15	9.90	27.90	13.83	0.0013	9.85	19.94
2866.0	14	8.90	26.90	13.99	0.0009	8.85	17.93
0.0	0	-5.10	12.90	16.28	#DIV/0!	-5.07	-10.27
0.0	0	-5.10	12.90	16.28	#DIV/0!	-5.07	-10.27

Formulas:

$F_T = -4.85 + 0.25\,T$

$R_{cp} = R + F_T - F_Z$

$L = f(R) = 16.3 - 0.1641\,R_{cl}$

$a = f(G_s) = 1.65\,G_s / (2.65\,(G_s - 1))$

$R_{cl} = R + F_m$

$$D(mm) = A\sqrt{\frac{L(cm)}{t(min)}}$$

$$\text{Percent Finer} = \frac{aR_{cp}}{50}100$$

$$A = f(G_s, T) = \sqrt{\frac{30\eta}{(G_s - 1)\gamma_\omega}}$$

$\eta = 0.0911 \times 10^{-4}$ (g-s/cm^2) (if T = 25 ^oC)

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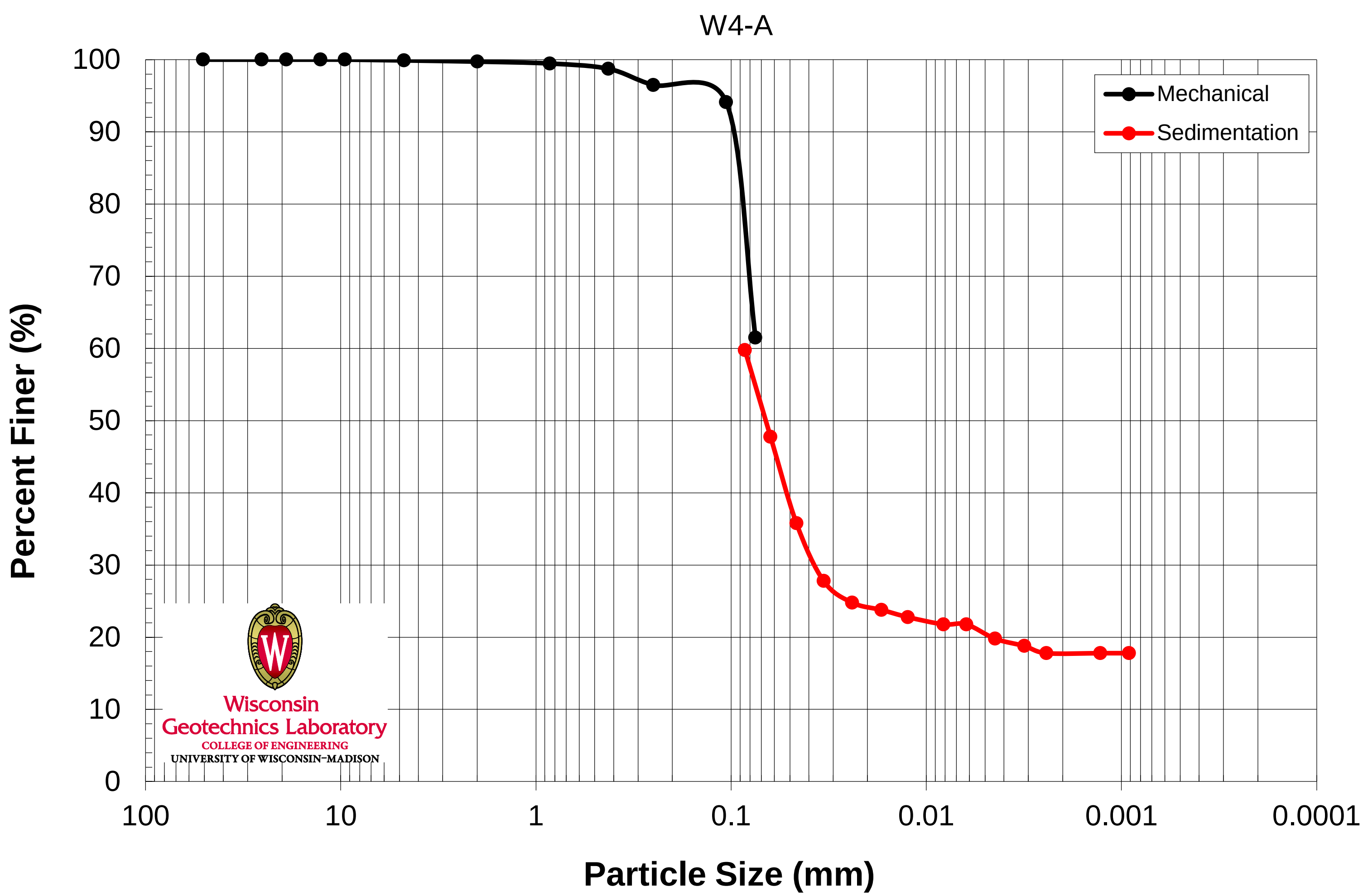
W4-A
Percent Finer (%)
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
Particle Size (mm)
Mechanical
Sedimentation
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Mechanical Particle Size Analysis - ASTM D 422

Sample ID:	**W4-A**		Test Date:
Weight of Air Dry Sample =	1051	g	Initials:

Sieve No.	Sieve Opening	Weight Retained on Each Sieve	Percent Retained on Each Sieve	Cumulative Percent Retained	Percent Finer
	(mm)	(g)	(%)	(%)	(%)
2"	50.800	0.00	0	0	100
1"	25.400	0.00	0.00	0.00	100.00
3/4"	19.000	0.00	0.00	0.00	100.00
1/2"	12.700	0.00	0.00	0.00	100.00
3/8"	9.520	0.00	0.00	0.00	100.00
4	4.750	1.15	0.11	0.11	99.89
10	2.000	1.75	0.17	0.28	99.72
20	0.850	2.75	0.26	0.54	99.46
40	0.425	7.72	0.73	1.27	98.73
60	0.250	23.69	2.25	3.53	96.47
100	0.106	24.75	2.36	5.88	94.12
200	0.075	342.77	32.62	38.50	61.50
Pan		646.26	61.50	100.00	0.00
Total Weight (g) =		**1051**			

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Sedimentation Particle Size Analysis - ASTM D 422

Sample ID:	**W4-A**	Temp. Correction, A	0.0131
Specific Gravity, G_s =	2.6	Hydrometer Type:	ASTM 152H
Dry Weight of Soil, W (g) =	50	Temperature of Test, C	23
Meniscus Correction, F_m =	0.5	Zero Correction, F_z	6
Temperature Correction, F_T =	0.9	a	1.012
Material Max. Size and Percentage (%)	40 98.73		

Time (min)	Hydrometer Reading, R	R_{cp}	R_{cl}	L (cm)	D (mm)	Final Percent Finer (%)	Percent Finer
0.0	0				0.425	98.73	
0.3	35	29.90	44.90	10.56	0.0849	59.75	60.52
0.5	29	23.90	38.90	11.54	0.0628	47.76	48.38
1.0	23	17.90	32.90	12.52	0.0462	35.77	36.23
2.0	19	13.90	28.90	13.18	0.0335	27.78	28.14
4.0	17.5	12.40	27.40	13.42	0.0239	24.78	25.10
8.0	17	11.90	26.90	13.50	0.0170	23.78	24.09
15.0	16.5	11.40	26.40	13.58	0.0124	22.78	23.08
35.0	16	10.90	25.90	13.67	0.0082	21.78	22.06
60.0	16	10.90	25.90	13.67	0.0062	21.78	22.06
120.0	15	9.90	24.90	13.83	0.0044	19.78	20.04
240.0	14.5	9.40	24.40	13.91	0.0031	18.79	19.03
406.0	14	8.90	23.90	13.99	0.0024	17.79	18.02
1455.0	14	8.90	23.90	13.99	0.0013	17.79	18.02
2857.0	14	8.90	23.90	13.99	0.0009	17.79	18.02

Formulas:

$F_T = -4.85 + 0.25\,T$

$R_{cp} = R + F_T - F_Z$

$L = f(R) = 16.3 - 0.1641\,R_{cl}$

$a = f(G_s) = 1.65\,G_s / (2.65\,(G_s - 1))$

$R_{cl} = R + F_m$

$$D(mm) = A\sqrt{\frac{L(cm)}{t(min)}}$$

$$A = f(G_s, T) = \sqrt{\frac{30\eta}{(G_s - 1)\gamma_\omega}}$$

$$\text{Percent Finer} = \frac{aR_{cp}}{50}100$$

$\eta = 0.0911 \times 10^{-4}$ (g-s/cm^2) (if T = 25 ^{o}C)

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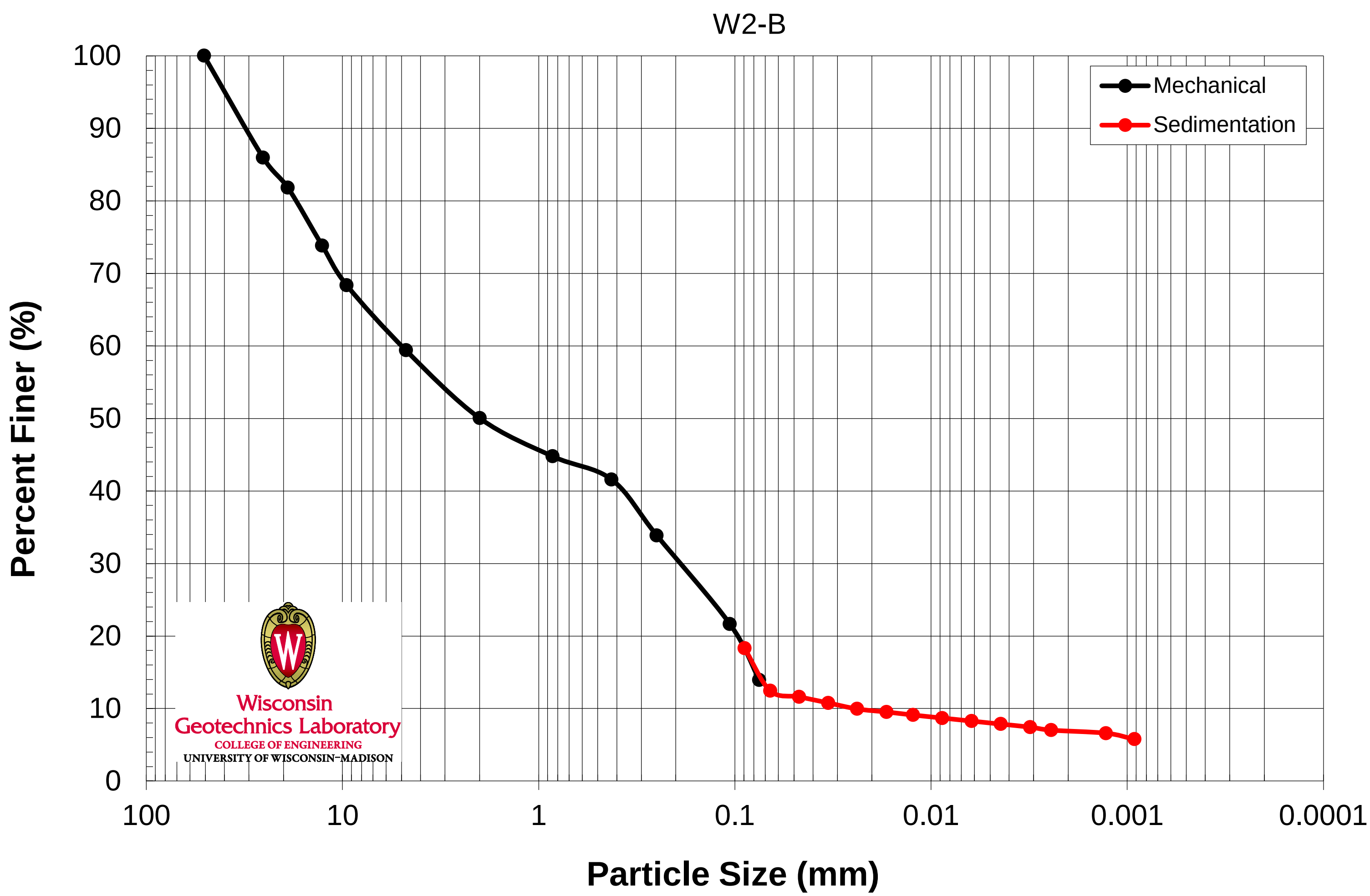
W2-B
Percent Finer (%)
Particle Size (mm)
Mechanical
Sedimentation
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
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Mechanical Particle Size Analysis - ASTM D 422

Sample ID: **W2-B** Test Date:

Weight of Air Dry Sample = 1584 g Initials:

Sieve No.	Sieve Opening	Weight Retained on Each Sieve	Percent Retained on Each Sieve	Cumulative Percent Retained	Percent Finer
	(mm)	(g)	(%)	(%)	(%)
2"	50.800	0.00	0	0	100
1"	25.400	222.48	14.04	14.04	85.96
3/4"	19.000	65.42	4.13	18.17	81.83
1/2"	12.700	126.64	7.99	26.16	73.84
3/8"	9.520	86.57	5.46	31.63	68.37
4	4.750	142.35	8.98	40.61	59.39
10	2.000	148.20	9.35	49.96	50.04
20	0.850	83.29	5.26	55.22	44.78
40	0.425	50.76	3.20	58.42	41.58
60	0.250	122.19	7.71	66.14	33.86
100	0.106	193.49	12.21	78.35	21.65
200	0.075	122.12	7.71	86.06	13.94
Pan		220.95	13.94	100.00	0.00

Total Weight (g) = 1584

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Sedimentation Particle Size Analysis - ASTM D 422

Sample ID:	**W2-B**
Specific Gravity, G_s =	2.63
Dry Weight of Soil, W (g) =	50
Meniscus Correction, F_m =	0.5
Temperature Correction, F_T =	0.9
Material Max. Size and Percentage (%)	40 41.58

Temp. Correction, A	0.0129
Hydrometer Type:	ASTM 152H
Temperature of Test, C	23
Zero Correction, F_z	6
a	1.005

Time (min)	Hydrometer Reading, R	R_{cp}	R_{cl}	L (cm)	D (mm)	Final Percent Finer (%)	Percent Finer
0.0	0				0.425	41.58	
0.2	27	21.90	36.40	11.87	0.0892	18.30	44.01
0.5	20	14.90	29.40	13.01	0.0661	12.45	29.94
1.0	19	13.90	28.40	13.18	0.0470	11.61	27.93
2.0	18	12.90	27.40	13.34	0.0334	10.78	25.92
4.0	17	11.90	26.40	13.50	0.0238	9.94	23.91
8.0	16.5	11.40	25.90	13.58	0.0169	9.53	22.91
15.0	16	10.90	25.40	13.67	0.0124	9.11	21.91
30.0	15.5	10.40	24.90	13.75	0.0088	8.69	20.90
60.0	15	9.90	24.40	13.83	0.0062	8.27	19.90
120.0	14.5	9.40	23.90	13.91	0.0044	7.85	18.89
240.0	14	8.90	23.40	13.99	0.0031	7.44	17.89
396.0	13.5	8.40	22.90	14.08	0.0024	7.02	16.88
1446.0	13	7.90	22.40	14.16	0.0013	6.60	15.88
2848.0	12	6.90	21.40	14.32	0.0009	5.77	13.87
0.0	0	-5.10	9.40	16.28	#DIV/0!	-4.26	-10.25
0.0	0	-5.10	9.40	16.28	#DIV/0!	-4.26	-10.25

Formulas:

$F_T = -4.85 + 0.25\ T$

$R_{cp} = R + F_T - F_Z$

$L = f(R) = 16.3 - 0.1641\ R_{cl}$

$a = f(G_s) = 1.65\ G_s / (2.65\ (G_s - 1))$

$R_{cl} = R + F_m$

$$D(mm) = A\sqrt{\frac{L(cm)}{t(min)}}$$

$$\text{Percent Finer} = \frac{aR_{cp}}{50}100$$

$$A = f(G_s, T) = \sqrt{\frac{30\eta}{(G_s - 1)\gamma_\omega}}$$

$\eta = 0.0911 \times 10^{-4}$ (g-s/cm^2) (if T = 25 ^{o}C)

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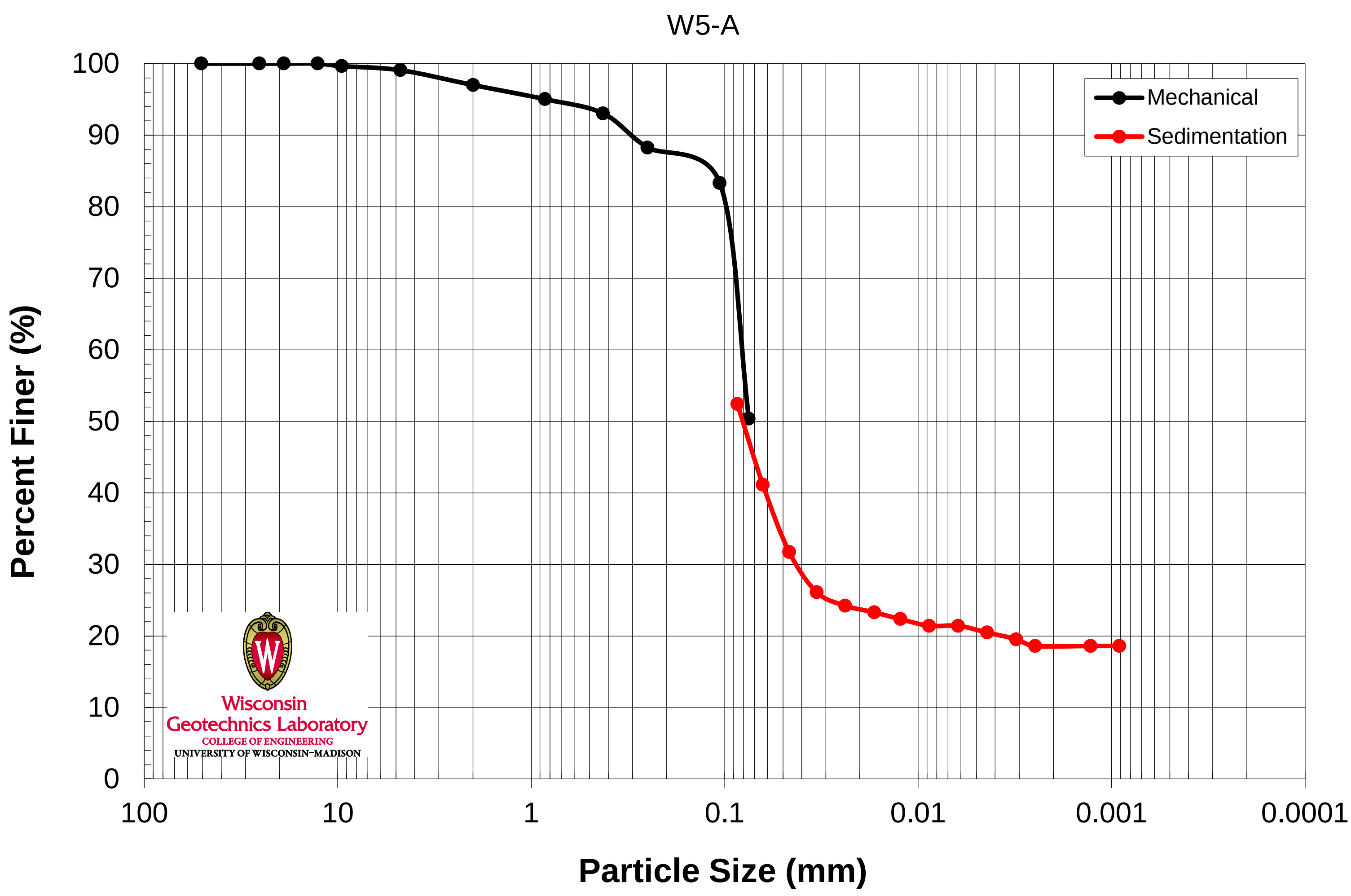

W5-A
Percent Finer (%)
Particle Size (mm)
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
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Sedimentation
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Mechanical Particle Size Analysis - ASTM D 422

Sample ID: **W5-A** Test Date:

Weight of Air Dry Sample = 1100 g Initials:

Sieve No.	Sieve Opening	Weight Retained on Each Sieve	Percent Retained on Each Sieve	Cumulative Percent Retained	Percent Finer
	(mm)	(g)	(%)	(%)	(%)
2"	50.800	0.00	0	0	100
1"	25.400	0.00	0.00	0.00	100.00
3/4"	19.000	0.00	0.00	0.00	100.00
1/2"	12.700	0.00	0.00	0.00	100.00
3/8"	9.520	4.00	0.36	0.36	99.64
4	4.750	6.16	0.56	0.92	99.08
10	2.000	22.81	2.07	3.00	97.00
20	0.850	21.74	1.98	4.97	95.03
40	0.425	21.89	1.99	6.96	93.04
60	0.250	52.45	4.77	11.73	88.27
100	0.106	54.44	4.95	16.68	83.32
200	0.075	362.25	32.94	49.62	50.38
Pan		554.15	50.38	100.00	0.00
	Total Weight (g) =	**1100**			

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Sedimentation Particle Size Analysis - ASTM D 422

Sample ID:	**W5-A**
Specific Gravity, G_s =	2.61
Dry Weight of Soil, W (g) =	50
Meniscus Correction, F_m =	0.5
Temperature Correction, F_T =	0.9
Material Max. Size and Percentage (%)	40 93.04

Temp. Correction, A	0.0130
Hydrometer Type:	ASTM 152H
Temperature of Test, C	23
Zero Correction, F_z	6
a	1.010

Time (min)	Hydrometer Reading, R	R_{cp}	R_{cl}	L (cm)	D (mm)	Final Percent Finer (%)	Percent Finer
0.0	0				0.425	93.04	
0.3	33	27.90	43.90	10.89	0.0860	52.42	56.34
0.5	27	21.90	37.90	11.87	0.0635	41.14	44.22
1.0	22	16.90	32.90	12.69	0.0464	31.75	34.13
2.0	19	13.90	29.90	13.18	0.0334	26.11	28.07
4.0	18	12.90	28.90	13.34	0.0238	24.24	26.05
8.0	17.5	12.40	28.40	13.42	0.0169	23.30	25.04
15.0	17	11.90	27.90	13.50	0.0124	22.36	24.03
30.0	16.5	11.40	27.40	13.58	0.0088	21.42	23.02
60.0	16.5	11.40	27.40	13.58	0.0062	21.42	23.02
120.0	16	10.90	26.90	13.67	0.0044	20.48	22.01
242.0	15.5	10.40	26.40	13.75	0.0031	19.54	21.00
380.0	15	9.90	25.90	13.83	0.0025	18.60	19.99
1430.0	15	9.90	25.90	13.83	0.0013	18.60	19.99
2832.0	15	9.90	25.90	13.83	0.0009	18.60	19.99
0.0	0	-5.10	10.90	16.28	#DIV/0!	-9.58	-10.30
0.0	0	-5.10	10.90	16.28	#DIV/0!	-9.58	-10.30

Formulas:

$F_T = -4.85 + 0.25\ T$

$R_{cp} = R + F_T - F_Z$

$L = f(R) = 16.3 - 0.1641\ R_{cl}$

$a = f(G_s) = 1.65\ G_s / (2.65\ (G_s - 1))$

$R_{cl} = R + F_m$

$$D(mm) = A\sqrt{\frac{L(cm)}{t(min)}}$$

$$A = f(G_s, T) = \sqrt{\frac{30\eta}{(G_s - 1)\gamma_\omega}}$$

$$\text{Percent Finer} = \frac{aR_{cp}}{50}100$$

$\eta = 0.0911 \times 10^{-4}$ (g-s/cm^2) (if T = 25 ^oC)

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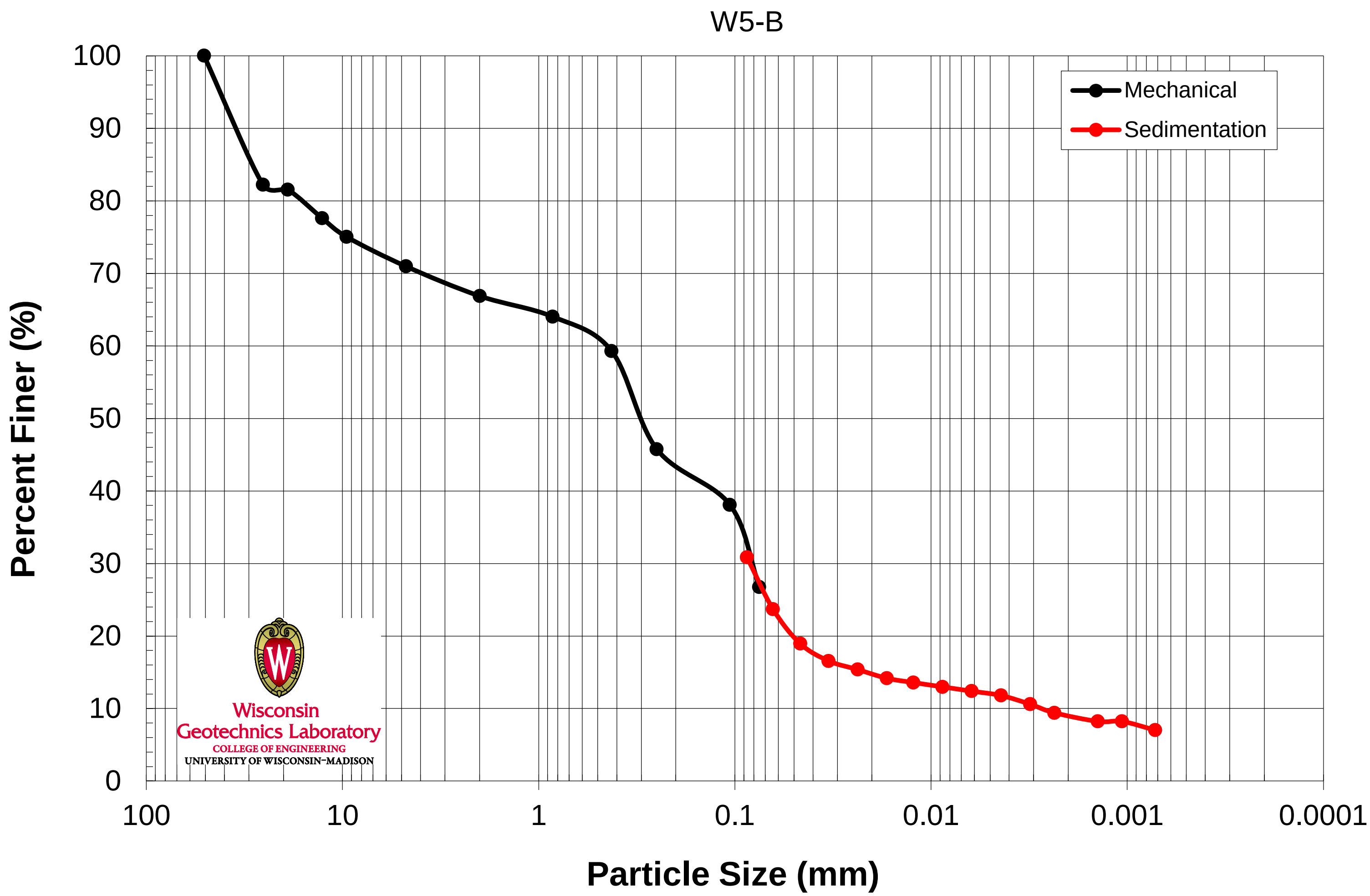

W5-B
Percent Finer (%)
Particle Size (mm)
Mechanical
Sedimentation
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
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Mechanical Particle Size Analysis - ASTM D 422

Sample ID: **W5-B** Test Date:

Weight of Air Dry Sample = 1512 g Initials:

Sieve No.	Sieve Opening	Weight Retained on Each Sieve	Percent Retained on Each Sieve	Cumulative Percent Retained	Percent Finer
	(mm)	(g)	(%)	(%)	(%)
2"	50.8000	0.00	0	0	100
1"	25.4000	269.02	17.79	17.79	82.21
3/4"	19.0000	10.19	0.67	18.47	81.53
1/2"	12.7000	59.39	3.93	22.39	77.61
3/8"	9.5200	38.95	2.58	24.97	75.03
4	4.7500	61.39	4.06	29.03	70.97
10	2.0000	61.84	4.09	33.12	66.88
20	0.8500	42.92	2.84	35.96	64.04
40	0.4250	71.73	4.74	40.70	59.30
60	0.2500	204.64	13.53	54.24	45.76
100	0.1060	115.96	7.67	61.91	38.09
200	0.0750	171.25	11.33	73.23	26.77
Pan		404.71	26.77	100.00	0.00

Total Weight (g) = 1512

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Sedimentation Particle Size Analysis - ASTM D 422

Sample ID:	**W5-B**
Specific Gravity, G_s =	2.63
Dry Weight of Soil, W (g) =	50
Meniscus Correction, F_m =	0.5
Temperature Correction, F_T =	0.9
Material Max. Size and Percentage (%)	40 59.30

Temp. Correction, A	0.0129
Hydrometer Type:	ASTM 152H
Temperature of Test, C	23
Zero Correction, F_z	6
a	1.005

Time (min)	Hydrometer Reading, R	R_{cp}	R_{cl}	L (cm)	D (mm)	Final Percent Finer (%)	Percent Finer
0.0	0				0.425	59.30	
0.2	31	25.90	40.90	11.21	0.0867	30.86	52.05
0.5	25	19.90	34.90	12.19	0.0639	23.71	39.99
1.0	21	15.90	30.90	12.85	0.0464	18.95	31.95
2.0	19	13.90	28.90	13.18	0.0332	16.56	27.93
4.0	18	12.90	27.90	13.34	0.0236	15.37	25.92
8.0	17	11.90	26.90	13.50	0.0168	14.18	23.91
15.0	16.5	11.40	26.40	13.58	0.0123	13.58	22.91
30.0	16	10.90	25.90	13.67	0.0087	12.99	21.91
60.0	15.5	10.40	25.40	13.75	0.0062	12.39	20.90
120.0	15	9.90	24.90	13.83	0.0044	11.80	19.90
240.0	14	8.90	23.90	13.99	0.0031	10.61	17.89
429.0	13	7.90	22.90	14.16	0.0024	9.41	15.88
1209.0	12	6.90	21.90	14.32	0.0014	8.22	13.87
2128.0	12	6.90	21.90	14.32	0.0011	8.22	13.87
4683.0	11	5.90	20.90	14.48	0.0007	7.03	11.86
0.0	0	-5.10	9.90	16.28	#DIV/0!	-6.08	-10.25

Formulas:

$F_T = -4.85 + 0.25\ T$

$R_{cp} = R + F_T - F_Z$

$L = f(R) = 16.3 - 0.1641\ R_{cl}$

$a = f(G_s) = 1.65\ G_s / (2.65\ (G_s - 1))$

$R_{cl} = R + F_m$

$$D(mm) = A\sqrt{\frac{L(cm)}{t(min)}}$$

$$A = f(G_s, T) = \sqrt{\frac{30\eta}{(G_s - 1)\gamma_\omega}}$$

$$\text{Percent Finer} = \frac{aR_{cp}}{50}100$$

$\eta = 0.0911 \times 10^{-4}$ (g-s/cm^2) (if T = 25 ^{o}C)

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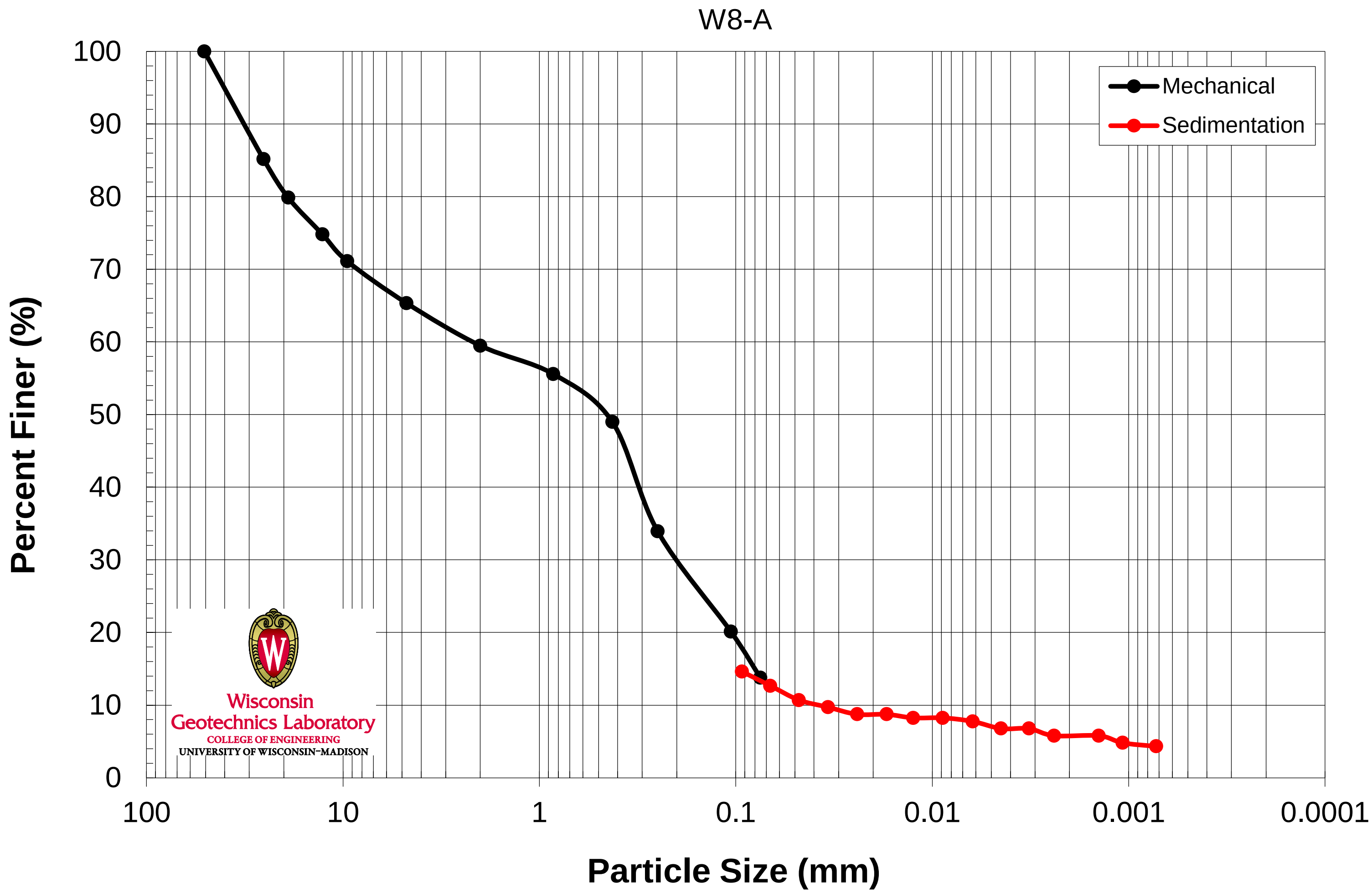

W8-A
Percent Finer (%)
Particle Size (mm)
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
Mechanical
Sedimentation
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Mechanical Particle Size Analysis - ASTM D 422

Sample ID: **W8-A** Test Date:

Weight of Air Dry Sample = 1354 g Initials:

Sieve No.	Sieve Opening	Weight Retained on Each Sieve	Percent Retained on Each Sieve	Cumulative Percent Retained	Percent Finer
	(mm)	(g)	(%)	(%)	(%)
2"	50.800	0.00	0	0	100
1"	25.400	200.78	14.83	14.83	85.17
3/4"	19.000	72.08	5.32	20.15	79.85
1/2"	12.700	68.48	5.06	25.20	74.80
3/8"	9.520	49.77	3.67	28.88	71.12
4	4.750	78.25	5.78	34.66	65.34
10	2.000	79.27	5.85	40.51	59.49
20	0.850	52.87	3.90	44.41	55.59
40	0.425	89.60	6.62	51.03	48.97
60	0.250	203.74	15.04	66.07	33.93
100	0.106	186.92	13.80	79.88	20.12
200	0.075	85.98	6.35	86.22	13.78
Pan		186.57	13.78	100.00	0.00
	Total Weight (g) =	**1354**			

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Sedimentation Particle Size Analysis - ASTM D 422

Sample ID:	**W8-A**	Temp. Correction, A	0.0129
Specific Gravity, G_s =	2.64	Hydrometer Type:	ASTM 152H
Dry Weight of Soil, W (g) =	50	Temperature of Test, C	23
Meniscus Correction, F_m =	0.5	Zero Correction, F_z	6
Temperature Correction, F_T =	0.9	a	1.002
Material Max. Size and Percentage (%)	40 48.97		

Time (min)	Hydrometer Reading, R	R_{cp}	R_{cl}	L (cm)	D (mm)	Final Percent Finer (%)	Percent Finer
0.0	0				0.425	48.97	
0.3	20	14.90	26.90	13.01	0.0931	14.63	29.87
0.5	18	12.90	24.90	13.34	0.0667	12.67	25.86
1.0	16	10.90	22.90	13.67	0.0477	10.70	21.85
2.0	15	9.90	21.90	13.83	0.0339	9.72	19.85
4.0	14	8.90	20.90	13.99	0.0241	8.74	17.84
8.0	14	8.90	20.90	13.99	0.0171	8.74	17.84
15.0	13.5	8.40	20.40	14.08	0.0125	8.25	16.84
30.0	13.5	8.40	20.40	14.08	0.0088	8.25	16.84
61.0	13	7.90	19.90	14.16	0.0062	7.76	15.84
120.0	12	6.90	18.90	14.32	0.0045	6.77	13.83
230.0	12	6.90	18.90	14.32	0.0032	6.77	13.83
419.0	11	5.90	17.90	14.48	0.0024	5.79	11.83
1200.0	11	5.90	17.90	14.48	0.0014	5.79	11.83
2118.0	10	4.90	16.90	14.65	0.0011	4.81	9.82
4673.0	9.5	4.40	16.40	14.73	0.0007	4.32	8.82
-59096737.0	0	-5.10	6.90	16.28	#NUM!	-5.01	-10.22

Formulas:

$F_T = -4.85 + 0.25\,T$

$R_{cp} = R + F_T - F_Z$

$L = f(R) = 16.3 - 0.1641\,R_{cl}$

$a = f(G_s) = 1.65\,G_s / (2.65\,(G_s - 1))$

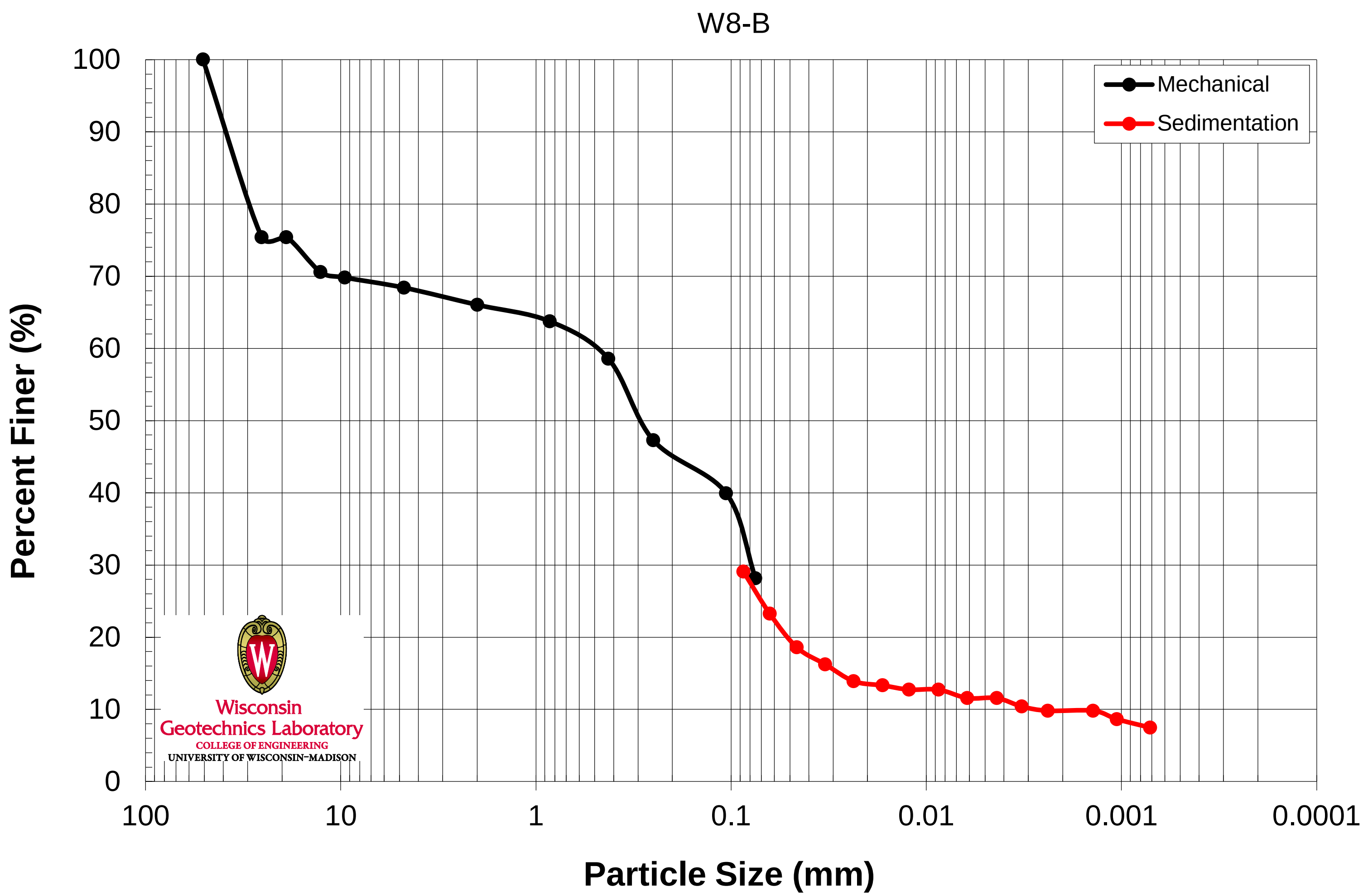
$R_{cl} = R + F_m$

$$D(mm) = A\sqrt{\frac{L(cm)}{t(min)}}$$

$$A = f(G_s, T) = \sqrt{\frac{30\eta}{(G_s - 1)\gamma_\omega}}$$

$$\text{Percent Finer} = \frac{aR_{cp}}{50}100$$

$\eta = 0.0911 \times 10^{-4}$ (g-s/cm^2) (if T = 25 ^oC)



W8-B
Percent Finer (%)
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
Particle Size (mm)
Mechanical
Sedimentation
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Mechanical Particle Size Analysis - ASTM D 422

Sample ID: **W8-B** Test Date:

Weight of Air Dry Sample = 1016 g Initials:

Sieve No.	Sieve Opening	Weight Retained on Each Sieve	Percent Retained on Each Sieve	Cumulative Percent Retained	Percent Finer
	(mm)	(g)	(%)	(%)	(%)
2"	50.8	0.00	0	0	100
1"	25.4	249.88	24.59	24.59	75.41
3/4"	19.0	0.00	0.00	24.59	75.41
1/2"	12.7	48.98	4.82	29.41	70.59
3/8"	9.52	7.89	0.78	30.19	69.81
4	4.75	14.19	1.40	31.59	68.41
10	2.00	24.17	2.38	33.96	66.04
20	0.85	23.12	2.28	36.24	63.76
40	0.425	52.87	5.20	41.44	58.56
60	0.250	114.81	11.30	52.74	47.26
100	0.106	74.36	7.32	60.06	39.94
200	0.075	119.61	11.77	71.83	28.17
Pan		286.23	28.17	100.00	0.00
	Total Weight (g) =	**1016**			

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Sedimentation Particle Size Analysis - ASTM D 422

Sample ID:	**W8-B**
Specific Gravity, G_s =	2.66
Dry Weight of Soil, W (g) =	50
Meniscus Correction, F_m =	0.5
Temperature Correction, F_T =	0.9
Material Max. Size and Percentage (%)	40 58.56

Temp. Correction, A	0.0128
Hydrometer Type:	ASTM 152H
Temperature of Test, C	23
Zero Correction, F_z	6
a	0.998

Time (min)	Hydrometer Reading, R	R_{cp}	R_{cl}	L (cm)	D (mm)	Final Percent Finer (%)	Percent Finer
0.0	0				0.425	58.56	
0.2	30	24.90	39.90	11.38	0.0866	29.10	49.69
0.5	25	19.90	34.90	12.19	0.0634	23.25	39.71
1.0	21	15.90	30.90	12.85	0.0460	18.58	31.73
2.0	19	13.90	28.90	13.18	0.0329	16.24	27.74
4.0	17	11.90	26.90	13.50	0.0236	13.91	23.75
8.0	16.5	11.40	26.40	13.58	0.0167	13.32	22.75
15.0	16	10.90	25.90	13.67	0.0122	12.74	21.75
30.0	16	10.90	25.90	13.67	0.0087	12.74	21.75
60.0	15	9.90	24.90	13.83	0.0062	11.57	19.76
120.0	15	9.90	24.90	13.83	0.0044	11.57	19.76
220.0	14	8.90	23.90	13.99	0.0032	10.40	17.76
408.0	13.5	8.40	23.40	14.08	0.0024	9.82	16.76
1189.0	13.5	8.40	23.40	14.08	0.0014	9.82	16.76
2107.0	12.5	7.40	22.40	14.24	0.0011	8.65	14.77
4662.0	11.5	6.40	21.40	14.40	0.0007	7.48	12.77
-59096748.0	0	-5.10	9.90	16.28	#NUM!	-5.96	-10.18

Formulas:

$F_T = -4.85 + 0.25\ T$

$R_{cp} = R + F_T - F_Z$

$L = f(R) = 16.3 - 0.1641\ R_{cl}$

$a = f(G_s) = 1.65\ G_s / (2.65\ (G_s - 1))$

$R_{cl} = R + F_m$

$$D(mm) = A\sqrt{\frac{L(cm)}{t(min)}}$$

$$A = f(G_s, T) = \sqrt{\frac{30\eta}{(G_s - 1)\gamma_\omega}}$$

$$\text{Percent Finer} = \frac{aR_{cp}}{50}100$$

$\eta = 0.0911 \times 10^{-4}$ (g-s/cm^2) (if T = 25 ^{o}C)

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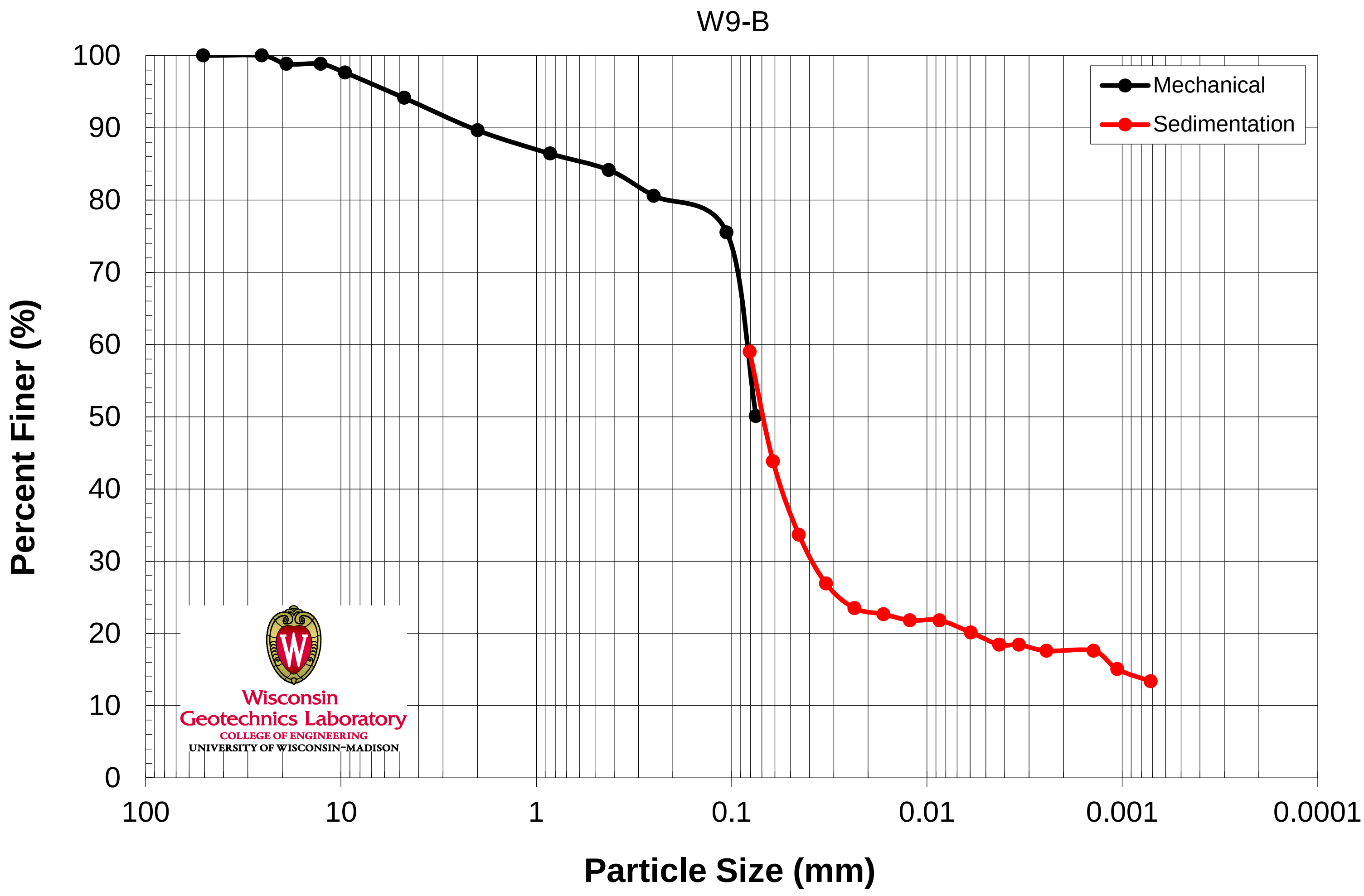

W9-B
Percent Finer (%)
100
90
80
70
60
50
40
30
20
10
0
100
10
1
0.1
0.01
0.001
0.0001
Particle Size (mm)
Mechanical
Sedimentation
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Mechanical Particle Size Analysis - ASTM D 422

Sample ID: **W9-B** Test Date:

Weight of Air Dry Sample = 1027 g Initials:

Sieve No.	Sieve Opening	Weight Retained on Each Sieve	Percent Retained on Each Sieve	Cumulative Percent Retained	Percent Finer
	(mm)	(g)	(%)	(%)	(%)
2"	50.8	0.00	0	0	100
1"	25.4	0.00	0.00	0.00	100
3/4"	19.0	11.91	1.16	1.16	98.84
1/2"	12.7	0.00	0.00	1.16	98.84
3/8"	9.52	12.33	1.20	2.36	97.64
4	4.75	36.00	3.51	5.87	94.13
10	2.00	46.08	4.49	10.35	89.65
20	0.85	33.14	3.23	13.58	86.42
40	0.425	23.26	2.26	15.84	84.16
60	0.250	36.69	3.57	19.42	80.58
100	0.106	51.93	5.06	24.47	75.53
200	0.075	261.16	25.43	49.90	50.10
Pan		514.52	50.10	100.00	0.00
	Total Weight (g) =	**1027**			

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Sedimentation Particle Size Analysis - ASTM D 422

Sample ID:	**W9-B**	
Specific Gravity, G_s =		2.63
Dry Weight of Soil, W (g) =		50
Meniscus Correction, F_m =		0.5
Temperature Correction, F_T =		0.9
Material Max. Size and Percentage (%)		40 84.16

Temp. Correction, A	0.0129
Hydrometer Type:	ASTM 152H
Temperature of Test, C	23
Zero Correction, F_z	6
a	1.005

Time (min)	Hydrometer Reading, R	R_{cp}	R_{cl}	L (cm)	D (mm)	Final Percent Finer (%)	Percent Finer
0.0	0				0.425	84.16	
0.2	40	34.90	50.90	9.74	0.0808	59.02	70.14
0.5	31	25.90	41.90	11.21	0.0613	43.80	52.05
1.0	25	19.90	35.90	12.19	0.0452	33.66	39.99
2.0	21	15.90	31.90	12.85	0.0328	26.89	31.95
4.0	19	13.90	29.90	13.18	0.0235	23.51	27.93
8.0	18.5	13.40	29.40	13.26	0.0167	22.66	26.93
15.0	18	12.90	28.90	13.34	0.0122	21.82	25.92
30.0	18	12.90	28.90	13.34	0.0086	21.82	25.92
64.0	17	11.90	27.90	13.50	0.0059	20.13	23.91
126.0	16	10.90	26.90	13.67	0.0043	18.43	21.91
201.0	16	10.90	26.90	13.67	0.0034	18.43	21.91
388.0	15.5	10.40	26.40	13.75	0.0024	17.59	20.90
1169.0	15.5	10.40	26.40	13.75	0.0014	17.59	20.90
2088.0	14	8.90	24.90	13.99	0.0011	15.05	17.89
4642.0	13	7.90	23.90	14.16	0.0007	13.36	15.88
-59096768.0	0	-5.10	10.90	16.28	#NUM!	-8.63	-10.25

Formulas:

$F_T = -4.85 + 0.25\,T$

$R_{cp} = R + F_T - F_Z$

$L = f(R) = 16.3 - 0.1641\,R_{cl}$

$a = f(G_s) = 1.65\,G_s / (2.65\,(G_s - 1))$

$R_{cl} = R + F_m$

$$D(mm) = A\sqrt{\frac{L(cm)}{t(min)}}$$

$$A = f(G_s, T) = \sqrt{\frac{30\eta}{(G_s - 1)\gamma_\omega}}$$

$$\text{Percent Finer} = \frac{aR_{cp}}{50}100$$

$\eta = 0.0911 \times 10^{-4}$ (g-s/cm^2) (if T = 25 ^{o}C)

COMPACTION AND HYDRAULIC PROPERTIES OF SOILS FROM BLANDING, UTAH

by

C.H. Benson and X. Wang

Geotechnics Report No. 12-41

Wisconsin Geotechnics Laboratory

University of Wisconsin-Madison
Madison, Wisconsin 53706
USA

24 July 2012

1. SCOPE

This report describes results of laboratory tests to determine the compaction and hydraulic properties of soil samples from Blanding, Utah. The soils were delivered to the Wisconsin Geotechnics Laboratory as disturbed samples in 20-L buckets (2 buckets per soil). Index properties of the soils were determined previously and are reported in Geotechnics Report No. 12-37.

2. METHODS

The same soil samples used for index properties testing were used for the tests conducted in this study. Tests were conducted to determine standard Proctor compaction curves, saturated hydraulic conductivity, soil water characteristic curves (SWCCs), and 1.5 MPa moisture content. The following ASTM methods were employed:

D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft (600 kN-m/m))

D 5084 Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

D 6836 Standard Test Methods for Determination of the Soil Water Characteristic Curve for Desorption Using Hanging Column, Pressure Extractor, Chilled Mirror Hygrometer, or Centrifuge

Test specimens for the saturated hydraulic conductivity, SWCC, and 1.5 MPa moisture content tests were prepared at 85% of maximum dry unit weight and optimum water content per standard Proctor, as specified by the requestor.

Saturated hydraulic conductivity of each test specimen was measured in a flexible-wall permeameter following the methods in ASTM D 5084. The backpressure was set at 30 psi and the hydraulic gradient was 10. The effective stress was set at 5.0 psi to simulate the low state of stress in a cover while ensuring good contact between the membrane and the test specimen.

The wet end of the SWCC was measured following the procedures in ASTM D 6836 using a hanging column (Method A) or a pressure plate extractor (Method B). A chilled mirror hygrometer (Method D) was used to complete the dry end of the SWCC after the hanging column test or pressure plate test was complete. SWCCs were prepared by combining data from the pressure plate and chilled mirror hygrometer tests as described in D 6836. van Genuchten's equation was fit to the SWCC data:

$$\frac{\theta-\theta_r}{\theta_s-\theta_r}=\left[\frac{1}{1+(\alpha\psi)^n}\right]^m \qquad (1)$$

where θ is volumetric water content, θ_r is residual water content, θ_s is saturated volumetric water content, ψ is matric suction, and α, m, and n are fitting parameters. Equation 1 was fit to the data using a non-linear least-squares optimization procedure with the constraint $m = 1-n^{-1}$.

Moisture contents at 1.5 MPa were determined using the procedures in Method D of ASTM D 6836. Test specimens were prepared at three moisture contents bracketing a suction of 1.5 MPa. Moisture content was then regressed on suction, and the moisture content at 1.5 MPa was determined from the regression equation.

3. RESULTS

Optimum water contents and maximum dry unit weights from the compaction tests are summarized in Table 1. Saturated hydraulic conductivities and van Genuchten parameters for the SWCCs are summarized in Table 2. Gravimetric moisture contents at 1.5 MPa are summarized in Table 3. Data recorded from the tests are in the appendix.

Table 1. Summary of index properties for soils from Blanding, Utah.

Sample ID	Optimum Water Content (%)	Maximum Dry Unit Weight (pcf)
E1-A1/2 Composite	11.0	118
E3-A1/2 Composite	19.0	105
E8-B1/2 Composite	10.5	125
W2-B1/2 Composite	8.5	128
W5-B1/2 Composite	10.0	122
W8-A1/2 Composite	13.0	117
W9-B1/2 Composite	14.0	115

Table 2. Summary of saturated hydraulic conductivities and van Genuchten Parameters

Sample ID	Sat. Hydraulic Conductivity (cm/s)	Saturated Vol. Water Content (θ_s)	Residual Vol. Water Content (θ_r)	α (1/kPa)	n
E1-A1/2 Composite	1.3×10^{-4}	0.38	0.024	0.0797	1.35
E3-A1/2 Composite	9.5×10^{-5}	0.44	0.00	0.0787	1.19
W2-B1/2 Composite	1.5×10^{-3}	0.32	0.00	0.2160	1.32
W5-B1/2 Composite	1.1×10^{-3}	0.36	0.00	0.1180	1.35
W8-A1/2 Composite	1.2×10^{-3}	0.37	0.00	0.1840	1.35
W9-B1/2 Composite	4.1×10^{-4}	0.40	0.00	0.0729	1.26

Table 3. Summary of 1.5 MPa gravimetric moisture contents.

Sample ID	Gravimetric Water Content (%)
E8-B1/2 Composite	6.0
W2-A1/2 Composite	6.9
W5-A1/2 Composite	7.0
W8-B1/2 Composite	6.4

APPENDIX:

DATA SHEETS

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STANDARD PROCTOR COMPACTION TEST

(ASTM D 698)

Sample I.D.	**E1_(A1/A2)**	Test Date	6/8/2012
Procedure	A	Volume of Mold (ft^3)	0.033
Weight of Hammer (lb)	5.5	Hammer Drop (in)	12
No. of Blows per Layer	25	No. of Layers	3

Test No.	WT of Mold (lb)	WT of Mold + Wet Soil (lb)	WT of Wet Soil (lb)	Wet Unit Weight (pcf)	Water Content (%)	Dry Unit Weight (pcf)
1	9.48	13.05	3.57	107.13	3.6	103.38
2	9.48	13.45	3.97	119.09	7.6	110.65
3	9.48	13.86	4.38	131.44	11.0	118.40
4	9.48	13.81	4.33	129.94	13.6	114.37
5	9.48	13.47	3.99	119.56	19.7	99.87

Test No	#1	#2	#3	#4	#5
Can No.	T2	M7	14	T4	B3
WT of Can (g)	30.8	24.4	30.7	24.6	25.3
WT of Can + Wet Soil (g)	201.8	135.8	153.7	173.2	175.9
WT of Can + Dry Soil (g)	195.8	127.9	141.5	155.4	151.1
Water Content (%)	3.6	7.6	11.0	13.6	19.7

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STANDARD PROCTOR COMPACTION TEST

(ASTM D 698)

Sample I.D.	**E3_(A1/A2)**	Test Date	6/8/2012
Procedure	A	Volume of Mold (ft^3)	0.033
Weight of Hammer (lb)	5.5	Hammer Drop (in)	12
No. of Blows per Layer	25	No. of Layers	3

Test No.	WT of Mold	WT of Mold + Wet Soil	WT of Wet Soil	Wet Unit Weight	Water Content	Dry Unit Weight
	(lb)	(lb)	(lb)	(pcf)	(%)	(pcf)
1	9.48	13.27	3.79	113.56	14.2	99.45
2	9.48	13.59	4.11	123.19	17.8	104.56
3	9.48	13.67	4.19	125.74	21.2	103.76
4	9.48	13.56	4.08	122.43	23.7	98.95
5	9.48	13.44	3.96	118.87	26.9	93.64

Test No	#1	#2	#3	#4	#5
Can No.	SL	7	W3	62	A3
WT of Can (g)	31.8	24.7	24.6	31.2	25.1
WT of Can + Wet Soil (g)	172.6	147	143	163.1	162.2
WT of Can + Dry Soil (g)	155.1	128.5	122.3	137.8	133.1
Water Content (%)	14.2	17.8	21.2	23.7	26.9

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STANDARD PROCTOR COMPACTION TEST

(ASTM D 698)

Sample I.D.	**E8_(B1/B2)**	Test Date	6/10/2012
Procedure	C	Volume of Mold (ft^3)	0.075
Weight of Hammer (lb)	5.5	Hammer Drop (in)	12
No. of Blows per Layer	56	No. of Layers	3

Test No.	WT of Mold	WT of Mold + Wet Soil	WT of Wet Soil	Wet Unit Weight	Water Content	Dry Unit Weight
	(lb)	(lb)	(lb)	(pcf)	(%)	(pcf)
1	14.20	24.23	10.03	133.67	8.7	122.98
2	14.20	24.54	10.34	137.93	10.5	124.82
3	14.20	24.44	10.24	136.59	12.2	121.75
4	14.20	24.25	10.05	134.03	13.8	117.81
5			0.00	0.00	#DIV/0!	#DIV/0!

Test No	#1	#2	#3	#4	#5
Can No.	J4	EA	TR3L	2 - 4	
WT of Can (g)	24.9	31.2	24.6	30.9	
WT of Can + Wet Soil (g)	176.2	160.6	166.3	159.8	
WT of Can + Dry Soil (g)	164.1	148.3	150.9	144.2	
Water Content (%)	8.7	10.5	12.2	13.8	#DIV/0!

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STANDARD PROCTOR COMPACTION TEST

(ASTM D 698)

Sample I.D.	**W2_(B1/B2)**	Test Date	6/10/2012
Procedure	C	Volume of Mold (ft^3)	0.075
Weight of Hammer (lb)	5.5	Hammer Drop (in)	12
No. of Blows per Layer	56	No. of Layers	3

Test No.	WT of Mold (lb)	WT of Mold + Wet Soil (lb)	WT of Wet Soil (lb)	Wet Unit Weight (pcf)	Water Content (%)	Dry Unit Weight (pcf)
1	14.20	23.93	9.73	129.71	6.0	122.41
2	14.20	24.54	10.34	137.82	8.1	127.48
3	14.20	24.60	10.40	138.69	9.3	126.88
4	14.20	24.42	10.22	136.28	11.0	122.73
5			0	0	#DIV/0!	#DIV/0!

Test No	#1	#2	#3	#4	#5
Can No.	T4	28	14	3	
WT of Can (g)	24.5	24.5	30.6	31.1	
WT of Can + Wet Soil (g)	189.8	175.1	212.6	216.2	
WT of Can + Dry Soil (g)	180.5	163.8	197.1	197.8	
Water Content (%)	6.0	8.1	9.3	11.0	#DIV/0!

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STANDARD PROCTOR COMPACTION TEST

(ASTM D 698)

Sample I.D.	**W5_(B1/B2)**	Test Date	6/10/2012
Procedure	C	Volume of Mold (ft^3)	0.075
Weight of Hammer (lb)	5.5	Hammer Drop (in)	12
No. of Blows per Layer	56	No. of Layers	3

Test No.	WT of Mold	WT of Mold + Wet Soil	WT of Wet Soil	Wet Unit Weight	Water Content	Dry Unit Weight
	(lb)	(lb)	(lb)	(pcf)	(%)	(pcf)
1	14.20	23.26	9.06	120.85	5.5	114.51
2	14.20	23.60	9.40	125.28	6.9	117.22
3	14.20	24.27	10.07	134.21	10.1	121.91
4	14.20	24.28	10.08	134.39	11.9	120.14
5	14.20	24.02	9.82	130.90	15.1	113.70

Test No	#1	#2	#3	#4	#5
Can No.	21	Y1	5	W3	29
WT of Can (g)	31.1	30.9	24.3	24.7	30.7
WT of Can + Wet Soil (g)	196.9	208.1	164	171.8	184.4
WT of Can + Dry Soil (g)	188.2	196.7	151.2	156.2	164.2
Water Content (%)	5.5	6.9	10.1	11.9	15.1

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STANDARD PROCTOR COMPACTION TEST

(ASTM D 698)

Sample I.D.	**W8_(A1/A2)**	Test Date	6/9/2012
Procedure	C	Volume of Mold (ft^3)	0.075
Weight of Hammer (lb)	5.5	Hammer Drop (in)	12
No. of Blows per Layer	56	No. of Layers	3

Test No.	WT of Mold (lb)	WT of Mold + Wet Soil (lb)	WT of Wet Soil (lb)	Wet Unit Weight (pcf)	Water Content (%)	Dry Unit Weight (pcf)
1	14.20	22.99	8.79	117.16	6.7	109.79
2	14.20	23.55	9.35	124.72	9.5	113.90
3	14.20	23.95	9.75	130.00	11.3	116.81
4	14.20	24.13	9.93	132.43	14.4	115.80
5	14.20	23.74	9.54	127.15	16.7	108.97

Test No	#1	#2	#3	#4	#5
Can No.	W81	B	29	2-4	J4
WT of Can (g)	24.7	30.9	30.7	30.9	24.9
WT of Can + Wet Soil (g)	185.3	175	174.6	179.8	186.5
WT of Can + Dry Soil (g)	175.2	162.5	160	161.1	163.4
Water Content (%)	6.7	9.5	11.3	14.4	16.7

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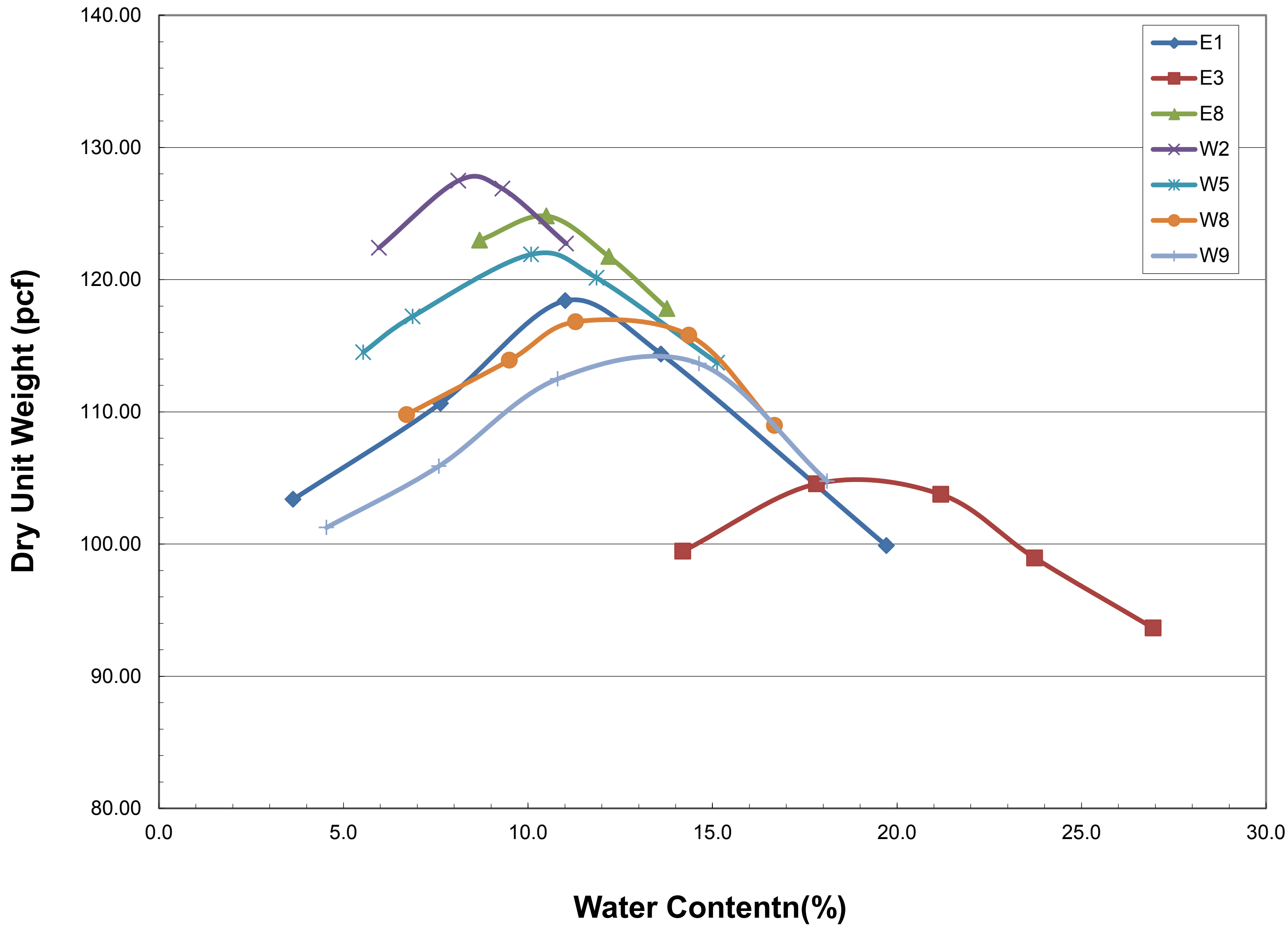
STANDARD PROCTOR COMPACTION TEST

(ASTM D 698)

Sample I.D.	**W9_(B1/B2)**	Test Date	6/10/2012
Procedure	A	Volume of Mold (ft^3)	0.033
Weight of Hammer (lb)	5.5	Hammer Drop (in)	12
No. of Blows per Layer	25	No. of Layers	3

Test No.	WT of Mold	WT of Mold + Wet Soil	WT of Wet Soil	Wet Unit Weight	Water Content	Dry Unit Weight
	(lb)	(lb)	(lb)	(pcf)	(%)	(pcf)
1	9.47	13.00	3.53	105.85	4.5	101.25
2	9.47	13.27	3.80	113.92	7.6	105.89
3	9.47	13.62	4.15	124.64	10.8	112.49
4	9.47	13.81	4.34	130.28	14.6	113.65
5	9.47	13.59	4.12	123.72	18.1	104.76

Test No	#1	#2	#3	#4	#5
Can No.	B26	SL	7	X2	R17-3
WT of Can (g)	30.8	31.8	24.7	30.8	30.8
WT of Can + Wet Soil (g)	201.1	187.8	161.1	185.1	169.1
WT of Can + Dry Soil (g)	193.7	176.8	147.8	165.4	147.9
Water Content (%)	4.5	7.6	10.8	14.6	18.1



140.00
130.00
120.00
110.00
100.00
90.00
80.00
0.0
5.0
10.0
15.0
20.0
25.0
30.0
Dry Unit Weight (pcf)
Water Contentn(%)
E1
E3
E8
W2
W5
W8
W9

Wisconsin Geotechnics Laboratory

Hydraulic Conductivity Test

ASTM D 5084

Sample I.D.	**E1_(A1/A2)**	**Test Date :**	**7/17/12**

Cell Pressure =	35.8	psi	Diameter of Sample, D =	15.2	cm
Inflow Pressure =	31.6	psi	Length of Sample, L =	11.6	cm
Outflow Pressre =	30.0	psi	Area of Sample, A =	182.41	cm^2
Pressure Difference =	1.6	psi	Sample Volume, V =	2123.9	cm^3
Effective Stress =	5.0	psi	a_{in} =	5	cm^2
Hydraulic Gradient, i =	10		a_{out} =	5	cm^2
Weight of wet sample =	3787.6	(g)	Sample Water Content =	11.0	(%)
Wet Density =	1.8	g/cm^3	Dry Density =	1.61	g/cm^3

$$K_s = \frac{a_{in} * a_{out}}{(a_{in} + a_{out})} \frac{L}{A * \Delta t} Ln\left\{\frac{(\Delta H_1)}{(\Delta H_2)}\right\}$$

Can #	WT of Can	WT of Can + Wet Soil	WT of Can + Dry Soil	Water Content
	(g)	(g)	(g)	(%)
				11.00

Date, Time	Inflow	OutFlow	Δt	H	Time	K	Q_{out} / Q_{in}	Q_{in}	Q_{out}
			(sec)	(cm)	(min)	(cm/sec)			
8:23:00	4.8	20.5	0.0	15.7	0.0				
8:25:00	11.0	14.5	120.0	3.5	2.0	1.33E-04	1.0	31	30
8:26:00	14.0	11.5	60.0	-2.5	3.0	1.41E-04	1.0	15	15
8:27:00	16.6	9.1	60.0	-7.5	4.0	1.24E-04	0.9	13	12
8:28:00	19.0	7.0	60.0	-12.0	5.0	1.16E-04	0.9	12	10.5
8:29:00	21.2	4.6	60.0	-16.6	6.0	1.25E-04	1.1	11	12
8:30:00	23.4	2.7	60.0	-20.7	7.0	1.16E-04	0.9	11	9.5
8:32:00	0.0	24.7	120.0	24.7	9.0				
8:33:00	3.8	21.0	60.0	17.2	10.0	1.49E-04	1.0	19	18.5
8:34:00	7.3	17.5	60.0	10.2	11.0	1.48E-04	1.0	17.5	17.5
8:35:00	10.5	14.5	60.0	4.0	12.0	1.38E-04	0.9	16	15
8:36:00	13.5	12.0	60.0	-1.5	13.0	1.29E-04	0.8	15	12.5
8:37:00	16.0	9.2	60.0	-6.8	14.0	1.30E-04	1.1	12.5	14
8:38:00	18.8	6.8	60.0	-12.0	15.0	1.34E-04	0.9	14	12
8:39:00	21.0	4.6	60.0	-16.4	16.0	1.19E-04	1.0	11	11
8:40:00	23.2	2.6	60.0	-20.6	17.0	1.19E-04	0.9	11	10
8:42:00	0.0	24.0	120.0	24.0	19.0				
8:43:00	4.0	20.0	60.0	16.0	20.0	1.61E-04	1.0	20	20
8:44:00	7.5	16.8	60.0	9.3	21.0	1.42E-04	0.9	17.5	16
8:45:00	10.8	13.8	60.0	3.0	22.0	1.41E-04	0.9	16.5	15
8:46:00	13.7	11.0	60.0	-2.7	23.0	1.35E-04	1.0	14.5	14
8:47:00	16.4	8.4	60.0	-8.0	24.0	1.32E-04	1.0	13.5	13
8:48:00	19.0	6.0	60.0	-13.0	25.0	1.30E-04	0.9	13	12
8:49:00	21.3	3.8	60.0	-17.5	26.0	1.23E-04	1.0	11.5	11
8:50:00	23.6	1.6	60.0	-22.0	27.0	1.29E-04	1.0	11.5	11

K (cm/s) = 1.3E-04

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Hydraulic Conductivity Test

ASTM D 5084

Sample I.D.	E3_(A1/A2)	Test Date :	7/17/12

Cell Pressure =	35.8	psi	Diameter of Sample, D =	15.2	cm
Inflow Pressure =	31.6	psi	Length of Sample, L =	11.6	cm
Outflow Pressre =	30.0	psi	Area of Sample, A =	182.41	cm^2
Pressure Difference =	1.6	psi	Sample Volume, V =	2123.9	cm^3
Effective Stress =	5.0	psi	a_{in} =	5	cm^2
Hydraulic Gradient, i =	10		a_{out} =	5	cm^2
Weight of wet sample =	3615.2	(g)	Sample Water Content =	19.0	(%)
Wet Density =	1.7	g/cm^3	Dry Density =	1.43	g/cm^3

$$K_s = \frac{a_{in} * a_{out}}{(a_{in} + a_{out})} \frac{L}{A * \Delta t} Ln\left\{\frac{(\Delta H_1)}{(\Delta H_2)}\right\}$$

Can #	WT of Can	WT of Can + Wet Soil	WT of Can + Dry Soil	Water Content
	(g)	(g)	(g)	(%)
				19.00

Date, Time	Inflow	OutFlow	Δt	H	Time	K	Q_{out} / Q_{in}	Q_{in}	Q_{out}
			(sec)	(cm)	(min)	(cm/sec)			
9:05	0.0	24.0	0.0	24.0	0.0				
9:06	2.7	21.5	60.0	18.8	1.0	1.03E-04	0.9	13.5	12.5
9:07	5.2	19.0	60.0	13.8	2.0	1.03E-04	1.0	12.5	12.5
9:08	7.5	16.5	60.0	9.0	3.0	1.03E-04	1.1	11.5	12.5
9:09	9.8	14.2	60.0	4.4	4.0	1.03E-04	1.0	11.5	11.5
9:10	12.0	12.0	60.0	0.0	5.0	1.02E-04	1.0	11	11
9:11	14.0	10.0	60.0	-4.0	6.0	9.63E-05	1.0	10	10
9:12	15.8	8.0	60.0	-7.8	7.0	9.48E-05	1.1	9	10
9:13	17.8	6.0	60.0	-11.8	8.0	1.04E-04	1.0	10	10
9:14	19.5	4.2	60.0	-15.3	9.0	9.41E-05	1.1	8.5	9
9:15	21.0	2.5	60.0	-18.5	10.0	8.90E-05	1.1	7.5	8.5
9:16	22.8	1.0	60.0	-21.8	11.0	9.50E-05	0.8	9	7.5
9:18	0.0	24.5	120.0	24.5	13.0				
9:19	2.8	21.5	60.0	18.7	14.0	1.15E-04	1.1	14	15
9:20	5.6	19.0	60.0	13.4	15.0	1.10E-04	0.9	14	12.5
9:21	7.6	16.4	60.0	8.8	16.0	9.90E-05	1.3	10	13
9:22	10.0	14.0	60.0	4.0	17.0	1.07E-04	1.0	12	12
9:23	12.2	11.8	60.0	-0.4	18.0	1.02E-04	1.0	11	11
9:24	14.6	9.5	60.0	-5.1	19.0	1.14E-04	1.0	12	11.5
9:25	16.7	7.6	60.0	-9.1	20.0	1.01E-04	0.9	10.5	9.5
9:26	18.0	5.6	60.0	-12.4	21.0	8.62E-05	1.5	6.5	10
9:27	19.9	4.1	60.0	-15.8	22.0	9.19E-05	0.8	9.5	7.5
9:28	21.6	2.0	60.0	-19.6	23.0	1.07E-04	1.2	8.5	10.5
9:29	23.3	0.4	60.0	-22.9	24.0	9.62E-05	0.9	8.5	8

K (cm/s) = 9.5E-05

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Hydraulic Conductivity Test

ASTM D 5084

Sample I.D.	**W2_(B1/B2)**	**Test Date :**	**7/17/12**

Cell Pressure =	35.8	psi	Diameter of Sample, D =	15.2	cm
Inflow Pressure =	31.6	psi	Length of Sample, L =	11.6	cm
Outflow Pressre =	30.0	psi	Area of Sample, A =	182.41	cm^2
Pressure Difference =	1.6	psi	Sample Volume, V =	2123.9	cm^3
Effective Stress =	5.0	psi	a_{in} =	5	cm^2
Hydraulic Gradient, i =	10		a_{out} =	5	cm^2
Weight of wet sample =	4018.9	(g)	Sample Water Content =	8.5	(%)
Wet Density =	1.9	g/cm^3	Dry Density =	1.74	g/cm^3

$$K_s = \frac{a_{in} * a_{out}}{(a_{in} + a_{out})} \frac{L}{A * \Delta t} Ln\left\{\frac{(\Delta H_1)}{(\Delta H_2)}\right\}$$

Can #	WT of Can	WT of Can + Wet Soil	WT of Can + Dry Soil	Water Content
	(g)	(g)	(g)	(%)
				8.50

Date, Time	**Inflow**	**OutFlow**	**Δt**	**H**	**Time**	**K**	**Q_{out} / Q_{in}**	**Q_{in}**	**Q_{out}**
			(sec)	**(cm)**	**(min)**	**(cm/sec)**			
10:00:00	0.0	24.5	0.0	24.5	0.0				
10:00:10	6.4	18.0	10.0	11.6	0.2	1.58E-03	1.0	32	32.5
10:00:20	11.6	12.5	10.0	0.9	0.3	1.44E-03	1.1	26	27.5
10:00:30	16.4	7.5	10.0	-8.9	0.5	1.44E-03	1.0	24	25
10:00:40	20.6	3.0	10.0	-17.6	0.7	1.40E-03	1.1	21	22.5
10:03:00	0.0	24.5	140.0	24.5	3.0				
10:03:10	6.2	18.0	10.0	11.8	3.2	1.55E-03	1.0	31	32.5
10:03:20	11.4	12.6	10.0	1.2	3.3	1.42E-03	1.0	26	27
10:03:30	16.2	7.6	10.0	-8.6	3.5	1.44E-03	1.0	24	25
10:03:40	20.6	2.9	10.0	-17.7	3.7	1.46E-03	1.1	22	23.5
10:07:00	0.0	24.6	200.0	24.6	7.0			-103	
10:07:10	5.9	18.7	10.0	12.8	7.2	1.44E-03	1.0	29.5	29.5
10:07:20	11.2	12.9	10.0	1.7	7.3	1.48E-03	1.1	26.5	29
10:07:30	15.9	7.8	10.0	-8.1	7.5	1.43E-03	1.1	23.5	25.5
10:07:40	20.5	3.2	10.0	-17.3	7.7	1.47E-03	1.0	23	23
10:11:00	0.0	24.6	200.0	24.6	11.0				
10:11:10	5.8	18.7	10.0	12.9	11.2	1.42E-03	1.0	29	29.5
10:11:20	11.0	13.0	10.0	2.0	11.3	1.45E-03	1.1	26	28.5
10:11:30	15.9	8.0	10.0	-7.9	11.5	1.44E-03	1.0	24.5	25
10:11:40	20.4	3.3	10.0	-17.1	11.7	1.47E-03	1.0	22.5	23.5
10:15:00	0.0	24.5	200.0	24.5	15.0				
10:15:10	5.9	18.5	10.0	12.6	15.2	1.45E-03	1.0	29.5	30
10:15:20	11.0	12.9	10.0	1.9	15.3	1.43E-03	1.1	25.5	28
10:15:30	16.0	7.9	10.0	-8.1	15.5	1.46E-03	1.0	25	25
10:15:40	20.5	3.0	10.0	-17.5	15.7	1.51E-03	1.1	22.5	24.5
10:20:00	0.0	24.7	260.0	24.7	20.0				
10:20:10	6.0	18.8	10.0	12.8	20.2	1.45E-03	1.0	30	29.5
10:20:20	11.5	13.2	10.0	1.7	20.3	1.48E-03	1.0	27.5	28
10:20:30	16.3	8.0	10.0	-8.3	20.5	1.46E-03	1.1	24	26
10:20:40	20.8	3.3	10.0	-17.5	20.7	1.47E-03	1.0	22.5	23.5

K (cm/s) = 1.5E-03

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Hydraulic Conductivity Test

ASTM D 5084

Sample I.D.	W5_(B1/B2)	Test Date :	7/17/12

Cell Pressure =	35.8	psi	Diameter of Sample, D =	15.2	cm
Inflow Pressure =	31.6	psi	Length of Sample, L =	11.6	cm
Outflow Pressre =	30.0	psi	Area of Sample, A =	182.41	cm^2
Pressure Difference =	1.6	psi	Sample Volume, V =	2123.9	cm^3
Effective Stress =	5.0	psi	a_{in} =	5	cm^2
Hydraulic Gradient, i =	10		a_{out} =	5	cm^2
Weight of wet sample =	3878.3	(g)	Sample Water Content =	10.0	(%)
Wet Density =	1.8	g/cm^3	Dry Density =	1.66	g/cm^3

$$K_s = \frac{a_{in} * a_{out}}{(a_{in} + a_{out})} \frac{L}{A * \Delta t} Ln\left\{\frac{(\Delta H_1)}{(\Delta H_2)}\right\}$$

Can #	WT of Can	WT of Can + Wet Soil	WT of Can + Dry Soil	Water Content
	(g)	(g)	(g)	(%)
				10.00

Date, Time	Inflow	OutFlow	Δt	H	Time	K	Q_{out} / Q_{in}	Q_{in}	Q_{out}
			(sec)	(cm)	(min)	(cm/sec)			
10:56:00	0.0	24.2	0.0	24.2	0.0				
10:56:10	5.4	18.8	10.0	13.4	0.2	1.31E-03	1.0	27	27
10:56:20	9.4	14.8	10.0	5.4	0.3	1.05E-03	1.0	20	20
10:56:30	12.9	11.2	10.0	-1.7	0.5	9.91E-04	1.0	17.5	18
10:56:40	16.4	7.8	10.0	-8.6	0.7	1.03E-03	1.0	17.5	17
10:56:50	19.6	4.6	10.0	-15.0	0.8	1.01E-03	1.0	16	16
10:57:00	22.3	1.8	10.0	-20.5	1.0	9.26E-04	1.0	13.5	14
11:00:00	0.0	24.2	180.0	24.2	4.0				
11:00:10	5.0	19.2	10.0	14.2	4.2	1.21E-03	1.0	25	25
11:00:20	9.0	15.0	10.0	6.0	4.3	1.07E-03	1.1	20	21
11:00:30	13.0	11.2	10.0	-1.8	4.5	1.09E-03	1.0	20	19
11:00:40	16.5	7.7	10.0	-8.8	4.7	1.04E-03	1.0	17.5	17.5
11:00:50	19.7	4.4	10.0	-15.3	4.8	1.03E-03	1.0	16	16.5
11:01:00	22.8	1.4	10.0	-21.4	5.0	1.03E-03	1.0	15.5	15
11:05:00	0.0	24.5	240.0	24.5	9.0				
11:05:10	4.7	19.8	10.0	15.1	9.2	1.13E-03	1.0	23.5	23.5
11:05:20	8.9	15.6	10.0	6.7	9.3	1.09E-03	1.0	21	21
11:05:30	12.8	11.6	10.0	-1.2	9.5	1.09E-03	1.0	19.5	20
11:05:40	16.6	8.0	10.0	-8.6	9.7	1.10E-03	0.9	19	18
11:05:50	19.7	4.8	10.0	-14.9	9.8	9.98E-04	1.0	15.5	16
11:06:00	22.7	1.8	10.0	-20.9	10.0	1.01E-03	1.0	15	15
11:12:00	0.0	24.5	360.0	24.5	16.0				
11:12:10	4.8	19.8	10.0	15.0	16.2	1.15E-03	1.0	24	23.5
11:12:20	8.9	15.5	10.0	6.6	16.3	1.09E-03	1.0	20.5	21.5
11:12:30	12.8	11.6	10.0	-1.2	16.5	1.08E-03	1.0	19.5	19.5
11:12:40	16.3	8.1	10.0	-8.2	16.7	1.04E-03	1.0	17.5	17.5
11:12:50	19.6	4.8	10.0	-14.8	16.8	1.04E-03	1.0	16.5	16.5
11:13:00	22.6	1.8	10.0	-20.8	17.0	1.01E-03	1.0	15	15
11:17:00	0.0	24.5	240.0	24.5	21.0				
11:17:10	4.7	19.7	10.0	15.0	21.2	1.15E-03	1.0	23.5	24
11:17:20	8.9	16.5	10.0	7.6	21.3	9.54E-04	0.8	21	16
11:17:30	12.9	11.6	10.0	-1.3	21.5	1.23E-03	1.2	20	24.5
11:17:40	16.5	8.0	10.0	-8.5	21.7	1.07E-03	1.0	18	18
11:17:50	19.8	4.7	10.0	-15.1	21.8	1.05E-03	1.0	16.5	16.5
11:18:00	22.7	1.7	10.0	-21.0	22.0	9.97E-04	1.0	14.5	15

K (cm/s) = 1.1E-03

Wisconsin Geotechnics Laboratory

Hydraulic Conductivity Test

ASTM D 5084

Sample I.D.	W8_(A1/A2)	Test Date :	7/17/12

Cell Pressure =	35.8	psi	Diameter of Sample, D =	15.2	cm
Inflow Pressure =	31.6	psi	Length of Sample, L =	11.6	cm
Outflow Pressre =	30.0	psi	Area of Sample, A =	182.41	cm^2
Pressure Difference =	1.6	psi	Sample Volume, V =	2123.9	cm^3
Effective Stress =	5.0	psi	a_{in} =	5	cm^2
Hydraulic Gradient, i =	10		a_{out} =	5	cm^2
Weight of wet sample =	3823.8	(g)	Sample Water Content =	13.0	(%)
Wet Density =	1.8	g/cm^3	Dry Density =	1.59	g/cm^3

$$K_s = \frac{a_{in} * a_{out}}{(a_{in} + a_{out})} \frac{L}{A * \Delta t} Ln\left\{\frac{(\Delta H_1)}{(\Delta H_2)}\right\}$$

Can #	WT of Can	WT of Can + Wet Soil	WT of Can + Dry Soil	Water Content
	(g)	(g)	(g)	(%)
				13.00

Date, Time	Inflow	OutFlow	Δt	H	Time	K	Q_{out} / Q_{in}	Q_{in}	Q_{out}
			(sec)	(cm)	(min)	(cm/sec)			
11:41:00	0.0	24.5	0.0	24.5	0.0				
11:41:10	5.3	19.6	10.0	14.3	0.2	1.23E-03	0.9	26.5	24.5
11:41:20	10.0	14.8	10.0	4.8	0.3	1.24E-03	1.0	23.5	24
11:41:30	14.4	10.5	10.0	-3.9	0.5	1.23E-03	1.0	22	21.5
11:41:40	18.3	6.4	10.0	-11.9	0.7	1.22E-03	1.1	19.5	20.5
11:41:50	21.8	3.0	10.0	-18.8	0.8	1.13E-03	1.0	17.5	17
11:45:00	0.0	24.0	190.0	24.0	4.0				
11:45:10	4.9	19.0	10.0	14.1	4.2	1.20E-03	1.0	24.5	25
11:45:20	9.5	14.3	10.0	4.8	4.3	1.22E-03	1.0	23	23.5
11:45:30	13.8	10.0	10.0	-3.8	4.5	1.21E-03	1.0	21.5	21.5
11:45:40	17.6	6.1	10.0	-11.5	4.7	1.17E-03	1.0	19	19.5
11:45:50	21.0	2.7	10.0	-18.3	4.8	1.11E-03	1.0	17	17
11:48:00	0.0	24.0	130.0	24.0	7.0				
11:48:10	4.9	19.0	10.0	14.1	7.2	1.20E-03	1.0	24.5	25
11:48:20	9.4	15.5	10.0	6.1	7.3	1.04E-03	0.8	22.5	17.5
11:48:30	13.5	10.3	10.0	-3.2	7.5	1.30E-03	1.3	20.5	26
11:48:40	17.4	6.4	10.0	-11.0	7.7	1.18E-03	1.0	19.5	19.5
11:48:50	20.9	2.9	10.0	-18.0	7.8	1.14E-03	1.0	17.5	17.5
11:55:00	0.0	24.5	370.0	24.5	14.0				
11:55:10	4.9	19.5	10.0	14.6	14.2	1.20E-03	1.0	24.5	25
11:55:20	9.5	14.9	10.0	5.4	14.3	1.20E-03	1.0	23	23
11:55:30	13.6	10.8	10.0	-2.8	14.5	1.15E-03	1.0	20.5	20.5
11:55:40	17.4	7.0	10.0	-10.4	14.7	1.15E-03	1.0	19	19
11:55:50	20.9	3.4	10.0	-17.5	14.8	1.15E-03	1.0	17.5	18
12:00:00	0.0	24.5	250.0	24.5	19.0				
12:00:10	4.9	19.5	10.0	14.6	19.2	1.20E-03	1.0	24.5	25
12:00:20	9.2	14.9	10.0	5.7	19.3	1.16E-03	1.1	21.5	23
12:00:30	13.3	11.0	10.0	-2.3	19.5	1.12E-03	1.0	20.5	19.5
12:00:40	17.2	6.9	10.0	-10.3	19.7	1.20E-03	1.1	19.5	20.5
12:00:50	20.9	3.3	10.0	-17.6	19.8	1.18E-03	1.0	18.5	18

K (cm/s) = 1.2E-03

Wisconsin Geotechnics Laboratory

Hydraulic Conductivity Test

ASTM D 5084 - 00

Sample I.D.	W9_(B1/B2)	Test Date :	7/17/12

Cell Pressure =	35.8	psi	Diameter of Sample, D =	15.2	cm
Inflow Pressure =	31.6	psi	Length of Sample, L =	11.6	cm
Outflow Pressre =	30.0	psi	Area of Sample, A =	182.41	cm^2
Pressure Difference =	1.6	psi	Sample Volume, V =	2123.9	cm^3
Effective Stress =	5.0	psi	a_{in} =	5	cm^2
Hydraulic Gradient, i =	10		a_{out} =	5	cm^2
Weight of wet sample =	3792.1	(g)	Sample Water Content =	14.0	(%)
Wet Density =	1.8	g/cm^3	Dry Density =	1.57	g/cm^3

$$K_s = \frac{a_{in} * a_{out}}{(a_{in} + a_{out})} \frac{L}{A * \Delta t} Ln\left\{\frac{(\Delta H_1)}{(\Delta H_2)}\right\}$$

Can #	WT of Can	WT of Can + Wet Soil	WT of Can + Dry Soil	Water Content
	(g)	(g)	(g)	(%)
				14.00

Date, Time	Inflow	OutFlow	Δt	H	Time	K	Q_{out} / Q_{in}	Q_{in}	Q_{out}
			(sec)	(cm)	(min)	(cm/sec)			
13:01:00	0.0	24.0	0.0	24.0	0.0				
13:01:10	1.8	22.6	10.0	20.8	0.2	3.78E-04	0.8	9	7
13:01:20	3.4	21.0	10.0	17.6	0.3	3.88E-04	1.0	8	8
13:01:30	5.0	19.6	10.0	14.6	0.5	3.72E-04	0.9	8	7
13:01:40	6.5	18.0	10.0	11.5	0.7	3.94E-04	1.1	7.5	8
13:01:50	8.0	16.6	10.0	8.6	0.8	3.78E-04	0.9	7.5	7
13:02:00	9.4	15.1	10.0	5.7	1.0	3.87E-04	1.1	7	7.5
13:02:10	10.9	13.8	10.0	2.9	1.2	3.82E-04	0.9	7.5	6.5
13:02:20	12.2	12.4	10.0	0.2	1.3	3.78E-04	1.1	6.5	7
13:02:30	13.6	11.0	10.0	-2.6	1.5	4.01E-04	1.0	7	7
13:02:40	14.9	9.8	10.0	-5.1	1.7	3.67E-04	0.9	6.5	6
13:02:50	16.2	8.5	10.0	-7.7	1.8	3.91E-04	1.0	6.5	6.5
13:03:00	17.5	7.2	10.0	-10.3	2.0	4.01E-04	1.0	6.5	6.5
13:03:10	18.8	6.0	10.0	-12.8	2.2	3.95E-04	0.9	6.5	6
13:03:20	20.0	4.9	10.0	-15.1	2.3	3.72E-04	0.9	6	5.5
13:03:30	21.0	3.8	10.0	-17.2	2.5	3.48E-04	1.1	5	5.5
13:03:40	22.3	2.6	10.0	-19.7	2.7	4.24E-04	0.9	6.5	6
13:03:50	23.6	1.5	10.0	-22.1	2.8	4.18E-04	0.8	6.5	5.5
13:07:00	0.0	24.0	190.0	24.0	6.0				
13:07:20	3.6	20.5	20.0	16.9	6.3	4.26E-04	1.0	18	17.5
13:07:40	6.9	17.1	20.0	10.2	6.7	4.24E-04	1.0	16.5	17
13:08:00	9.9	14.3	20.0	4.4	7.0	3.86E-04	0.9	15	14
13:08:20	12.8	11.6	20.0	-1.2	7.3	3.92E-04	0.9	14.5	13.5
13:08:40	15.4	8.8	20.0	-6.6	7.7	3.97E-04	1.1	13	14
13:09:00	18.0	6.3	20.0	-11.7	8.0	3.94E-04	1.0	13	12.5
13:09:20	20.5	3.8	20.0	-16.7	8.3	4.06E-04	1.0	12.5	12.5
13:09:40	23.0	1.6	20.0	-21.4	8.7	4.01E-04	0.9	12.5	11
13:13:00	0.0	24.0	200.0	24.0	12.0				
13:13:30	5.0	19.0	30.0	14.0	12.5	4.05E-04	1.0	25	25
13:14:00	9.7	14.3	30.0	4.6	13.0	4.11E-04	1.0	23.5	23.5
13:14:30	14.0	10.0	30.0	-4.0	13.5	4.06E-04	1.0	21.5	21.5
13:15:00	18.0	6.2	30.0	-11.8	14.0	3.97E-04	1.0	20	19
13:15:30	21.8	2.6	30.0	-19.2	14.5	4.06E-04	0.9	19	18
13:20:00	0.0	24.5	270.0	24.5	19.0				

13:20:20	3.5	21.0	20.0	17.5	19.3	4.18E-04	1.0	17.5	17.5
13:20:40	6.7	17.8	20.0	11.1	19.7	4.03E-04	1.0	16	16
13:21:00	9.9	14.7	20.0	4.8	20.0	4.17E-04	1.0	16	15.5
13:21:20	12.9	11.8	20.0	-1.1	20.3	4.12E-04	1.0	15	14.5
13:21:40	15.7	9.2	20.0	-6.5	20.7	3.96E-04	0.9	14	13
13:22:00	18.3	6.6	20.0	-11.7	21.0	4.01E-04	1.0	13	13
13:22:20	20.9	4.0	20.0	-16.9	21.3	4.22E-04	1.0	13	13
					K (cm/s) =	**4.1E-04**			

Geotechnics Laboratory
University of Wisconsin-Madison
Pressure Plate Extractor Test

ASTM D 6836 - 02 (Method B)

Sample I.D.	**E1_(A1/A2)**		**Test Date**		
WT of Sample Ring =	70.9	g	G_s =	2.61	6/16/2012
Provided Dry Density, γ_d =	100.3	pcf			
Provided Water Content, w =	11.0	%			
Diameter of Sample Ring, D =	7.26	cm			
Height of Sample Ring, L =	2.54	cm			
Sample Volume, V =	105.27	cm^3			
After Saturation, Sample Height Swell	-0.02	cm			
After Saturation, Sample Dry Density	1.62	(g/cm^3)			
Saturaded Water Content, w =	23.4	%			
Saturaded Water Content, θ =	37.92	%			

Applied Pressure	**Reading**	**Suction**	**Gravimetric Water Content**	**Volumetric Water Content**
(psi)	**(cm)**	**(kPa)**		
0	4	0.001	0.234	0.379
0.25	3.2	1.724	0.235	0.381
0.5	4.1	3.449	0.234	0.379
1	8	6.897	0.230	0.372
2	28.4	13.794	0.207	0.335
4	80.5	27.588	0.148	0.240
8	96.5	55.176	0.130	0.211
15	108.5	103.455	0.117	0.189
30	116	206.910	0.108	0.175
61	120	420.717	0.104	0.168
		0.000	0.239	0.386
		0.000	0.239	0.386
	Activity Meter Test	360.00	0.066	0.106
		4090.00	0.042	0.068
		49640.00	0.022	0.035

Activity Meter Test

Suction	Wt of Can	Wt of Can + Wet Soil	Wt of Can + Dry Soil	Gravimetric Water Content	Volumetric Water Content
(Mpa)	(g)	(g)	(g)		
49.64	7.6704	15.1835	15.0238	0.022	0.035
4.09	7.7126	15.3462	15.037	0.042	0.068
0.36	8.0127	15.8145	15.3346	0.066	0.106

Fit van Genuchten Eqn to SWCC Data

van Genuchten Eqn

$$\Theta = \frac{\theta - \theta_r}{\theta_s - \theta_r} = \left[\frac{1}{1+(\alpha\psi)^n}\right]^m$$

θ_r =	0.0236
θ_s =	0.3792
α =	0.0797
n =	1.3495
m =	0.2590

FOR FITTING

Applied Suction (kPa)	Measured VWC	Predicted VWC	ΔWC (%)	$(\Delta WC)^2$
0.001	0.379	0.3792	0.000	0.000
1.72	0.381	0.3731	0.008	0.000
3.45	0.379	0.3646	0.014	0.000
6.90	0.372	0.3468	0.025	0.001
13.79	0.335	0.3157	0.019	0.000
27.59	0.240	0.2736	-0.034	0.001
55.18	0.211	0.2287	-0.018	0.000
103.46	0.189	0.1913	-0.002	0.000
206.91	0.175	0.1563	0.019	0.000
420.72	0.168	0.1276	0.041	0.002
360.00	0.106	0.1333	-0.027	0.001
4090.00	0.068	0.0707	-0.002	0.000
49640.00	0.035	0.0433	-0.008	0.000

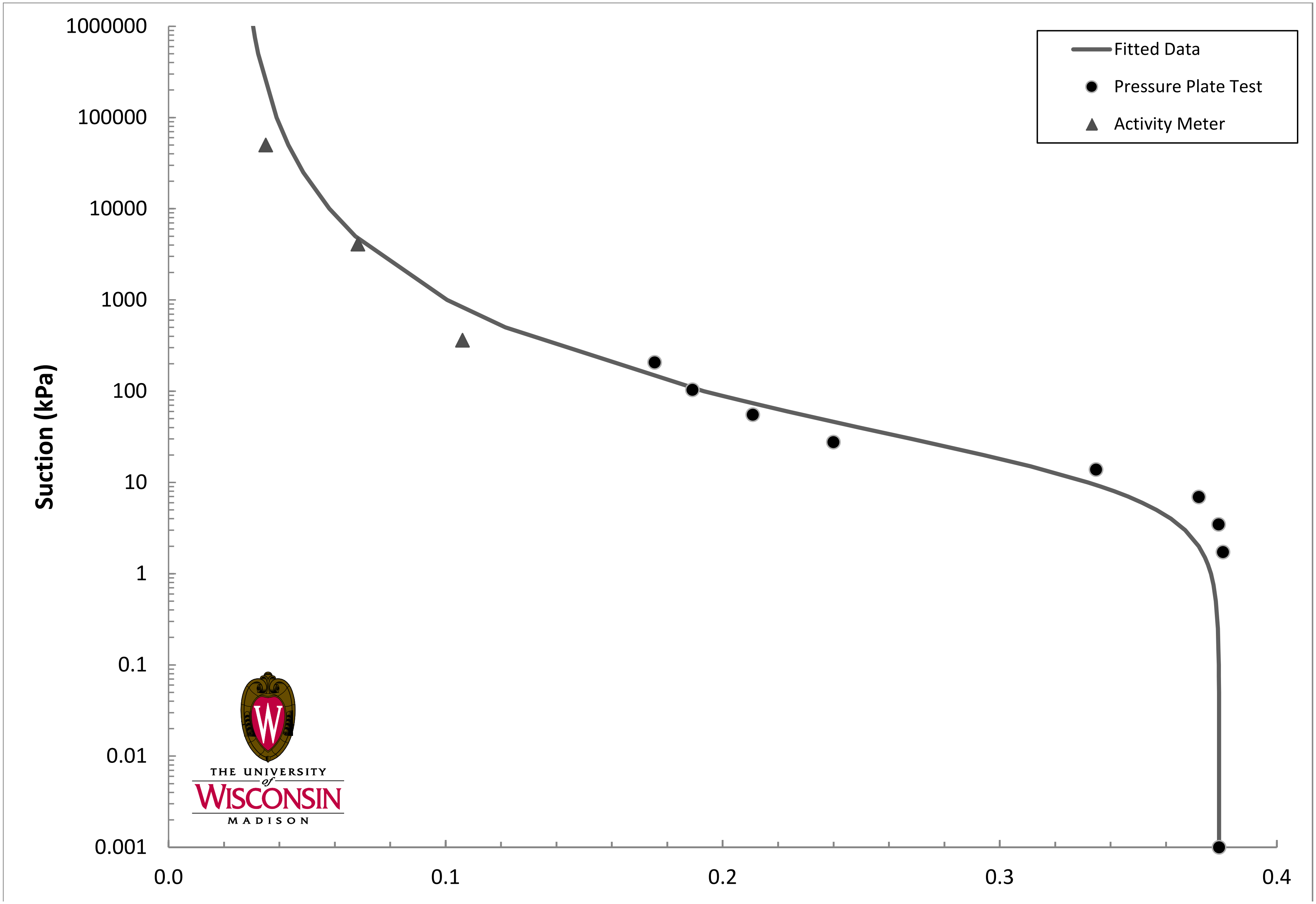
Residual = 0.000425339

press plate data (FROM PAGE 2)

water activity meter data (FROM PAGE 2)

FOR GRAPHING

Suction (kPa)	VWC
0.001	0.3792
0.025	0.3791
0.05	0.3791
0.075	0.3791
0.1	0.3790
0.15	0.3789
0.25	0.3787
0.5	0.3780
0.75	0.3771
1	0.3762
1.25	0.3752
1.5	0.3741
2	0.3718
3	0.3669
4	0.3618
5	0.3566
6	0.3514
7	0.3463
8	0.3413
9	0.3365
10	0.3318
15	0.3111
20	0.2941
30	0.2682
40	0.2494
50	0.2349
60	0.2234
70	0.2139
80	0.2060
90	0.1991
100	0.1931
500	0.1215
1000	0.1005
5000	0.0675
10000	0.0580
25000	0.0486
5.00E+04	0.0432
1.00E+05	0.0390



Suction (kPa)
1000000
100000
10000
1000
100
10
1
0.1
0.01
0.001
0.0
0.1
0.2
0.3
0.4
Fitted Data
Pressure Plate Test
Activity Meter
THE UNIVERSITY of WISCONSIN MADISON

Geotechnics Laboratory
University of Wisconsin-Madison
Pressure Plate Extractor Test

ASTM D 6836 - 02 (Method B)

Sample I.D.	**E3_(A1/A2)**		**Test Date**	6/16/2012
WT of Sample Ring =	69.2	g	G_s =	2.53
Provided Dry Density, γ_d =	89.25	pcf		
Provided Water Content, w =	19.0	%		
Diameter of Sample Ring, D =	7.26	cm		
Height of Sample Ring, L =	2.54	cm		
Sample Volume, V =	105.27	cm^3		
After Saturation, Sample Height Swell	0.02	cm		
After Saturation, Sample Dry Density	1.42	(g/cm^3)		
Saturaded Water Content, w =	31.0	%		
Saturaded Water Content, θ =	43.90	%		

Applied Pressure	**Reading**	**Suction**	**Gravimetric Water Content**	**Volumetric Water Content**
(psi)	**(cm)**	**(kPa)**		
0	11.1	0.001	0.310	0.439
0.25	12.7	1.724	0.308	0.436
0.5	14	3.449	0.306	0.434
1	15.5	6.897	0.304	0.431
2	40.4	13.794	0.273	0.387
4	59.5	27.588	0.248	0.352
10	83	68.970	0.219	0.310
20	106	137.940	0.190	0.269
40	118.5	275.880	0.174	0.247
82	127.5	565.554	0.163	0.231
		0.000	0.324	0.459
		0.000	0.324	0.459
	Activity Meter Test	4130.00	0.107	0.152
	Activity Meter Test	9560.00	0.087	0.123
	Activity Meter Test	36450.00	0.067	0.096

Activity Meter Test

Suction	Wt of Can	Wt of Can + Wet Soil	Wt of Can + Dry Soil	Gravimetric Water Content	Volumetric Water Content
(Mpa)	(g)	(g)	(g)		
36.45	7.7599	14.4494	14.0272	0.067	0.096
9.56	7.7453	14.5806	14.0358	0.087	0.123
4.13	7.5893	14.5888	13.9098	0.107	0.152

Fit van Genuchten Eqn to SWCC Data

van Genuchten Eqn

$$\Theta = \frac{\theta - \theta_r}{\theta_s - \theta_r} = \left[\frac{1}{1+(\alpha\psi)^n}\right]^m$$

θ_r =	0.0000
θ_s =	0.4390
α =	0.0787
n =	1.1870
m =	0.1575

FOR GRAPHING

Suction (kPa)	VWC
0.001	0.4390
0.025	0.4390
0.05	0.4389
0.075	0.4389
0.1	0.4388
0.15	0.4387
0.25	0.4384
0.5	0.4376
0.75	0.4367
1	0.4358
1.25	0.4348
1.5	0.4338
2	0.4318
3	0.4277
4	0.4237
5	0.4197
6	0.4159
7	0.4122
8	0.4086
9	0.4052
10	0.4019
15	0.3873
20	0.3752
30	0.3562
40	0.3418
50	0.3303
60	0.3209
70	0.3129
80	0.3061
90	0.3000
100	0.2946
500	0.2205
1000	0.1939
5000	0.1436
10000	0.1262
25000	0.1063
5.00E+04	0.0934
1.00E+05	0.0821

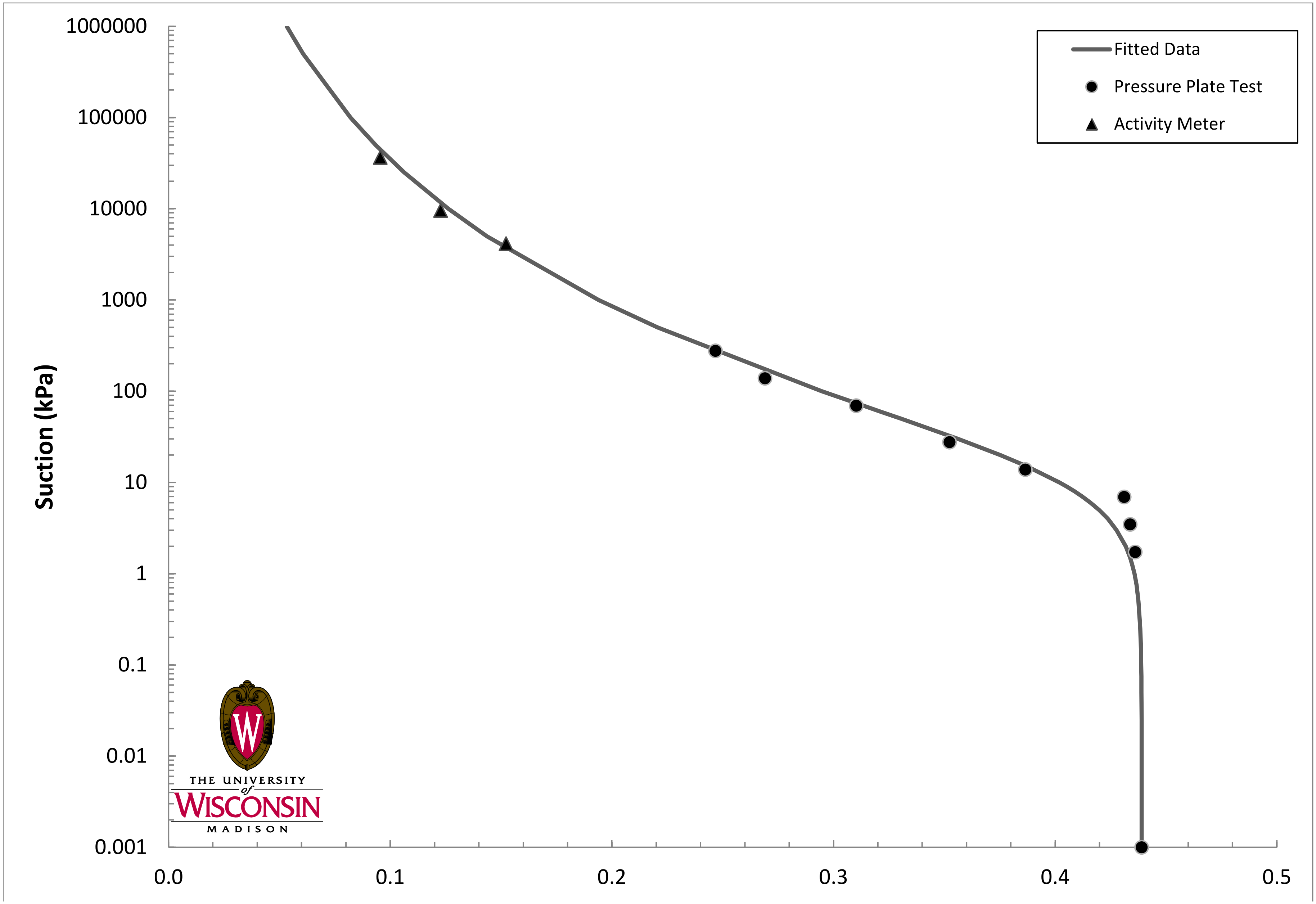
FOR FITTING

Applied Suction (kPa)	Measured VWC	Predicted VWC	ΔWC (%)	$(\Delta WC)^2$
0.001	0.439	0.4390	0.000	0.000
1.72	0.436	0.4329	0.003	0.000
3.45	0.434	0.4259	0.008	0.000
6.90	0.431	0.4126	0.019	0.000
13.79	0.387	0.3905	-0.004	0.000
27.59	0.352	0.3602	-0.008	0.000
68.97	0.310	0.3137	-0.003	0.000
137.94	0.269	0.2786	-0.009	0.000
275.88	0.247	0.2459	0.001	0.000
565.55	0.231	0.2155	0.015	0.000
4130.00	0.152	0.1489	0.003	0.000
9560.00	0.123	0.1273	-0.004	0.000
36450.00	0.096	0.0991	-0.004	0.000

Residual = 6.70081E-05

press plate data (FROM PAGE 2)

water activity meter data (FROM PAGE 2)



Suction (kPa)
1000000
100000
10000
1000
100
10
1
0.1
0.01
0.001
0.0
0.1
0.2
0.3
0.4
0.5
Fitted Data
Pressure Plate Test
Activity Meter
THE UNIVERSITY of WISCONSIN MADISON

Geotechnics Laboratory
University of Wisconsin-Madison
Hanging Column and Activity Meter Test
ASTM D 6836 - 02 (Method A and D)

Sample I.D.	W2_(B1/B2)		Test Date	
Volume, V =	200	cm^3	G_s =	2.63
Solid WT =	348.5	g		
Water WT =	67	g		
Dry Unit Weight =	1.74	g/cm^3	108.78	pcf
Saturated Water Content =	19.3	%		
Tube Area, A =	0.19	cm^2		

Left Manometer Reading	Right Manometer Reading	Horizontal Outflow Reading	Water Expelled from Soil Sample	Suction	Grav. Water Content	Volumetric Water Content
(cm)	(cm)	(cm)	(mL)	(cm)		
199	199	2.5		0.000	0.19	0.34
201	197.7	24	4.085	3.300	0.18	0.32
202.8	195.7	31	5.415	7.100	0.18	0.31
206.1	192.4	38	6.745	13.700	0.17	0.30
209.4	189.1	42	7.505	20.300	0.17	0.30
213.5	185	46.6	8.379	28.500	0.17	0.30
216.5	182	52.4	9.481	34.500	0.17	0.29
221	177.5	59	10.735	43.500	0.16	0.28
225	173.1	72	13.205	51.900	0.16	0.27
229	168.5	79.3	14.592	60.500	0.15	0.26
235.2	163.1	96	17.765	72.100	0.14	0.25
248	150	119.4	22.211	98.000	0.13	0.23
257.5	140.8	131	24.415	116.700	0.12	0.21
266.5	131.5	144.5	26.980	135.000	0.12	0.20
287.5	110.5	163.5	30.590	177.000	0.11	0.18
317.5	81	176	32.965	236.500	0.10	0.17
391.5	6.5	200	37.525	385.000	0.09	0.15
			-0.475	0.000	0.19	0.34
			-0.475	0.000	0.19	0.34
	1.0 MPa = 1000.0 kPa 1.0 kPa = 10.2 cm		Activity Meter Test	2448.00	0.059	0.104
				11424.00	0.037	0.065
				264588.00	0.014	0.025

Activity Meter Test

Suction	Wt of Can	Wt of Can + Wet Soil	Wt of Can + Dry Soil	Gravimetric Water Content	Volumetric Water Content
(Mpa)	(g)	(g)	(g)		
25.94	7.6398	15.8339	15.719	0.014	0.025
1.12	7.8975	16.1932	15.8943	0.037	0.065
0.24	8.0743	16.5516	16.0763	0.059	0.104

Fit van Genuchten Eqn to SWCC Data

van Genuchten Eqn

$$\Theta = \frac{\theta - \theta_r}{\theta_s - \theta_r} = \left[\frac{1}{1+(\alpha\psi)^n}\right]^m$$

θ_r =	0.0000
θ_s =	0.3166
α =	0.0216
n =	1.3212
m =	0.2431

FOR GRAPHING

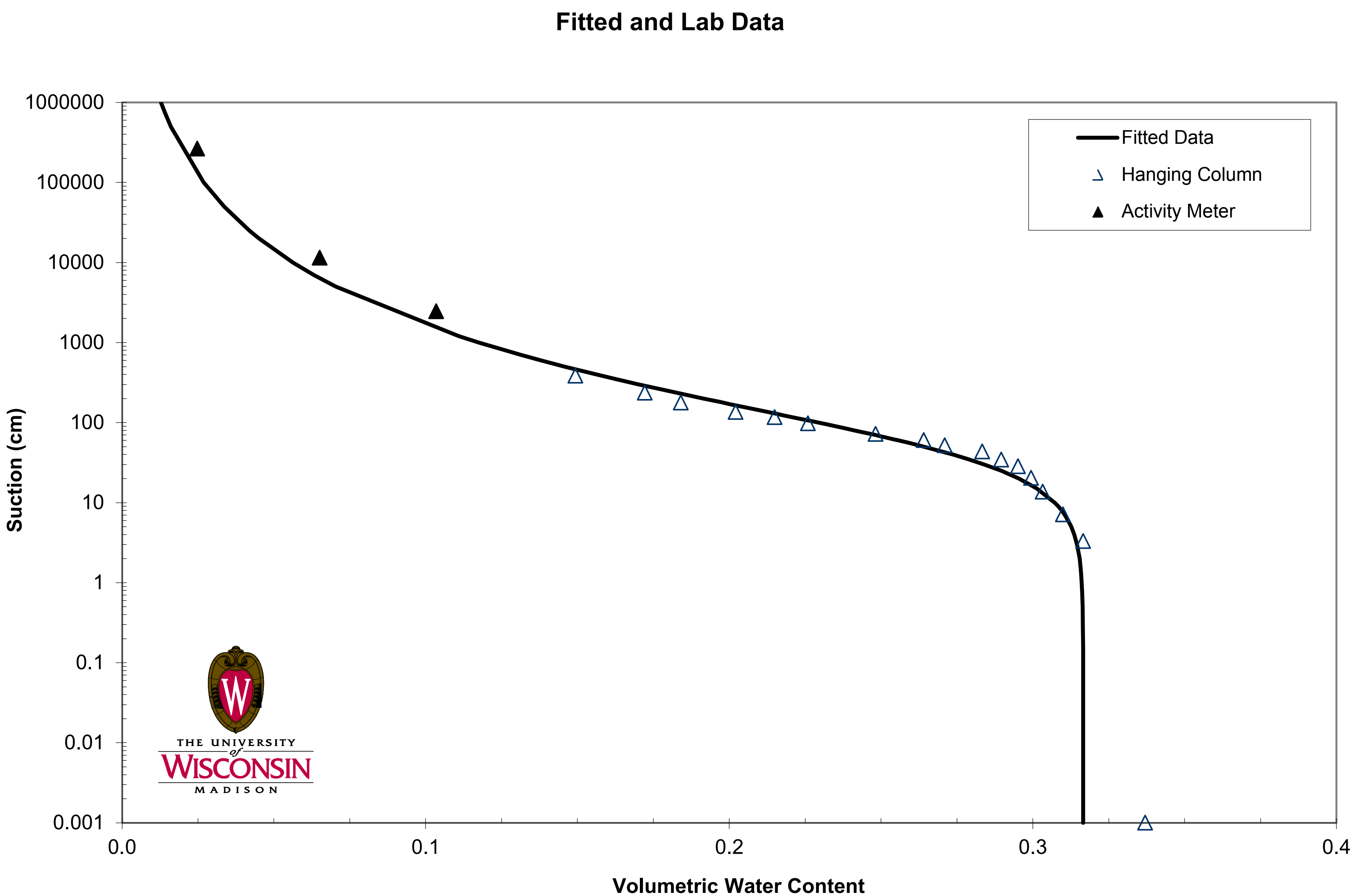
Suction (cm)	VWC
0.001	0.3166
0.025	0.3166
0.05	0.3166
0.075	0.3166
0.1	0.3166
0.15	0.3166
0.25	0.3165
0.5	0.3164
0.75	0.3163
1	0.3161
1.25	0.3159
1.5	0.3158
2	0.3154
3	0.3146
4	0.3136
5	0.3127
6	0.3116
7	0.3106
8	0.3095
9	0.3083
10	0.3072
15	0.3013
20	0.2954
25	0.2896
30	0.2840
35	0.2786
40	0.2735
45	0.2687
50	0.2641
55	0.2598
60	0.2557
62	0.2541
65	0.2518
67	0.2503
70	0.2481
75	0.2446
80	0.2412

FOR FITTING

Applied Suction (cm)	Measured VWC	Predicted VWC	ΔWC (%)	$(\Delta WC)^2$
0.001	0.337	0.3166	0.020	0.000
3.30	0.317	0.3143	0.002	0.000
7.10	0.310	0.3104	-0.001	0.000
13.70	0.303	0.3029	0.000	0.000
20.30	0.299	0.2950	0.004	0.000
28.50	0.295	0.2856	0.009	0.000
34.50	0.290	0.2792	0.010	0.000
43.50	0.283	0.2701	0.013	0.000
51.90	0.271	0.2625	0.009	0.000
60.50	0.264	0.2553	0.009	0.000
72.10	0.248	0.2466	0.002	0.000
98.00	0.226	0.2304	-0.004	0.000
116.70	0.215	0.2209	-0.006	0.000
135.00	0.202	0.2129	-0.011	0.000
177.00	0.184	0.1981	-0.014	0.000
236.50	0.172	0.1826	-0.010	0.000
385.00	0.149	0.1581	-0.009	0.000
2448.00	0.104	0.0884	0.015	0.000
11424.00	0.065	0.0540	0.011	0.000
264588.00	0.025	0.0197	0.005	0.000
			Residual =	9.49943E-05

press plate data (FROM PAGE 2)

water activity meter data (FROM PAGE 2)



Fitted and Lab Data
Fitted Data
Hanging Column
Activity Meter
Suction (cm)
1000000
100000
10000
1000
100
10
1
0.1
0.01
0.001
0.0
0.1
0.2
0.3
0.4
Volumetric Water Content
THE UNIVERSITY of WISCONSIN MADISON

Geotechnics Laboratory
University of Wisconsin-Madison
Hanging Column and Activity Meter Test
ASTM D 6836 - 02 (Method A and D)

Sample I.D.	W5_(B1/B2)		Test Date	
Volume, V =	200	cm^3	G_s =	2.63
Solid WT =	332.2	g		
Water WT =	74	g		
Dry Unit Weight =	1.661	g/cm^3	103.7	pcf
Saturated Water Content =	22	%		
Tube Area, A =	0.19	cm^2		

Left Manometer Reading	Right Manometer Reading	Horizontal Outflow Reading	Water Expelled from Soil Sample	Suction	Grav. Water Content	Volumetric Water Content
(cm)	(cm)	(cm)	(mL)	(cm)		
198.5	198.5	2.8		0.000	0.22	0.37
201	197.2	13	1.938	3.800	0.22	0.36
202.6	195.4	20.8	3.420	7.200	0.21	0.35
205.7	192.1	28.7	4.921	13.600	0.21	0.34
209	189	34.2	5.966	20.000	0.20	0.34
213.2	184.6	39.3	6.935	28.600	0.20	0.33
216.3	181.4	41.5	7.353	34.900	0.20	0.33
221.8	175.8	42.5	7.543	46.000	0.20	0.33
227.5	170	47.5	8.493	57.500	0.20	0.33
232.3	165.2	52.6	9.462	67.100	0.19	0.32
237.6	159.7	67	12.198	77.900	0.18	0.31
249.5	148	80.5	14.763	101.500	0.18	0.29
256	141	86	15.808	115.000	0.17	0.29
265	132	99	18.278	133.000	0.17	0.28
281.8	115	124	23.028	166.800	0.15	0.25
314.5	81.5	150	27.968	233.000	0.14	0.23
388	8	188	35.188	380.000	0.12	0.19
			-0.532	0.000	0.22	0.37
			-0.532	0.000	0.22	0.37
	1.0 MPa = 1000.0 kPa 1.0 kPa = 10.2 cm		Activity Meter Test	4794.00	0.057	0.095
				17544.00	0.035	0.058
				320280.00	0.013	0.022

Activity Meter Test

Suction	Wt of Can	Wt of Can + Wet Soil	Wt of Can + Dry Soil	Gravimetric Water Content	Volumetric Water Content
(Mpa)	(g)	(g)	(g)		
31.4	7.7689	15.4851	15.3826	0.013	0.022
1.72	7.6668	15.5828	15.3142	0.035	0.058
0.47	7.6092	15.7261	15.2859	0.057	0.095

Fit van Genuchten Eqn to SWCC Data

van Genuchten Eqn

$$\Theta = \frac{\theta - \theta_r}{\theta_s - \theta_r} = \left[\frac{1}{1+(\alpha\psi)^n}\right]^m$$

θ_r =	0.0000
θ_s =	0.3583
α =	0.0118
n =	1.3487
m =	0.2586

FOR GRAPHING

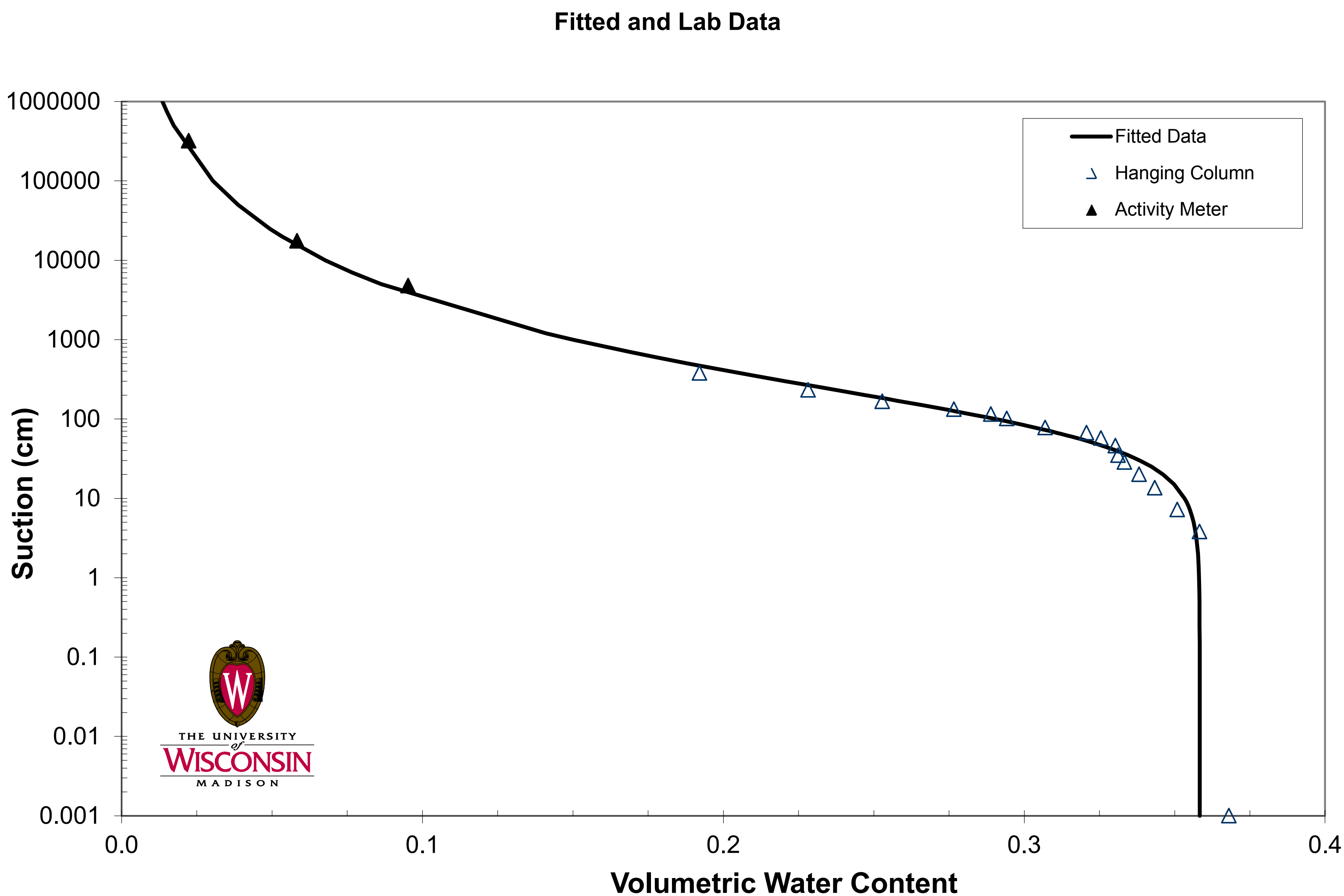
Suction (cm)	VWC
0.001	0.3583
0.025	0.3583
0.05	0.3583
0.075	0.3583
0.1	0.3583
0.15	0.3583
0.25	0.3583
0.5	0.3582
0.75	0.3582
1	0.3581
1.25	0.3580
1.5	0.3579
2	0.3577
3	0.3573
4	0.3568
5	0.3563
6	0.3557
7	0.3552
8	0.3546
9	0.3539
10	0.3533
15	0.3498
20	0.3461
25	0.3423
30	0.3384
35	0.3345
40	0.3306
45	0.3268
50	0.3230
55	0.3193
60	0.3157
62	0.3143
65	0.3122
67	0.3109
70	0.3088
75	0.3055
80	0.3023

FOR FITTING

Applied Suction (cm)	Measured VWC	Predicted VWC	ΔWC (%)	$(\Delta WC)^2$
0.001	0.368	0.3583	0.010	0.000
3.80	0.358	0.3569	0.001	0.000
7.20	0.351	0.3550	-0.004	0.000
13.60	0.343	0.3508	-0.007	0.000
20.00	0.338	0.3461	-0.008	0.000
28.60	0.333	0.3395	-0.006	0.000
34.90	0.331	0.3346	-0.003	0.000
46.00	0.330	0.3260	0.004	0.000
57.50	0.326	0.3175	0.008	0.000
67.10	0.321	0.3108	0.010	0.000
77.90	0.307	0.3036	0.003	0.000
101.50	0.294	0.2895	0.005	0.000
115.00	0.289	0.2822	0.007	0.000
133.00	0.277	0.2734	0.003	0.000
166.80	0.253	0.2591	-0.006	0.000
233.00	0.228	0.2372	-0.009	0.000
380.00	0.192	0.2054	-0.013	0.000
4794.00	0.095	0.0875	0.008	0.000
17544.00	0.058	0.0557	0.003	0.000
320280.00	0.022	0.0202	0.002	0.000
			Residual =	4.58839E-05

press plate data (FROM PAGE 2)

water activity meter data (FROM PAGE 2)



Fitted and Lab Data
1000000
100000
10000
1000
100
10
1
0.1
0.01
0.001
Suction (cm)
0.0
0.1
0.2
0.3
0.4
Volumetric Water Content
Fitted Data
Hanging Column
Activity Meter
THE UNIVERSITY of WISCONSIN MADISON

Geotechnics Laboratory
University of Wisconsin-Madison
Hanging Column and Activity Meter Test
ASTM D 6836 - 02 (Method A and D)

Sample I.D.	W8_(A1/A2)		Test Date	
Volume, V =	200	cm^3	G_s =	2.64
Solid WT =	318.5	g		
Water WT =	79	g		
Dry Unit Weight =	1.59	g/cm^3	99.41	pcf
Saturated Water Content =	25	%		
Tube Area, A =	0.19	cm^2		

Left Manometer Reading	Right Manometer Reading	Horizontal Outflow Reading	Water Expelled from Soil Sample	Suction	Grav. Water Content	Volumetric Water Content
(cm)	(cm)	(cm)	(mL)	(cm)		
198.3	198.3	0.8		0.000	0.25	0.40
200	197	24.5	4.503	3.000	0.23	0.37
202	195	30.4	5.624	7.000	0.23	0.37
205	191.8	35.6	6.612	13.200	0.23	0.36
208.3	188.5	38.9	7.239	19.800	0.23	0.36
212	184.8	41.9	7.809	27.200	0.22	0.36
215.4	181.1	43.5	8.113	34.300	0.22	0.36
220.4	176.3	50	9.348	44.100	0.22	0.35
223.7	173	66.1	12.407	50.700	0.21	0.33
228.6	168	79	14.858	60.600	0.20	0.32
233.3	163.4	102.3	19.285	69.900	0.19	0.30
240.5	156	124	23.408	84.500	0.18	0.28
247.3	149.5	139	26.258	97.800	0.17	0.27
257	139.5	160	30.248	117.500	0.15	0.25
276.5	120.5	185	34.998	156.000	0.14	0.22
309.2	88	206	38.988	221.200	0.13	0.20
381	17	233	44.118	364.000	0.11	0.18
			-0.152	0.000	0.25	0.40
			-0.152	0.000	0.25	0.40
			Activity Meter Test	11424.00	0.054	0.087
	1.0 MPa = 1000.0 kPa			45798.00	0.034	0.054
	1.0 kPa = 10.2 cm			500616.00	0.012	0.020

Activity Meter Test

Suction	Wt of Can	Wt of Can + Wet Soil	Wt of Can + Dry Soil	Gravimetric Water Content	Volumetric Water Content
(Mpa)	(g)	(g)	(g)		
49.08	7.9693	15.3475	15.257	0.012	0.020
4.49	10.3871	17.9633	17.7137	0.034	0.054
1.12	8.2429	16.041	15.6388	0.054	0.087

Fit van Genuchten Eqn to SWCC Data

van Genuchten Eqn

$$\Theta = \frac{\theta - \theta_r}{\theta_s - \theta_r} = \left[\frac{1}{1+(\alpha\psi)^n}\right]^m$$

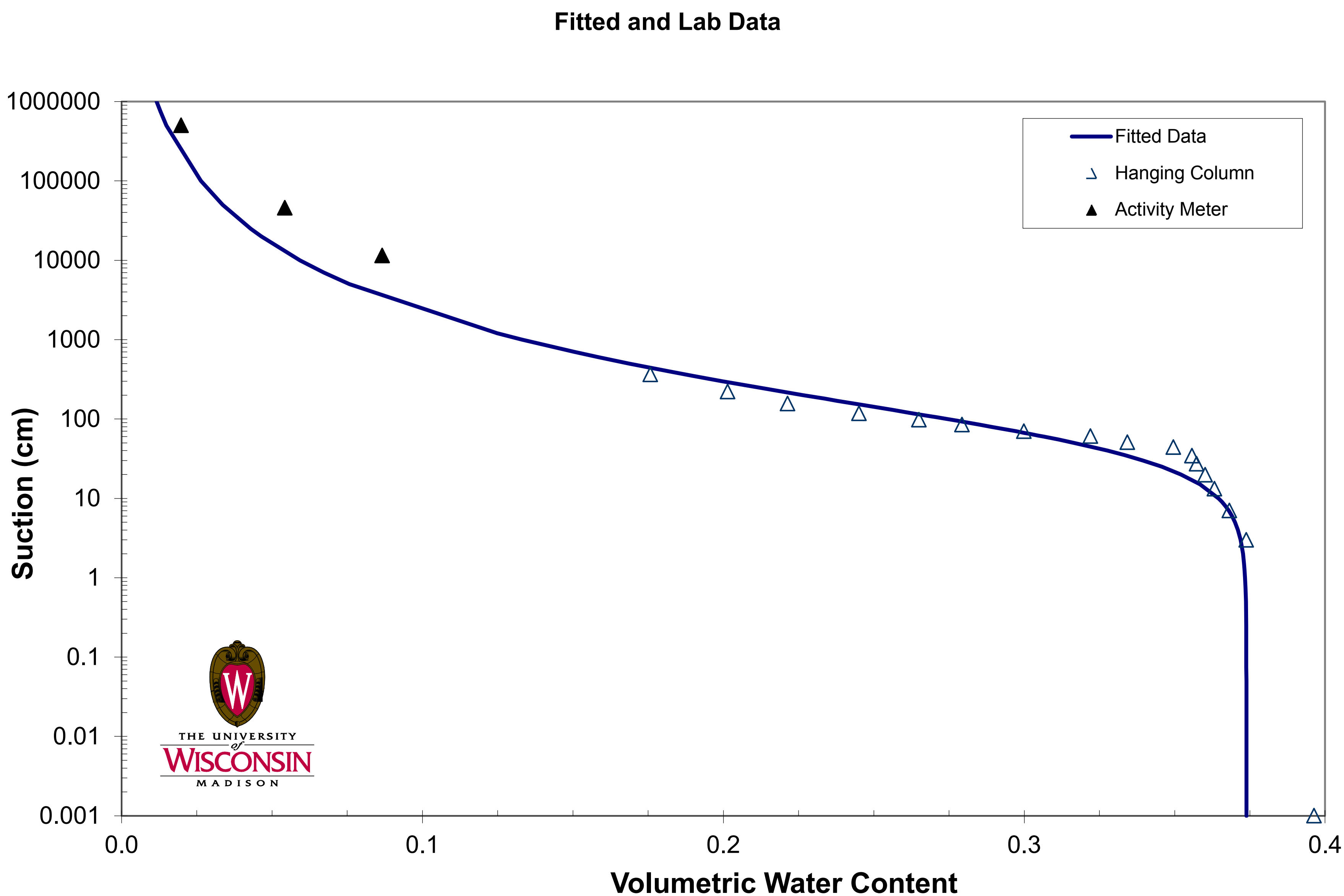
θ_r =	0.0000
θ_s =	0.3738
α =	0.0184
n =	1.3531
m =	0.2609

FOR GRAPHING	
Suction (cm)	VWC
0.001	0.3738
0.025	0.3738
0.05	0.3738
0.075	0.3738
0.1	0.3738
0.15	0.3738
0.25	0.3738
0.5	0.3737
0.75	0.3735
1	0.3734
1.25	0.3732
1.5	0.3731
2	0.3727
3	0.3719
4	0.3710
5	0.3701
6	0.3690
7	0.3680
8	0.3669
9	0.3657
10	0.3646
15	0.3584
20	0.3521
25	0.3457
30	0.3395
35	0.3334
40	0.3276
45	0.3219
50	0.3166
55	0.3114
60	0.3065
62	0.3046
65	0.3018
67	0.3000
70	0.2973
75	0.2930
80	0.2889

FOR FITTING				
Applied Suction (cm)	Measured VWC	Predicted VWC	ΔWC (%)	$(\Delta WC)^2$
0.001	0.396	0.3738	0.023	0.001
3.00	0.374	0.3719	0.002	0.000
7.00	0.368	0.3680	0.000	0.000
13.20	0.363	0.3607	0.003	0.000
19.80	0.360	0.3524	0.008	0.000
27.20	0.357	0.3430	0.014	0.000
34.30	0.356	0.3343	0.022	0.000
44.10	0.350	0.3229	0.027	0.001
50.70	0.334	0.3158	0.018	0.000
60.60	0.322	0.3059	0.016	0.000
69.90	0.300	0.2974	0.003	0.000
84.50	0.279	0.2854	-0.006	0.000
97.80	0.265	0.2757	-0.011	0.000
117.50	0.245	0.2633	-0.018	0.000
156.00	0.221	0.2437	-0.022	0.000
221.20	0.201	0.2197	-0.018	0.000
364.00	0.176	0.1875	-0.012	0.000
11424.00	0.087	0.0566	0.030	0.001
45798.00	0.054	0.0347	0.020	0.000
500616.00	0.020	0.0149	0.005	0.000
			Residual =	0.000266321

press plate data (FROM PAGE 2)

water activity meter data (FROM PAGE 2)



Fitted and Lab Data
Fitted Data
Hanging Column
Activity Meter
1000000
100000
10000
1000
100
10
1
0.1
0.01
0.001
Suction (cm)
0.0
0.1
0.2
0.3
0.4
Volumetric Water Content
THE UNIVERSITY of WISCONSIN MADISON

Geotechnics Laboratory
University of Wisconsin-Madison
Pressure Plate Extractor Test
ASTM D 6836 - 02 (Method B)

Sample I.D.	W9_(B1/B2)		Test Date	6/16/2012
WT of Sample Ring =	71.2	g	G_s =	2.63
Provided Dry Density, γ_d =	97.75	pcf		
Provided Water Content, w =	14.0	%		
Diameter of Sample Ring, D =	7.26	cm		
Height of Sample Ring, L =	2.54	cm		
Sample Volume, V =	105.27	cm^3		
After Saturation, Sample Height Swell	-0.01	cm		
After Saturation, Sample Dry Density	1.57	(g/cm^3)		
Saturaded Water Content, w =	25.5	%		
Saturaded Water Content, θ =	40.15	%		

Applied Pressure	Reading		Suction	Gravimetric Water Content	Volumetric Water Content
(psi)	(cm)		(kPa)		
0	4		0.001	0.255	0.402
0.25	6		1.724	0.253	0.398
0.5	6		3.449	0.253	0.398
1	9.4		6.897	0.249	0.392
2	28		13.794	0.228	0.358
4	65		27.588	0.185	0.291
8.8	87.5		60.694	0.159	0.250
15	98.2		103.455	0.147	0.231
30	110.5		206.910	0.133	0.208
61	117.5		420.717	0.124	0.196
			0.000	0.260	0.409
			0.000	0.260	0.409
		Activity Meter Test	1900.00	0.068	0.107
			9980.00	0.044	0.070
			49420.00	0.023	0.037

Activity Meter Test

Suction	Wt of Can	Wt of Can + Wet Soil	Wt of Can + Dry Soil	Gravimetric Water Content	Volumetric Water Content
(Mpa)	(g)	(g)	(g)		
49.42	7.5967	14.8996	14.7337	0.023	0.037
9.98	8.4947	15.9007	15.5857	0.044	0.070
1.9	7.6924	15.3037	14.8201	0.068	0.107

Fit van Genuchten Eqn to SWCC Data

van Genuchten Eqn

$$\Theta = \frac{\theta - \theta_r}{\theta_s - \theta_r} = \left[\frac{1}{1+(\alpha\psi)^n}\right]^m$$

θ_r =	0.0000
θ_s =	0.4015
α =	0.0729
n =	1.2569
m =	0.2044

FOR GRAPHING

Suction (kPa)	VWC
0.001	0.4015
0.025	0.4015
0.05	0.4014
0.075	0.4014
0.1	0.4013
0.15	0.4012
0.25	0.4010
0.5	0.4002
0.75	0.3994
1	0.3985
1.25	0.3976
1.5	0.3966
2	0.3946
3	0.3903
4	0.3860
5	0.3817
6	0.3774
7	0.3732
8	0.3692
9	0.3653
10	0.3615
15	0.3444
20	0.3301
30	0.3077
40	0.2909
50	0.2776
60	0.2668
70	0.2577
80	0.2499
90	0.2431
100	0.2371
500	0.1590
1000	0.1333
5000	0.0882
10000	0.0738
25000	0.0583
5.00E+04	0.0488
1.00E+05	0.0409

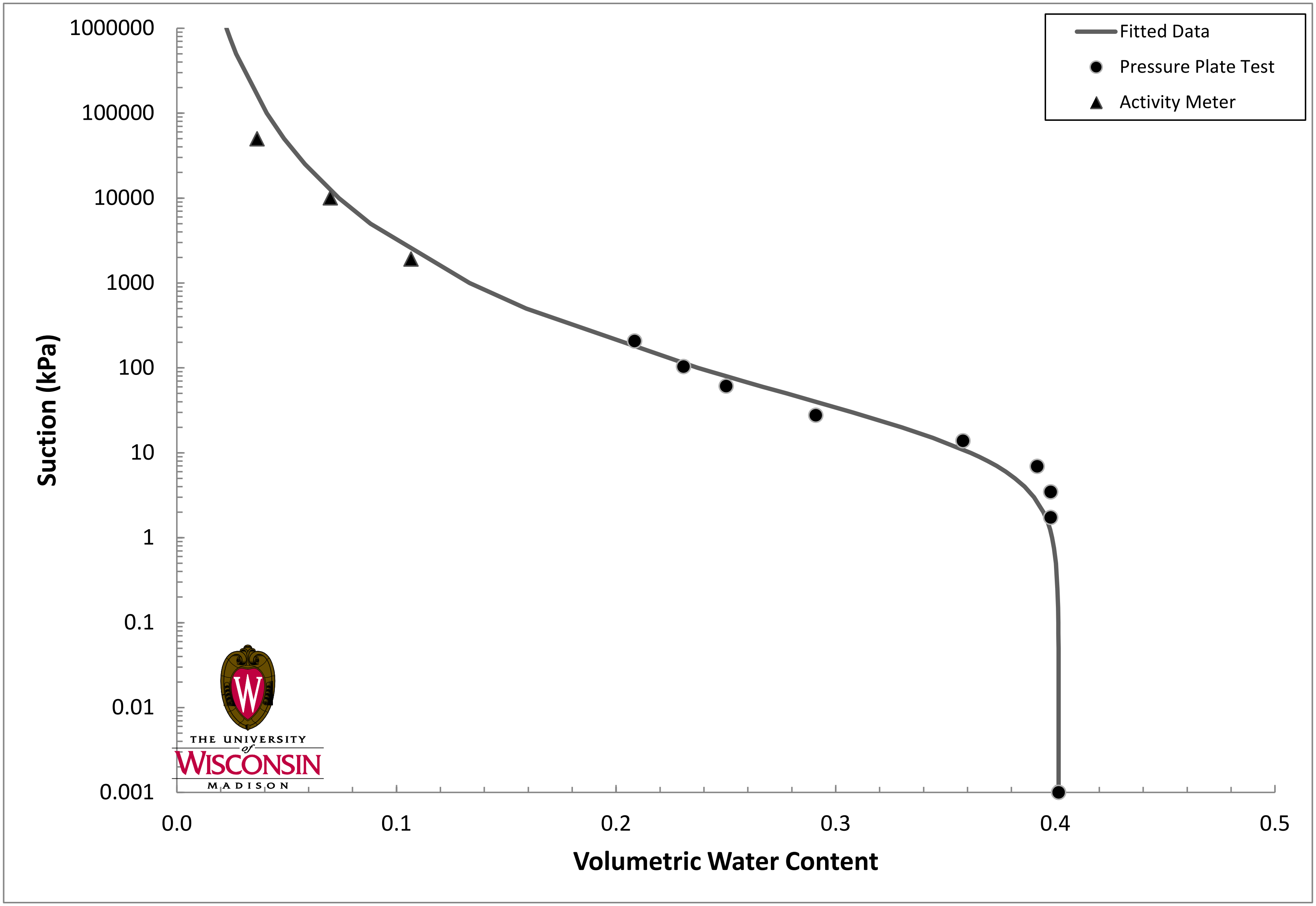
FOR FITTING

Applied Suction (kPa)	Measured VWC	Predicted VWC	ΔWC (%)	$(\Delta WC)^2$
0.001	0.402	0.4015	0.000	0.000
1.72	0.398	0.3957	0.002	0.000
3.45	0.398	0.3884	0.009	0.000
6.90	0.392	0.3737	0.018	0.000
13.79	0.358	0.3482	0.010	0.000
27.59	0.291	0.3125	-0.022	0.000
60.69	0.250	0.2661	-0.016	0.000
103.46	0.231	0.2352	-0.005	0.000
206.91	0.208	0.1986	0.010	0.000
420.72	0.196	0.1662	0.030	0.001
1900.00	0.107	0.1131	-0.006	0.000
9980.00	0.070	0.0739	-0.004	0.000
49420.00	0.037	0.0490	-0.012	0.000

Residual = 0.000187613

press plate data (FROM PAGE 2)

water activity meter data (FROM PAGE 2)



Fitted Data
Pressure Plate Test
Activity Meter
Suction (kPa)
1000000
100000
10000
1000
100
10
1
0.1
0.01
0.001
0.0
0.1
0.2
0.3
0.4
0.5
Volumetric Water Content
THE UNIVERSITY of WISCONSIN MADISON

15 Bar (1.5 MPa) Moisture Content

Sample I.D.	WT of Moisture Can (G)	WT of Wet Soil + Moisture Can (g)	WT of Dry Soil + Moisture Can (g)	Water Content (%)	Suction (MPa)	**15 Bar Moisture Content** (See Plots)
E8_(B1/B2)	7.67	15.7008	15.4575	3.1	13.66	**6.0**
	7.7131	15.9538	15.5736	4.8	2.73	
	8.0119	16.3007	15.8023	6.4	1.14	
W2_(A1/A2)	7.6693	15.6094	15.3727	3.1	39.48	**6.9**
	7.713	15.758	15.3519	5.3	6.72	
	8.0122	16.2961	15.6924	7.9	0.71	
W5_(A1/A2)	7.5901	14.9987	14.769	3.2	22.98	**7.0**
	7.7454	15.3792	14.9965	5.3	4.73	
	7.761	15.5428	14.9547	8.2	0.81	
W8_(B1/B2)	7.5969	15.1856	14.9434	3.3	10.45	**6.4**
	8.4944	16.1118	15.7007	5.7	1.84	
	7.6935	15.6657	15.0576	8.3	0.77	

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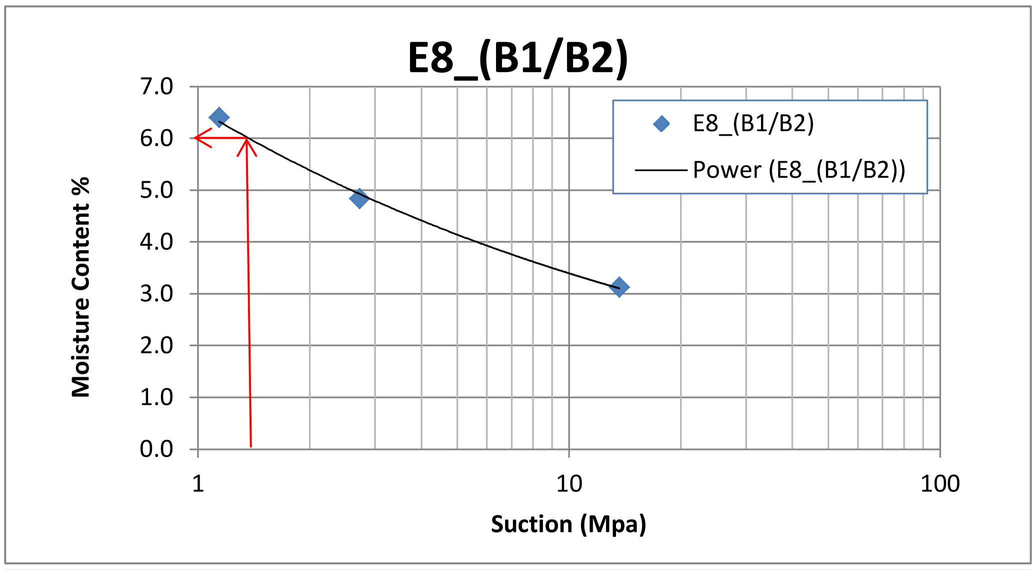
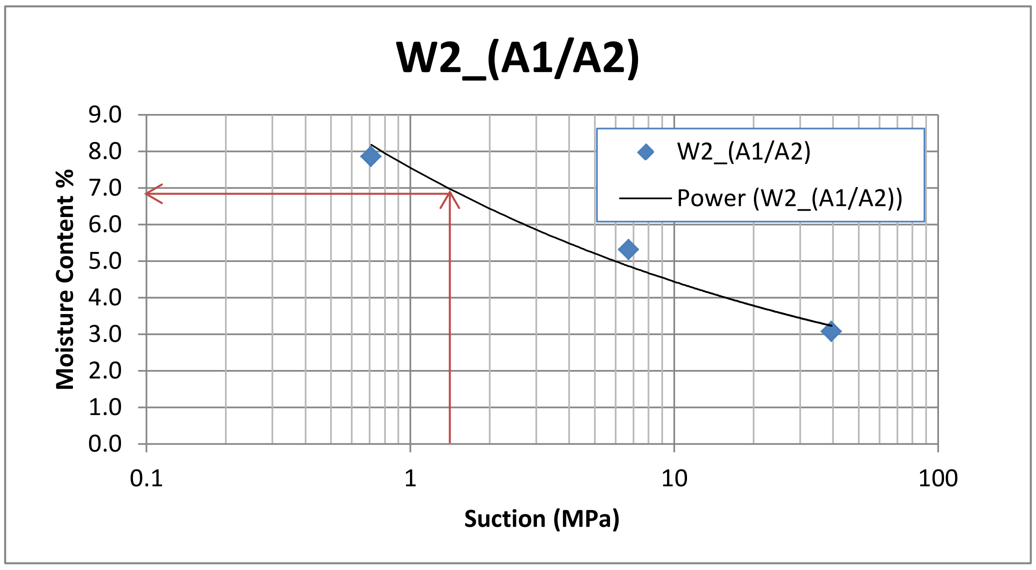
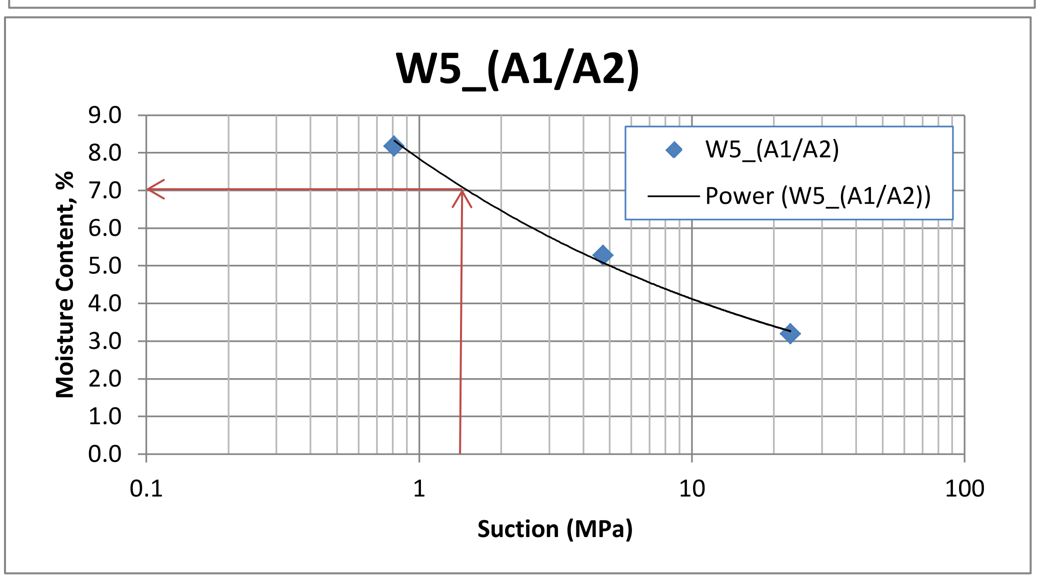
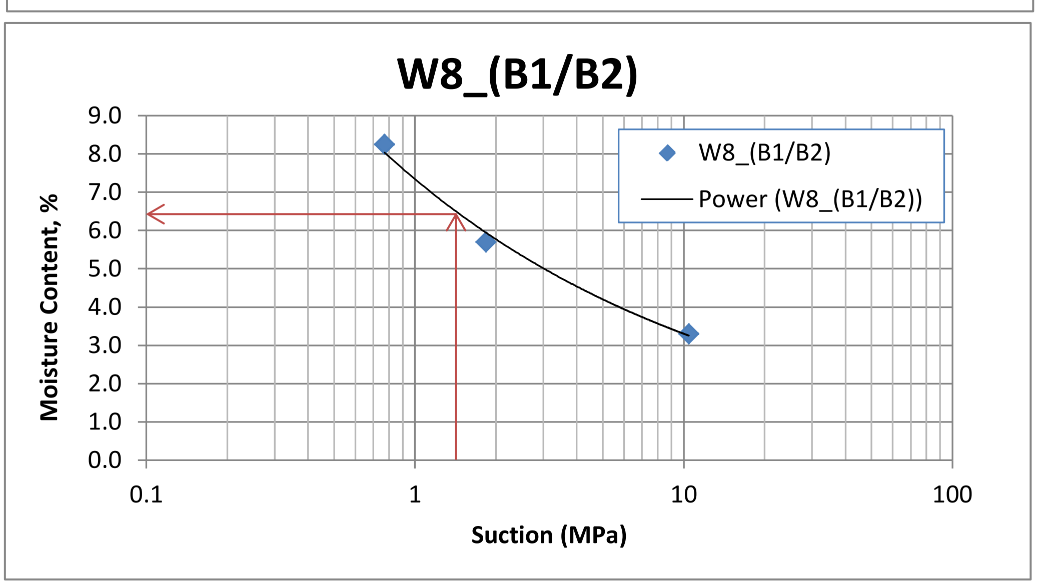

E8_(B1/B2)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Moisture Content %
1
10
100
Suction (Mpa)
E8_(B1/B2)
Power (E8_(B1/B2))


W2_(A1/A2)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Moisture Content %
0.1
1
10
100
Suction (MPa)
W2_(A1/A2)
Power (W2_(A1/A2))


W5_(A1/A2)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Moisture Content, %
0.1
1
10
100
Suction (MPa)
W5_(A1/A2)
Power (W5_(A1/A2))


W8_(B1/B2)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Moisture Content, %
0.1
1
10
100
Suction (MPa)
W8_(B1/B2)
Power (W8_(B1/B2))

APPENDIX B

FREEZE/THAW MODELING

White Mesa Uranium Mill
Frost Penetration Analysis

May 21, 2012

Geo-Smith Engineering, LLC
2591 Legacy Way
Grand Junction, CO 81503

Problem Statement:

Depth of frost penetration into the final cover for the proposed White Mesa uranium mill tailings impoundment will be determined using the procedure adopted by the U.S. Department of Energy and accepted Nuclear Regulatory Commission (DOE, 1989). The depth of freezing into a soil cover (depth of frost penetration) is governed by the local climate, soil material and soil moisture content expected during the operational life of the cover. A computational procedure to predict frost depth was initially proposed by Berggren (1943), later improved and codified by Aldrich and Paynter (1953). Smith and Rager (2002) apply these previous studies to determine an adequate thickness of a protective soil layer to protect an underlying compacted soil.

Method of Solution:

- Obtain site-specific climate data for the site from historic records kept by the Western Regional Climate Center at the Desert Research Institute (DRI).
- Use the method described in Smith and Rager (2002) to predict the maximum depth of frost penetration into a design soil cover profile at a specific site, based on the site's maximum and minimum temperatures. Temperatures are analyzed for a "Frost Year", a year beginning October 1st running through September 30th. This depth will determine the thickness of protective soil required to overlie a compacted soil radon/infiltration barrier.

Sources of Formula and References:

Modified Berggren Formula (MBF), (1968). U.S. Army Cold Regions Research and Engineering Laboratory, CRREL Special Report SR 122, Oct.

Smith, G. E. and Rager, R. E. (2002). "Protective Layer Design in Landfill Covers Based on Frost Penetration." ASCE J. Geotechnical/Geoenvironmental Engineering, 128:9, 794-799.

U.S. Department of Energy (U.S. DOE), 1989. Technical Approach Document, Revision II, Uranium Mill Tailings Remedial Action Project, UMTRA-DOE/AL 050425.0002, Albuquerque, New Mexico.

Data:

- Daily maximum-minimum temperature data are available for Blanding, UT from the Western Regional Climate Center back to the 1920's. Some years contain insufficient data to use the procedure proposed by Smith and Rager (2002), however an acceptable range of data exists.

- Spreadsheet data reduction used and presented in Attachment B.1.

- Final cover configuration for the upper portion of the cover section for the White Mesa mill tailings is presented in Table A.

Table A
Cover Material Soil Properties for Freeze/Thaw Analysis

Cover Layer	Design Thickness (inches)	Placed Density (pcf)	Gravimetric Water Content (%)
Erosion Protection (topsoil to rock mulch with 75% topsoil/25% minus 1-inch gravel)	6	99 to 107	6
Water Storage/Biointrusion/Frost Protection/Radon Attenuation Layer (low compaction water storage, rooting zone)	-	99	7.8

Calculation Procedure:

- *Step 1 Determine Freeze-Index Parameters*
  Climate data consisting of 53 years of at least 95% maximum and minimum daily air temperatures are available for the Blanding, UT NWS station. The procedure outlined in Smith and Rager (2002) was followed to compute the air-freeze index (degree-days), duration of freeze, and mean annual temperature for each station and year. Spreadsheets used in data reduction are provided in Attachment B.1 while plotted data are included as Attachment B.3.

- *Step 2 Determine Surface Temperature Correction Data*
  The daily temperature data used to determine the freeze-index parameters are typically measured 1.5 m above the ground surface. However, measured ground temperatures can be greater than air temperatures due to the effects of snow cover, net solar radiation, thermal conduction from warmer soils below the surface, and convective heat transfer (Smith and Rager, 2002). The ratio of the surface-freeze index to the air-freeze index is related through a factor, N. Because of the complexity and uncertainty between the freeze indices, an estimate for N recommended for practitioners (Army and Air Force, 1988) and Smith and Rager (2002) is 0.7.

- *Step 3 Determine Soil Thermal Properties*
  Soil thermal properties: thermal conductivity, heat capacity, and latent heat of fusion are products of empirical relationships between the dry unit weight (pcf) and gravimetric moisture content (%). These relationships are reproduced in Aitken and Berg (1968) originally published by Aldrich and Paynter (1953) and Kersten (1949). Thermal properties vary between fine-grained and coarse-grained soil types with fine-grained soils providing greater insulating properties.

- *Step 4 Determine Annual Frost Depths*
  Annual frost depths were determined for each of the subject years using the Modified Berggren Formula (MBF) as discussed in Smith and Rager (2002). The MBF was converted to PC software by the U. S. Army Corps of Engineers in 1968. Computer output for each year analyzed, including design air freezing index, design surface freezing index, mean annual temperature, length of freezing season, and total frost penetration, are presented as Attachment B.2.

- *Step 5 Determine Extreme Frost Depth*
  Extreme-value frost depths for the 200-year recurrence interval are determined by extrapolating beyond the record of observed data using the cumulative probability distribution of the Gumbel function (Smith and Rager, 2002). Frost depths are plotted in relation to the standard variate and recurrence interval, and linear regression is used to extrapolate and interpolate freezing depths. Graphical results of the extreme frost depth analysis are included in Attachment B.3, illustrating a maximum frost penetration of 32 inches for a recurrence interval of 200 years (0.5% chance of occurrence in any given year) with surface factor of 0.7.

Discussion:

The depth of frost penetration is reduced when the soil-water content increases because frozen water insulates underlying soils, thus the drier the soil the greater the depth of frost penetration. Also, given similar density and moisture conditions, the depth of frost penetration into coarse-grain soils, such as a rocky soil layer, is slightly greater than for a fine-grained soil layer due to lower thermal capacity of coarse-grain soils.

Computer Source:

- MBF (Modified Berggren Formula). Coded for personal computer use by U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory in 1968.

- Microsoft Excel, version 2003.

References:

Aldrich, H.P. and Paynter, H.M., 1953. "Analytical studies of freezing and thawing of soils," First interim report, U.S. Army Corps of Engineers, New England Division, Arctic Construction and Frost Effects Laboratory (ACFEL) Technical Report 42.

Army and Air Force (1988). (Departments of the Army and the Air Force). "Arctic and Subarctic Construction Calculation Methods for Determination of Depths of Freeze and Thaw in Soils, First Intern Report." Army TM 5-852-6, Air Force AFR 88-19, Vol. 6.

Berggren, W.P. , 1943. "Prediction of temperature distribution in frozen soils", Trans. Am. Geophys. Union, 3, 71-77.

Kersten, M.S., 1949."Laboratory research for the determination of the thermal properties of soils, "Final Report, U.S. Army Corps of Engineers, New England Division, Arctic Construction and Frost Effects Laboratory (ACFEL) Technical Report 23.

Modified Berggren Formula (MBF), (1968). U.S. Army Cold Regions Research and Engineering Laboratory, CRREL Special Report SR 122, Oct.

Smith, G. E. and Rager, R. E. (2002). "Protective Layer Design in Landfill Covers Based on Frost Penetration." ASCE J. Geotechnical/Geoenvironmental Engineering, 128:9, 794-799.

ATTACHMENT B.1

CLIMATE DATA REDUCTION

SPREADSHEET ANALYSIS AND

FREEZE-INDEX PARAMETER GRAPHS

(see Excel Spreadsheet “blanding_temp (2).xls”)

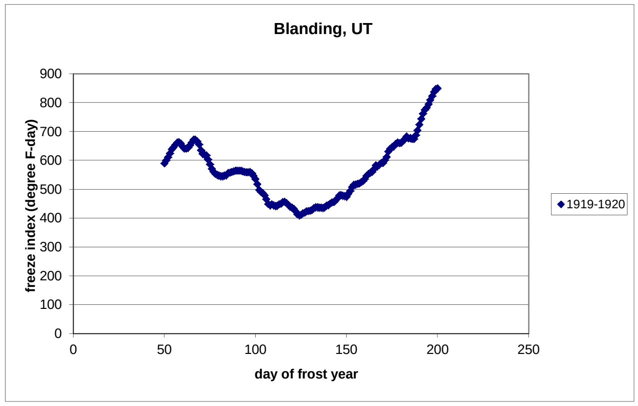
Blanding, UT - Frost Depth Analysis
1919-1920

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	64	37	50.5	18.5	18.5
275	2	68	39	53.5	21.5	40
276	3	62	39	50.5	18.5	58.5
277	4	56	29	42.5	10.5	69
278	5	62	34	48	16	85
279	6	65	39	52	20	105
280	7	60	44	52	20	125
281	8	65	35	50	18	143
282	9	62	36	49	17	160
283	10	58	38	48	16	176
284	11	65	35	50	18	194
285	12	58	41	49.5	17.5	211.5
286	13	59	39	49	17	228.5
287	14	62	38	50	18	246.5
288	15	57	33	45	13	259.5
289	16	63	33	48	16	275.5
290	17	62	35	48.5	16.5	292
291	18	66	37	51.5	19.5	311.5
292	19	51	31	41	9	320.5
293	20	58	31	44.5	12.5	333
294	21	57	29	43	11	344
295	22	60	34	47	15	359
296	23	62	42	52	20	379
297	24	58	38	48	16	395
298	25	48	38	43	11	406
299	26	48	33	40.5	8.5	414.5
300	27	44	29	36.5	4.5	419
301	28	45	23	34	2	421
302	29	53	26	39.5	7.5	428.5
303	30	49	26	37.5	5.5	434
304	31	43	27	35	3	437
305	32	48	23	35.5	3.5	440.5
306	33	49	25	37	5	445.5
307	34	58	33	45.5	13.5	459
308	35	59	33	46	14	473
309	36	59	33	46	14	487
310	37	54	29	41.5	9.5	496.5
311	38	42	30	36	4	500.5
312	39	53	32	42.5	10.5	511
313	40	36	22	29	-3	508
314	41	43	20	31.5	-0.5	507.5
315	42	47	23	35	3	510.5
316	43	52	22	37	5	515.5
317	44	49	24	36.5	4.5	520
318	45	53	27	40	8	528
319	46	57	30	43.5	11.5	539.5
320	47	62	28	45	13	552.5
321	48	59	31	45	13	565.5
322	49	56	38	47	15	580.5
323	50	45	38	41.5	9.5	590
324	51	48	36	42	10	600
325	52	54	31	42.5	10.5	610.5
326	53	60	32	46	14	624.5
327	54	60	32	46	14	638.5
328	55	47	31	39	7	645.5
329	56	51	31	41	9	654.5
330	57	46	33	39.5	7.5	662
331	58	41	26	33.5	1.5	663.5
332	59	35	19	27	-5	658.5
333	60	28	14	21	-11	647.5
334	61	37	14	25.5	-6.5	641
335	62	41	23	32	0	641
336	63	48	22	35	3	644
337	64	52	29	40.5	8.5	652.5
338	65	48	36	42	10	662.5
339	66	46	37	41.5	9.5	672
340	67	44	21	32.5	0.5	672.5
341	68	34	18	26	-6	666.5
342	69	30	12	21	-11	655.5
343	70	20	5	12.5	-19.5	636
344	71	33	5	19	-13	623
345	72	43	14	28.5	-3.5	619.5
346	73	38	22	30	-2	617.5
347	74	24	12	18	-14	603.5
348	75	26	5	15.5	-16.5	587
349	76	27	5	16	-16	571
350	77	33	11	22	-10	561
351	78	35	14	24.5	-7.5	553.5
352	79	37	19	28	-4	549.5
353	80	40	20	30	-2	547.5
354	81	39	21	30	-2	545.5
355	82	43	20	31.5	-0.5	545
356	83	43	26	34.5	2.5	547.5
357	84	42	25	33.5	1.5	549
358	85	53	26	39.5	7.5	556.5
359	86	41	25	33	1	557.5
360	87	43	26	34.5	2.5	560
361	88	47	22	34.5	2.5	562.5
362	89	41	26	33.5	1.5	564
363	90	42	23	32.5	0.5	564.5
364	91	40	23	31.5	-0.5	564
365	92	41	23	32	0	564
366	93	40	21	30.5	-1.5	562.5
1	94	39	19	29	-3	559.5
2	95	38	25	31.5	-0.5	559
3	96	37	26	31.5	-0.5	558.5
4	97	38	29	33.5	1.5	560
5	98	33	23	28	-4	556
6	99	28	18	23	-9	547
7	100	28	14	21	-11	536
8	101	25	2	13.5	-18.5	517.5
9	102	24	1	12.5	-19.5	498
10	103	42	9	25.5	-6.5	491.5
11	104	32	22	27	-5	486.5
12	105	33	15	24	-8	478.5

13	106	33	5	19	-13	465.5
14	107	27	5	16	-16	449.5
15	108	43	11	27	-5	444.5
16	109	46	24	35	3	447.5
17	110	41	18	29.5	-2.5	445
18	111	39	19	29	-3	442
19	112	42	24	33	1	443
20	113	45	28	36.5	4.5	447.5
21	114	40	30	35	3	450.5
22	115	42	32	37	5	455.5
23	116	42	24	33	1	456.5
24	117	34	21	27.5	-4.5	452
25	118	31	21	26	-6	446
26	119	33	20	26.5	-5.5	440.5
27	120	38	18	28	-4	436.5
28	121	34	21	27.5	-4.5	432
29	122	30	18	24	-8	424
30	123	32	10	21	-11	413
31	124	38	20	29	-3	410
32	125	38	28	33	1	411
33	126	47	28	37.5	5.5	416.5
34	127	40	30	35	3	419.5
35	128	46	26	36	4	423.5
36	129	46	21	33.5	1.5	425
37	130	42	24	33	1	426
38	131	39	29	34	2	428
39	132	45	31	38	6	434
40	133	43	28	35.5	3.5	437.5
41	134	42	22	32	0	437.5
42	135	42	20	31	-1	436.5
43	136	39	26	32.5	0.5	437
44	137	42	20	31	-1	436
45	138	46	22	34	2	438
46	139	49	26	37.5	5.5	443.5
47	140	47	22	34.5	2.5	446
48	141	49	24	36.5	4.5	450.5
49	142	45	27	36	4	454.5
50	143	44	22	33	1	455.5
51	144	44	32	38	6	461.5
52	145	50	29	39.5	7.5	469
53	146	48	35	41.5	9.5	478.5
54	147	42	25	33.5	1.5	480
55	148	40	20	30	-2	478
56	149	42	19	30.5	-1.5	476.5
57	150	45	15	30	-2	474.5
58	151	54	31	42.5	10.5	485
59	152	52	30	41	9	494
60	153	56	36	46	14	508
61	154	50	29	39.5	7.5	515.5
62	155	40	27	33.5	1.5	517
63	156	46	21	33.5	1.5	518.5
64	157	42	25	33.5	1.5	520
65	158	48	26	37	5	525
66	159	49	22	35.5	3.5	528.5
67	160	52	27	39.5	7.5	536
68	161	53	33	43	11	547
69	162	46	31	38.5	6.5	553.5
70	163	42	29	35.5	3.5	557
71	164	48	22	35	3	560
72	165	56	29	42.5	10.5	570.5
73	166	60	30	45	13	583.5
74	167	42	16	29	-3	580.5
75	168	53	22	37.5	5.5	586
76	169	52	22	37	5	591
77	170	47	18	32.5	0.5	591.5
78	171	57	26	41.5	9.5	601
79	172	59	28	43.5	11.5	612.5
80	173	64	36	50	18	630.5
81	174	52	33	42.5	10.5	641
82	175	48	28	38	6	647
83	176	45	23	34	2	649
84	177	50	31	40.5	8.5	657.5
85	178	48	25	36.5	4.5	662
86	179	38	21	29.5	-2.5	659.5
87	180	47	20	33.5	1.5	661
88	181	52	26	39	7	668
89	182	51	28	39.5	7.5	675.5
90	183	50	29	39.5	7.5	683
91	184	39	12	25.5	-6.5	676.5
92	185	46	21	33.5	1.5	678
93	186	37	20	28.5	-3.5	674.5
94	187	49	15	32	0	674.5
95	188	61	29	45	13	687.5
96	189	66	32	49	17	704.5
97	190	66	38	52	20	724.5
98	191	65	38	51.5	19.5	744
99	192	66	34	50	18	762
100	193	59	32	45.5	13.5	775.5
101	194	54	25	39.5	7.5	783
102	195	60	29	44.5	12.5	795.5
103	196	62	30	46	14	809.5
104	197	55	36	45.5	13.5	823
105	198	60	34	47	15	838
106	199	55	28	41.5	9.5	847.5
107	200	40	28	34	2	849.5
108	201	42	28	35	3	852.5
109	202	44	26	35	3	855.5
110	203	56	23	39.5	7.5	863
111	204	40	22	31	-1	862
112	205	52	20	36	4	866
113	206	48	28	38	6	872
114	207	54	28	41	9	881
115	208	52	29	40.5	8.5	889.5
116	209	52	30	41	9	898.5
117	210	53	28	40.5	8.5	907
118	211	65	35	50	18	925
119	212	71	41	56	24	949
120	213	73	43	58	26	975
121	214	68	42	55	23	998

122	215	67	38	52.5	20.5	1018.5
123	216	64	38	51	19	1037.5
124	217	68	35	51.5	19.5	1057
125	218	65	39	52	20	1077
126	219	69	38	53.5	21.5	1098.5
127	220	73	47	60	28	1126.5
128	221	75	48	61.5	29.5	1156
129	222	69	46	57.5	25.5	1181.5
130	223	64	46	55	23	1204.5
131	224	57	39	48	16	1220.5
132	225	65	36	50.5	18.5	1239
133	226	61	43	52	20	1259
134	227	62	38	50	18	1277
135	228	57	40	48.5	16.5	1293.5
136	229	60	40	50	18	1311.5
137	230	70	41	55.5	23.5	1335
138	231	79	47	63	31	1366
139	232	82	49	65.5	33.5	1399.5
140	233	84	52	68	36	1435.5
141	234	74	50	62	30	1465.5
142	235	63	46	54.5	22.5	1488
143	236	67	44	55.5	23.5	1511.5
144	237	73	46	59.5	27.5	1539
145	238	77	49	63	31	1570
146	239	72	50	61	29	1599
147	240	71	45	58	26	1625
148	241	77	48	62.5	30.5	1655.5
149	242	80	52	66	34	1689.5
150	243	79	51	65	33	1722.5
151	244	77	48	62.5	30.5	1753
152	245	75	47	61	29	1782
153	246	77	46	61.5	29.5	1811.5
154	247	79	49	64	32	1843.5
155	248	77	55	66	34	1877.5
156	249	79	52	65.5	33.5	1911
157	250	78	54	66	34	1945
158	251	76	50	63	31	1976
159	252	83	52	67.5	35.5	2011.5
160	253	82	56	69	37	2048.5
161	254	75	54	64.5	32.5	2081
162	255	75	50	62.5	30.5	2111.5
163	256	77	48	62.5	30.5	2142
164	257	77	54	65.5	33.5	2175.5
165	258	76	53	64.5	32.5	2208
166	259	76	48	62	30	2238
167	260	76	49	62.5	30.5	2268.5
168	261	78	51	64.5	32.5	2301
169	262	79	51	65	33	2334
170	263	77	52	64.5	32.5	2366.5
171	264	81	51	66	34	2400.5
172	265	84	51	67.5	35.5	2436
173	266	85	54	69.5	37.5	2473.5
174	267	86	58	72	40	2513.5
175	268	83	51	67	35	2548.5
176	269	82	54	68	36	2584.5
177	270	64	52	58	26	2610.5
178	271	66	54	60	28	2638.5
179	272	73	50	61.5	29.5	2668
180	273	75	52	63.5	31.5	2699.5
181	274	80	51	65.5	33.5	2733
182	275	83	56	69.5	37.5	2770.5
183	276	85	56	70.5	38.5	2809
184	277	84	58	71	39	2848
185	278	83	56	69.5	37.5	2885.5
186	279	82	56	69	37	2922.5
187	280	84	56	70	38	2960.5
188	281	89	57	73	41	3001.5
189	282	90	57	73.5	41.5	3043
190	283	91	60	75.5	43.5	3086.5
191	284	87	61	74	42	3128.5
192	285	87	62	74.5	42.5	3171
193	286	84	59	71.5	39.5	3210.5
194	287	83	52	67.5	35.5	3246
195	288	84	56	70	38	3284
196	289	83	52	67.5	35.5	3319.5
197	290	82	58	70	38	3357.5
198	291	85	60	72.5	40.5	3398
199	292	87	58	72.5	40.5	3438.5
200	293	88	57	72.5	40.5	3479
201	294	87	51	69	37	3516
202	295	88	53	70.5	38.5	3554.5
203	296	86	50	68	36	3590.5
204	297	84	52	68	36	3626.5
205	298	85	58	71.5	39.5	3666
206	299	86	62	74	42	3708
207	300	85	55	70	38	3746
208	301	87	61	74	42	3788
209	302	88	61	74.5	42.5	3830.5
210	303	88	61	74.5	42.5	3873
211	304	86	60	73	41	3914
212	305	86	60	73	41	3955
213	306	83	59	71	39	3994
214	307	80	59	69.5	37.5	4031.5
215	308	76	56	66	34	4065.5
216	309	79	55	67	35	4100.5
217	310	78	58	68	36	4136.5
218	311	87	59	73	41	4177.5
219	312	87	60	73.5	41.5	4219
220	313	85	61	73	41	4260
221	314	83	57	70	38	4298
222	315	87	58	72.5	40.5	4338.5
223	316	84	60	72	40	4378.5
224	317	83	58	70.5	38.5	4417
225	318	83	59	71	39	4456
226	319	86	61	73.5	41.5	4497.5
227	320	88	59	73.5	41.5	4539
228	321	83	56	69.5	37.5	4576.5
229	322	85	54	69.5	37.5	4614
230	323	80	54	67	35	4649

231	324	73	52	62.5	30.5	4679.5
232	325	72	51	61.5	29.5	4709
233	326	76	44	60	28	4737
234	327	81	47	64	32	4769
235	328	84	50	67	35	4804
236	329	83	54	68.5	36.5	4840.5
237	330	73	56	64.5	32.5	4873
238	331	75	51	63	31	4904
239	332	71	52	61.5	29.5	4933.5
240	333	74	41	57.5	25.5	4959
241	334	78	49	63.5	31.5	4990.5
242	335	83	49	66	34	5024.5
243	336	82	50	66	34	5058.5
244	337	84	52	68	36	5094.5
245	338	84	52	68	36	5130.5
246	339	83	53	68	36	5166.5
247	340	81	51	66	34	5200.5
248	341	74	49	61.5	29.5	5230
249	342	68	48	58	26	5256
250	343	70	45	57.5	25.5	5281.5
251	344	67	47	57	25	5306.5
252	345	70	46	58	26	5332.5
253	346	73	43	58	26	5358.5
254	347	76	44	60	28	5386.5
255	348	75	45	60	28	5414.5
256	349	75	45	60	28	5442.5
257	350	76	50	63	31	5473.5
258	351	81	52	66.5	34.5	5508
259	352	80	58	69	37	5545
260	353	78	54	66	34	5579
261	354	82	53	67.5	35.5	5614.5
262	355	83	55	69	37	5651.5
263	356	81	56	68.5	36.5	5688
264	357	68	50	59	27	5715
265	358	63	45	54	22	5737
266	359	65	40	52.5	20.5	5757.5
267	360	70	45	57.5	25.5	5783
268	361	63	36	49.5	17.5	5800.5
269	362	65	35	50	18	5818.5
270	363	71	45	58	26	5844.5
271	364	78	42	60	28	5872.5
272	365	75	49	62	30	5902.5
273	366	75	51	63	31	5933.5



67	672.5		length of freeze (day)	58
125	411		frost depth (^{0}F-day)	261.5
			average temperature	48.2

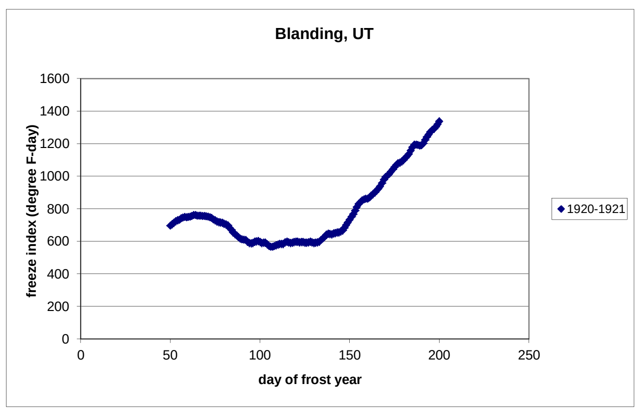
1920-1921

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{0}F)	cumulative degree day (^{0}F)
274	1	73	52	62.5	30.5	30.5
275	2	75	53	64	32	62.5
276	3	75	46	60.5	28.5	91
277	4	79	57	68	36	127
278	5	74	51	62.5	30.5	157.5
279	6	72	51	61.5	29.5	187
280	7	70	46	58	26	213
281	8	71	43	57	25	238
282	9	74	48	61	29	267
283	10	67	47	57	25	292
284	11	62	32	47	15	307
285	12	65	37	51	19	326
286	13	58	34	46	14	340
287	14	62	33	47.5	15.5	355.5
288	15	61	32	46.5	14.5	370
289	16	65	36	50.5	18.5	388.5
290	17	65	38	51.5	19.5	408
291	18	62	38	50	18	426
292	19	56	38	47	15	441
293	20	45	31	38	6	447
294	21	40	23	31.5	-0.5	446.5
295	22	49	26	37.5	5.5	452
296	23	52	31	41.5	9.5	461.5
297	24	59	31	45	13	474.5
298	25	41	25	33	1	475.5
299	26	64	31	47.5	15.5	491
300	27	55	33	44	12	503
301	28	58	32	45	13	516
302	29	57	31	44	12	528
303	30	50	39	44.5	12.5	540.5
304	31	48	31	39.5	7.5	548
305	32	45	29	37	5	553
306	33	50	25	37.5	5.5	558.5
307	34	48	26	37	5	563.5
308	35	51	27	39	7	570.5
309	36	50	38	44	12	582.5
310	37	50	39	44.5	12.5	595
311	38	51	38	44.5	12.5	607.5
312	39	49	28	38.5	6.5	614
313	40	48	30	39	7	621
314	41	50	30	40	8	629
315	42	50	31	40.5	8.5	637.5
316	43	50	31	40.5	8.5	646
317	44	45	31	38	6	652
318	45	47	25	36	4	656
319	46	43	27	35	3	659
320	47	46	30	38	6	665
321	48	51	28	39.5	7.5	672.5
322	49	54	31	42.5	10.5	683
323	50	56	35	45.5	13.5	696.5
324	51	55	31	43	11	707.5
325	52	52	28	40	8	715.5
326	53	51	30	40.5	8.5	724
327	54	50	27	38.5	6.5	730.5
328	55	46	23	34.5	2.5	733
329	56	51	31	41	9	742
330	57	47	25	36	4	746
331	58	45	27	36	4	750
332	59	39	20	29.5	-2.5	747.5
333	60	48	21	34.5	2.5	750
334	61	46	20	33	1	751
335	62	49	24	36.5	4.5	755.5

336	63	46	31	38.5	6.5	762
337	64	42	21	31.5	-0.5	761.5
338	65	38	20	29	-3	758.5
339	66	38	24	31	-1	757.5
340	67	42	21	31.5	-0.5	757
341	68	41	22	31.5	-0.5	756.5
342	69	40	22	31	-1	755.5
343	70	40	19	29.5	-2.5	753
344	71	39	21	30	-2	751
345	72	37	20	28.5	-3.5	747.5
346	73	35	21	28	-4	743.5
347	74	33	11	22	-10	733.5
348	75	40	16	28	-4	729.5
349	76	37	13	25	-7	722.5
350	77	36	20	28	-4	718.5
351	78	38	24	31	-1	717.5
352	79	41	17	29	-3	714.5
353	80	35	16	25.5	-6.5	708
354	81	33	25	29	-3	705
355	82	35	15	25	-7	698
356	83	26	10	18	-14	684
357	84	28	10	19	-13	671
358	85	24	11	17.5	-14.5	656.5
359	86	32	11	21.5	-10.5	646
360	87	32	11	21.5	-10.5	635.5
361	88	34	10	22	-10	625.5
362	89	33	11	22	-10	615.5
363	90	36	21	28.5	-3.5	612
364	91	40	20	30	-2	610
365	92	40	22	31	-1	609
1	93	32	10	21	-11	598
2	94	35	15	25	-7	591
3	95	38	21	29.5	-2.5	588.5
4	96	45	25	35	3	591.5
5	97	53	27	40	8	599.5
6	98	42	24	33	1	600.5
7	99	43	24	33.5	1.5	602
8	100	37	18	27.5	-4.5	597.5
9	101	35	16	25.5	-6.5	591
10	102	47	22	34.5	2.5	593.5
11	103	40	22	31	-1	592.5
12	104	32	13	22.5	-9.5	583
13	105	33	8	20.5	-11.5	571.5
14	106	43	14	28.5	-3.5	568
15	107	41	23	32	0	568
16	108	45	25	35	3	571
17	109	42	34	38	6	577
18	110	43	30	36.5	4.5	581.5
19	111	44	27	35.5	3.5	585
20	112	39	23	31	-1	584
21	113	44	22	33	1	585
22	114	52	30	41	9	594
23	115	49	24	36.5	4.5	598.5
24	116	36	22	29	-3	595.5
25	117	39	17	28	-4	591.5
26	118	42	23	32.5	0.5	592
27	119	41	32	36.5	4.5	596.5
28	120	38	30	34	2	598.5
29	121	42	23	32.5	0.5	599
30	122	35	20	27.5	-4.5	594.5
31	123	44	25	34.5	2.5	597
32	124	41	23	32	0	597
33	125	37	17	27	-5	592
34	126	45	22	33.5	1.5	593.5
35	127	41	26	33.5	1.5	595
36	128	42	28	35	3	598
37	129	36	21	28.5	-3.5	594.5
38	130	35	21	28	-4	590.5
39	131	42	28	35	3	593.5
40	132	46	20	33	1	594.5
41	133	50	22	36	4	598.5
42	134	55	27	41	9	607.5
43	135	55	29	42	10	617.5
44	136	57	30	43.5	11.5	629
45	137	58	31	44.5	12.5	641.5
46	138	56	22	39	7	648.5
47	139	47	12	29.5	-2.5	646
48	140	46	13	29.5	-2.5	643.5
49	141	49	28	38.5	6.5	650
50	142	45	22	33.5	1.5	651.5
51	143	46	25	35.5	3.5	655
52	144	40	27	33.5	1.5	656.5
53	145	49	24	36.5	4.5	661
54	146	50	27	38.5	6.5	667.5
55	147	62	35	48.5	16.5	684
56	148	63	34	48.5	16.5	700.5
57	149	62	33	47.5	15.5	716
58	150	65	34	49.5	17.5	733.5
59	151	64	35	49.5	17.5	751
60	152	65	34	49.5	17.5	768.5
61	153	67	38	52.5	20.5	789
62	154	67	42	54.5	22.5	811.5
63	155	59	42	50.5	18.5	830
64	156	51	39	45	13	843
65	157	52	30	41	9	852
66	158	46	29	37.5	5.5	857.5
67	159	45	28	36.5	4.5	862
68	160	44	20	32	0	862
69	161	53	27	40	8	870
70	162	57	30	43.5	11.5	881.5
71	163	52	32	42	10	891.5
72	164	49	36	42.5	10.5	902
73	165	48	37	42.5	10.5	912.5
74	166	52	37	44.5	12.5	925
75	167	60	31	45.5	13.5	938.5
76	168	62	40	51	19	957.5
77	169	68	41	54.5	22.5	980
78	170	60	37	48.5	16.5	996.5
79	171	53	29	41	9	1005.5

80	172	54	26	40	8	1013.5
81	173	59	38	48.5	16.5	1030
82	174	58	32	45	13	1043
83	175	61	32	46.5	14.5	1057.5
84	176	58	33	45.5	13.5	1071
85	177	50	31	40.5	8.5	1079.5
86	178	50	22	36	4	1083.5
87	179	52	30	41	9	1092.5
88	180	48	31	39.5	7.5	1100
89	181	52	38	45	13	1113
90	182	58	28	43	11	1124
91	183	57	32	44.5	12.5	1136.5
92	184	68	39	53.5	21.5	1158
93	185	64	40	52	20	1178
94	186	59	39	49	17	1195
95	187	42	21	31.5	-0.5	1194.5
96	188	35	23	29	-3	1191.5
97	189	40	19	29.5	-2.5	1189
98	190	48	19	33.5	1.5	1190.5
99	191	59	30	44.5	12.5	1203
100	192	65	39	52	20	1223
101	193	66	37	51.5	19.5	1242.5
102	194	60	35	47.5	15.5	1258
103	195	61	32	46.5	14.5	1272.5
104	196	56	31	43.5	11.5	1284
105	197	50	30	40	8	1292
106	198	54	33	43.5	11.5	1303.5
107	199	62	36	49	17	1320.5
108	200	65	34	49.5	17.5	1338
109	201	69	39	54	22	1360
110	202	63	37	50	18	1378
111	203	60	34	47	15	1393
112	204	69	37	53	21	1414
113	205	67	47	57	25	1439
114	206	61	29	45	13	1452
115	207	45	25	35	3	1455
116	208	53	26	39.5	7.5	1462.5
117	209	57	28	42.5	10.5	1473
118	210	65	32	48.5	16.5	1489.5
119	211	68	37	52.5	20.5	1510
120	212	63	37	50	18	1528
121	213	75	45	60	28	1556
122	214	73	43	58	26	1582
123	215	73	42	57.5	25.5	1607.5
124	216	72	41	56.5	24.5	1632
125	217	70	43	56.5	24.5	1656.5
126	218	51	39	45	13	1669.5
127	219	48	29	38.5	6.5	1676
128	220	59	33	46	14	1690
129	221	65	35	50	18	1708
130	222	66	42	54	22	1730
131	223	71	41	56	24	1754
132	224	72	46	59	27	1781
133	225	77	48	62.5	30.5	1811.5
134	226	76	46	61	29	1840.5
135	227	73	40	56.5	24.5	1865
136	228	69	50	59.5	27.5	1892.5
137	229	60	47	53.5	21.5	1914
138	230	54	43	48.5	16.5	1930.5
139	231	60	31	45.5	13.5	1944
140	232	72	38	55	23	1967
141	233	68	47	57.5	25.5	1992.5
142	234	67	43	55	23	2015.5
143	235	68	46	57	25	2040.5
144	236	66	40	53	21	2061.5
145	237	64	41	52.5	20.5	2082
146	238	76	34	55	23	2105
147	239	75	46	60.5	28.5	2133.5
148	240	79	50	64.5	32.5	2166
149	241	75	50	62.5	30.5	2196.5
150	242	75	45	60	28	2224.5
151	243	70	41	55.5	23.5	2248
152	244	72	42	57	25	2273
153	245	77	45	61	29	2302
154	246	78	43	60.5	28.5	2330.5
155	247	63	47	55	23	2353.5
156	248	65	45	55	23	2376.5
157	249	68	49	58.5	26.5	2403
158	250	76	51	63.5	31.5	2434.5
159	251	83	53	68	36	2470.5
160	252	85	55	70	38	2508.5
161	253	85	60	72.5	40.5	2549
162	254	87	61	74	42	2591
163	255	85	58	71.5	39.5	2630.5
164	256	74	55	64.5	32.5	2663
165	257	70	56	63	31	2694
166	258	74	52	63	31	2725
167	259	74	47	60.5	28.5	2753.5
168	260	74	56	65	33	2786.5
169	261	69	45	57	25	2811.5
170	262	71	41	56	24	2835.5
171	263	77	47	62	30	2865.5
172	264	81	53	67	35	2900.5
173	265	84	57	70.5	38.5	2939
174	266	86	57	71.5	39.5	2978.5
175	267	87	58	72.5	40.5	3019
176	268	88	57	72.5	40.5	3059.5
177	269	87	53	70	38	3097.5
178	270	88	52	70	38	3135.5
179	271	88	58	73	41	3176.5
180	272	89	56	72.5	40.5	3217
181	273	90	61	75.5	43.5	3260.5
182	274	90	60	75	43	3303.5
183	275	87	62	74.5	42.5	3346
184	276	82	46	64	32	3378
185	277	68	54	61	29	3407
186	278	79	42	60.5	28.5	3435.5
187	279	84	55	69.5	37.5	3473
188	280	88	57	72.5	40.5	3513.5

189	281	87	59	73	41	3554.5
190	282	84	59	71.5	39.5	3594
191	283	86	60	73	41	3635
192	284	87	59	73	41	3676
193	285	83	58	70.5	38.5	3714.5
194	286	83	55	69	37	3751.5
195	287	87	58	72.5	40.5	3792
196	288	82	57	69.5	37.5	3829.5
197	289	83	60	71.5	39.5	3869
198	290	86	61	73.5	41.5	3910.5
199	291	85	60	72.5	40.5	3951
200	292	89	64	76.5	44.5	3995.5
201	293	86	61	73.5	41.5	4037
202	294	85	61	73	41	4078
203	295	88	59	73.5	41.5	4119.5
204	296	87	58	72.5	40.5	4160
205	297	89	60	74.5	42.5	4202.5
206	298	84	60	72	40	4242.5
207	299	83	59	71	39	4281.5
208	300	85	56	70.5	38.5	4320
209	301	88	59	73.5	41.5	4361.5
210	302	88	59	73.5	41.5	4403
211	303	80	57	68.5	36.5	4439.5
212	304	72	55	63.5	31.5	4471
213	305	78	54	66	34	4505
214	306	80	54	67	35	4540
215	307	85	60	72.5	40.5	4580.5
216	308	86	57	71.5	39.5	4620
217	309	86	57	71.5	39.5	4659.5
218	310	88	59	73.5	41.5	4701
219	311	83	54	68.5	36.5	4737.5
220	312	77	59	68	36	4773.5
221	313	79	53	66	34	4807.5
222	314	82	55	68.5	36.5	4844
223	315	86	54	70	38	4882
224	316	85	56	70.5	38.5	4920.5
225	317	85	55	70	38	4958.5
226	318	76	57	66.5	34.5	4993
227	319	75	50	62.5	30.5	5023.5
228	320	82	51	66.5	34.5	5058
229	321	83	53	68	36	5094
230	322	82	55	68.5	36.5	5130.5
231	323	82	53	67.5	35.5	5166
232	324	77	57	67	35	5201
233	325	70	56	63	31	5232
234	326	70	57	63.5	31.5	5263.5
235	327	75	52	63.5	31.5	5295
236	328	75	52	63.5	31.5	5326.5
237	329	74	53	63.5	31.5	5358
238	330	81	53	67	35	5393
239	331	83	57	70	38	5431
240	332	82	54	68	36	5467
241	333	83	57	70	38	5505
242	334	82	57	69.5	37.5	5542.5
243	335	77	52	64.5	32.5	5575
244	336	80	52	66	34	5609
245	337	77	55	66	34	5643
246	338	77	49	63	31	5674
247	339	77	47	62	30	5704
248	340	78	48	63	31	5735
249	341	78	47	62.5	30.5	5765.5
250	342	79	52	65.5	33.5	5799
251	343	79	50	64.5	32.5	5831.5
252	344	78	48	63	31	5862.5
253	345	78	48	63	31	5893.5
254	346	77	49	63	31	5924.5
255	347	77	48	62.5	30.5	5955
256	348	73	50	61.5	29.5	5984.5
257	349	84	48	66	34	6018.5
258	350	82	48	65	33	6051.5
259	351	76	46	61	29	6080.5
260	352	76	51	63.5	31.5	6112
261	353	77	42	59.5	27.5	6139.5
262	354	72	42	57	25	6164.5
263	355	74	39	56.5	24.5	6189
264	356	76	45	60.5	28.5	6217.5
265	357	80	49	64.5	32.5	6250
266	358	80	49	64.5	32.5	6282.5
267	359	82	49	65.5	33.5	6316
268	360	80	49	64.5	32.5	6348.5
269	361	83	51	67	35	6383.5
270	362	84	48	66	34	6417.5
271	363	80	51	65.5	33.5	6451
272	364	75	40	57.5	25.5	6476.5
273	365	71	48	59.5	27.5	6504



65	758.5	length of freeze (day)	42
107	568	frost depth (^{o}F-day)	190.5
		average temperature	49.8

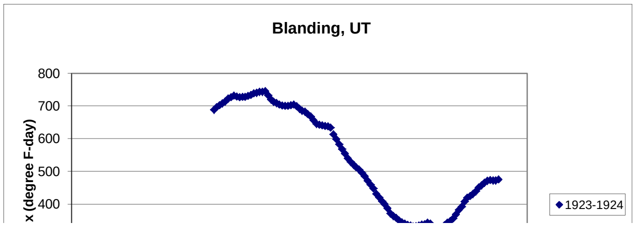
1923-1924

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	70	44	57	25	25
275	2	67	39	53	21	46
276	3	69	40	54.5	22.5	68.5
277	4	70	42	56	24	92.5
278	5	71	44	57.5	25.5	118
279	6	66	39	52.5	20.5	138.5
280	7	65	45	55	23	161.5
281	8	64	42	53	21	182.5
282	9	61	33	47	15	197.5
283	10	62	34	48	16	213.5
284	11	62	36	49	17	230.5
285	12	63	45	54	22	252.5
286	13	67	40	53.5	21.5	274
287	14	60	29	44.5	12.5	286.5
288	15	55	31	43	11	297.5
289	16	60	33	46.5	14.5	312
290	17	56	44	50	18	330
291	18	60	31	45.5	13.5	343.5
292	19	61	33	47	15	358.5
293	20	63	34	48.5	16.5	375

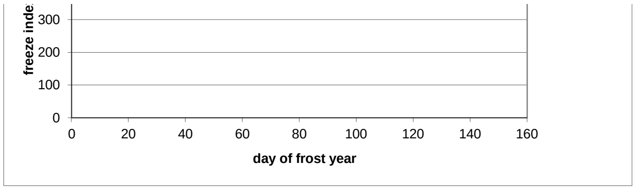
294	21	64	33	48.5	16.5	391.5
295	22	64	34	49	17	408.5
296	23	41	36	38.5	6.5	415
297	24	46	31	38.5	6.5	421.5
298	25	50	29	39.5	7.5	429
299	26	49	28	38.5	6.5	435.5
300	27	54	29	41.5	9.5	445
301	28	57	31	44	12	457
302	29	59	30	44.5	12.5	469.5
303	30	62	28	45	13	482.5
304	31	46	36	41	9	491.5
305	32	49	35	42	10	501.5
306	33	51	31	41	9	510.5
307	34	53	36	44.5	12.5	523
308	35	57	34	45.5	13.5	536.5
309	36	57	36	46.5	14.5	551
310	37	61	30	45.5	13.5	564.5
311	38	65	34	49.5	17.5	582
312	39	46	37	41.5	9.5	591.5
313	40	54	34	44	12	603.5
314	41	42	39	40.5	8.5	612
315	42	41	34	37.5	5.5	617.5
316	43	44	36	40	8	625.5
317	44	50	30	40	8	633.5
318	45	53	29	41	9	642.5
319	46	54	34	44	12	654.5
320	47	50	33	41.5	9.5	664
321	48	53	31	42	10	674
322	49	52	29	40.5	8.5	682.5
323	50	50	27	38.5	6.5	689
324	51	51	29	40	8	697
325	52	46	29	37.5	5.5	702.5
326	53	50	26	38	6	708.5
327	54	48	28	38	6	714.5
328	55	52	29	40.5	8.5	723
329	56	43	30	36.5	4.5	727.5
330	57	43	31	37	5	732.5
331	58	33	25	29	-3	729.5
332	59	40	20	30	-2	727.5
333	60	43	22	32.5	0.5	728
334	61	42	22	32	0	728
335	62	40	30	35	3	731
336	63	42	29	35.5	3.5	734.5
337	64	46	27	36.5	4.5	739
338	65	44	24	34	2	741
339	66	46	24	35	3	744
340	67	40	23	31.5	-0.5	743.5
341	68	42	26	34	2	745.5
342	69	26	14	20	-12	733.5
343	70	24	14	19	-13	720.5
344	71	31	19	25	-7	713.5
345	72	33	23	28	-4	709.5
346	73	35	20	27.5	-4.5	705
347	74	34	24	29	-3	702
348	75	35	26	30.5	-1.5	700.5
349	76	37	28	32.5	0.5	701
350	77	39	29	34	2	703
351	78	39	28	33.5	1.5	704.5
352	79	34	20	27	-5	699.5
353	80	31	18	24.5	-7.5	692
354	81	35	18	26.5	-5.5	686.5
355	82	41	16	28.5	-3.5	683
356	83	35	14	24.5	-7.5	675.5
357	84	34	16	25	-7	668.5
358	85	30	10	20	-12	656.5
359	86	28	14	21	-11	645.5
360	87	32	26	29	-3	642.5
361	88	33	28	30.5	-1.5	641
362	89	31	29	30	-2	639
363	90	32	30	31	-1	638
364	91	30	26	28	-4	634
365	92	22	1	11.5	-20.5	613.5
1	93	24	10	17	-15	598.5
2	94	21	13	17	-15	583.5
3	95	24	10	17	-15	568.5
4	96	28	8	18	-14	554.5
5	97	28	8	18	-14	540.5
6	98	30	11	20.5	-11.5	529
7	99	34	13	23.5	-8.5	520.5
8	100	33	15	24	-8	512.5
9	101	30	20	25	-7	505.5
10	102	33	13	23	-9	496.5
11	103	28	14	21	-11	485.5
12	104	26	10	18	-14	471.5
13	105	29	12	20.5	-11.5	460
14	106	30	11	20.5	-11.5	448.5
15	107	22	8	15	-17	431.5
16	108	30	12	21	-11	420.5
17	109	29	12	20.5	-11.5	409
18	110	33	13	23	-9	400
19	111	30	8	19	-13	387
20	112	32	2	17	-15	372
21	113	36	12	24	-8	364
22	114	35	16	25.5	-6.5	357.5
23	115	34	15	24.5	-7.5	350
24	116	37	16	26.5	-5.5	344.5
25	117	36	20	28	-4	340.5
26	118	37	19	28	-4	336.5
27	119	41	18	29.5	-2.5	334
28	120	39	20	29.5	-2.5	331.5
29	121	44	21	32.5	0.5	332
30	122	42	26	34	2	334
31	123	47	24	35.5	3.5	337.5
32	124	42	24	33	1	338.5
33	125	46	27	36.5	4.5	343
34	126	35	24	29.5	-2.5	340.5
35	127	33	12	22.5	-9.5	331
36	128	40	13	26.5	-5.5	325.5
37	129	36	27	31.5	-0.5	325

38	130	41	25	33	1	326
39	131	52	30	41	9	335
40	132	49	31	40	8	343
41	133	45	29	37	5	348
42	134	52	28	40	8	356
43	135	58	32	45	13	369
44	136	56	35	45.5	13.5	382.5
45	137	53	31	42	10	392.5
46	138	58	37	47.5	15.5	408
47	139	57	31	44	12	420
48	140	50	24	37	5	425
49	141	48	28	38	6	431
50	142	53	28	40.5	8.5	439.5
51	143	57	30	43.5	11.5	451
52	144	49	29	39	7	458
53	145	45	34	39.5	7.5	465.5
54	146	43	33	38	6	471.5
55	147	42	26	34	2	473.5
56	148	38	24	31	-1	472.5
57	149	40	25	32.5	0.5	473
58	150	45	24	34.5	2.5	475.5
59	151	46	21	33.5	1.5	477
60	152	53	29	41	9	486
61	153	52	31	41.5	9.5	495.5
62	154	55	34	44.5	12.5	508
63	155	48	29	38.5	6.5	514.5
64	156	47	24	35.5	3.5	518
65	157	38	22	30	-2	516
66	158	50	21	35.5	3.5	519.5
67	159	52	26	39	7	526.5
68	160	54	24	39	7	533.5
69	161	40	18	29	-3	530.5
70	162	54	21	37.5	5.5	536
71	163	41	19	30	-2	534
72	164	47	26	36.5	4.5	538.5
73	165	43	17	30	-2	536.5
74	166	40	23	31.5	-0.5	536
75	167	38	21	29.5	-2.5	533.5
76	168	36	21	28.5	-3.5	530
77	169	39	19	29	-3	527
78	170	37	26	31.5	-0.5	526.5
79	171	33	20	26.5	-5.5	521
80	172	32	26	29	-3	518
81	173	31	27	29	-3	515
82	174	32	24	28	-4	511
83	175	33	24	28.5	-3.5	507.5
84	176	40	33	36.5	4.5	512
85	177	45	32	38.5	6.5	518.5
86	178	54	31	42.5	10.5	529
87	179	58	30	44	12	541
88	180	44	29	36.5	4.5	545.5
89	181	40	22	31	-1	544.5
90	182	35	20	27.5	-4.5	540
91	183	41	13	27	-5	535
92	184	50	33	41.5	9.5	544.5
93	185	55	31	43	11	555.5
94	186	54	33	43.5	11.5	567
95	187	56	37	46.5	14.5	581.5
96	188	60	36	48	16	597.5
97	189	67	46	56.5	24.5	622
98	190	68	50	59	27	649
99	191	64	45	54.5	22.5	671.5
100	192	60	40	50	18	689.5
101	193	59	38	48.5	16.5	706
102	194	61	40	50.5	18.5	724.5
103	195	60	33	46.5	14.5	739
104	196	62	35	48.5	16.5	755.5
105	197	64	37	50.5	18.5	774
106	198	60	29	44.5	12.5	786.5
107	199	48	23	35.5	3.5	790
108	200	60	21	40.5	8.5	798.5
109	201	68	37	52.5	20.5	819
110	202	74	46	60	28	847
111	203	61	37	49	17	864
112	204	74	39	56.5	24.5	888.5
113	205	66	36	51	19	907.5
114	206	68	40	54	22	929.5
115	207	56	33	44.5	12.5	942
116	208	54	32	43	11	953
117	209	54	28	41	9	962
118	210	57	29	43	11	973
119	211	55	32	43.5	11.5	984.5
120	212	64	34	49	17	1001.5
121	213	65	44	54.5	22.5	1024
122	214	66	43	54.5	22.5	1046.5
123	215	72	48	60	28	1074.5
124	216	75	47	61	29	1103.5
125	217	65	46	55.5	23.5	1127
126	218	62	39	50.5	18.5	1145.5
127	219	58	37	47.5	15.5	1161
128	220	67	37	52	20	1181
129	221	69	45	57	25	1206
130	222	70	43	56.5	24.5	1230.5
131	223	72	48	60	28	1258.5
132	224	75	47	61	29	1287.5
133	225	79	49	64	32	1319.5
134	226	75	48	61.5	29.5	1349
135	227	74	49	61.5	29.5	1378.5
136	228	75	43	59	27	1405.5
137	229	72	46	59	27	1432.5
138	230	73	45	59	27	1459.5
139	231	75	47	61	29	1488.5
140	232	77	46	61.5	29.5	1518
141	233	79	48	63.5	31.5	1549.5
142	234	81	52	66.5	34.5	1584
143	235	74	51	62.5	30.5	1614.5
144	236	78	49	63.5	31.5	1646
145	237	79	48	63.5	31.5	1677.5
146	238	76	47	61.5	29.5	1707

147	239	80	48	64	32	1739
148	240	68	54	61	29	1768
149	241	64	42	53	21	1789
150	242	65	42	53.5	21.5	1810.5
151	243	66	40	53	21	1831.5
152	244	65	36	50.5	18.5	1850
153	245	72	43	57.5	25.5	1875.5
154	246	78	56	67	35	1910.5
155	247	83	56	69.5	37.5	1948
156	248	86	61	73.5	41.5	1989.5
157	249	83	54	68.5	36.5	2026
158	250	79	51	65	33	2059
159	251	76	48	62	30	2089
160	252	70	39	54.5	22.5	2111.5
161	253	76	40	58	26	2137.5
162	254	83	51	67	35	2172.5
163	255	85	56	70.5	38.5	2211
164	256	86	58	72	40	2251
165	257	85	59	72	40	2291
166	258	87	60	73.5	41.5	2332.5
167	259	90	63	76.5	44.5	2377
168	260	91	64	77.5	45.5	2422.5
169	261	93	57	75	43	2465.5
170	262	86	58	72	40	2505.5
171	263	79	54	66.5	34.5	2540
172	264	80	47	63.5	31.5	2571.5
173	265	78	49	63.5	31.5	2603
174	266	81	52	66.5	34.5	2637.5
175	267	84	66	75	43	2680.5
176	268	88	69	78.5	46.5	2727
177	269	90	73	81.5	49.5	2776.5
178	270	91	76	83.5	51.5	2828
179	271	93	59	76	44	2872
180	272	95	77	86	54	2926
181	273	92	71	81.5	49.5	2975.5
182	274	91	61	76	44	3019.5
183	275	90	63	76.5	44.5	3064
184	276	92	64	78	46	3110
185	277	78	60	69	37	3147
186	278	84	66	75	43	3190
187	279	86	68	77	45	3235
188	280	88	59	73.5	41.5	3276.5
189	281	84	56	70	38	3314.5
190	282	88	64	76	44	3358.5
191	283	90	66	78	46	3404.5
192	284	94	55	74.5	42.5	3447
193	285	84	56	70	38	3485
194	286	90	57	73.5	41.5	3526.5
195	287	88	62	75	43	3569.5
196	288	85	64	74.5	42.5	3612
197	289	81	60	70.5	38.5	3650.5
198	290	83	62	72.5	40.5	3691
199	291	85	63	74	42	3733
200	292	82	57	69.5	37.5	3770.5
201	293	83	60	71.5	39.5	3810
202	294	86	61	73.5	41.5	3851.5
203	295	85	60	72.5	40.5	3892
204	296	87	60	73.5	41.5	3933.5
205	297	82	59	70.5	38.5	3972
206	298	88	66	77	45	4017
207	299	86	65	75.5	43.5	4060.5
208	300	89	57	73	41	4101.5
209	301	86	56	71	39	4140.5
210	302	80	61	70.5	38.5	4179
211	303	84	57	70.5	38.5	4217.5
212	304	86	60	73	41	4258.5
213	305	82	63	72.5	40.5	4299
214	306	84	63	73.5	41.5	4340.5
215	307	86	58	72	40	4380.5
216	308	84	56	70	38	4418.5
217	309	81	56	68.5	36.5	4455
218	310	85	56	70.5	38.5	4493.5
219	311	84	54	69	37	4530.5
220	312	83	52	67.5	35.5	4566
221	313	84	56	70	38	4604
222	314	85	57	71	39	4643
223	315	84	58	71	39	4682
224	316	86	56	71	39	4721
225	317	84	57	70.5	38.5	4759.5
226	318	80	57	68.5	36.5	4796
227	319	82	58	70	38	4834
228	320	81	54	67.5	35.5	4869.5
229	321	80	57	68.5	36.5	4906
230	322	78	54	66	34	4940
231	323	79	48	63.5	31.5	4971.5
232	324	82	53	67.5	35.5	5007
233	325	81	50	65.5	33.5	5040.5
234	326	85	47	66	34	5074.5
235	327	86	55	70.5	38.5	5113
236	328	90	61	75.5	43.5	5156.5
237	329	88	62	75	43	5199.5
238	330	89	64	76.5	44.5	5244
239	331	88	63	75.5	43.5	5287.5
240	332	90	59	74.5	42.5	5330
241	333	91	61	76	44	5374
242	334	86	60	73	41	5415
243	335	85	57	71	39	5454
244	336	84	58	71	39	5493
245	337	86	60	73	41	5534
246	338	83	61	72	40	5574
247	339	85	67	76	44	5618
248	340	87	68	77.5	45.5	5663.5
249	341	90	69	79.5	47.5	5711
250	342	86	56	71	39	5750
251	343	86	58	72	40	5790
252	344	82	59	70.5	38.5	5828.5
253	345	76	44	60	28	5856.5
254	346	70	54	62	30	5886.5
255	347	66	44	55	23	5909.5



256	348	71	41	56	24	5933.5
257	349	73	44	58.5	26.5	5960
258	350	75	46	60.5	28.5	5988.5
259	351	76	49	62.5	30.5	6019
260	352	71	49	60	28	6047
261	353	72	46	59	27	6074
262	354	68	44	56	24	6098
263	355	59	36	47.5	15.5	6113.5
264	356	70	42	56	24	6137.5
265	357	72	43	57.5	25.5	6163
266	358	73	43	58	26	6189
267	359	76	41	58.5	26.5	6215.5
268	360	70	43	56.5	24.5	6240
269	361	68	40	54	22	6262
270	362	64	35	49.5	17.5	6279.5
271	363	70	37	53.5	21.5	6301
272	364	71	36	53.5	21.5	6322.5
273	365	73	41	57	25	6347.5
274	366	72	42	57	25	6372.5



68	745.5	length of freeze (day)	62
130	326	frost depth (^oF-day)	419.5
		average temperature	49.4

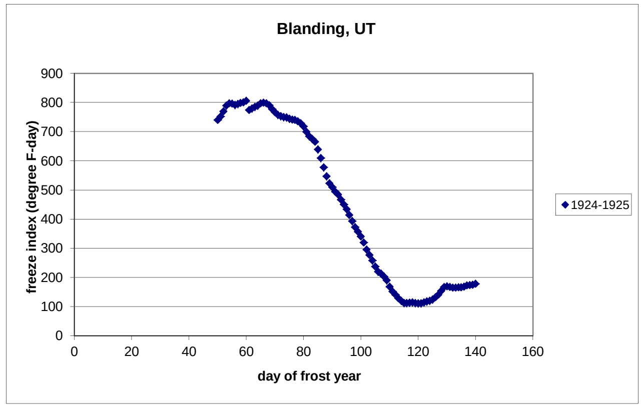
1924-1925

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	71	31	51	19	19
275	2	69	29	49	17	36
276	3	73	34	53.5	21.5	57.5
277	4	74	35	54.5	22.5	80
278	5	75	37	56	24	104
279	6	77	38	57.5	25.5	129.5
280	7	69	36	52.5	20.5	150
281	8	68	37	52.5	20.5	170.5
282	9	67	38	52.5	20.5	191
283	10	64	45	54.5	22.5	213.5
284	11	44	34	39	7	220.5
285	12	48	32	40	8	228.5
286	13	49	28	38.5	6.5	235
287	14	53	36	44.5	12.5	247.5
288	15	65	42	53.5	21.5	269
289	16	73	43	58	26	295
290	17	70	44	57	25	320
291	18	68	32	50	18	338
292	19	55	32	43.5	11.5	349.5
293	20	58	34	46	14	363.5
294	21	62	35	48.5	16.5	380
295	22	65	39	52	20	400
296	23	66	40	53	21	421
297	24	68	39	53.5	21.5	442.5
298	25	70	39	54.5	22.5	465
299	26	69	40	54.5	22.5	487.5
300	27	62	35	48.5	16.5	504
301	28	60	35	47.5	15.5	519.5
302	29	48	34	41	9	528.5
303	30	47	26	36.5	4.5	533
304	31	53	26	39.5	7.5	540.5
305	32	62	29	45.5	13.5	554
306	33	63	35	49	17	571
307	34	64	38	51	19	590
308	35	64	40	52	20	610
309	36	60	38	49	17	627
310	37	57	30	43.5	11.5	638.5
311	38	41	21	31	-1	637.5
312	39	49	23	36	4	641.5
313	40	51	31	41	9	650.5
314	41	49	35	42	10	660.5
315	42	43	17	30	-2	658.5
316	43	48	24	36	4	662.5
317	44	49	27	38	6	668.5
318	45	51	29	40	8	676.5
319	46	54	34	44	12	688.5
320	47	56	33	44.5	12.5	701
321	48	60	34	47	15	716
322	49	57	29	43	11	727
323	50	55	36	45.5	13.5	740.5
324	51	54	35	44.5	12.5	753
325	52	60	38	49	17	770
326	53	64	39	51.5	19.5	789.5
327	54	50	29	39.5	7.5	797
328	55	41	21	31	-1	796
329	56	38	19	28.5	-3.5	792.5
330	57	46	24	35	3	795.5
331	58	45	26	35.5	3.5	799
332	59	47	21	34	2	801
333	60	48	27	37.5	5.5	806.5
334	61	49	28		-32	774.5
335	62	49	26	37.5	5.5	780
336	63	47	29	38	6	786
337	64	40	32	36	4	790
338	65	45	34	39.5	7.5	797.5
339	66	41	28	34.5	2.5	800
340	67	32	26	29	-3	797
341	68	33	19	26	-6	791
342	69	26	11	18.5	-13.5	777.5
343	70	24	18	21	-11	766.5
344	71	29	18	23.5	-8.5	758
345	72	35	20	27.5	-4.5	753.5
346	73	37	21	29	-3	750.5
347	74	39	23	31	-1	749.5
348	75	34	20	27	-5	744.5
349	76	36	22	29	-3	741.5
350	77	38	24	31	-1	740.5
351	78	36	20	28	-4	736.5
352	79	31	19	25	-7	729.5
353	80	29	12	20.5	-11.5	718
354	81	24	3	13.5	-18.5	699.5
355	82	28	6	17	-15	684.5
356	83	26	21	23.5	-8.5	676
357	84	27	17	22	-10	666
358	85	18	-8	5	-27	639

359	86	10	-5	2.5	-29.5	609.5
360	87	12	-10	1	-31	578.5
361	88	10	-8	1	-31	547.5
362	89	19	-3	8	-24	523.5
363	90	29	8	18.5	-13.5	510
364	91	24	10	17	-15	495
365	92	28	16	22	-10	485
1	93	19	10	14.5	-17.5	467.5
2	94	18	12	15	-17	450.5
3	95	22	9	15.5	-16.5	434
4	96	20	4	12	-20	414
5	97	21	1	11	-21	393
6	98	19	4	11.5	-20.5	372.5
7	99	27	7	17	-15	357.5
8	100	24	6	15	-17	340.5
9	101	20	4	12	-20	320.5
10	102	18	-4	7	-25	295.5
11	103	24	4	14	-18	277.5
12	104	24	1	12.5	-19.5	258
13	105	20	4	12	-20	238
14	106	26	2	14	-18	220
15	107	30	20	25	-7	213
16	108	31	15	23	-9	204
17	109	28	8	18	-14	190
18	110	21	0	10.5	-21.5	168.5
19	111	23	8	15.5	-16.5	152
20	112	32	10	21	-11	141
21	113	30	10	20	-12	129
22	114	33	14	23.5	-8.5	120.5
23	115	34	15	24.5	-7.5	113
24	116	38	24	31	-1	112
25	117	40	28	34	2	114
26	118	41	25	33	1	115
27	119	39	20	29.5	-2.5	112.5
28	120	40	21	30.5	-1.5	111
29	121	41	24	32.5	0.5	111.5
30	122	44	26	35	3	114.5
31	123	43	28	35.5	3.5	118
32	124	40	28	34	2	120
33	125	42	30	36	4	124
34	126	49	31	40	8	132
35	127	50	31	40.5	8.5	140.5
36	128	51	40	45.5	13.5	154
37	129	52	38	45	13	167
38	130	46	24	35	3	170
39	131	40	19	29.5	-2.5	167.5
40	132	38	22	30	-2	165.5
41	133	40	24	32	0	165.5
42	134	42	23	32.5	0.5	166
43	135	44	21	32.5	0.5	166.5
44	136	45	24	34.5	2.5	169
45	137	46	26	36	4	173
46	138	43	24	33.5	1.5	174.5
47	139	42	24	33	1	175.5
48	140	45	25	35	3	178.5
49	141	48	26	37	5	183.5
50	142	51	25	38	6	189.5
51	143	49	28	38.5	6.5	196
52	144	47	31	39	7	203
53	145	44	30	37	5	208
54	146	46	28	37	5	213
55	147	44	31	37.5	5.5	218.5
56	148	50	25	37.5	5.5	224
57	149	49	28	38.5	6.5	230.5
58	150	46	25	35.5	3.5	234
59	151	45	25	35	3	237
60	152	45	M	-	-	237
61	153	54	28	41	9	246
62	154	53	34	43.5	11.5	257.5
63	155	54	30	42	10	267.5
64	156	57	33	45	13	280.5
65	157	60	32	46	14	294.5
66	158	55	34	44.5	12.5	307
67	159	54	35	44.5	12.5	319.5
68	160	50	30	40	8	327.5
69	161	48	24	36	4	331.5
70	162	41	20	30.5	-1.5	330
71	163	44	25	34.5	2.5	332.5
72	164	41	23	32	0	332.5
73	165	46	20	33	1	333.5
74	166	47	24	35.5	3.5	337
75	167	60	26	43	11	348
76	168	57	20	38.5	6.5	354.5
77	169	58	21	39.5	7.5	362
78	170	54	27	40.5	8.5	370.5
79	171	57	31	44	12	382.5
80	172	60	35	47.5	15.5	398
81	173	60	34	47	15	413
82	174	61	36	48.5	16.5	429.5
83	175	58	38	48	16	445.5
84	176	64	37	50.5	18.5	464
85	177	65	40	52.5	20.5	484.5
86	178	61	32	46.5	14.5	499
87	179	54	39	46.5	14.5	513.5
88	180	61	37	49	17	530.5
89	181	56	31	43.5	11.5	542
90	182	63	36	49.5	17.5	559.5
91	183	58	30	44	12	571.5
92	184	56	37	46.5	14.5	586
93	185	59	39	49	17	603
94	186	64	41	52.5	20.5	623.5
95	187	60	40	50	18	641.5
96	188	54	42	48	16	657.5
97	189	57	30	43.5	11.5	669
98	190	60	36	48	16	685
99	191	65	42	53.5	21.5	706.5
100	192	67	45	56	24	730.5
101	193	69	49	59	27	757.5
102	194	68	47	57.5	25.5	783

103	195	74	48	61	29	812
104	196	72	42	57	25	837
105	197	74	50	62	30	867
106	198	72	49	60.5	28.5	895.5
107	199	70	38	54	22	917.5
108	200	68	40	54	22	939.5
109	201	66	37	51.5	19.5	959
110	202	60	40	50	18	977
111	203	56	40	48	16	993
112	204	52	28	40	8	1001
113	205	41	30	35.5	3.5	1004.5
114	206	56	27	41.5	9.5	1014
115	207	60	31	45.5	13.5	1027.5
116	208	66	40	53	21	1048.5
117	209	70	42	56	24	1072.5
118	210	72	44	58	26	1098.5
119	211	68	44	56	24	1122.5
120	212	67	40	53.5	21.5	1144
121	213	65	42	53.5	21.5	1165.5
122	214	68	44	56	24	1189.5
123	215	71	42	56.5	24.5	1214
124	216	70	44	57	25	1239
125	217	77	48	62.5	30.5	1269.5
126	218	75	46	60.5	28.5	1298
127	219	77	47	62	30	1328
128	220	78	54	66	34	1362
129	221	84	46	65	33	1395
130	222	79	46	62.5	30.5	1425.5
131	223	77	50	63.5	31.5	1457
132	224	71	45	58	26	1483
133	225	64	40	52	20	1503
134	226	68	46	57	25	1528
135	227	71	47	59	27	1555
136	228	82	44	63	31	1586
137	229	78	44	61	29	1615
138	230	79	45	62	30	1645
139	231	77	47	62	30	1675
140	232	82	55	68.5	36.5	1711.5
141	233	78	56	67	35	1746.5
142	234	77	55	66	34	1780.5
143	235	79	57	68	36	1816.5
144	236	80	56	68	36	1852.5
145	237	79	57	68	36	1888.5
146	238	78	56	67	35	1923.5
147	239	81	52	66.5	34.5	1958
148	240	79	54	66.5	34.5	1992.5
149	241	80	56	68	36	2028.5
150	242	79	53	66	34	2062.5
151	243	75	49	62	30	2092.5
152	244	71	41	56	24	2116.5
153	245	72	50	61	29	2145.5
154	246	69	51	60	28	2173.5
155	247	64	45	54.5	22.5	2196
156	248	61	42	51.5	19.5	2215.5
157	249	62	41	51.5	19.5	2235
158	250	61	36	48.5	16.5	2251.5
159	251	70	46	58	26	2277.5
160	252	73	47	60	28	2305.5
161	253	77	51	64	32	2337.5
162	254	75	36	55.5	23.5	2361
163	255	77	44	60.5	28.5	2389.5
164	256	79	60	69.5	37.5	2427
165	257	77	55	66	34	2461
166	258	79	54	66.5	34.5	2495.5
167	259	82	64	73	41	2536.5
168	260	81	61	71	39	2575.5
169	261	82	59	70.5	38.5	2614
170	262	86	62	74	42	2656
171	263	84	56	70	38	2694
172	264	81	57	69	37	2731
173	265	85	54	69.5	37.5	2768.5
174	266	78	60	69	37	2805.5
175	267	86	60	73	41	2846.5
176	268	83	64	73.5	41.5	2888
177	269	82	57	69.5	37.5	2925.5
178	270	87	60	73.5	41.5	2967
179	271	89	70	79.5	47.5	3014.5
180	272	86	72	79	47	3061.5
181	273	84	70	77	45	3106.5
182	274	79	64	71.5	39.5	3146
183	275	83	57	70	38	3184
184	276	79	56	67.5	35.5	3219.5
185	277	76	56	66	34	3253.5
186	278	74	55	64.5	32.5	3286
187	279	73	58	65.5	33.5	3319.5
188	280	78	61	69.5	37.5	3357
189	281	84	62	73	41	3398
190	282	86	63	74.5	42.5	3440.5
191	283	85	58	71.5	39.5	3480
192	284	87	64	75.5	43.5	3523.5
193	285	90	59	74.5	42.5	3566
194	286	95	62	78.5	46.5	3612.5
195	287	91	77	84	52	3664.5
196	288	99	79	89	57	3721.5
197	289	96	68	82	50	3771.5
198	290	95	79	87	55	3826.5
199	291	93	64	78.5	46.5	3873
200	292	92	70	81	49	3922
201	293	86	64	75	43	3965
202	294	84	59	71.5	39.5	4004.5
203	295	85	62	73.5	41.5	4046
204	296	86	64	75	43	4089
205	297	88	67	77.5	45.5	4134.5
206	298	87	65	76	44	4178.5
207	299	85	64	74.5	42.5	4221
208	300	81	62	71.5	39.5	4260.5
209	301	85	67	76	44	4304.5
210	302	83	57	70	38	4342.5
211	303	84	57	70.5	38.5	4381

212	304	86	58	72	40	4421
213	305	86	59	72.5	40.5	4461.5
214	306	84	54	69	37	4498.5
215	307	88	61	74.5	42.5	4541
216	308	81	60	70.5	38.5	4579.5
217	309	80	57	68.5	36.5	4616
218	310	84	68	76	44	4660
219	311	82	64	73	41	4701
220	312	84	56	70	38	4739
221	313	80	58	69	37	4776
222	314	74	54	64	32	4808
223	315	76	48	62	30	4838
224	316	78	56	67	35	4873
225	317	84	57	70.5	38.5	4911.5
226	318	86	57	71.5	39.5	4951
227	319	84	54	69	37	4988
228	320	83	58	70.5	38.5	5026.5
229	321	81	60	70.5	38.5	5065
230	322	83	61	72	40	5105
231	323	82	58	70	38	5143
232	324	86	57	71.5	39.5	5182.5
233	325	86	59	72.5	40.5	5223
234	326	85	62	73.5	41.5	5264.5
235	327	78	67	72.5	40.5	5305
236	328	81	68	74.5	42.5	5347.5
237	329	80	54	67	35	5382.5
238	330	82	61	71.5	39.5	5422
239	331	80	58	69	37	5459
240	332	74	53	63.5	31.5	5490.5
241	333	75	54	64.5	32.5	5523
242	334	84	59	71.5	39.5	5562.5
243	335	79	55	67	35	5597.5
244	336	75	55	65	33	5630.5
245	337	78	55	66.5	34.5	5665
246	338	80	57	68.5	36.5	5701.5
247	339	79	48	63.5	31.5	5733
248	340	78	54	66	34	5767
249	341	80	57	68.5	36.5	5803.5
250	342	81	56	68.5	36.5	5840
251	343	77	53	65	33	5873
252	344	81	52	66.5	34.5	5907.5
253	345	77	53	65	33	5940.5
254	346	79	49	64	32	5972.5
255	347	76	49	62.5	30.5	6003
256	348	73	46	59.5	27.5	6030.5
257	349	79	45	62	30	6060.5
258	350	78	50	64	32	6092.5
259	351	80	56	68	36	6128.5
260	352	80	55	67.5	35.5	6164
261	353	78	56	67	35	6199
262	354	62	51	56.5	24.5	6223.5
263	355	64	42	53	21	6244.5
264	356	61	41	51	19	6263.5
265	357	64	40	52	20	6283.5
266	358	66	38	52	20	6303.5
267	359	69	42	55.5	23.5	6327
268	360	71	44	57.5	25.5	6352.5
269	361	76	50	63	31	6383.5
270	362	M	M	-	-	-
271	363	M	M	-	-	-
272	364	M	M	-	-	-
273	365	M	M	-	-	-



60	806.5	length of freeze (day)	60
120	111	frost depth (^oF-day)	695.5
		average temperature	49.9

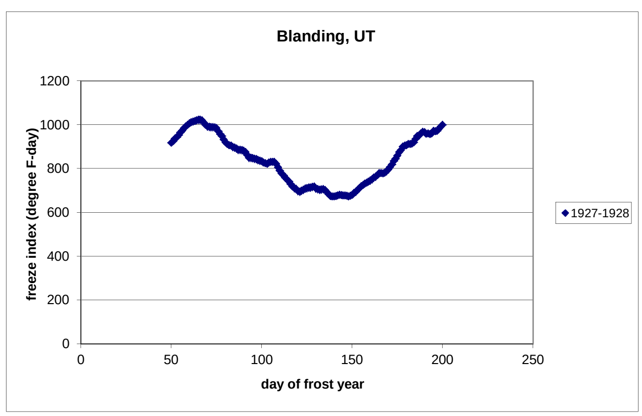
1927-1928

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	61	31	46	14	14
275	2	64	28	46	14	28
276	3	70	36	53	21	49
277	4	71	36	53.5	21.5	70.5
278	5	68	38	53	21	91.5
279	6	67	39	53	21	112.5
280	7	68	38	53	21	133.5
281	8	71	36	53.5	21.5	155
282	9	70	38	54	22	177
283	10	68	40	54	22	199
284	11	70	39	54.5	22.5	221.5
285	12	68	41	54.5	22.5	244
286	13	72	40	56	24	268
287	14	71	42	56.5	24.5	292.5
288	15	73	43	58	26	318.5
289	16	75	45	60	28	346.5
290	17	71	43	57	25	371.5
291	18	73	42	57.5	25.5	397
292	19	74	41	57.5	25.5	422.5
293	20	75	44	59.5	27.5	450
294	21	73	43	58	26	476
295	22	72	41	56.5	24.5	500.5
296	23	74	43	58.5	26.5	527
297	24	72	40	56	24	551
298	25	71	38	54.5	22.5	573.5
299	26	70	36	53	21	594.5
300	27	67	34	50.5	18.5	613
301	28	69	32	50.5	18.5	631.5
302	29	65	33	49	17	648.5
303	30	59	36	47.5	15.5	664
304	31	54	39	46.5	14.5	678.5
305	32	56	38	47	15	693.5
306	33	55	35	45	13	706.5
307	34	57	38	47.5	15.5	722
308	35	63	31	47	15	737
309	36	58	33	45.5	13.5	750.5
310	37	54	38	46	14	764.5
311	38	55	40	47.5	15.5	780
312	39	58	37	47.5	15.5	795.5
313	40	60	36	48	16	811.5
314	41	59	36	47.5	15.5	827
315	42	54	27	40.5	8.5	835.5
316	43	58	29	43.5	11.5	847

317	44	57	28	42.5	10.5	857.5
318	45	55	26	40.5	8.5	866
319	46	57	28	42.5	10.5	876.5
320	47	58	29	43.5	11.5	888
321	48	58	27	42.5	10.5	898.5
322	49	56	29	42.5	10.5	909
323	50	57	25	41	9	918
324	51	56	24	40	8	926
325	52	57	28	42.5	10.5	936.5
326	53	55	22	38.5	6.5	943
327	54	56	27	41.5	9.5	952.5
328	55	58	29	43.5	11.5	964
329	56	57	27	42	10	974
330	57	58	28	43	11	985
331	58	55	23	39	7	992
332	59	54	25	39.5	7.5	999.5
333	60	54	26	40	8	1007.5
334	61	50	22	36	4	1011.5
335	62	44	26	35	3	1014.5
336	63	45	24	34.5	2.5	1017
337	64	46	25	35.5	3.5	1020.5
338	65	46	23	34.5	2.5	1023
339	66	43	21	32	0	1023
340	67	40	18	29	-3	1020
341	68	38	7	22.5	-9.5	1010.5
342	69	31	12	21.5	-10.5	1000
343	70	34	16	25	-7	993
344	71	39	21	30	-2	991
345	72	41	20	30.5	-1.5	989.5
346	73	43	22	32.5	0.5	990
347	74	40	21	30.5	-1.5	988.5
348	75	39	18	28.5	-3.5	985
349	76	33	1	17	-15	970
350	77	31	7	19	-13	957
351	78	32	14	23	-9	948
352	79	31	2	16.5	-15.5	932.5
353	80	30	9	19.5	-12.5	920
354	81	32	17	24.5	-7.5	912.5
355	82	34	18	26	-6	906.5
356	83	36	24	30	-2	904.5
357	84	34	20	27	-5	899.5
358	85	36	21	28.5	-3.5	896
359	86	38	18	28	-4	892
360	87	40	12	26	-6	886
361	88	39	25	32	0	886
362	89	38	24	31	-1	885
363	90	36	22	29	-3	882
364	91	33	19	26	-6	876
365	92	33	1	17	-15	861
1	93	35	6	20.5	-11.5	849.5
2	94	48	15	31.5	-0.5	849
3	95	45	18	31.5	-0.5	848.5
4	96	40	18	29	-3	845.5
5	97	41	18	29.5	-2.5	843
6	98	40	18	29	-3	840
7	99	40	18	29	-3	837
8	100	39	18	28.5	-3.5	833.5
9	101	38	15	26.5	-5.5	828
10	102	41	15	28	-4	824
11	103	45	16	30.5	-1.5	822.5
12	104	53	21	37	5	827.5
13	105	48	21	34.5	2.5	830
14	106	44	21	32.5	0.5	830.5
15	107	44	21	32.5	0.5	831
16	108	34	11	22.5	-9.5	821.5
17	109	29	3	16	-16	805.5
18	110	30	4	17	-15	790.5
19	111	32	8	20	-12	778.5
20	112	34	11	22.5	-9.5	769
21	113	36	9	22.5	-9.5	759.5
22	114	37	9	23	-9	750.5
23	115	35	11	23	-9	741.5
24	116	32	8	20	-12	729.5
25	117	31	9	20	-12	717.5
26	118	39	13	26	-6	711.5
27	119	41	15	28	-4	707.5
28	120	35	11	23	-9	698.5
29	121	39	19	29	-3	695.5
30	122	50	22	36	4	699.5
31	123	48	23	35.5	3.5	703
32	124	52	25	38.5	6.5	709.5
33	125	39	28	33.5	1.5	711
34	126	37	32	34.5	2.5	713.5
35	127	34	31	32.5	0.5	714
36	128	41	29	35	3	717
37	129	41	24	32.5	0.5	717.5
38	130	28	21	24.5	-7.5	710
39	131	35	21	28	-4	706
40	132	41	18	29.5	-2.5	703.5
41	133	44	24	34	2	705.5
42	134	41	26	33.5	1.5	707
43	135	34	20	27	-5	702
44	136	32	14	23	-9	693
45	137	29	15	22	-10	683
46	138	31	15	23	-9	674
47	139	44	17	30.5	-1.5	672.5
48	140	46	19	32.5	0.5	673
49	141	46	22	34	2	675
50	142	47	23	35	3	678
51	143	46	23	34.5	2.5	680.5
52	144	40	22	31	-1	679.5
53	145	38	21	29.5	-2.5	677
54	146	42	24	33	1	678
55	147	37	22	29.5	-2.5	675.5
56	148	42	18	30	-2	673.5
57	149	46	23	34.5	2.5	676
58	150	52	22	37	5	681
59	151	51	29	40	8	689
60	152	44	31	37.5	5.5	694.5

61	153	48	33	40.5	8.5	703
62	154	44	35	39.5	7.5	710.5
63	155	46	37	41.5	9.5	720
64	156	46	29	37.5	5.5	725.5
65	157	46	29	37.5	5.5	731
66	158	45	27	36	4	735
67	159	46	28	37	5	740
68	160	52	25	38.5	6.5	746.5
69	161	49	26	37.5	5.5	752
70	162	49	28	38.5	6.5	758.5
71	163	47	26	36.5	4.5	763
72	164	51	28	39.5	7.5	770.5
73	165	51	31	41	9	779.5
74	166	42	22	32	0	779.5
75	167	41	21	31	-1	778.5
76	168	49	21	35	3	781.5
77	169	54	24	39	7	788.5
78	170	54	27	40.5	8.5	797
79	171	61	24	42.5	10.5	807.5
80	172	58	29	43.5	11.5	819
81	173	63	32	47.5	15.5	834.5
82	174	54	31	42.5	10.5	845
83	175	59	34	46.5	14.5	859.5
84	176	61	36	48.5	16.5	876
85	177	48	34	41	9	885
86	178	62	34	48	16	901
87	179	46	25	35.5	3.5	904.5
88	180	46	23	34.5	2.5	907
89	181	54	21	37.5	5.5	912.5
90	182	42	22	32	0	912.5
91	183	42	25	33.5	1.5	914
92	184	49	25	37	5	919
93	185	61	37	49	17	936
94	186	51	39	45	13	949
95	187	40	29	34.5	2.5	951.5
96	188	50	32	41	9	960.5
97	189	53	25	39	7	967.5
98	190	42	18	30	-2	965.5
99	191	38	12	25	-7	958.5
100	192	54	13	33.5	1.5	960
101	193	40	19	29.5	-2.5	957.5
102	194	42	28	35	3	960.5
103	195	58	28	43	11	971.5
104	196	36	27	31.5	-0.5	971
105	197	37	28	32.5	0.5	971.5
106	198	60	26	43	11	982.5
107	199	48	35	41.5	9.5	992
108	200	50	30	40	8	1000
109	201	62	27	44.5	12.5	1012.5
110	202	60	24	42	10	1022.5
111	203	54	45	49.5	17.5	1040
112	204	52	29	40.5	8.5	1048.5
113	205	41	26	33.5	1.5	1050
114	206	62	28	45	13	1063
115	207	48	30	39	7	1070
116	208	46	30	38	6	1076
117	209	46	38	42	10	1086
118	210	52	35	43.5	11.5	1097.5
119	211	70	44	57	25	1122.5
120	212	M	44	-	-	1122.5
121	213	M	45	-	-	1122.5
122	214	M	42	-	-	1122.5
123	215	M	42	-	-	1122.5
124	216	M	38	-	-	1122.5
125	217	M	43	-	-	1122.5
126	218	74	43	58.5	26.5	1149
127	219	77	43	60	28	1177
128	220	77	52	64.5	32.5	1209.5
129	221	77	42	59.5	27.5	1237
130	222	70	46	58	26	1263
131	223	M	42	-	-	1263
132	224	M	40	-	-	1263
133	225	M	40	-	-	1263
134	226	M	33	-	-	1263
135	227	M	30	-	-	1263
136	228	M	41	-	-	1263
137	229	M	40	-	-	1263
138	230	62	32	47	15	1278
139	231	71	42	56.5	24.5	1302.5
140	232	72	40	56	24	1326.5
141	233	73	42	57.5	25.5	1352
142	234	80	45	62.5	30.5	1382.5
143	235	80	48	64	32	1414.5
144	236	78	47	62.5	30.5	1445
145	237	73	48	60.5	28.5	1473.5
146	238	82	45	63.5	31.5	1505
147	239	86	48	67	35	1540
148	240	85	47	66	34	1574
149	241	87	46	66.5	34.5	1608.5
150	242	89	47	68	36	1644.5
151	243	84	48	66	34	1678.5
152	244	89	44	66.5	34.5	1713
153	245	89	47	68	36	1749
154	246	89	48	68.5	36.5	1785.5
155	247	88	53	70.5	38.5	1824
156	248	74	42	58	26	1850
157	249	83	48	65.5	33.5	1883.5
158	250	83	48	65.5	33.5	1917
159	251	91	64	77.5	45.5	1962.5
160	252	88	53	70.5	38.5	2001
161	253	86	62	74	42	2043
162	254	90	70	80	48	2091
163	255	79	51	65	33	2124
164	256	65	42	53.5	21.5	2145.5
165	257	64	40	52	20	2165.5
166	258	71	38	54.5	22.5	2188
167	259	79	45	62	30	2218
168	260	86	44	65	33	2251
169	261	88	44	66	34	2285

170	262	83	42	62.5	30.5	2315.5
171	263	78	45	61.5	29.5	2345
172	264	80	50	65	33	2378
173	265	82	42	62	30	2408
174	266	84	48	66	34	2442
175	267	88	57	72.5	40.5	2482.5
176	268	90	49	69.5	37.5	2520
177	269	91	49	70	38	2558
178	270	92	50	71	39	2597
179	271	92	47	69.5	37.5	2634.5
180	272	89	47	68	36	2670.5
181	273	90	46	68	36	2706.5
182	274	85	49	67	35	2741.5
183	275	88	47	67.5	35.5	2777
184	276	90	48	69	37	2814
185	277	91	48	69.5	37.5	2851.5
186	278	92	48	70	38	2889.5
187	279	94	47	70.5	38.5	2928
188	280	93	51	72	40	2968
189	281	88	50	69	37	3005
190	282	94	44	69	37	3042
191	283	86	50	68	36	3078
192	284	91	59	75	43	3121
193	285	95	58	76.5	44.5	3165.5
194	286	93	57	75	43	3208.5
195	287	92	54	73	41	3249.5
196	288	90	54	72	40	3289.5
197	289	95	56	75.5	43.5	3333
198	290	89	59	74	42	3375
199	291	92	55	73.5	41.5	3416.5
200	292	92	56	74	42	3458.5
201	293	94	55	74.5	42.5	3501
202	294	82	62	72	40	3541
203	295	89	50	69.5	37.5	3578.5
204	296	92	51	71.5	39.5	3618
205	297	89	53	71	39	3657
206	298	88	54	71	39	3696
207	299	89	52	70.5	38.5	3734.5
208	300	84	52	68	36	3770.5
209	301	95	61	78	46	3816.5
210	302	95	56	75.5	43.5	3860
211	303	94	53	73.5	41.5	3901.5
212	304	95	56	75.5	43.5	3945
213	305	94	63	78.5	46.5	3991.5
214	306	90	63	76.5	44.5	4036
215	307	92	53	72.5	40.5	4076.5
216	308	82	49	65.5	33.5	4110
217	309	81	48	64.5	32.5	4142.5
218	310	82	44	63	31	4173.5
219	311	83	48	65.5	33.5	4207
220	312	86	54	70	38	4245
221	313	92	54	73	41	4286
222	314	92	53	72.5	40.5	4326.5
223	315	92	54	73	41	4367.5
224	316	89	58	73.5	41.5	4409
225	317	92	54	73	41	4450
226	318	93	51	72	40	4490
227	319	91	55	73	41	4531
228	320	90	58	74	42	4573
229	321	88	53	70.5	38.5	4611.5
230	322	92	54	73	41	4652.5
231	323	94	53	73.5	41.5	4694
232	324	96	53	74.5	42.5	4736.5
233	325	95	56	75.5	43.5	4780
234	326	96	55	75.5	43.5	4823.5
235	327	94	55	74.5	42.5	4866
236	328	84	45	64.5	32.5	4898.5
237	329	89	46	67.5	35.5	4934
238	330	79	55	67	35	4969
239	331	75	45	60	28	4997
240	332	81	49	65	33	5030
241	333	88	50	69	37	5067
242	334	89	54	71.5	39.5	5106.5
243	335	72	58	65	33	5139.5
244	336	79	48	63.5	31.5	5171
245	337	88	53	70.5	38.5	5209.5
246	338	88	49	68.5	36.5	5246
247	339	89	45	67	35	5281
248	340	91	48	69.5	37.5	5318.5
249	341	90	49	69.5	37.5	5356
250	342	89	51	70	38	5394
251	343	91	49	70	38	5432
252	344	92	51	71.5	39.5	5471.5
253	345	90	48	69	37	5508.5
254	346	84	52	68	36	5544.5
255	347	83	41	62	30	5574.5
256	348	83	39	61	29	5603.5
257	349	84	36	60	28	5631.5
258	350	80	44	62	30	5661.5
259	351	89	42	65.5	33.5	5695
260	352	88	53	70.5	38.5	5733.5
261	353	93	51	72	40	5773.5
262	354	90	50	70	38	5811.5
263	355	88	49	68.5	36.5	5848
264	356	92	50	71	39	5887
265	357	79	50	64.5	32.5	5919.5
266	358	84	43	63.5	31.5	5951
267	359	83	42	62.5	30.5	5981.5
268	360	82	40	61	29	6010.5
269	361	87	40	63.5	31.5	6042
270	362	85	45	65	33	6075
271	363	81	44	62.5	30.5	6105.5
272	364	78	52	65	33	6138.5
273	365	81	44	62.5	30.5	6169
274	366	80	45	62.5	30.5	6199.5



68	1010.5	length of freeze (day)	81
149	676	frost depth (^oF-day)	334.5
		average temperature	49.6

1928-1929

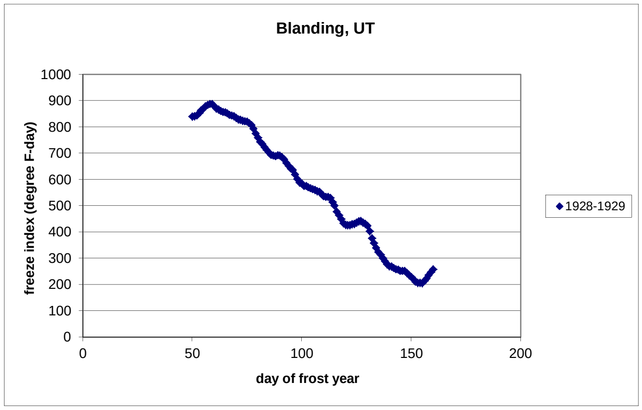
day of frost year degree cumulative

day of year	(consecutive date)	max. temp.	min. temp	avg. temp	day (°F)	degree day (°F)
274	1	79	42	60.5	28.5	28.5
275	2	81	51	66	34	62.5
276	3	84	42	63	31	93.5
277	4	84	41	62.5	30.5	124
278	5	82	47	64.5	32.5	156.5
279	6	80	31	55.5	23.5	180
280	7	86	42	64	32	212
281	8	85	40	62.5	30.5	242.5
282	9	84	43	63.5	31.5	274
283	10	86	40	63	31	305
284	11	80	53	66.5	34.5	339.5
285	12	M	46	-	-	339.5
286	13	70	36	53	21	360.5
287	14	74	30	52	20	380.5
288	15	49	32	40.5	8.5	389
289	16	57	31	44	12	401
290	17	62	29	45.5	13.5	414.5
291	18	65	33	49	17	431.5
292	19	66	30	48	16	447.5
293	20	70	35	52.5	20.5	468
294	21	68	28	48	16	484
295	22	72	31	51.5	19.5	503.5
296	23	70	28	49	17	520.5
297	24	68	32	50	18	538.5
298	25	69	39	54	22	560.5
299	26	72	34	53	21	581.5
300	27	66	34	50	18	599.5
301	28	71	33	52	20	619.5
302	29	70	36	53	21	640.5
303	30	75	41	58	26	666.5
304	31	54	34	44	12	678.5
305	32	52	31	41.5	9.5	688
306	33	50	28	39	7	695
307	34	46	26	36	4	699
308	35	57	27	42	10	709
309	36	54	29	41.5	9.5	718.5
310	37	60	32	46	14	732.5
311	38	60	31	45.5	13.5	746
312	39	64	34	49	17	763
313	40	64	24	44	12	775
314	41	62	25	43.5	11.5	786.5
315	42	62	34	48	16	802.5
316	43	63	27	45	13	815.5
317	44	55	38	46.5	14.5	830
318	45	48	26	37	5	835
319	46	47	29	38	6	841
320	47	50	27	38.5	6.5	847.5
321	48	38	21	29.5	-2.5	845
322	49	38	24	31	-1	844
323	50	42	14	28	-4	840
324	51	48	18	33	1	841
325	52	50	20	35	3	844
326	53	58	23	40.5	8.5	852.5
327	54	56	29	42.5	10.5	863
328	55	52	24	38	6	869
329	56	56	27	41.5	9.5	878.5
330	57	42	33	37.5	5.5	884
331	58	40	32	36	4	888
332	59	37	25	31	-1	887
333	60	38	12	25	-7	880
334	61	33	11	22	-10	870
335	62	33	25	29	-3	867
336	63	36	15	25.5	-6.5	860.5
337	64	32	26	29	-3	857.5
338	65	44	16	30	-2	855.5
339	66	44	13	28.5	-3.5	852
340	67	44	9	26.5	-5.5	846.5
341	68	46	13	29.5	-2.5	844
342	69	45	13	29	-3	841
343	70	39	14	26.5	-5.5	835.5
344	71	38	13	25.5	-6.5	829
345	72	42	20	31	-1	828
346	73	39	16	27.5	-4.5	823.5
347	74	40	20	30	-2	821.5
348	75	37	25	31	-1	820.5
349	76	35	17	26	-6	814.5
350	77	35	15	25	-7	807.5
351	78	36	0	18	-14	793.5
352	79	30	-2	14	-18	775.5
353	80	31	0	15.5	-16.5	759
354	81	31	2	16.5	-15.5	743.5
355	82	42	4	23	-9	734.5
356	83	34	7	20.5	-11.5	723
357	84	35	8	21.5	-10.5	712.5
358	85	39	7	23	-9	703.5
359	86	38	5	21.5	-10.5	693
360	87	46	14	30	-2	691
361	88	53	6	29.5	-2.5	688.5
362	89	42	29	35.5	3.5	692
363	90	42	20	31	-1	691
364	91	38	13	25.5	-6.5	684.5
365	92	36	12	24	-8	676.5
1	93	30	8	19	-13	663.5
2	94	33	8	20.5	-11.5	652
3	95	28	14	21	-11	641
4	96	34	20	27	-5	636
5	97	30	-1	14.5	-17.5	618.5
6	98	32	-2	15	-17	601.5
7	99	38	0	19	-13	588.5
8	100	46	10	28	-4	584.5
9	101	37	9	23	-9	575.5
10	102	43	20	31.5	-0.5	575
11	103	45	10	27.5	-4.5	570.5
12	104	42	14	28	-4	566.5
13	105	47	9	28	-4	562.5
14	106	44	15	29.5	-2.5	560
15	107	42	12	27	-5	555
16	108	41	20	30.5	-1.5	553.5

17	109	36	12	24	-8	545.5
18	110	32	13	22.5	-9.5	536
19	111	38	22	30	-2	534
20	112	38	25	31.5	-0.5	533.5
21	113	37	20	28.5	-3.5	530
22	114	30	2	16	-16	514
23	115	28	9	18.5	-13.5	500.5
24	116	23	-6	8.5	-23.5	477
25	117	32	6	19	-13	464
26	118	29	7	18	-14	450
27	119	31	1	16	-16	434
28	120	43	9	26	-6	428
29	121	43	18	30.5	-1.5	426.5
30	122	47	16	31.5	-0.5	426
31	123	46	25	35.5	3.5	429.5
32	124	40	28	34	2	431.5
33	125	43	31	37	5	436.5
34	126	45	28	36.5	4.5	441
35	127	44	22	33	1	442
36	128	39	12	25.5	-6.5	435.5
37	129	36	20	28	-4	431.5
38	130	30	18	24	-8	423.5
39	131	21	2	11.5	-20.5	403
40	132	24	-14	5	-27	376
41	133	35	-8	13.5	-18.5	357.5
42	134	34	-5	14.5	-17.5	340
43	135	33	-2	15.5	-16.5	323.5
44	136	41	3	22	-10	313.5
45	137	30	7	18.5	-13.5	300
46	138	37	5	21	-11	289
47	139	37	5	21	-11	278
48	140	41	6	23.5	-8.5	269.5
49	141	45	18	31.5	-0.5	269
50	142	39	13	26	-6	263
51	143	44	11	27.5	-4.5	258.5
52	144	45	15	30	-2	256.5
53	145	43	12	27.5	-4.5	252
54	146	45	19	32	0	252
55	147	40	24	32	0	252
56	148	34	16	25	-7	245
57	149	37	9	23	-9	236
58	150	36	13	24.5	-7.5	228.5
59	151	32	15	23.5	-8.5	220
60	152	40	4	22	-10	210
61	153	38	20	29	-3	207
62	154	43	20	31.5	-0.5	206.5
63	155	41	20	30.5	-1.5	205
64	156	60	23	41.5	9.5	214.5
65	157	56	26	41	9	223.5
66	158	56	33	44.5	12.5	236
67	159	55	32	43.5	11.5	247.5
68	160	53	32	42.5	10.5	258
69	161	52	34	43	11	269
70	162	51	27	39	7	276
71	163	50	26	38	6	282
72	164	39	11	25	-7	275
73	165	42	20	31	-1	274
74	166	45	19	32	0	274
75	167	46	20	33	1	275
76	168	52	23	37.5	5.5	280.5
77	169	54	25	39.5	7.5	288
78	170	53	32	42.5	10.5	298.5
79	171	59	28	43.5	11.5	310
80	172	60	30	45	13	323
81	173	61	37	49	17	340
82	174	50	38	44	12	352
83	175	43	25	34	2	354
84	176	41	20	30.5	-1.5	352.5
85	177	46	25	35.5	3.5	356
86	178	52	26	39	7	363
87	179	60	28	44	12	375
88	180	66	30	48	16	391
89	181	63	31	47	15	406
90	182	56	29	42.5	10.5	416.5
91	183	58	20	39	7	423.5
92	184	62	27	44.5	12.5	436
93	185	64	35	49.5	17.5	453.5
94	186	63	45	54	22	475.5
95	187	50	34	42	10	485.5
96	188	58	17	37.5	5.5	491
97	189	62	25	43.5	11.5	502.5
98	190	60	30	45	13	515.5
99	191	54	27	40.5	8.5	524
100	192	46	13	29.5	-2.5	521.5
101	193	54	19	36.5	4.5	526
102	194	65	24	44.5	12.5	538.5
103	195	68	55	61.5	29.5	568
104	196	67	31	49	17	585
105	197	67	34	50.5	18.5	603.5
106	198	73	41	57	25	628.5
107	199	73	34	53.5	21.5	650
108	200	67	35	51	19	669
109	201	60	35	47.5	15.5	684.5
110	202	68	27	47.5	15.5	700
111	203	75	35	55	23	723
112	204	77	30	53.5	21.5	744.5
113	205	60	36	48	16	760.5
114	206	55	30	42.5	10.5	771
115	207	58	38	48	16	787
116	208	59	27	43	11	798
117	209	58	32	45	13	811
118	210	55	30	42.5	10.5	821.5
119	211	M	34	-	#VALUE!	821.5
120	212	M	M	-	-	821.5
121	213	M	28	-	-	821.5
122	214	63	28	45.5	13.5	835
123	215	M	31	-	-	835
124	216	M	35	-	-	835
125	217	M	37	-	-	835

126	218	M	36	-	#VALUE!	835
127	219	M	36	-	#VALUE!	835
128	220	M	35	-	#VALUE!	835
129	221	M	35	-	#VALUE!	835
130	222	M	45	-	#VALUE!	835
131	223	M	38	-	-	835
132	224	M	46	-	-	835
133	225	M	38	-	-	835
134	226	M	41	-	-	835
135	227	M	50	-	-	835
136	228	M	45	-	-	835
137	229	75	40	-	-	835
138	230	70	45	57.5	25.5	860.5
139	231	75	39	57	25	885.5
140	232	69	49	59	27	912.5
141	233	70	40	55	23	935.5
142	234	69	41	55	23	958.5
143	235	64	45	54.5	22.5	981
144	236	72	42	57	25	1006
145	237	78	45	61.5	29.5	1035.5
146	238	75	48	61.5	29.5	1065
147	239	58	32	45	13	1078
148	240	55	34	44.5	12.5	1090.5
149	241	66	35	50.5	18.5	1109
150	242	78	42	60	28	1137
151	243	77	45	61	29	1166
152	244	76	36	56	24	1190
153	245	75	36	55.5	23.5	1213.5
154	246	77	37	57	25	1238.5
155	247	76	36	56	24	1262.5
156	248	74	45	59.5	27.5	1290
157	249	72	41	56.5	24.5	1314.5
158	250	75	44	59.5	27.5	1342
159	251	77	41	59	27	1369
160	252	79	44	61.5	29.5	1398.5
161	253	80	41	60.5	28.5	1427
162	254	79	37	58	26	1453
163	255	74	44	59	27	1480
164	256	79	45	62	30	1510
165	257	85	44	64.5	32.5	1542.5
166	258	79	53	66	34	1576.5
167	259	77	52	64.5	32.5	1609
168	260	79	34	56.5	24.5	1633.5
169	261	86	41	63.5	31.5	1665
170	262	84	46	65	33	1698
171	263	85	41	63	31	1729
172	264	87	49	68	36	1765
173	265	84	50	67	35	1800
174	266	91	51	71	39	1839
175	267	89	49	69	37	1876
176	268	91	49	70	38	1914
177	269	93	49	71	39	1953
178	270	89	48	68.5	36.5	1989.5
179	271	96	57	76.5	44.5	2034
180	272	94	61	77.5	45.5	2079.5
181	273	90	62	76	44	2123.5
182	274	90	56	73	41	2164.5
183	275	91	53	72	40	2204.5
184	276	91	54	72.5	40.5	2245
185	277	90	55	72.5	40.5	2285.5
186	278	92	54	73	41	2326.5
187	279	90	56	73	41	2367.5
188	280	91	54	72.5	40.5	2408
189	281	88	60	74	42	2450
190	282	81	57	69	37	2487
191	283	80	53	66.5	34.5	2521.5
192	284	83	53	68	36	2557.5
193	285	76	58	67	35	2592.5
194	286	80	55	67.5	35.5	2628
195	287	85	56	70.5	38.5	2666.5
196	288	90	60	75	43	2709.5
197	289	90	60	75	43	2752.5
198	290	88	59	73.5	41.5	2794
199	291	89	60	74.5	42.5	2836.5
200	292	87	59	73	41	2877.5
201	293	88	57	72.5	40.5	2918
202	294	90	65	77.5	45.5	2963.5
203	295	88	59	73.5	41.5	3005
204	296	83	59	71	39	3044
205	297	91	60	75.5	43.5	3087.5
206	298	89	60	74.5	42.5	3130
207	299	89	63	76	44	3174
208	300	86	58	72	40	3214
209	301	74	56	65	33	3247
210	302	81	55	68	36	3283
211	303	79	58	68.5	36.5	3319.5
212	304	80	60	70	38	3357.5
213	305	82	59	70.5	38.5	3396
214	306	80	52	66	34	3430
215	307	83	60	71.5	39.5	3469.5
216	308	78	55	66.5	34.5	3504
217	309	72	57	64.5	32.5	3536.5
218	310	73	57	65	33	3569.5
219	311	82	52	67	35	3604.5
220	312	82	53	67.5	35.5	3640
221	313	80	52	66	34	3674
222	314	78	57	67.5	35.5	3709.5
223	315	81	51	66	34	3743.5
224	316	85	50	67.5	35.5	3779
225	317	88	52	70	38	3817
226	318	87	53	70	38	3855
227	319	88	53	70.5	38.5	3893.5
228	320	88	57	72.5	40.5	3934
229	321	87	57	72	40	3974
230	322	85	55	70	38	4012
231	323	88	55	71.5	39.5	4051.5
232	324	88	52	70	38	4089.5
233	325	84	59	71.5	39.5	4129
234	326	85	52	68.5	36.5	4165.5

235	327	84	54	69	37	4202.5
236	328	83	54	68.5	36.5	4239
237	329	89	54	71.5	39.5	4278.5
238	330	87	58	72.5	40.5	4319
239	331	84	57	70.5	38.5	4357.5
240	332	88	56	72	40	4397.5
241	333	89	58	73.5	41.5	4439
242	334	84	58	71	39	4478
243	335	88	55	71.5	39.5	4517.5
244	336	85	57	71	39	4556.5
245	337	82	54	68	36	4592.5
246	338	74	52	63	31	4623.5
247	339	69	48	58.5	26.5	4650
248	340	71	45	58	26	4676
249	341	68	45	56.5	24.5	4700.5
250	342	70	45	57.5	25.5	4726
251	343	65	43	54	22	4748
252	344	66	34	50	18	4766
253	345	68	35	51.5	19.5	4785.5
254	346	70	38	54	22	4807.5
255	347	76	40	58	26	4833.5
256	348	77	40	58.5	26.5	4860
257	349	80	42	61	29	4889
258	350	80	45	62.5	30.5	4919.5
259	351	77	46	61.5	29.5	4949
260	352	73	48	60.5	28.5	4977.5
261	353	69	51	60	28	5005.5
262	354	78	46	62	30	5035.5
263	355	75	52	63.5	31.5	5067
264	356	72	56	64	32	5099
265	357	73	52	62.5	30.5	5129.5
266	358	70	47	58.5	26.5	5156
267	359	73	41	57	25	5181
268	360	74	44	59	27	5208
269	361	72	43	57.5	25.5	5233.5
270	362	74	44	59	27	5260.5
271	363	77	45	61	29	5289.5
272	364	75	45	60	28	5317.5
273	365	73	45	59	27	5344.5



59	887	length of freeze (day)	96
155	205	frost depth (^{o}F-day)	682
		average temperature	47.3

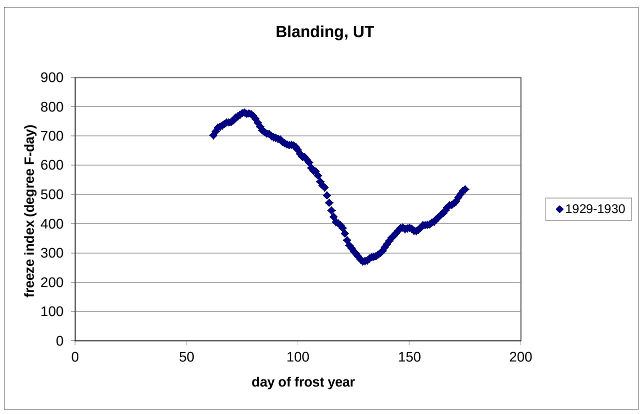
1929-1930

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	75	35	55	23	23
275	2	79	37	58	26	49
276	3	79	36	57.5	25.5	74.5
277	4	79	33	56	24	98.5
278	5	80	40	60	28	126.5
279	6	76	39	57.5	25.5	152
280	7	74	45	59.5	27.5	179.5
281	8	78	36	57	25	204.5
282	9	72	34	53	21	225.5
283	10	74	37	55.5	23.5	249
284	11	77	40	58.5	26.5	275.5
285	12	73	36	54.5	22.5	298
286	13	71	59	65	33	331
287	14	70	40	55	23	354
288	15	67	41	54	22	376
289	16	66	45	55.5	23.5	399.5
290	17	65	35	50	18	417.5
291	18	67	36	51.5	19.5	437
292	19	72	42	57	25	462
293	20	74	39	56.5	24.5	486.5
294	21	72	33	52.5	20.5	507
295	22	59	42	50.5	18.5	525.5
296	23	56	41	48.5	16.5	542
297	24	54	21	37.5	5.5	547.5
298	25	58	21	39.5	7.5	555
299	26	62	29	45.5	13.5	568.5
300	27	62	25	43.5	11.5	580
301	28	57	33	45	13	593
302	29	48	22	35	3	596
303	30	42	27	34.5	2.5	598.5
304	31	46	15	30.5	-1.5	597
305	32	46	15	30.5	-1.5	595.5
306	33	49	15	32	0	595.5
307	34	57	23	40	8	603.5
308	35	56	19	37.5	5.5	609
309	36	60	23	41.5	9.5	618.5
310	37	58	23	40.5	8.5	627
311	38	59	23	41	9	636
312	39	54	20	37	5	641
313	40	50	17	33.5	1.5	642.5
314	41	46	20	33	1	643.5
315	42	31	11	21	-11	632.5
316	43	43	11	27	-5	627.5
317	44	54	12	33	1	628.5
318	45	60	20	40	8	636.5
319	46	65	27	46	14	650.5
320	47	60	23	41.5	9.5	660
321	48	60	27	43.5	11.5	671.5
322	49	60	22	41	9	680.5
323	50	53	17	35	3	683.5
324	51	42	10	26	-6	677.5
325	52	43	13	28	-4	673.5
326	53	43	20	31.5	-0.5	673
327	54	41	5	23	-9	664
328	55	43	10	26.5	-5.5	658.5
329	56	50	17	33.5	1.5	660
330	57	55	18	36.5	4.5	664.5
331	58	57	20	38.5	6.5	671
332	59	49	19	34	2	673
333	60	62	22	42	10	683
334	61	56	23	39.5	7.5	690.5
335	62	63	25	44	12	702.5
336	63	64	27	45.5	13.5	716
337	64	65	24	44.5	12.5	728.5
338	65	57	14	35.5	3.5	732

339	66	56	18	37	5	737
340	67	52	20	36	4	741
341	68	57	19	38	6	747
342	69	48	15	31.5	-0.5	746.5
343	70	49	18	33.5	1.5	748
344	71	52	23	37.5	5.5	753.5
345	72	54	29	41.5	9.5	763
346	73	52	21	36.5	4.5	767.5
347	74	55	19	37	5	772.5
348	75	55	20	37.5	5.5	778
349	76	53	16	34.5	2.5	780.5
350	77	35	20	27.5	-4.5	776
351	78	46	21	33.5	1.5	777.5
352	79	48	11	29.5	-2.5	775
353	80	35	15	25	-7	768
354	81	37	9	23	-9	759
355	82	32	4	18	-14	745
356	83	33	5	19	-13	732
357	84	33	5	19	-13	719
358	85	44	10	27	-5	714
359	86	42	10	26	-6	708
360	87	47	15	31	-1	707
361	88	43	8	25.5	-6.5	700.5
362	89	45	11	28	-4	696.5
363	90	46	13	29.5	-2.5	694
364	91	46	12	29	-3	691
365	92	44	15	29.5	-2.5	688.5
1	93	38	9	23.5	-8.5	680
2	94	45	10	27.5	-4.5	675.5
3	95	45	10	27.5	-4.5	671
4	96	45	14	29.5	-2.5	668.5
5	97	41	26	33.5	1.5	670
6	98	40	19	29.5	-2.5	667.5
7	99	35	19	27	-5	662.5
8	100	34	10	22	-10	652.5
9	101	32	5	18.5	-13.5	639
10	102	35	9	22	-10	629
11	103	42	20	31	-1	628
12	104	27	20	23.5	-8.5	619.5
13	105	27	18	22.5	-9.5	610
14	106	23	4	13.5	-18.5	591.5
15	107	32	11	21.5	-10.5	581
16	108	32	29	30.5	-1.5	579.5
17	109	34	1	17.5	-14.5	565
18	110	22	0	11	-21	544
19	111	27	12	19.5	-12.5	531.5
20	112	34	16	25	-7	524.5
21	113	24	-15	4.5	-27.5	497
22	114	27	-13	7	-25	472
23	115	25	-13	6	-26	446
24	116	26	-6	10	-22	424
25	117	27	2	14.5	-17.5	406.5
26	118	33	21	27	-5	401.5
27	119	42	10	26	-6	395.5
28	120	38	7	22.5	-9.5	386
29	121	30	-5	12.5	-19.5	366.5
30	122	24	-5	9.5	-22.5	344
31	123	29	0	14.5	-17.5	326.5
32	124	39	6	22.5	-9.5	317
33	125	35	7	21	-11	306
34	126	37	10	23.5	-8.5	297.5
35	127	39	6	22.5	-9.5	288
36	128	35	10	22.5	-9.5	278.5
37	129	40	10	25	-7	271.5
38	130	49	17	33	1	272.5
39	131	52	16	34	2	274.5
40	132	58	20	39	7	281.5
41	133	59	15	37	5	286.5
42	134	48	18	33	1	287.5
43	135	49	19	34	2	289.5
44	136	53	22	37.5	5.5	295
45	137	51	24	37.5	5.5	300.5
46	138	56	23	39.5	7.5	308
47	139	58	30	44	12	320
48	140	58	27	42.5	10.5	330.5
49	141	56	30	43	11	341.5
50	142	56	30	43	11	352.5
51	143	48	30	39	7	359.5
52	144	55	25	40	8	367.5
53	145	53	30	41.5	9.5	377
54	146	48	34	41	9	386
55	147	47	20	33.5	1.5	387.5
56	148	37	17	27	-5	382.5
57	149	46	21	33.5	1.5	384
58	150	48	22	35	3	387
59	151	46	11	28.5	-3.5	383.5
60	152	37	13	25	-7	376.5
61	153	48	15	31.5	-0.5	376
62	154	50	23	36.5	4.5	380.5
63	155	54	23	38.5	6.5	387
64	156	52	28	40	8	395
65	157	44	20	32	0	395
66	158	45	21	33	1	396
67	159	47	21	34	2	398
68	160	53	24	38.5	6.5	404.5
69	161	50	20	35	3	407.5
70	162	53	29	41	9	416.5
71	163	57	20	38.5	6.5	423
72	164	57	21	39	7	430
73	165	51	24	37.5	5.5	435.5
74	166	60	24	42	10	445.5
75	167	54	31	42.5	10.5	456
76	168	49	30	39.5	7.5	463.5
77	169	44	22	33	1	464.5
78	170	52	22	37	5	469.5
79	171	57	23	40	8	477.5
80	172	59	30	44.5	12.5	490
81	173	63	23	43	11	501
82	174	57	29	43	11	512

83	175	53	23	38	6	518
84	176	62	35	48.5	16.5	534.5
85	177	57	32	44.5	12.5	547
86	178	52	22	37	5	552
87	179	47	14	30.5	-1.5	550.5
88	180	54	21	37.5	5.5	556
89	181	58	22	40	8	564
90	182	54	33	43.5	11.5	575.5
91	183	48	35	41.5	9.5	585
92	184	57	30	43.5	11.5	596.5
93	185	60	31	45.5	13.5	610
94	186	69	29	49	17	627
95	187	75	39	57	25	652
96	188	75	36	55.5	23.5	675.5
97	189	74	36	55	23	698.5
98	190	79	40	59.5	27.5	726
99	191	70	50	60	28	754
100	192	68	50	59	27	781
101	193	68	41	54.5	22.5	803.5
102	194	70	54	62	30	833.5
103	195	67	37	52	20	853.5
104	196	64	32	48	16	869.5
105	197	60	30	45	13	882.5
106	198	67	30	48.5	16.5	899
107	199	61	47	54	22	921
108	200	67	28	47.5	15.5	936.5
109	201	72	30	51	19	955.5
110	202	75	37	56	24	979.5
111	203	79	38	58.5	26.5	1006
112	204	78	40	59	27	1033
113	205	79	47	63	31	1064
114	206	68	44	56	24	1088
115	207	62	36	49	17	1105
116	208	67	37	52	20	1125
117	209	65	40	52.5	20.5	1145.5
118	210	65	39	52	20	1165.5
119	211	63	33	48	16	1181.5
120	212	65	37	51	19	1200.5
121	213	69	33	51	19	1219.5
122	214	72	38	55	23	1242.5
123	215	65	38	51.5	19.5	1262
124	216	57	41	49	17	1279
125	217	54	28	41	9	1288
126	218	57	28	42.5	10.5	1298.5
127	219	53	36	44.5	12.5	1311
128	220	48	25	36.5	4.5	1315.5
129	221	48	25	36.5	4.5	1320
130	222	56	23	39.5	7.5	1327.5
131	223	62	28	45	13	1340.5
132	224	67	31	49	17	1357.5
133	225	71	36	53.5	21.5	1379
134	226	75	38	56.5	24.5	1403.5
135	227	73	36	54.5	22.5	1426
136	228	66	37	51.5	19.5	1445.5
137	229	58	33	45.5	13.5	1459
138	230	64	33	48.5	16.5	1475.5
139	231	73	38	55.5	23.5	1499
140	232	78	41	59.5	27.5	1526.5
141	233	79	43	61	29	1555.5
142	234	78	29	53.5	21.5	1577
143	235	75	37	56	24	1601
144	236	78	46	62	30	1631
145	237	80	43	61.5	29.5	1660.5
146	238	83	42	62.5	30.5	1691
147	239	81	45	63	31	1722
148	240	81	40	60.5	28.5	1750.5
149	241	80	34	57	25	1775.5
150	242	75	47	61	29	1804.5
151	243	76	49	62.5	30.5	1835
152	244	68	31	49.5	17.5	1852.5
153	245	71	34	52.5	20.5	1873
154	246	72	36	54	22	1895
155	247	75	38	56.5	24.5	1919.5
156	248	81	43	62	30	1949.5
157	249	89	45	67	35	1984.5
158	250	86	48	67	35	2019.5
159	251	87	49	68	36	2055.5
160	252	85	55	70	38	2093.5
161	253	83	56	69.5	37.5	2131
162	254	86	47	66.5	34.5	2165.5
163	255	90	48	69	37	2202.5
164	256	91	49	70	38	2240.5
165	257	87	48	67.5	35.5	2276
166	258	90	49	69.5	37.5	2313.5
167	259	90	53	71.5	39.5	2353
168	260	88	52	70	38	2391
169	261	82	52	67	35	2426
170	262	75	43	59	27	2453
171	263	84	48	66	34	2487
172	264	78	57	67.5	35.5	2522.5
173	265	81	42	61.5	29.5	2552
174	266	81	41	61	29	2581
175	267	82	39	60.5	28.5	2609.5
176	268	85	43	64	32	2641.5
177	269	88	45	66.5	34.5	2676
178	270	90	47	68.5	36.5	2712.5
179	271	89	52	70.5	38.5	2751
180	272	91	49	70	38	2789
181	273	91	49	70	38	2827
182	274	91	52	71.5	39.5	2866.5
183	275	91	51	71	39	2905.5
184	276	94	51	72.5	40.5	2946
185	277	94	52	73	41	2987
186	278	91	58	74.5	42.5	3029.5
187	279	92	58	75	43	3072.5
188	280	89	58	73.5	41.5	3114
189	281	86	55	70.5	38.5	3152.5
190	282	84	56	70	38	3190.5
191	283	84	54	69	37	3227.5

192	284	81	53	67	35	3262.5
193	285	81	58	69.5	37.5	3300
194	286	83	53	68	36	3336
195	287	87	53	70	38	3374
196	288	90	56	73	41	3415
197	289	89	58	73.5	41.5	3456.5
198	290	87	57	72	40	3496.5
199	291	85	57	71	39	3535.5
200	292	75	58	66.5	34.5	3570
201	293	79	55	67	35	3605
202	294	81	53	67	35	3640
203	295	78	51	64.5	32.5	3672.5
204	296	83	57	70	38	3710.5
205	297	85	54	69.5	37.5	3748
206	298	88	53	70.5	38.5	3786.5
207	299	85	55	70	38	3824.5
208	300	85	53	69	37	3861.5
209	301	87	58	72.5	40.5	3902
210	302	83	59	71	39	3941
211	303	87	58	72.5	40.5	3981.5
212	304	87	57	72	40	4021.5
213	305	85	57	71	39	4060.5
214	306	87	59	73	41	4101.5
215	307	86	56	71	39	4140.5
216	308	89	55	72	40	4180.5
217	309	93	54	73.5	41.5	4222
218	310	89	57	73	41	4263
219	311	82	54	68	36	4299
220	312	82	51	66.5	34.5	4333.5
221	313	77	54	65.5	33.5	4367
222	314	81	55	68	36	4403
223	315	77	55	66	34	4437
224	316	79	49	64	32	4469
225	317	80	51	65.5	33.5	4502.5
226	318	78	55	66.5	34.5	4537
227	319	81	50	65.5	33.5	4570.5
228	320	81	50	65.5	33.5	4604
229	321	79	55	67	35	4639
230	322	85	51	68	36	4675
231	323	88	47	67.5	35.5	4710.5
232	324	89	47	68	36	4746.5
233	325	91	53	72	40	4786.5
234	326	84	60	72	40	4826.5
235	327	85	51	68	36	4862.5
236	328	82	52	67	35	4897.5
237	329	84	54	69	37	4934.5
238	330	88	56	72	40	4974.5
239	331	87	56	71.5	39.5	5014
240	332	88	52	70	38	5052
241	333	89	56	72.5	40.5	5092.5
242	334	88	50	69	37	5129.5
243	335	85	49	67	35	5164.5
244	336	84	46	65	33	5197.5
245	337	86	52	69	37	5234.5
246	338	84	53	68.5	36.5	5271
247	339	84	53	68.5	36.5	5307.5
248	340	80	52	66	34	5341.5
249	341	75	48	61.5	29.5	5371
250	342	66	47	56.5	24.5	5395.5
251	343	70	45	57.5	25.5	5421
252	344	76	46	61	29	5450
253	345	76	47	61.5	29.5	5479.5
254	346	73	43	58	26	5505.5
255	347	75	43	59	27	5532.5
256	348	74	42	58	26	5558.5
257	349	72	41	56.5	24.5	5583
258	350	74	42	58	26	5609
259	351	80	43	61.5	29.5	5638.5
260	352	83	46	64.5	32.5	5671
261	353	83	45	64	32	5703
262	354	82	42	62	30	5733
263	355	82	48	65	33	5766
264	356	80	49	64.5	32.5	5798.5
265	357	74	45	59.5	27.5	5826
266	358	68	36	52	20	5846
267	359	67	38	52.5	20.5	5866.5
268	360	66	35	50.5	18.5	5885
269	361	78	38	58	26	5911
270	362	70	36	53	21	5932
271	363	73	38	55.5	23.5	5955.5
272	364	74	39	56.5	24.5	5980
273	365	75	42	58.5	26.5	6006.5



76	780.5	length of freeze (day)	53
129	271.5	frost depth (^{o}F-day)	509
		average temperature	48.5

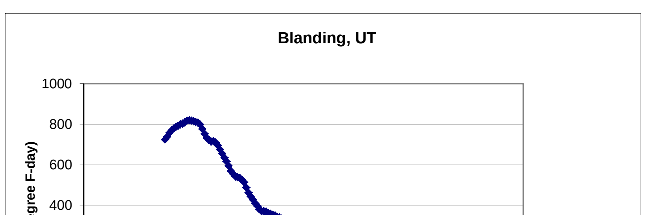
1931-1932

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	78	45	61.5	29.5	29.5
275	2	67	52	59.5	27.5	57
276	3	66	45	55.5	23.5	80.5
277	4	68	44	56	24	104.5
278	5	71	44	57.5	25.5	130
279	6	72	45	58.5	26.5	156.5
280	7	67	44	55.5	23.5	180
281	8	72	46	59	27	207
282	9	71	48	59.5	27.5	234.5
283	10	64	44	54	22	256.5
284	11	64	38	51	19	275.5
285	12	64	35	49.5	17.5	293
286	13	67	35	51	19	312
287	14	69	35	52	20	332
288	15	69	38	53.5	21.5	353.5
289	16	72	37	54.5	22.5	376
290	17	72	39	55.5	23.5	399.5
291	18	69	49	59	27	426.5
292	19	62	44	53	21	447.5
293	20	58	40	49	17	464.5
294	21	52	39	45.5	13.5	478
295	22	54	35	44.5	12.5	490.5

296	23	60	35	47.5	15.5	506
297	24	65	36	50.5	18.5	524.5
298	25	66	39	52.5	20.5	545
299	26	60	40	50	18	563
300	27	55	25	40	8	571
301	28	58	31	44.5	12.5	583.5
302	29	55	40	47.5	15.5	599
303	30	58	26	42	10	609
304	31	61	27	44	12	621
305	32	69	32	50.5	18.5	639.5
306	33	66	30	48	16	655.5
307	34	66	31	48.5	16.5	672
308	35	67	32	49.5	17.5	689.5
309	36	67	31	49	17	706.5
310	37	66	34	50	18	724.5
311	38	62	32	47	15	739.5
312	39	58	42	50	18	757.5
313	40	52	39	45.5	13.5	771
314	41	51	30	40.5	8.5	779.5
315	42	45	35	40	8	787.5
316	43	43	32	37.5	5.5	793
317	44	46	33	39.5	7.5	800.5
318	45	45	26	35.5	3.5	804
319	46	48	29	38.5	6.5	810.5
320	47	45	35	40	8	818.5
321	48	44	21	32.5	0.5	819
322	49	39	23	31	-1	818
323	50	40	22	31	-1	817
324	51	35	19	27	-5	812
325	52	35	21	28	-4	808
326	53	25	20	22.5	-9.5	798.5
327	54	21	-1	10	-22	776.5
328	55	22	-6	8	-24	752.5
329	56	32	-7	12.5	-19.5	733
330	57	28	14	21	-11	722
331	58	38	14	26	-6	716
332	59	43	23	33	1	717
333	60	40	10	25	-7	710
334	61	35	1	18	-14	696
335	62	29	-4	12.5	-19.5	676.5
336	63	19	4	11.5	-20.5	656
337	64	17	4	10.5	-21.5	634.5
338	65	20	9	14.5	-17.5	617
339	66	19	2	10.5	-21.5	595.5
340	67	22	-9	6.5	-25.5	570
341	68	38	-3	17.5	-14.5	555.5
342	69	31	10	20.5	-11.5	544
343	70	31	22	26.5	-5.5	538.5
344	71	35	24	29.5	-2.5	536
345	72	24	19	21.5	-10.5	525.5
346	73	32	11	21.5	-10.5	515
347	74	21	-11	5	-27	488
348	75	24	-11	6.5	-25.5	462.5
349	76	28	-2	13	-19	443.5
350	77	37	-3	17	-15	428.5
351	78	31	-2	14.5	-17.5	411
352	79	32	3	17.5	-14.5	396.5
353	80	32	2	17	-15	381.5
354	81	38	5	21.5	-10.5	371
355	82	44	19	31.5	-0.5	370.5
356	83	39	24	31.5	-0.5	370
357	84	36	11	23.5	-8.5	361.5
358	85	42	15	28.5	-3.5	358
359	86	44	13	28.5	-3.5	354.5
360	87	40	15	27.5	-4.5	350
361	88	40	12	26	-6	344
362	89	36	23	29.5	-2.5	341.5
363	90	34	18	26	-6	335.5
364	91	38	-1	18.5	-13.5	322
365	92	36	-3	16.5	-15.5	306.5
1	93	38	-1	18.5	-13.5	293
2	94	41	-1	20	-12	281
3	95	39	4	21.5	-10.5	270.5
4	96	34	10	22	-10	260.5
5	97	31	15	23	-9	251.5
6	98	36	4	20	-12	239.5
7	99	35	5	20	-12	227.5
8	100	35	10	22.5	-9.5	218
9	101	37	8	22.5	-9.5	208.5
10	102	41	12	26.5	-5.5	203
11	103	37	12	24.5	-7.5	195.5
12	104	34	13	23.5	-8.5	187
13	105	31	12	21.5	-10.5	176.5
14	106	24	4	14	-18	158.5
15	107	21	10	15.5	-16.5	142
16	108	26	14	20	-12	130
17	109	29	-1	14	-18	112
18	110	29	1	15	-17	95
19	111	38	4	21	-11	84
20	112	28	11	19.5	-12.5	71.5
21	113	31	5	18	-14	57.5
22	114	31	-1	15	-17	40.5
23	115	26	-5	10.5	-21.5	19
24	116	20	-5	7.5	-24.5	-5.5
25	117	31	-9	11	-21	-26.5
26	118	28	-5	11.5	-20.5	-47
27	119	31	-1	15	-17	-64
28	120	24	4	14	-18	-82
29	121	15	-12	1.5	-30.5	-112.5
30	122	28	-5	11.5	-20.5	-133
31	123	37	9	23	-9	-142
32	124	38	19	28.5	-3.5	-145.5
33	125	35	26	30.5	-1.5	-147
34	126	26	2	14	-18	-165
35	127	32	-2	15	-17	-182
36	128	38	8	23	-9	-191
37	129	47	20	33.5	1.5	-189.5
38	130	46	32	39	7	-182.5
39	131	44	26	35	3	-179.5

40	132	38	33	35.5	3.5	-176
41	133	44	32	38	6	-170
42	134	40	18	29	-3	-173
43	135	48	14	31	-1	-174
44	136	55	18	36.5	4.5	-169.5
45	137	45	30	37.5	5.5	-164
46	138	48	28	38	6	-158
47	139	45	20	32.5	0.5	-157.5
48	140	45	18	31.5	-0.5	-158
49	141	45	24	34.5	2.5	-155.5
50	142	59	24	41.5	9.5	-146
51	143	48	30	39	7	-139
52	144	48	25	36.5	4.5	-134.5
53	145	55	20	37.5	5.5	-129
54	146	55	20	37.5	5.5	-123.5
55	147	56	25	40.5	8.5	-115
56	148	58	26	42	10	-105
57	149	58	32	45	13	-92
58	150	67	34	50.5	18.5	-73.5
59	151	62	31	46.5	14.5	-59
60	152	55	33	44	12	-47
61	153	46	35	40.5	8.5	-38.5
62	154	43	21	32	0	-38.5
63	155	38	27	32.5	0.5	-38
64	156	37	18	27.5	-4.5	-42.5
65	157	47	18	32.5	0.5	-42
66	158	54	26	40	8	-34
67	159	59	30	44.5	12.5	-21.5
68	160	58	32	45	13	-8.5
69	161	51	29	40	8	-0.5
70	162	46	32	39	7	6.5
71	163	45	25	35	3	9.5
72	164	41	27	34	2	11.5
73	165	49	15	32	0	11.5
74	166	52	23	37.5	5.5	17
75	167	57	23	40	8	25
76	168	53	27	40	8	33
77	169	57	25	41	9	42
78	170	63	27	45	13	55
79	171	65	35	50	18	73
80	172	37	35	36	4	77
81	173	47	30	38.5	6.5	83.5
82	174	44	25	34.5	2.5	86
83	175	51	28	39.5	7.5	93.5
84	176	61	29	45	13	106.5
85	177	58	35	46.5	14.5	121
86	178	44	30	37	5	126
87	179	53	21	37	5	131
88	180	58	25	41.5	9.5	140.5
89	181	52	32	42	10	150.5
90	182	56	25	40.5	8.5	159
91	183	65	26	45.5	13.5	172.5
92	184	68	30	49	17	189.5
93	185	67	37	52	20	209.5
94	186	65	34	49.5	17.5	227
95	187	M	M	-	-	227
96	188	M	M	-	-	227
97	189	63	36	49.5	17.5	244.5
98	190	62	28	45	13	257.5
99	191	57	21	39	7	264.5
100	192	54	31	42.5	10.5	275
101	193	62	27	44.5	12.5	287.5
102	194	68	40	54	22	309.5
103	195	71	34	52.5	20.5	330
104	196	72	38	55	23	353
105	197	65	40	52.5	20.5	373.5
106	198	70	39	54.5	22.5	396
107	199	73	42	57.5	25.5	421.5
108	200	68	44	56	24	445.5
109	201	66	42	54	22	467.5
110	202	79	29	54	22	489.5
111	203	66	48	57	25	514.5
112	204	60	33	46.5	14.5	529
113	205	50	27	38.5	6.5	535.5
114	206	52	24	38	6	541.5
115	207	59	29	44	12	553.5
116	208	65	29	47	15	568.5
117	209	60	40	50	18	586.5
118	210	47	30	38.5	6.5	593
119	211	48	22	35	3	596
120	212	58	30	44	12	608
121	213	64	35	49.5	17.5	625.5
122	214	71	38	54.5	22.5	648
123	215	69	38	53.5	21.5	669.5
124	216	68	38	53	21	690.5
125	217	69	38	53.5	21.5	712
126	218	58	30	44	12	724
127	219	56	29	42.5	10.5	734.5
128	220	60	31	45.5	13.5	748
129	221	68	31	49.5	17.5	765.5
130	222	74	35	54.5	22.5	788
131	223	62	41	51.5	19.5	807.5
132	224	65	38	51.5	19.5	827
133	225	71	42	56.5	24.5	851.5
134	226	75	43	59	27	878.5
135	227	71	43	57	25	903.5
136	228	70	43	56.5	24.5	928
137	229	75	41	58	26	954
138	230	78	50	64	32	986
139	231	77	48	62.5	30.5	1016.5
140	232	70	55	62.5	30.5	1047
141	233	74	35	54.5	22.5	1069.5
142	234	80	46	63	31	1100.5
143	235	70	45	57.5	25.5	1126
144	236	68	33	50.5	18.5	1144.5
145	237	73	36	54.5	22.5	1167
146	238	70	44	57	25	1192
147	239	72	35	53.5	21.5	1213.5
148	240	76	41	58.5	26.5	1240

149	241	75	43	59	27	1267
150	242	74	40	57	25	1292
151	243	68	38	53	21	1313
152	244	70	35	52.5	20.5	1333.5
153	245	70	35	52.5	20.5	1354
154	246	73	37	55	23	1377
155	247	74	43	58.5	26.5	1403.5
156	248	63	47	55	23	1426.5
157	249	69	36	52.5	20.5	1447
158	250	68	44	56	24	1471
159	251	65	40	52.5	20.5	1491.5
160	252	70	33	51.5	19.5	1511
161	253	74	34	54	22	1533
162	254	79	45	62	30	1563
163	255	78	44	61	29	1592
164	256	84	44	64	32	1624
165	257	88	50	69	37	1661
166	258	87	56	71.5	39.5	1700.5
167	259	84	47	65.5	33.5	1734
168	260	77	41	59	27	1761
169	261	76	45	60.5	28.5	1789.5
170	262	78	43	60.5	28.5	1818
171	263	81	46	63.5	31.5	1849.5
172	264	85	51	68	36	1885.5
173	265	88	56	72	40	1925.5
174	266	88	61	74.5	42.5	1968
175	267	80	54	67	35	2003
176	268	87	54	70.5	38.5	2041.5
177	269	90	56	73	41	2082.5
178	270	96	54	75	43	2125.5
179	271	90	56	73	41	2166.5
180	272	87	56	71.5	39.5	2206
181	273	90	59	74.5	42.5	2248.5
182	274	86	59	72.5	40.5	2289
183	275	85	61	73	41	2330
184	276	77	56	66.5	34.5	2364.5
185	277	88	54	71	39	2403.5
186	278	90	60	75	43	2446.5
187	279	91	54	72.5	40.5	2487
188	280	93	54	73.5	41.5	2528.5
189	281	94	60	77	45	2573.5
190	282	93	60	76.5	44.5	2618
191	283	93	60	76.5	44.5	2662.5
192	284	87	61	74	42	2704.5
193	285	80	60	70	38	2742.5
194	286	78	55	66.5	34.5	2777
195	287	83	55	69	37	2814
196	288	82	51	66.5	34.5	2848.5
197	289	88	59	73.5	41.5	2890
198	290	87	57	72	40	2930
199	291	86	57	71.5	39.5	2969.5
200	292	86	59	72.5	40.5	3010
201	293	87	52	69.5	37.5	3047.5
202	294	91	53	72	40	3087.5
203	295	89	59	74	42	3129.5
204	296	89	58	73.5	41.5	3171
205	297	90	58	74	42	3213
206	298	88	57	72.5	40.5	3253.5
207	299	90	57	73.5	41.5	3295
208	300	94	53	73.5	41.5	3336.5
209	301	87	58	72.5	40.5	3377
210	302	85	60	72.5	40.5	3417.5
211	303	89	60	74.5	42.5	3460
212	304	80	60	70	38	3498
213	305	85	54	69.5	37.5	3535.5
214	306	85	54	69.5	37.5	3573
215	307	89	51	70	38	3611
216	308	89	58	73.5	41.5	3652.5
217	309	90	61	75.5	43.5	3696
218	310	91	55	73	41	3737
219	311	90	55	72.5	40.5	3777.5
220	312	92	56	74	42	3819.5
221	313	90	56	73	41	3860.5
222	314	90	55	72.5	40.5	3901
223	315	81	61	71	39	3940
224	316	87	50	68.5	36.5	3976.5
225	317	88	50	69	37	4013.5
226	318	90	52	71	39	4052.5
227	319	90	60	75	43	4095.5
228	320	88	69	78.5	46.5	4142
229	321	92	57	74.5	42.5	4184.5
230	322	90	61	75.5	43.5	4228
231	323	85	61	73	41	4269
232	324	86	56	71	39	4308
233	325	86	58	72	40	4348
234	326	84	58	71	39	4387
235	327	89	54	71.5	39.5	4426.5
236	328	88	56	72	40	4466.5
237	329	88	56	72	40	4506.5
238	330	87	55	71	39	4545.5
239	331	81	57	69	37	4582.5
240	332	71	52	61.5	29.5	4612
241	333	70	53	61.5	29.5	4641.5
242	334	76	50	63	31	4672.5
243	335	75	47	61	29	4701.5
244	336	74	43	58.5	26.5	4728
245	337	81	40	60.5	28.5	4756.5
246	338	81	45	63	31	4787.5
247	339	86	45	65.5	33.5	4821
248	340	85	47	66	34	4855
249	341	89	47	68	36	4891
250	342	88	51	69.5	37.5	4928.5
251	343	85	50	67.5	35.5	4964
252	344	89	47	68	36	5000
253	345	87	48	67.5	35.5	5035.5
254	346	84	39	61.5	29.5	5065
255	347	M	M	-	-	5065
256	348	85	40	62.5	30.5	5095.5
257	349	84	40	62	30	5125.5



258	350	84	40	62	30	5155.5
259	351	85	40	62.5	30.5	5186
260	352	85	41	63	31	5217
261	353	84	41	62.5	30.5	5247.5
262	354	82	42	62	30	5277.5
263	355	81	43	62	30	5307.5
264	356	79	43	61	29	5336.5
265	357	80	43	61.5	29.5	5366
266	358	88	44	66	34	5400
267	359	72	44	58	26	5426
268	360	58	44	51	19	5445
269	361	69	41	55	23	5468
270	362	71	40	55.5	23.5	5491.5
271	363	73	40	56.5	24.5	5516
272	364	72	49	60.5	28.5	5544.5
273	365	70	49	59.5	27.5	5572
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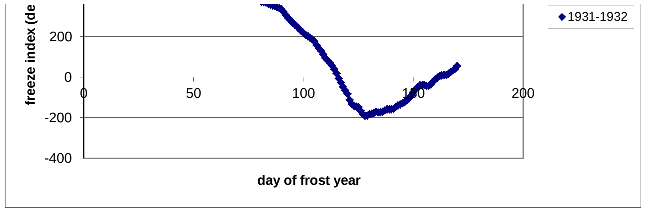

49	818	length of freeze (day)	81
130	-189.5	frost depth (^{o}F-day)	1007.5
		average temperature	47.3

1980-1981

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	87	47	67	35	35
275	2	85	56	70.5	38.5	73.5
276	3	84	46	65	33	106.5
277	4	82	43	62.5	30.5	137
278	5	81	50	65.5	33.5	170.5
279	6	80	48	64	32	202.5
280	7	82	45	63.5	31.5	234
281	8	82	46	64	32	266
282	9	82	45	63.5	31.5	297.5
283	10	79	48	63.5	31.5	329
284	11	77	41	59	27	356
285	12	71	47	59	27	383
286	13	65	43	54	22	405
287	14	62	39	50.5	18.5	423.5
288	15	44	31	37.5	5.5	429
289	16	46	30	38	6	435
290	17	51	25	38	6	441
291	18	56	28	42	10	451
292	19	61	33	47	15	466
293	20	63	31	47	15	481
294	21	64	30	47	15	496
295	22	64	31	47.5	15.5	511.5
296	23	51	26	38.5	6.5	518
297	24	57	22	39.5	7.5	525.5
298	25	63	26	44.5	12.5	538
299	26	47	30	38.5	6.5	544.5
300	27	44	33	38.5	6.5	551
301	28	51	25	38	6	557
302	29	56	25	40.5	8.5	565.5
303	30	59	25	42	10	575.5
304	31	60	30	45	13	588.5
305	32	64	32	48	16	604.5
306	33	66	31	48.5	16.5	621
307	34	69	30	49.5	17.5	638.5
308	35	72	30	51	19	657.5
309	36	70	39	54.5	22.5	680
310	37	66	35	50.5	18.5	698.5
311	38	66	35	50.5	18.5	717
312	39	67	34	50.5	18.5	735.5
313	40	68	36	52	20	755.5
314	41	68	39	53.5	21.5	777
315	42	66	37	51.5	19.5	796.5
316	43	63	39	51	19	815.5
317	44	52	37	44.5	12.5	828
318	45	46	22	34	2	830
319	46	45	17	31	-1	829
320	47	42	23	32.5	0.5	829.5
321	48	42	18	30	-2	827.5
322	49	45	14	29.5	-2.5	825
323	50	47	16	31.5	-0.5	824.5
324	51	50	20	35	3	827.5
325	52	50	23	36.5	4.5	832
326	53	47	21	34	2	834
327	54	47	24	35.5	3.5	837.5
328	55	41	31	36	4	841.5
329	56	46	22	34	2	843.5
330	57	47	18	32.5	0.5	844
331	58	46	19	32.5	0.5	844.5
332	59	56	25	40.5	8.5	853
333	60	47	28	37.5	5.5	858.5
334	61	51	32	41.5	9.5	868
335	62	53	26	39.5	7.5	875.5
336	63	53	26	39.5	7.5	883
337	64	57	33	45	13	896
338	65	55	30	42.5	10.5	906.5
339	66	38	30	34	2	908.5
340	67	41	32	36.5	4.5	913
341	68	39	32	35.5	3.5	916.5
342	69	42	25	33.5	1.5	918
343	70	42	19	30.5	-1.5	916.5
344	71	45	17	31	-1	915.5
345	72	52	20	36	4	919.5
346	73	47	23	35	3	922.5
347	74	50	27	38.5	6.5	929
348	75	56	28	42	10	939
349	76	60	30	45	13	952
350	77	63	31	47	15	967
351	78	61	28	44.5	12.5	979.5
352	79	54	27	40.5	8.5	988
353	80	52	27	39.5	7.5	995.5
354	81	49	26	37.5	5.5	1001
355	82	49	27	38	6	1007
356	83	52	28	40	8	1015
357	84	48	29	38.5	6.5	1021.5
358	85	50	25	37.5	5.5	1027
359	86	54	26	40	8	1035
360	87	58	31	44.5	12.5	1047.5

361	88	55	27	41	9	1056.5
362	89	52	32	42	10	1066.5
363	90	59	32	45.5	13.5	1080
364	91	54	28	41	9	1089
365	92	53	30	41.5	9.5	1098.5
1	93	55	26	40.5	8.5	1107
2	94	55	31	43	11	1118
3	95	54	28	41	9	1127
4	96	54	32	43	11	1138
5	97	47	25	36	4	1142
6	98	49	20	34.5	2.5	1144.5
7	99	45	18	31.5	-0.5	1144
8	100	47	20	33.5	1.5	1145.5
9	101	50	20	35	3	1148.5
10	102	53	22	37.5	5.5	1154
11	103	51	24	37.5	5.5	1159.5
12	104	52	29	40.5	8.5	1168
13	105	59	27	43	11	1179
14	106	50	21	35.5	3.5	1182.5
15	107	48	23	35.5	3.5	1186
16	108	50	23	36.5	4.5	1190.5
17	109	47	25	36	4	1194.5
18	110	53	20	36.5	4.5	1199
19	111	54	25	39.5	7.5	1206.5
20	112	56	25	40.5	8.5	1215
21	113	58	24	41	9	1224
22	114	52	24	38	6	1230
23	115	52	23	37.5	5.5	1235.5
24	116	48	24	36	4	1239.5
25	117	45	19	32	0	1239.5
26	118	42	15	28.5	-3.5	1236
27	119	43	16	29.5	-2.5	1233.5
28	120	39	30	34.5	2.5	1236
29	121	42	20	31	-1	1235
30	122	34	20	27	-5	1230
31	123	33	13	23	-9	1221
32	124	38	16	27	-5	1216
33	125	44	13	28.5	-3.5	1212.5
34	126	48	18	33	1	1213.5
35	127	46	16	31	-1	1212.5
36	128	46	17	31.5	-0.5	1212
37	129	47	18	32.5	0.5	1212.5
38	130	49	21	35	3	1215.5
39	131	44	18	31	-1	1214.5
40	132	42	26	34	2	1216.5
41	133	34	13	23.5	-8.5	1208
42	134	40	11	25.5	-6.5	1201.5
43	135	52	20	36	4	1205.5
44	136	54	22	38	6	1211.5
45	137	56	26	41	9	1220.5
46	138	60	30	45	13	1233.5
47	139	60	29	44.5	12.5	1246
48	140	59	34	46.5	14.5	1260.5
49	141	63	30	46.5	14.5	1275
50	142	60	32	46	14	1289
51	143	58	28	43	11	1300
52	144	45	23	34	2	1302
53	145	56	20	38	6	1308
54	146	58	25	41.5	9.5	1317.5
55	147	56	28	42	10	1327.5
56	148	57	29	43	11	1338.5
57	149	59	28	43.5	11.5	1350
58	150	48	22	35	3	1353
59	151	55	22	38.5	6.5	1359.5
60	152	52	31	41.5	9.5	1369
61	153	41	32	36.5	4.5	1373.5
62	154	46	25	35.5	3.5	1377
63	155	47	21	34	2	1379
64	156	51	27	39	7	1386
65	157	41	27	34	2	1388
66	158	44	27	35.5	3.5	1391.5
67	159	51	26	38.5	6.5	1398
68	160	53	24	38.5	6.5	1404.5
69	161	53	30	41.5	9.5	1414
70	162	45	29	37	5	1419
71	163	50	26	38	6	1425
72	164	52	25	38.5	6.5	1431.5
73	165	45	31	38	6	1437.5
74	166	53	27	40	8	1445.5
75	167	54	30	42	10	1455.5
76	168	44	28	36	4	1459.5
77	169	50	20	35	3	1462.5
78	170	57	25	41	9	1471.5
79	171	49	32	40.5	8.5	1480
80	172	52	35	43.5	11.5	1491.5
81	173	58	35	46.5	14.5	1506
82	174	64	35	49.5	17.5	1523.5
83	175	57	36	46.5	14.5	1538
84	176	59	33	46	14	1552
85	177	64	33	48.5	16.5	1568.5
86	178	43	28	35.5	3.5	1572
87	179	43	29	36	4	1576
88	180	55	26	40.5	8.5	1584.5
89	181	48	31	39.5	7.5	1592
90	182	54	21	37.5	5.5	1597.5
91	183	63	29	46	14	1611.5
92	184	64	33	48.5	16.5	1628
93	185	43	28	35.5	3.5	1631.5
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95	187	58	23	40.5	8.5	1643.5
96	188	65	31	48	16	1659.5
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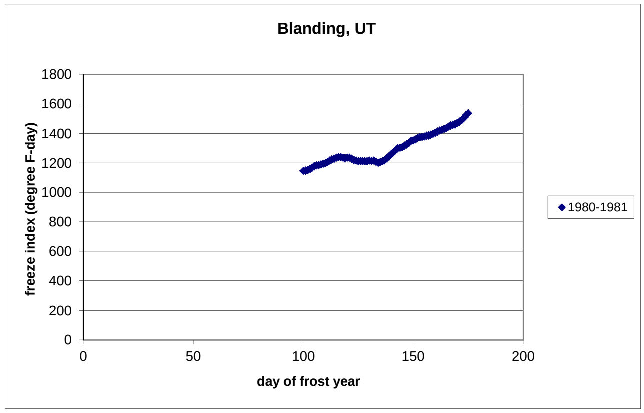
98	190	64	32	48	16	1693.5
99	191	69	33	51	19	1712.5
100	192	71	36	53.5	21.5	1734
101	193	69	35	52	20	1754
102	194	63	36	49.5	17.5	1771.5
103	195	68	40	54	22	1793.5
104	196	68	40	54	22	1815.5

105	197	61	39	50	18	1833.5
106	198	70	38	54	22	1855.5
107	199	75	43	59	27	1882.5
108	200	71	45	58	26	1908.5
109	201	56	36	46	14	1922.5
110	202	61	36	48.5	16.5	1939
111	203	68	34	51	19	1958
112	204	69	40	54.5	22.5	1980.5
113	205	76	39	57.5	25.5	2006
114	206	77	42	59.5	27.5	2033.5
115	207	78	45	61.5	29.5	2063
116	208	77	42	59.5	27.5	2090.5
117	209	72	46	59	27	2117.5
118	210	78	45	61.5	29.5	2147
119	211	82	43	62.5	30.5	2177.5
120	212	84	48	66	34	2211.5
121	213	83	51	67	35	2246.5
122	214	76	47	61.5	29.5	2276
123	215	70	46	58	26	2302
124	216	72	32	52	20	2322
125	217	74	42	58	26	2348
126	218	70	38	54	22	2370
127	219	64	29	46.5	14.5	2384.5
128	220	63	35	49	17	2401.5
129	221	67	33	50	18	2419.5
130	222	71	38	54.5	22.5	2442
131	223	68	43	55.5	23.5	2465.5
132	224	73	39	56	24	2489.5
133	225	72	43	57.5	25.5	2515
134	226	77	48	62.5	30.5	2545.5
135	227	66	41	53.5	21.5	2567
136	228	50	38	44	12	2579
137	229	58	32	45	13	2592
138	230	70	36	53	21	2613
139	231	72	43	57.5	25.5	2638.5
140	232	63	40	51.5	19.5	2658
141	233	65	32	48.5	16.5	2674.5
142	234	71	37	54	22	2696.5
143	235	72	40	56	24	2720.5
144	236	75	44	59.5	27.5	2748
145	237	79	53	66	34	2782
146	238	74	52	63	31	2813
147	239	79	44	61.5	29.5	2842.5
148	240	75	48	61.5	29.5	2872
149	241	74	44	59	27	2899
150	242	79	43	61	29	2928
151	243	74	50	62	30	2958
152	244	80	45	62.5	30.5	2988.5
153	245	81	49	65	33	3021.5
154	246	72	48	60	28	3049.5
155	247	80	44	62	30	3079.5
156	248	85	57	71	39	3118.5
157	249	89	54	71.5	39.5	3158
158	250	91	56	73.5	41.5	3199.5
159	251	91	57	74	42	3241.5
160	252	91	55	73	41	3282.5
161	253	92	56	74	42	3324.5
162	254	90	56	73	41	3365.5
163	255	87	49	68	36	3401.5
164	256	82	51	66.5	34.5	3436
165	257	66	43	54.5	22.5	3458.5
166	258	70	36	53	21	3479.5
167	259	81	45	63	31	3510.5
168	260	88	47	67.5	35.5	3546
169	261	89	51	70	38	3584
170	262	92	53	72.5	40.5	3624.5
171	263	94	59	76.5	44.5	3669
172	264	95	61	78	46	3715
173	265	94	60	77	45	3760
174	266	96	58	77	45	3805
175	267	97	64	80.5	48.5	3853.5
176	268	99	62	80.5	48.5	3902
177	269	97	62	79.5	47.5	3949.5
178	270	95	56	75.5	43.5	3993
179	271	94	56	75	43	4036
180	272	89	56	72.5	40.5	4076.5
181	273	89	57	73	41	4117.5
182	274	77	59	68	36	4153.5
183	275	80	55	67.5	35.5	4189
184	276	89	54	71.5	39.5	4228.5
185	277	91	63	77	45	4273.5
186	278	98	66	82	50	4323.5
187	279	98	60	79	47	4370.5
188	280	93	62	77.5	45.5	4416
189	281	93	60	76.5	44.5	4460.5
190	282	88	59	73.5	41.5	4502
191	283	88	56	72	40	4542
192	284	92	60	76	44	4586
193	285	83	58	70.5	38.5	4624.5
194	286	82	60	71	39	4663.5
195	287	86	57	71.5	39.5	4703
196	288	86	58	72	40	4743
197	289	82	61	71.5	39.5	4782.5
198	290	82	58	70	38	4820.5
199	291	85	55	70	38	4858.5
200	292	92	57	74.5	42.5	4901
201	293	93	58	75.5	43.5	4944.5
202	294	94	65	79.5	47.5	4992
203	295	89	67	78	46	5038
204	296	90	62	76	44	5082
205	297	88	59	73.5	41.5	5123.5
206	298	89	60	74.5	42.5	5166
207	299	87	62	74.5	42.5	5208.5
208	300	87	58	72.5	40.5	5249
209	301	92	57	74.5	42.5	5291.5
210	302	91	57	74	42	5333.5
211	303	90	61	75.5	43.5	5377
212	304	93	60	76.5	44.5	5421.5
213	305	86	61	73.5	41.5	5463

214	306	91	57	74	42	5505
215	307	92	58	75	43	5548
216	308	92	60	76	44	5592
217	309	96	57	76.5	44.5	5636.5
218	310	97	57	77	45	5681.5
219	311	92	61	76.5	44.5	5726
220	312	88	58	73	41	5767
221	313	89	59	74	42	5809
222	314	78	57	67.5	35.5	5844.5
223	315	71	55	63	31	5875.5
224	316	72	53	62.5	30.5	5906
225	317	78	52	65	33	5939
226	318	79	51	65	33	5972
227	319	87	55	71	39	6011
228	320	85	54	69.5	37.5	6048.5
229	321	86	53	69.5	37.5	6086
230	322	88	55	71.5	39.5	6125.5
231	323	89	55	72	40	6165.5
232	324	86	56	71	39	6204.5
233	325	84	63	73.5	41.5	6246
234	326	83	56	69.5	37.5	6283.5
235	327	89	54	71.5	39.5	6323
236	328	89	58	73.5	41.5	6364.5
237	329	88	57	72.5	40.5	6405
238	330	93	57	75	43	6448
239	331	88	60	74	42	6490
240	332	88	56	72	40	6530
241	333	85	55	70	38	6568
242	334	89	56	72.5	40.5	6608.5
243	335	79	56	67.5	35.5	6644
244	336	84	49	66.5	34.5	6678.5
245	337	85	53	69	37	6715.5
246	338	87	53	70	38	6753.5
247	339	83	54	68.5	36.5	6790
248	340	69	52	60.5	28.5	6818.5
249	341	70	51	60.5	28.5	6847
250	342	77	51	64	32	6879
251	343	80	53	66.5	34.5	6913.5
252	344	78	51	64.5	32.5	6946
253	345	67	49	58	26	6972
254	346	75	46	60.5	28.5	7000.5
255	347	75	49	62	30	7030.5
256	348	82	49	65.5	33.5	7064
257	349	81	50	65.5	33.5	7097.5
258	350	83	52	67.5	35.5	7133
259	351	82	49	65.5	33.5	7166.5
260	352	83	49	66	34	7200.5
261	353	83	49	66	34	7234.5
262	354	82	50	66	34	7268.5
263	355	82	49	65.5	33.5	7302
264	356	82	51	66.5	34.5	7336.5
265	357	80	49	64.5	32.5	7369
266	358	75	53	64	32	7401
267	359	76	47	61.5	29.5	7430.5
268	360	74	48	61	29	7459.5
269	361	77	42	59.5	27.5	7487
270	362	80	44	62	30	7517
271	363	81	47	64	32	7549
272	364	79	52	65.5	33.5	7582.5
273	365	77	48	62.5	30.5	7613



117	1239.5	length of freeze (day)	19
136	1211.5	frost depth (^{o}F-day)	28
		average temperature	52.9

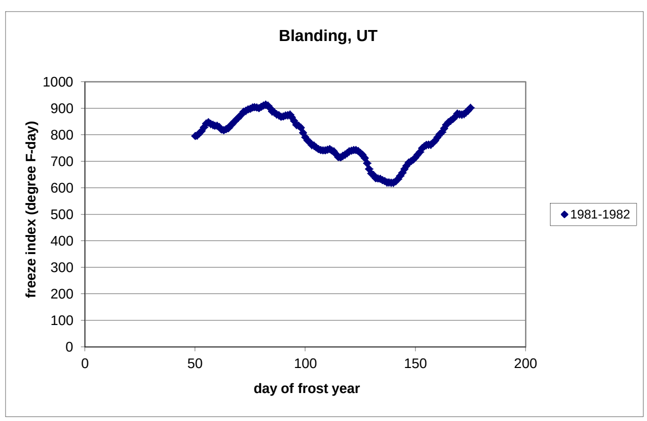
1981-1982

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	76	48	62	30	30
275	2	56	47	51.5	19.5	49.5
276	3	59	45	52	20	69.5
277	4	55	45	50	18	87.5
278	5	66	43	54.5	22.5	110
279	6	71	43	57	25	135
280	7	69	43	56	24	159
281	8	68	44	56	24	183
282	9	64	35	49.5	17.5	200.5
283	10	70	41	55.5	23.5	224
284	11	63	45	54	22	246
285	12	58	41	49.5	17.5	263.5
286	13	58	35	46.5	14.5	278
287	14	59	31	45	13	291
288	15	53	37	45	13	304
289	16	48	28	38	6	310
290	17	62	30	46	14	324
291	18	65	40	52.5	20.5	344.5
292	19	66	35	50.5	18.5	363
293	20	64	33	48.5	16.5	379.5
294	21	67	34	50.5	18.5	398
295	22	66	35	50.5	18.5	416.5
296	23	62	35	48.5	16.5	433
297	24	56	33	44.5	12.5	445.5
298	25	59	32	45.5	13.5	459
299	26	61	29	45	13	472
300	27	62	37	49.5	17.5	489.5
301	28	63	41	52	20	509.5
302	29	57	41	49	17	526.5
303	30	45	27	36	4	530.5
304	31	56	23	39.5	7.5	538
305	32	64	30	47	15	553
306	33	63	37	50	18	571
307	34	62	31	46.5	14.5	585.5
308	35	63	31	47	15	600.5
309	36	63	31	47	15	615.5
310	37	62	30	46	14	629.5
311	38	61	30	45.5	13.5	643
312	39	64	35	49.5	17.5	660.5
313	40	59	31	45	13	673.5
314	41	59	32	45.5	13.5	687
315	42	58	32	45	13	700
316	43	59	30	44.5	12.5	712.5
317	44	59	34	46.5	14.5	727

318	45	58	36	47	15	742
319	46	60	30	45	13	755
320	47	63	33	48	16	771
321	48	59	32	45.5	13.5	784.5
322	49	48	28	38	6	790.5
323	50	52	22	37	5	795.5
324	51	48	22	35	3	798.5
325	52	54	25	39.5	7.5	806
326	53	53	30	41.5	9.5	815.5
327	54	59	31	45	13	828.5
328	55	60	32	46	14	842.5
329	56	49	24	36.5	4.5	847
330	57	38	14	26	-6	841
331	58	38	20	29	-3	838
332	59	40	16	28	-4	834
333	60	36	28	32	0	834
334	61	37	17	27	-5	829
335	62	34	11	22.5	-9.5	819.5
336	63	42	18	30	-2	817.5
337	64	49	21	35	3	820.5
338	65	49	24	36.5	4.5	825
339	66	54	31	42.5	10.5	835.5
340	67	51	27	39	7	842.5
341	68	53	28	40.5	8.5	851
342	69	54	27	40.5	8.5	859.5
343	70	55	27	41	9	868.5
344	71	48	32	40	8	876.5
345	72	54	31	42.5	10.5	887
346	73	47	26	36.5	4.5	891.5
347	74	45	27	36	4	895.5
348	75	46	23	34.5	2.5	898
349	76	48	25	36.5	4.5	902.5
350	77	43	25	34	2	904.5
351	78	42	20	31	-1	903.5
352	79	41	18	29.5	-2.5	901
353	80	47	25	36	4	905
354	81	50	25	37.5	5.5	910.5
355	82	43	29	36	4	914.5
356	83	38	18	28	-4	910.5
357	84	35	10	22.5	-9.5	901
358	85	31	8	19.5	-12.5	888.5
359	86	37	21	29	-3	885.5
360	87	35	13	24	-8	877.5
361	88	39	19	29	-3	874.5
362	89	37	13	25	-7	867.5
363	90	45	22	33.5	1.5	869
364	91	42	31	36.5	4.5	873.5
365	92	36	29	32.5	0.5	874
1	93	41	28	34.5	2.5	876.5
2	94	33	10	21.5	-10.5	866
3	95	31	6	18.5	-13.5	852.5
4	96	28	8	18	-14	838.5
5	97	32	23	27.5	-4.5	834
6	98	36	13	24.5	-7.5	826.5
7	99	28	-1	13.5	-18.5	808
8	100	30	0	15	-17	791
9	101	34	5	19.5	-12.5	778.5
10	102	39	10	24.5	-7.5	771
11	103	31	15	23	-9	762
12	104	40	18	29	-3	759
13	105	36	14	25	-7	752
14	106	40	13	26.5	-5.5	746.5
15	107	40	15	27.5	-4.5	742
16	108	43	19	31	-1	741
17	109	45	19	32	0	741
18	110	48	21	34.5	2.5	743.5
19	111	46	23	34.5	2.5	746
20	112	37	17	27	-5	741
21	113	35	22	28.5	-3.5	737.5
22	114	32	10	21	-11	726.5
23	115	35	7	21	-11	715.5
24	116	46	16	31	-1	714.5
25	117	51	25	38	6	720.5
26	118	53	22	37.5	5.5	726
27	119	47	29	38	6	732
28	120	48	28	38	6	738
29	121	41	28	34.5	2.5	740.5
30	122	48	21	34.5	2.5	743
31	123	40	22	31	-1	742
32	124	36	21	28.5	-3.5	738.5
33	125	34	17	25.5	-6.5	732
34	126	30	18	24	-8	724
35	127	30	11	20.5	-11.5	712.5
36	128	27	-1	13	-19	693.5
37	129	21	-2	9.5	-22.5	671
38	130	33	-2	15.5	-16.5	654.5
39	131	36	17	26.5	-5.5	649
40	132	29	9	19	-13	636
41	133	42	20	31	-1	635
42	134	44	19	31.5	-0.5	634.5
43	135	40	14	27	-5	629.5
44	136	40	16	28	-4	625.5
45	137	36	19	27.5	-4.5	621
46	138	37	26	31.5	-0.5	620.5
47	139	34	27	30.5	-1.5	619
48	140	44	21	32.5	0.5	619.5
49	141	52	21	36.5	4.5	624
50	142	52	30	41	9	633
51	143	60	28	44	12	645
52	144	58	31	44.5	12.5	657.5
53	145	58	34	46	14	671.5
54	146	53	36	44.5	12.5	684
55	147	53	33	43	11	695
56	148	40	35	37.5	5.5	700.5
57	149	44	31	37.5	5.5	706
58	150	52	29	40.5	8.5	714.5
59	151	56	30	43	11	725.5
60	152	53	31	42	10	735.5
61	153	54	39	46.5	14.5	750

62	154	47	30	38.5	6.5	756.5
63	155	48	26	37	5	761.5
64	156	44	22	33	1	762.5
65	157	45	21	33	1	763.5
66	158	54	24	39	7	770.5
67	159	55	26	40.5	8.5	779
68	160	60	28	44	12	791
69	161	56	31	43.5	11.5	802.5
70	162	46	34	40	8	810.5
71	163	55	38	46.5	14.5	825
72	164	57	33	45	13	838
73	165	48	34	41	9	847
74	166	45	32	38.5	6.5	853.5
75	167	46	31	38.5	6.5	860
76	168	55	25	40	8	868
77	169	58	30	44	12	880
78	170	41	19	30	-2	878
79	171	44	18	31	-1	877
80	172	46	23	34.5	2.5	879.5
81	173	52	24	38	6	885.5
82	174	55	23	39	7	892.5
83	175	59	24	41.5	9.5	902
84	176	60	30	45	13	915
85	177	49	32	40.5	8.5	923.5
86	178	51	33	42	10	933.5
87	179	59	33	46	14	947.5
88	180	41	28	34.5	2.5	950
89	181	45	24	34.5	2.5	952.5
90	182	58	27	42.5	10.5	963
91	183	55	31	43	11	974
92	184	47	21	34	2	976
93	185	56	28	42	10	986
94	186	60	32	46	14	1000
95	187	55	23	39	7	1007
96	188	60	33	46.5	14.5	1021.5
97	189	49	28	38.5	6.5	1028
98	190	52	18	35	3	1031
99	191	55	26	40.5	8.5	1039.5
100	192	59	22	40.5	8.5	1048
101	193	67	35	51	19	1067
102	194	66	43	54.5	22.5	1089.5
103	195	68	36	52	20	1109.5
104	196	68	35	51.5	19.5	1129
105	197	66	33	49.5	17.5	1146.5
106	198	59	36	47.5	15.5	1162
107	199	66	33	49.5	17.5	1179.5
108	200	68	34	51	19	1198.5
109	201	55	28	41.5	9.5	1208
110	202	51	21	36	4	1212
111	203	58	28	43	11	1223
112	204	50	31	40.5	8.5	1231.5
113	205	53	32	42.5	10.5	1242
114	206	65	31	48	16	1258
115	207	68	43	55.5	23.5	1281.5
116	208	70	41	55.5	23.5	1305
117	209	72	44	58	26	1331
118	210	75	42	58.5	26.5	1357.5
119	211	72	43	57.5	25.5	1383
120	212	77	45	61	29	1412
121	213	76	44	60	28	1440
122	214	73	45	59	27	1467
123	215	73	42	57.5	25.5	1492.5
124	216	74	42	58	26	1518.5
125	217	67	38	52.5	20.5	1539
126	218	61	35	48	16	1555
127	219	69	35	52	20	1575
128	220	72	42	57	25	1600
129	221	65	40	52.5	20.5	1620.5
130	222	60	34	47	15	1635.5
131	223	62	35	48.5	16.5	1652
132	224	50	36	43	11	1663
133	225	60	41	50.5	18.5	1681.5
134	226	69	37	53	21	1702.5
135	227	67	45	56	24	1726.5
136	228	69	42	55.5	23.5	1750
137	229	73	42	57.5	25.5	1775.5
138	230	76	48	62	30	1805.5
139	231	70	42	56	24	1829.5
140	232	73	41	57	25	1854.5
141	233	79	44	61.5	29.5	1884
142	234	77	52	64.5	32.5	1916.5
143	235	78	46	62	30	1946.5
144	236	80	47	63.5	31.5	1978
145	237	79	50	64.5	32.5	2010.5
146	238	85	46	65.5	33.5	2044
147	239	76	50	63	31	2075
148	240	79	42	60.5	28.5	2103.5
149	241	75	44	59.5	27.5	2131
150	242	73	43	58	26	2157
151	243	77	39	58	26	2183
152	244	76	44	60	28	2211
153	245	78	45	61.5	29.5	2240.5
154	246	77	43	60	28	2268.5
155	247	78	44	61	29	2297.5
156	248	76	42	59	27	2324.5
157	249	72	38	55	23	2347.5
158	250	77	42	59.5	27.5	2375
159	251	76	42	59	27	2402
160	252	80	43	61.5	29.5	2431.5
161	253	83	54	68.5	36.5	2468
162	254	86	54	70	38	2506
163	255	84	54	69	37	2543
164	256	79	53	66	34	2577
165	257	79	46	62.5	30.5	2607.5
166	258	78	47	62.5	30.5	2638
167	259	86	51	68.5	36.5	2674.5
168	260	86	53	69.5	37.5	2712
169	261	83	56	69.5	37.5	2749.5
170	262	79	52	65.5	33.5	2783

171	263	83	49	66	34	2817
172	264	87	55	71	39	2856
173	265	87	54	70.5	38.5	2894.5
174	266	88	53	70.5	38.5	2933
175	267	89	55	72	40	2973
176	268	87	55	71	39	3012
177	269	89	56	72.5	40.5	3052.5
178	270	93	57	75	43	3095.5
179	271	92	55	73.5	41.5	3137
180	272	88	56	72	40	3177
181	273	81	54	67.5	35.5	3212.5
182	274	80	50	65	33	3245.5
183	275	84	48	66	34	3279.5
184	276	87	51	69	37	3316.5
185	277	82	50	66	34	3350.5
186	278	78	49	63.5	31.5	3382
187	279	81	42	61.5	29.5	3411.5
188	280	84	58	71	39	3450.5
189	281	83	54	68.5	36.5	3487
190	282	84	53	68.5	36.5	3523.5
191	283	90	53	71.5	39.5	3563
192	284	93	64	78.5	46.5	3609.5
193	285	95	66	80.5	48.5	3658
194	286	93	64	78.5	46.5	3704.5
195	287	94	56	75	43	3747.5
196	288	92	57	74.5	42.5	3790
197	289	90	55	72.5	40.5	3830.5
198	290	85	57	71	39	3869.5
199	291	87	55	71	39	3908.5
200	292	90	61	75.5	43.5	3952
201	293	95	58	76.5	44.5	3996.5
202	294	94	63	78.5	46.5	4043
203	295	95	63	79	47	4090
204	296	93	57	75	43	4133
205	297	89	59	74	42	4175
206	298	90	60	75	43	4218
207	299	89	63	76	44	4262
208	300	85	60	72.5	40.5	4302.5
209	301	82	59	70.5	38.5	4341
210	302	84	54	69	37	4378
211	303	88	59	73.5	41.5	4419.5
212	304	90	55	72.5	40.5	4460
213	305	90	57	73.5	41.5	4501.5
214	306	80	60	70	38	4539.5
215	307	83	52	67.5	35.5	4575
216	308	86	54	70	38	4613
217	309	91	53	72	40	4653
218	310	94	56	75	43	4696
219	311	91	61	76	44	4740
220	312	86	59	72.5	40.5	4780.5
221	313	90	56	73	41	4821.5
222	314	92	56	74	42	4863.5
223	315	88	57	72.5	40.5	4904
224	316	80	57	68.5	36.5	4940.5
225	317	73	57	65	33	4973.5
226	318	82	54	68	36	5009.5
227	319	85	55	70	38	5047.5
228	320	86	57	71.5	39.5	5087
229	321	89	60	74.5	42.5	5129.5
230	322	91	60	75.5	43.5	5173
231	323	91	59	75	43	5216
232	324	92	64	78	46	5262
233	325	89	61	75	43	5305
234	326	84	60	72	40	5345
235	327	81	56	68.5	36.5	5381.5
236	328	77	55	66	34	5415.5
237	329	72	56	64	32	5447.5
238	330	76	54	65	33	5480.5
239	331	79	52	65.5	33.5	5514
240	332	80	55	67.5	35.5	5549.5
241	333	85	52	68.5	36.5	5586
242	334	85	53	69	37	5623
243	335	87	54	70.5	38.5	5661.5
244	336	88	53	70.5	38.5	5700
245	337	88	62	75	43	5743
246	338	89	57	73	41	5784
247	339	87	58	72.5	40.5	5824.5
248	340	85	58	71.5	39.5	5864
249	341	88	60	74	42	5906
250	342	80	50	65	33	5939
251	343	82	52	67	35	5974
252	344	84	51	67.5	35.5	6009.5
253	345	77	51	64	32	6041.5
254	346	59	51	55	23	6064.5
255	347	66	46	56	24	6088.5
256	348	54	39	46.5	14.5	6103
257	349	63	36	49.5	17.5	6120.5
258	350	73	44	58.5	26.5	6147
259	351	75	45	60	28	6175
260	352	72	48	60	28	6203
261	353	74	50	62	30	6233
262	354	77	48	62.5	30.5	6263.5
263	355	76	50	63	31	6294.5
264	356	79	45	62	30	6324.5
265	357	81	49	65	33	6357.5
266	358	84	47	65.5	33.5	6391
267	359	80	50	65	33	6424
268	360	84	57	70.5	38.5	6462.5
269	361	80	50	65	33	6495.5
270	362	61	42	51.5	19.5	6515
271	363	56	37	46.5	14.5	6529.5
272	364	68	33	50.5	18.5	6548
273	365	68	40	54	22	6570



83	910.5	length of freeze (day)	57
140	619.5	frost depth (°F-day)	291
		average temperature	50.0

1982-1983

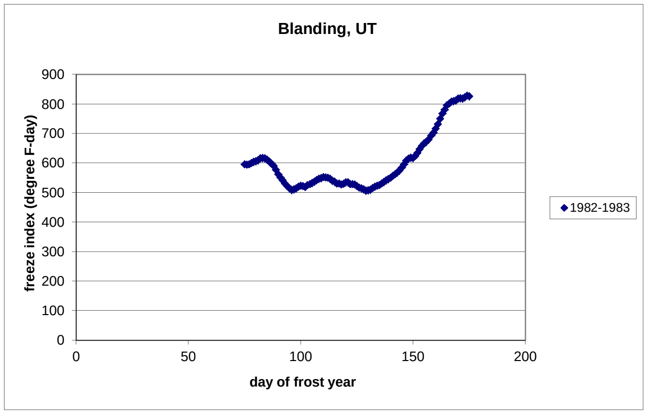
day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (°F)	cumulative degree day (°F)
274	1	60	30	45	13	13

275	2	66	33	49.5	17.5	30.5
276	3	68	33	50.5	18.5	49
277	4	70	38	54	22	71
278	5	64	34	49	17	88
279	6	64	26	45	13	101
280	7	68	33	50.5	18.5	119.5
281	8	50	33	41.5	9.5	129
282	9	51	28	39.5	7.5	136.5
283	10	58	33	45.5	13.5	150
284	11	56	32	44	12	162
285	12	61	29	45	13	175
286	13	63	28	45.5	13.5	188.5
287	14	66	33	49.5	17.5	206
288	15	67	31	49	17	223
289	16	69	39	54	22	245
290	17	68	35	51.5	19.5	264.5
291	18	68	33	50.5	18.5	283
292	19	58	26	42	10	293
293	20	64	28	46	14	307
294	21	60	30	45	13	320
295	22	65	34	49.5	17.5	337.5
296	23	70	36	53	21	358.5
297	24	69	35	52	20	378.5
298	25	66	41	53.5	21.5	400
299	26	57	38	47.5	15.5	415.5
300	27	44	30	37	5	420.5
301	28	50	23	36.5	4.5	425
302	29	49	21	35	3	428
303	30	57	31	44	12	440
304	31	51	34	42.5	10.5	450.5
305	32	53	29	41	9	459.5
306	33	47	27	37	5	464.5
307	34	48	18	33	1	465.5
308	35	55	20	37.5	5.5	471
309	36	57	23	40	8	479
310	37	56	24	40	8	487
311	38	57	26	41.5	9.5	496.5
312	39	52	36	44	12	508.5
313	40	48	32	40	8	516.5
314	41	44	32	38	6	522.5
315	42	41	27	34	2	524.5
316	43	47	19	33	1	525.5
317	44	47	24	35.5	3.5	529
318	45	43	15	29	-3	526
319	46	48	20	34	2	528
320	47	48	21	34.5	2.5	530.5
321	48	48	28	38	6	536.5
322	49	42	33	37.5	5.5	542
323	50	45	29	37	5	547
324	51	36	26	31	-1	546
325	52	39	25	32	0	546
326	53	39	28	33.5	1.5	547.5
327	54	46	25	35.5	3.5	551
328	55	38	28	33	1	552
329	56	46	28	37	5	557
330	57	52	29	40.5	8.5	565.5
331	58	48	26	37	5	570.5
332	59	46	23	34.5	2.5	573
333	60	41	27	34	2	575
334	61	40	30	35	3	578
335	62	33	26	29.5	-2.5	575.5
336	63	40	17	28.5	-3.5	572
337	64	44	17	30.5	-1.5	570.5
338	65	46	22	34	2	572.5
339	66	47	25	36	4	576.5
340	67	43	22	32.5	0.5	577
341	68	41	25	33	1	578
342	69	45	30	37.5	5.5	583.5
343	70	43	34	38.5	6.5	590
344	71	44	30	37	5	595
345	72	48	30	39	7	602
346	73	41	25	33	1	603
347	74	34	27	30.5	-1.5	601.5
348	75	37	15	26	-6	595.5
349	76	40	21	30.5	-1.5	594
350	77	44	23	33.5	1.5	595.5
351	78	48	25	36.5	4.5	600
352	79	47	25	36	4	604
353	80	46	22	34	2	606
354	81	48	24	36	4	610
355	82	50	26	38	6	616
356	83	36	30	33	1	617
357	84	37	25	31	-1	616
358	85	32	23	27.5	-4.5	611.5
359	86	34	17	25.5	-6.5	605
360	87	35	14	24.5	-7.5	597.5
361	88	37	12	24.5	-7.5	590
362	89	29	10	19.5	-12.5	577.5
363	90	27	5	16	-16	561.5
364	91	33	10	21.5	-10.5	551
365	92	34	10	22	-10	541
1	93	34	10	22	-10	531
2	94	35	11	23	-9	522
3	95	37	11	24	-8	514
4	96	41	14	27.5	-4.5	509.5
5	97	46	21	33.5	1.5	511
6	98	47	24	35.5	3.5	514.5
7	99	49	25	37	5	519.5
8	100	45	27	36	4	523.5
9	101	39	21	30	-2	521.5
10	102	41	18	29.5	-2.5	519
11	103	53	23	38	6	525
12	104	49	22	35.5	3.5	528.5
13	105	51	22	36.5	4.5	533
14	106	51	22	36.5	4.5	537.5
15	107	48	27	37.5	5.5	543
16	108	48	23	35.5	3.5	546.5
17	109	38	31	34.5	2.5	549
18	110	42	28	35	3	552

19	111	36	26	31	-1	551
20	112	37	25	31	-1	550
21	113	32	25	28.5	-3.5	546.5
22	114	37	15	26	-6	540.5
23	115	36	22	29	-3	537.5
24	116	32	19	25.5	-6.5	531
25	117	43	20	31.5	-0.5	530.5
26	118	41	16	28.5	-3.5	527
27	119	44	25	34.5	2.5	529.5
28	120	46	28	37	5	534.5
29	121	37	27	32	0	534.5
30	122	41	12	26.5	-5.5	529
31	123	42	20	31	-1	528
32	124	42	21	31.5	-0.5	527.5
33	125	40	12	26	-6	521.5
34	126	36	18	27	-5	516.5
35	127	34	26	30	-2	514.5
36	128	38	20	29	-3	511.5
37	129	40	15	27.5	-4.5	507
38	130	38	27	32.5	0.5	507.5
39	131	39	30	34.5	2.5	510
40	132	47	28	37.5	5.5	515.5
41	133	47	25	36	4	519.5
42	134	48	24	36	4	523.5
43	135	47	21	34	2	525.5
44	136	48	26	37	5	530.5
45	137	50	26	38	6	536.5
46	138	51	22	36.5	4.5	541
47	139	48	25	36.5	4.5	545.5
48	140	51	23	37	5	550.5
49	141	49	28	38.5	6.5	557
50	142	45	28	36.5	4.5	561.5
51	143	52	26	39	7	568.5
52	144	52	25	38.5	6.5	575
53	145	55	28	41.5	9.5	584.5
54	146	58	29	43.5	11.5	596
55	147	58	31	44.5	12.5	608.5
56	148	48	30	39	7	615.5
57	149	42	27	34.5	2.5	618
58	150	39	23	31	-1	617
59	151	44	33	38.5	6.5	623.5
60	152	51	36	43.5	11.5	635
61	153	55	34	44.5	12.5	647.5
62	154	53	32	42.5	10.5	658
63	155	48	33	40.5	8.5	666.5
64	156	43	32	37.5	5.5	672
65	157	52	29	40.5	8.5	680.5
66	158	54	34	44	12	692.5
67	159	55	29	42	10	702.5
68	160	61	32	46.5	14.5	717
69	161	62	32	47	15	732
70	162	62	38	50	18	750
71	163	62	37	49.5	17.5	767.5
72	164	59	32	45.5	13.5	781
73	165	55	38	46.5	14.5	795.5
74	166	46	30	38	6	801.5
75	167	48	28	38	6	807.5
76	168	41	27	34	2	809.5
77	169	40	29	34.5	2.5	812
78	170	45	32	38.5	6.5	818.5
79	171	44	22	33	1	819.5
80	172	41	22	31.5	-0.5	819
81	173	43	28	35.5	3.5	822.5
82	174	45	30	37.5	5.5	828
83	175	38	23	30.5	-1.5	826.5
84	176	43	13	28	-4	822.5
85	177	44	27	35.5	3.5	826
86	178	48	23	35.5	3.5	829.5
87	179	48	31	39.5	7.5	837
88	180	54	30	42	10	847
89	181	63	31	47	15	862
90	182	61	36	48.5	16.5	878.5
91	183	52	30	41	9	887.5
92	184	57	25	41	9	896.5
93	185	41	27	34	2	898.5
94	186	39	20	29.5	-2.5	896
95	187	39	21	30	-2	894
96	188	41	20	30.5	-1.5	892.5
97	189	41	20	30.5	-1.5	891
98	190	49	23	36	4	895
99	191	59	26	42.5	10.5	905.5
100	192	57	32	44.5	12.5	918
101	193	54	32	43	11	929
102	194	42	25	33.5	1.5	930.5
103	195	41	22	31.5	-0.5	930
104	196	45	28	36.5	4.5	934.5
105	197	51	23	37	5	939.5
106	198	58	30	44	12	951.5
107	199	66	32	49	17	968.5
108	200	63	35	49	17	985.5
109	201	63	31	47	15	1000.5
110	202	60	38	49	17	1017.5
111	203	57	37	47	15	1032.5
112	204	61	30	45.5	13.5	1046
113	205	66	34	50	18	1064
114	206	72	38	55	23	1087
115	207	66	34	50	18	1105
116	208	61	34	47.5	15.5	1120.5
117	209	62	39	50.5	18.5	1139
118	210	66	37	51.5	19.5	1158.5
119	211	64	40	52	20	1178.5
120	212	57	34	45.5	13.5	1192
121	213	55	29	42	10	1202
122	214	59	33	46	14	1216
123	215	65	33	49	17	1233
124	216	69	36	52.5	20.5	1253.5
125	217	68	38	53	21	1274.5
126	218	58	40	49	17	1291.5
127	219	68	30	49	17	1308.5

128	220	75	40	57.5	25.5	1334
129	221	74	39	56.5	24.5	1358.5
130	222	72	38	55	23	1381.5
131	223	54	35	44.5	12.5	1394
132	224	62	28	45	13	1407
133	225	64	39	51.5	19.5	1426.5
134	226	63	33	48	16	1442.5
135	227	63	33	48	16	1458.5
136	228	61	32	46.5	14.5	1473
137	229	52	30	41	9	1482
138	230	60	33	46.5	14.5	1496.5
139	231	53	40	46.5	14.5	1511
140	232	64	40	52	20	1531
141	233	74	36	55	23	1554
142	234	79	38	58.5	26.5	1580.5
143	235	79	44	61.5	29.5	1610
144	236	84	49	66.5	34.5	1644.5
145	237	86	56	71	39	1683.5
146	238	85	53	69	37	1720.5
147	239	87	59	73	41	1761.5
148	240	85	55	70	38	1799.5
149	241	83	50	66.5	34.5	1834
150	242	77	50	63.5	31.5	1865.5
151	243	80	50	65	33	1898.5
152	244	77	48	62.5	30.5	1929
153	245	77	43	60	28	1957
154	246	76	41	58.5	26.5	1983.5
155	247	77	41	59	27	2010.5
156	248	79	40	59.5	27.5	2038
157	249	80	40	60	28	2066
158	250	78	49	63.5	31.5	2097.5
159	251	78	52	65	33	2130.5
160	252	78	51	64.5	32.5	2163
161	253	81	48	64.5	32.5	2195.5
162	254	83	53	68	36	2231.5
163	255	67	48	57.5	25.5	2257
164	256	64	42	53	21	2278
165	257	75	39	57	25	2303
166	258	82	42	62	30	2333
167	259	85	49	67	35	2368
168	260	90	58	74	42	2410
169	261	91	52	71.5	39.5	2449.5
170	262	87	50	68.5	36.5	2486
171	263	86	50	68	36	2522
172	264	88	52	70	38	2560
173	265	89	50	69.5	37.5	2597.5
174	266	86	57	71.5	39.5	2637
175	267	70	55	62.5	30.5	2667.5
176	268	67	51	59	27	2694.5
177	269	74	49	61.5	29.5	2724
178	270	77	54	65.5	33.5	2757.5
179	271	83	50	66.5	34.5	2792
180	272	84	51	67.5	35.5	2827.5
181	273	85	52	68.5	36.5	2864
182	274	85	48	66.5	34.5	2898.5
183	275	86	50	68	36	2934.5
184	276	86	53	69.5	37.5	2972
185	277	89	51	70	38	3010
186	278	95	52	73.5	41.5	3051.5
187	279	95	59	77	45	3096.5
188	280	92	59	75.5	43.5	3140
189	281	88	60	74	42	3182
190	282	82	55	68.5	36.5	3218.5
191	283	85	56	70.5	38.5	3257
192	284	91	52	71.5	39.5	3296.5
193	285	89	55	72	40	3336.5
194	286	91	56	73.5	41.5	3378
195	287	92	53	72.5	40.5	3418.5
196	288	88	55	71.5	39.5	3458
197	289	88	54	71	39	3497
198	290	91	51	71	39	3536
199	291	93	58	75.5	43.5	3579.5
200	292	92	63	77.5	45.5	3625
201	293	90	61	75.5	43.5	3668.5
202	294	87	60	73.5	41.5	3710
203	295	80	58	69	37	3747
204	296	80	58	69	37	3784
205	297	88	58	73	41	3825
206	298	83	60	71.5	39.5	3864.5
207	299	80	57	68.5	36.5	3901
208	300	78	58	68	36	3937
209	301	84	52	68	36	3973
210	302	91	61	76	44	4017
211	303	90	61	75.5	43.5	4060.5
212	304	82	59	70.5	38.5	4099
213	305	87	59	73	41	4140
214	306	87	60	73.5	41.5	4181.5
215	307	85	62	73.5	41.5	4223
216	308	90	62	76	44	4267
217	309	88	64	76	44	4311
218	310	90	62	76	44	4355
219	311	91	63	77	45	4400
220	312	94	61	77.5	45.5	4445.5
221	313	91	61	76	44	4489.5
222	314	87	60	73.5	41.5	4531
223	315	85	57	71	39	4570
224	316	85	58	71.5	39.5	4609.5
225	317	92	58	75	43	4652.5
226	318	91	59	75	43	4695.5
227	319	90	60	75	43	4738.5
228	320	90	60	75	43	4781.5
229	321	89	60	74.5	42.5	4824
230	322	83	56	69.5	37.5	4861.5
231	323	81	55	68	36	4897.5
232	324	85	59	72	40	4937.5
233	325	84	54	69	37	4974.5
234	326	85	53	69	37	5011.5
235	327	87	54	70.5	38.5	5050
236	328	85	55	70	38	5088

237	329	85	56	70.5	38.5	5126.5
238	330	88	56	72	40	5166.5
239	331	88	55	71.5	39.5	5206
240	332	89	57	73	41	5247
241	333	83	58	70.5	38.5	5285.5
242	334	85	55	70	38	5323.5
243	335	91	55	73	41	5364.5
244	336	91	64	77.5	45.5	5410
245	337	90	63	76.5	44.5	5454.5
246	338	89	55	72	40	5494.5
247	339	89	53	71	39	5533.5
248	340	86	53	69.5	37.5	5571
249	341	91	54	72.5	40.5	5611.5
250	342	78	58	68	36	5647.5
251	343	82	53	67.5	35.5	5683
252	344	84	54	69	37	5720
253	345	84	57	70.5	38.5	5758.5
254	346	87	48	67.5	35.5	5794
255	347	90	55	72.5	40.5	5834.5
256	348	89	56	72.5	40.5	5875
257	349	85	50	67.5	35.5	5910.5
258	350	87	49	68	36	5946.5
259	351	91	50	70.5	38.5	5985
260	352	86	46	66	34	6019
261	353	82	51	66.5	34.5	6053.5
262	354	79	51	65	33	6086.5
263	355	67	36	51.5	19.5	6106
264	356	73	34	53.5	21.5	6127.5
265	357	79	39	59	27	6154.5
266	358	63	52	57.5	25.5	6180
267	359	67	50	58.5	26.5	6206.5
268	360	74	47	60.5	28.5	6235
269	361	78	46	62	30	6265
270	362	71	51	61	29	6294
271	363	74	45	59.5	27.5	6321.5
272	364	62	45	53.5	21.5	6343
273	365	53	45	49	17	6360



84	616	length of freeze (day)	13
97	511	frost depth (^{o}F-day)	105
		average temperature	49.4

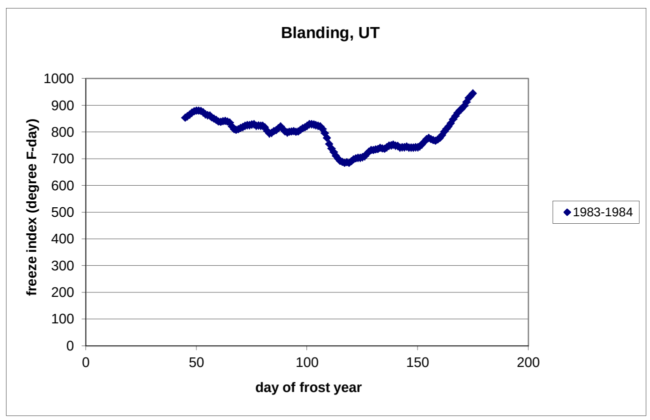
1983-1984

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	55	47	51	19	19
275	2	57	40	48.5	16.5	35.5
276	3	62	36	49	17	52.5
277	4	68	36	52	20	72.5
278	5	69	39	54	22	94.5
279	6	71	43	57	25	119.5
280	7	70	43	56.5	24.5	144
281	8	68	44	56	24	168
282	9	71	49	60	28	196
283	10	71	45	58	26	222
284	11	70	40	55	23	245
285	12	68	43	55.5	23.5	268.5
286	13	69	40	54.5	22.5	291
287	14	60	37	48.5	16.5	307.5
288	15	62	33	47.5	15.5	323
289	16	68	35	51.5	19.5	342.5
290	17	63	40	51.5	19.5	362
291	18	68	43	55.5	23.5	385.5
292	19	64	44	54	22	407.5
293	20	64	35	49.5	17.5	425
294	21	71	37	54	22	447
295	22	70	37	53.5	21.5	468.5
296	23	68	35	51.5	19.5	488
297	24	68	43	55.5	23.5	511.5
298	25	67	37	52	20	531.5
299	26	71	36	53.5	21.5	553
300	27	68	38	53	21	574
301	28	66	37	51.5	19.5	593.5
302	29	69	37	53	21	614.5
303	30	67	43	55	23	637.5
304	31	66	42	54	22	659.5
305	32	63	39	51	19	678.5
306	33	65	42	53.5	21.5	700
307	34	72	38	55	23	723
308	35	69	36	52.5	20.5	743.5
309	36	63	37	50	18	761.5
310	37	65	36	50.5	18.5	780
311	38	63	36	49.5	17.5	797.5
312	39	47	27	37	5	802.5
313	40	46	20	33	1	803.5
314	41	51	29	40	8	811.5
315	42	55	31	43	11	822.5
316	43	51	33	42	10	832.5
317	44	57	33	45	13	845.5
318	45	48	31	39.5	7.5	853
319	46	52	24	38	6	859
320	47	52	26	39	7	866
321	48	49	28	38.5	6.5	872.5
322	49	43	30	36.5	4.5	877
323	50	44	26	35	3	880
324	51	35	29	32	0	880
325	52	37	25	31	-1	879
326	53	36	17	26.5	-5.5	873.5
327	54	34	17	25.5	-6.5	867
328	55	39	16	27.5	-4.5	862.5
329	56	37	26	31.5	-0.5	862
330	57	34	16	25	-7	855
331	58	40	14	27	-5	850
332	59	40	14	27	-5	845
333	60	38	14	26	-6	839
334	61	42	20	31	-1	838
335	62	43	25	34	2	840
336	63	42	26	34	2	842
337	64	37	21	29	-3	839
338	65	37	20	28.5	-3.5	835.5
339	66	27	7	17	-15	820.5
340	67	35	8	21.5	-10.5	810

341	68	44	17	30.5	-1.5	808.5
342	69	45	23	34	2	810.5
343	70	48	25	36.5	4.5	815
344	71	48	24	36	4	819
345	72	47	26	36.5	4.5	823.5
346	73	42	27	34.5	2.5	826
347	74	40	24	32	0	826
348	75	42	27	34.5	2.5	828.5
349	76	42	24	33	1	829.5
350	77	35	16	25.5	-6.5	823
351	78	40	28	34	2	825
352	79	41	21	31	-1	824
353	80	38	25	31.5	-0.5	823.5
354	81	31	20	25.5	-6.5	817
355	82	26	13	19.5	-12.5	804.5
356	83	36	8	22	-10	794.5
357	84	39	30	34.5	2.5	797
358	85	46	30	38	6	803
359	86	40	32	36	4	807
360	87	44	33	38.5	6.5	813.5
361	88	46	32	39	7	820.5
362	89	32	15	23.5	-8.5	812
363	90	32	12	22	-10	802
364	91	38	18	28	-4	798
365	92	43	26	34.5	2.5	800.5
1	93	43	24	33.5	1.5	802
2	94	43	23	33	1	803
3	95	42	18	30	-2	801
4	96	45	21	33	1	802
5	97	52	25	38.5	6.5	808.5
6	98	50	24	37	5	813.5
7	99	48	25	36.5	4.5	818
8	100	50	25	37.5	5.5	823.5
9	101	50	26	38	6	829.5
10	102	43	20	31.5	-0.5	829
11	103	37	25	31	-1	828
12	104	40	20	30	-2	826
13	105	38	20	29	-3	823
14	106	37	24	30.5	-1.5	821.5
15	107	36	9	22.5	-9.5	812
16	108	31	0	15.5	-16.5	795.5
17	109	24	6	15	-17	778.5
18	110	22	-5	8.5	-23.5	755
19	111	28	3	15.5	-16.5	738.5
20	112	34	4	19	-13	725.5
21	113	30	5	17.5	-14.5	711
22	114	33	8	20.5	-11.5	699.5
23	115	38	11	24.5	-7.5	692
24	116	43	13	28	-4	688
25	117	41	17	29	-3	685
26	118	45	23	34	2	687
27	119	44	16	30	-2	685
28	120	54	21	37.5	5.5	690.5
29	121	55	23	39	7	697.5
30	122	49	23	36	4	701.5
31	123	47	21	34	2	703.5
32	124	44	21	32.5	0.5	704
33	125	48	21	34.5	2.5	706.5
34	126	49	21	35	3	709.5
35	127	54	27	40.5	8.5	718
36	128	54	27	40.5	8.5	726.5
37	129	51	24	37.5	5.5	732
38	130	43	23	33	1	733
39	131	47	21	34	2	735
40	132	46	20	33	1	736
41	133	46	27	36.5	4.5	740.5
42	134	38	23	30.5	-1.5	739
43	135	44	16	30	-2	737
44	136	52	25	38.5	6.5	743.5
45	137	43	32	37.5	5.5	749
46	138	46	22	34	2	751
47	139	50	18	34	2	753
48	140	36	21	28.5	-3.5	749.5
49	141	42	18	30	-2	747.5
50	142	36	18	27	-5	742.5
51	143	48	18	33	1	743.5
52	144	46	17	31.5	-0.5	743
53	145	45	25	35	3	746
54	146	43	13	28	-4	742
55	147	43	20	31.5	-0.5	741.5
56	148	41	24	32.5	0.5	742
57	149	42	25	33.5	1.5	743.5
58	150	48	16	32	0	743.5
59	151	51	19	35	3	746.5
60	152	56	24	40	8	754.5
61	153	55	26	40.5	8.5	763
62	154	58	26	42	10	773
63	155	48	26	37	5	778
64	156	33	22	27.5	-4.5	773.5
65	157	42	15	28.5	-3.5	770
66	158	46	13	29.5	-2.5	767.5
67	159	54	18	36	4	771.5
68	160	54	22	38	6	777.5
69	161	59	27	43	11	788.5
70	162	60	32	46	14	802.5
71	163	50	32	41	9	811.5
72	164	56	26	41	9	820.5
73	165	60	29	44.5	12.5	833
74	166	59	35	47	15	848
75	167	56	30	43	11	859
76	168	55	33	44	12	871
77	169	57	28	42.5	10.5	881.5
78	170	52	26	39	7	888.5
79	171	57	25	41	9	897.5
80	172	64	29	46.5	14.5	912
81	173	64	32	48	16	928
82	174	47	30	38.5	6.5	934.5
83	175	55	28	41.5	9.5	944
84	176	58	25	41.5	9.5	953.5

85	177	45	30	37.5	5.5	959
86	178	36	28	32	0	959
87	179	45	27	36	4	963
88	180	51	25	38	6	969
89	181	57	29	43	11	980
90	182	46	34	40	8	988
91	183	53	30	41.5	9.5	997.5
92	184	40	24	32	0	997.5
93	185	45	24	34.5	2.5	1000
94	186	51	25	38	6	1006
95	187	59	26	42.5	10.5	1016.5
96	188	64	31	47.5	15.5	1032
97	189	58	35	46.5	14.5	1046.5
98	190	60	30	45	13	1059.5
99	191	65	31	48	16	1075.5
100	192	47	33	40	8	1083.5
101	193	58	26	42	10	1093.5
102	194	54	32	43	11	1104.5
103	195	60	23	41.5	9.5	1114
104	196	60	35	47.5	15.5	1129.5
105	197	66	35	50.5	18.5	1148
106	198	73	34	53.5	21.5	1169.5
107	199	74	37	55.5	23.5	1193
108	200	76	40	58	26	1219
109	201	68	40	54	22	1241
110	202	59	32	45.5	13.5	1254.5
111	203	47	30	38.5	6.5	1261
112	204	53	33	43	11	1272
113	205	60	28	44	12	1284
114	206	67	33	50	18	1302
115	207	71	35	53	21	1323
116	208	60	23	41.5	9.5	1332.5
117	209	41	18	29.5	-2.5	1330
118	210	47	20	33.5	1.5	1331.5
119	211	42	27	34.5	2.5	1334
120	212	56	26	41	9	1343
121	213	62	30	46	14	1357
122	214	66	36	51	19	1376
123	215	63	42	52.5	20.5	1396.5
124	216	70	33	51.5	19.5	1416
125	217	70	45	57.5	25.5	1441.5
126	218	69	44	56.5	24.5	1466
127	219	63	40	51.5	19.5	1485.5
128	220	61	27	44	12	1497.5
129	221	71	37	54	22	1519.5
130	222	78	39	58.5	26.5	1546
131	223	82	43	62.5	30.5	1576.5
132	224	85	49	67	35	1611.5
133	225	85	48	66.5	34.5	1646
134	226	88	59	73.5	41.5	1687.5
135	227	85	55	70	38	1725.5
136	228	73	51	62	30	1755.5
137	229	75	46	60.5	28.5	1784
138	230	78	42	60	28	1812
139	231	75	49	62	30	1842
140	232	80	49	64.5	32.5	1874.5
141	233	85	48	66.5	34.5	1909
142	234	83	51	67	35	1944
143	235	86	53	69.5	37.5	1981.5
144	236	87	51	69	37	2018.5
145	237	86	51	68.5	36.5	2055
146	238	82	53	67.5	35.5	2090.5
147	239	85	46	65.5	33.5	2124
148	240	81	55	68	36	2160
149	241	88	46	67	35	2195
150	242	90	47	68.5	36.5	2231.5
151	243	90	51	70.5	38.5	2270
152	244	81	56	68.5	36.5	2306.5
153	245	76	46	61	29	2335.5
154	246	80	43	61.5	29.5	2365
155	247	79	50	64.5	32.5	2397.5
156	248	78	45	61.5	29.5	2427
157	249	59	43	51	19	2446
158	250	65	43	54	22	2468
159	251	65	48	56.5	24.5	2492.5
160	252	69	40	54.5	22.5	2515
161	253	70	35	52.5	20.5	2535.5
162	254	83	44	63.5	31.5	2567
163	255	79	43	61	29	2596
164	256	83	49	66	34	2630
165	257	86	47	66.5	34.5	2664.5
166	258	85	52	68.5	36.5	2701
167	259	81	54	67.5	35.5	2736.5
168	260	77	52	64.5	32.5	2769
169	261	83	45	64	32	2801
170	262	86	55	70.5	38.5	2839.5
171	263	86	54	70	38	2877.5
172	264	85	54	69.5	37.5	2915
173	265	85	44	64.5	32.5	2947.5
174	266	87	48	67.5	35.5	2983
175	267	92	52	72	40	3023
176	268	93	55	74	42	3065
177	269	86	59	72.5	40.5	3105.5
178	270	84	56	70	38	3143.5
179	271	88	57	72.5	40.5	3184
180	272	94	59	76.5	44.5	3228.5
181	273	93	60	76.5	44.5	3273
182	274	80	59	69.5	37.5	3310.5
183	275	88	57	72.5	40.5	3351
184	276	91	56	73.5	41.5	3392.5
185	277	90	62	76	44	3436.5
186	278	90	63	76.5	44.5	3481
187	279	92	64	78	46	3527
188	280	95	64	79.5	47.5	3574.5
189	281	96	56	76	44	3618.5
190	282	91	58	74.5	42.5	3661
191	283	89	61	75	43	3704
192	284	91	59	75	43	3747
193	285	93	59	76	44	3791

194	286	90	58	74	42	3833
195	287	85	61	73	41	3874
196	288	87	58	72.5	40.5	3914.5
197	289	88	57	72.5	40.5	3955
198	290	88	57	72.5	40.5	3995.5
199	291	91	57	74	42	4037.5
200	292	91	59	75	43	4080.5
201	293	92	57	74.5	42.5	4123
202	294	94	65	79.5	47.5	4170.5
203	295	88	56	72	40	4210.5
204	296	82	49	65.5	33.5	4244
205	297	85	58	71.5	39.5	4283.5
206	298	90	56	73	41	4324.5
207	299	87	59	73	41	4365.5
208	300	88	57	72.5	40.5	4406
209	301	88	60	74	42	4448
210	302	88	58	73	41	4489
211	303	86	58	72	40	4529
212	304	86	57	71.5	39.5	4568.5
213	305	87	56	71.5	39.5	4608
214	306	89	57	73	41	4649
215	307	88	57	72.5	40.5	4689.5
216	308	90	60	75	43	4732.5
217	309	92	61	76.5	44.5	4777
218	310	80	57	68.5	36.5	4813.5
219	311	86	55	70.5	38.5	4852
220	312	89	59	74	42	4894
221	313	90	56	73	41	4935
222	314	91	57	74	42	4977
223	315	87	58	72.5	40.5	5017.5
224	316	88	60	74	42	5059.5
225	317	90	64	77	45	5104.5
226	318	88	58	73	41	5145.5
227	319	88	60	74	42	5187.5
228	320	87	56	71.5	39.5	5227
229	321	87	60	73.5	41.5	5268.5
230	322	88	62	75	43	5311.5
231	323	88	58	73	41	5352.5
232	324	84	59	71.5	39.5	5392
233	325	79	57	68	36	5428
234	326	79	52	65.5	33.5	5461.5
235	327	85	56	70.5	38.5	5500
236	328	81	59	70	38	5538
237	329	79	55	67	35	5573
238	330	80	56	68	36	5609
239	331	84	58	71	39	5648
240	332	89	55	72	40	5688
241	333	87	54	70.5	38.5	5726.5
242	334	88	62	75	43	5769.5
243	335	91	63	77	45	5814.5
244	336	87	59	73	41	5855.5
245	337	82	56	69	37	5892.5
246	338	84	51	67.5	35.5	5928
247	339	87	50	68.5	36.5	5964.5
248	340	89	50	69.5	37.5	6002
249	341	89	52	70.5	38.5	6040.5
250	342	85	52	68.5	36.5	6077
251	343	83	48	65.5	33.5	6110.5
252	344	86	46	66	34	6144.5
253	345	88	48	68	36	6180.5
254	346	87	54	70.5	38.5	6219
255	347	77	58	67.5	35.5	6254.5
256	348	82	49	65.5	33.5	6288
257	349	84	46	65	33	6321
258	350	88	58	73	41	6362
259	351	78	58	68	36	6398
260	352	80	52	66	34	6432
261	353	82	47	64.5	32.5	6464.5
262	354	85	54	69.5	37.5	6502
263	355	85	51	68	36	6538
264	356	82	51	66.5	34.5	6572.5
265	357	78	51	64.5	32.5	6605
266	358	77	46	61.5	29.5	6634.5
267	359	77	47	62	30	6664.5
268	360	75	49	62	30	6694.5
269	361	68	35	51.5	19.5	6714
270	362	53	47	50	18	6732
271	363	69	46	57.5	25.5	6757.5
272	364	73	40	56.5	24.5	6782
273	365	72	36	54	22	6804
274	366	70	36	53	21	6825



51	880	length of freeze (day)	66
117	685	frost depth (^{o}F-day)	195
		average temperature	50.6

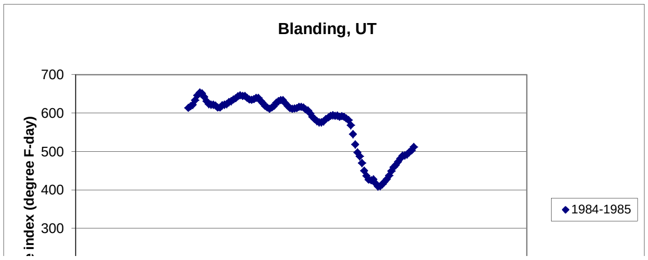
1984-1985

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	73	36	54.5	22.5	22.5
275	2	64	45	54.5	22.5	45
276	3	60	46	53	21	66
277	4	58	44	51	19	85
278	5	67	43	55	23	108
279	6	69	43	56	24	132
280	7	72	41	56.5	24.5	156.5
281	8	70	45	57.5	25.5	182
282	9	70	43	56.5	24.5	206.5
283	10	71	47	59	27	233.5
284	11	69	42	55.5	23.5	257
285	12	58	40	49	17	274
286	13	65	30	47.5	15.5	289.5
287	14	51	35	43	11	300.5
288	15	40	28	34	2	302.5
289	16	42	25	33.5	1.5	304
290	17	52	30	41	9	313
291	18	48	26	37	5	318
292	19	46	25	35.5	3.5	321.5
293	20	50	28	39	7	328.5
294	21	43	30	36.5	4.5	333
295	22	49	27	38	6	339
296	23	46	28	37	5	344

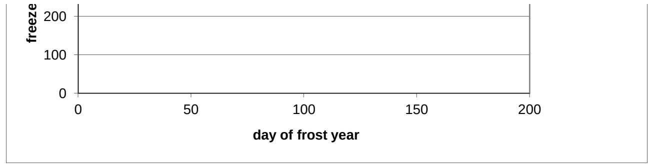
297	24	49	23	36	4	348
298	25	53	26	39.5	7.5	355.5
299	26	53	28	40.5	8.5	364
300	27	56	35	45.5	13.5	377.5
301	28	55	28	41.5	9.5	387
302	29	60	31	45.5	13.5	400.5
303	30	59	35	47	15	415.5
304	31	59	32	45.5	13.5	429
305	32	62	28	45	13	442
306	33	60	31	45.5	13.5	455.5
307	34	64	30	47	15	470.5
308	35	60	28	44	12	482.5
309	36	59	29	44	12	494.5
310	37	61	35	48	16	510.5
311	38	54	28	41	9	519.5
312	39	54	33	43.5	11.5	531
313	40	44	29	36.5	4.5	535.5
314	41	43	18	30.5	-1.5	534
315	42	56	25	40.5	8.5	542.5
316	43	61	29	45	13	555.5
317	44	58	34	46	14	569.5
318	45	52	28	40	8	577.5
319	46	53	28	40.5	8.5	586
320	47	52	30	41	9	595
321	48	53	31	42	10	605
322	49	49	24	36.5	4.5	609.5
323	50	51	22	36.5	4.5	614
324	51	50	22	36	4	618
325	52	49	24	36.5	4.5	622.5
326	53	56	31	43.5	11.5	634
327	54	57	32	44.5	12.5	646.5
328	55	49	30	39.5	7.5	654
329	56	35	24	29.5	-2.5	651.5
330	57	30	16	23	-9	642.5
331	58	34	8	21	-11	631.5
332	59	34	15	24.5	-7.5	624
333	60	43	18	30.5	-1.5	622.5
334	61	42	22	32	0	622.5
335	62	41	17	29	-3	619.5
336	63	39	16	27.5	-4.5	615
337	64	41	23	32	0	615
338	65	50	25	37.5	5.5	620.5
339	66	47	21	34	2	622.5
340	67	46	21	33.5	1.5	624
341	68	50	24	37	5	629
342	69	40	29	34.5	2.5	631.5
343	70	48	24	36	4	635.5
344	71	43	27	35	3	638.5
345	72	40	34	37	5	643.5
346	73	39	30	34.5	2.5	646
347	74	34	28	31	-1	645
348	75	38	26	32	0	645
349	76	30	24	27	-5	640
350	77	31	24	27.5	-4.5	635.5
351	78	40	23	31.5	-0.5	635
352	79	44	23	33.5	1.5	636.5
353	80	44	27	35.5	3.5	640
354	81	38	25	31.5	-0.5	639.5
355	82	37	12	24.5	-7.5	632
356	83	37	15	26	-6	626
357	84	36	13	24.5	-7.5	618.5
358	85	42	14	28	-4	614.5
359	86	39	19	29	-3	611.5
360	87	46	24	35	3	614.5
361	88	39	34	36.5	4.5	619
362	89	46	34	40	8	627
363	90	42	30	36	4	631
364	91	43	27	35	3	634
365	92	39	24	31.5	-0.5	633.5
1	93	33	15	24	-8	625.5
2	94	38	13	25.5	-6.5	619
3	95	38	14	26	-6	613
4	96	42	18	30	-2	611
5	97	43	23	33	1	612
6	98	43	23	33	1	613
7	99	40	30	35	3	616
8	100	35	29	32	0	616
9	101	40	22	31	-1	615
10	102	39	15	27	-5	610
11	103	36	22	29	-3	607
12	104	33	16	24.5	-7.5	599.5
13	105	38	8	23	-9	590.5
14	106	39	13	26	-6	584.5
15	107	38	16	27	-5	579.5
16	108	41	16	28.5	-3.5	576
17	109	46	18	32	0	576
18	110	50	19	34.5	2.5	578.5
19	111	52	24	38	6	584.5
20	112	48	24	36	4	588.5
21	113	46	27	36.5	4.5	593
22	114	42	25	33.5	1.5	594.5
23	115	39	22	30.5	-1.5	593
24	116	37	29	33	1	594
25	117	36	21	28.5	-3.5	590.5
26	118	41	26	33.5	1.5	592
27	119	40	21	30.5	-1.5	590.5
28	120	35	21	28	-4	586.5
29	121	37	18	27.5	-4.5	582
30	122	27	10	18.5	-13.5	568.5
31	123	20	-2	9	-23	545.5
32	124	18	-8	5	-27	518.5
33	125	24	-1	11.5	-20.5	498
34	126	29	14	21.5	-10.5	487.5
35	127	27	3	15	-17	470.5
36	128	28	-5	11.5	-20.5	450
37	129	34	3	18.5	-13.5	436.5
38	130	37	8	22.5	-9.5	427
39	131	43	18	30.5	-1.5	425.5
40	132	40	28	34	2	427.5

41	133	30	13	21.5	-10.5	417
42	134	39	10	24.5	-7.5	409.5
43	135	47	19	33	1	410.5
44	136	50	23	36.5	4.5	415
45	137	53	25	39	7	422
46	138	52	25	38.5	6.5	428.5
47	139	55	28	41.5	9.5	438
48	140	56	30	43	11	449
49	141	54	31	42.5	10.5	459.5
50	142	50	26	38	6	465.5
51	143	47	33	40	8	473.5
52	144	49	32	40.5	8.5	482
53	145	50	29	39.5	7.5	489.5
54	146	46	20	33	1	490.5
55	147	48	20	34	2	492.5
56	148	52	25	38.5	6.5	499
57	149	51	21	36	4	503
58	150	56	26	41	9	512
59	151	57	26	41.5	9.5	521.5
60	152	54	26	40	8	529.5
61	153	54	29	41.5	9.5	539
62	154	35	18	26.5	-5.5	533.5
63	155	36	11	23.5	-8.5	525
64	156	49	20	34.5	2.5	527.5
65	157	57	36	46.5	14.5	542
66	158	57	25	41	9	551
67	159	59	27	43	11	562
68	160	56	39	47.5	15.5	577.5
69	161	50	43	46.5	14.5	592
70	162	51	39	45	13	605
71	163	47	30	38.5	6.5	611.5
72	164	53	26	39.5	7.5	619
73	165	56	31	43.5	11.5	630.5
74	166	53	34	43.5	11.5	642
75	167	48	32	40	8	650
76	168	56	30	43	11	661
77	169	59	30	44.5	12.5	673.5
78	170	49	32	40.5	8.5	682
79	171	61	31	46	14	696
80	172	56	29	42.5	10.5	706.5
81	173	43	24	33.5	1.5	708
82	174	56	20	38	6	714
83	175	63	29	46	14	728
84	176	65	32	48.5	16.5	744.5
85	177	53	34	43.5	11.5	756
86	178	55	27	41	9	765
87	179	43	27	35	3	768
88	180	33	25	29	-3	765
89	181	40	20	30	-2	763
90	182	48	21	34.5	2.5	765.5
91	183	61	28	44.5	12.5	778
92	184	68	31	49.5	17.5	795.5
93	185	69	37	53	21	816.5
94	186	64	38	51	19	835.5
95	187	65	34	49.5	17.5	853
96	188	67	42	54.5	22.5	875.5
97	189	71	42	56.5	24.5	900
98	190	74	40	57	25	925
99	191	74	45	59.5	27.5	952.5
100	192	74	41	57.5	25.5	978
101	193	73	41	57	25	1003
102	194	72	41	56.5	24.5	1027.5
103	195	74	39	56.5	24.5	1052
104	196	76	39	57.5	25.5	1077.5
105	197	77	40	58.5	26.5	1104
106	198	73	41	57	25	1129
107	199	70	45	57.5	25.5	1154.5
108	200	58	33	45.5	13.5	1168
109	201	54	30	42	10	1178
110	202	57	36	46.5	14.5	1192.5
111	203	49	35	42	10	1202.5
112	204	50	33	41.5	9.5	1212
113	205	58	26	42	10	1222
114	206	64	33	48.5	16.5	1238.5
115	207	60	35	47.5	15.5	1254
116	208	48	29	38.5	6.5	1260.5
117	209	65	31	48	16	1276.5
118	210	58	42	50	18	1294.5
119	211	73	41	57	25	1319.5
120	212	80	43	61.5	29.5	1349
121	213	78	48	63	31	1380
122	214	76	43	59.5	27.5	1407.5
123	215	75	49	62	30	1437.5
124	216	72	54	63	31	1468.5
125	217	74	44	59	27	1495.5
126	218	75	45	60	28	1523.5
127	219	75	45	60	28	1551.5
128	220	74	41	57.5	25.5	1577
129	221	69	45	57	25	1602
130	222	64	40	52	20	1622
131	223	64	35	49.5	17.5	1639.5
132	224	50	37	43.5	11.5	1651
133	225	57	30	43.5	11.5	1662.5
134	226	67	31	49	17	1679.5
135	227	77	38	57.5	25.5	1705
136	228	72	45	58.5	26.5	1731.5
137	229	76	45	60.5	28.5	1760
138	230	73	41	57	25	1785
139	231	67	42	54.5	22.5	1807.5
140	232	70	41	55.5	23.5	1831
141	233	65	46	55.5	23.5	1854.5
142	234	71	39	55	23	1877.5
143	235	77	46	61.5	29.5	1907
144	236	81	47	64	32	1939
145	237	80	48	64	32	1971
146	238	79	46	62.5	30.5	2001.5
147	239	79	45	62	30	2031.5
148	240	81	43	62	30	2061.5
149	241	78	45	61.5	29.5	2091

150	242	74	45	59.5	27.5	2118.5
151	243	70	45	57.5	25.5	2144
152	244	73	41	57	25	2169
153	245	77	38	57.5	25.5	2194.5
154	246	75	42	58.5	26.5	2221
155	247	80	47	63.5	31.5	2252.5
156	248	81	44	62.5	30.5	2283
157	249	90	51	70.5	38.5	2321.5
158	250	95	55	75	43	2364.5
159	251	93	58	75.5	43.5	2408
160	252	93	56	74.5	42.5	2450.5
161	253	87	55	71	39	2489.5
162	254	84	51	67.5	35.5	2525
163	255	90	52	71	39	2564
164	256	90	55	72.5	40.5	2604.5
165	257	91	59	75	43	2647.5
166	258	93	60	76.5	44.5	2692
167	259	91	59	75	43	2735
168	260	89	58	73.5	41.5	2776.5
169	261	91	52	71.5	39.5	2816
170	262	91	55	73	41	2857
171	263	91	57	74	42	2899
172	264	89	52	70.5	38.5	2937.5
173	265	91	55	73	41	2978.5
174	266	93	53	73	41	3019.5
175	267	86	57	71.5	39.5	3059
176	268	79	45	62	30	3089
177	269	69	33	51	19	3108
178	270	83	42	62.5	30.5	3138.5
179	271	88	48	68	36	3174.5
180	272	88	51	69.5	37.5	3212
181	273	89	49	69	37	3249
182	274	90	49	69.5	37.5	3286.5
183	275	93	59	76	44	3330.5
184	276	93	54	73.5	41.5	3372
185	277	98	58	78	46	3418
186	278	98	58	78	46	3464
187	279	100	62	81	49	3513
188	280	100	64	82	50	3563
189	281	95	63	79	47	3610
190	282	96	61	78.5	46.5	3656.5
191	283	93	57	75	43	3699.5
192	284	95	59	77	45	3744.5
193	285	93	61	77	45	3789.5
194	286	92	58	75	43	3832.5
195	287	90	57	73.5	41.5	3874
196	288	93	61	77	45	3919
197	289	93	58	75.5	43.5	3962.5
198	290	89	62	75.5	43.5	4006
199	291	91	58	74.5	42.5	4048.5
200	292	84	57	70.5	38.5	4087
201	293	84	58	71	39	4126
202	294	85	55	70	38	4164
203	295	75	55	65	33	4197
204	296	81	56	68.5	36.5	4233.5
205	297	79	54	66.5	34.5	4268
206	298	86	59	72.5	40.5	4308.5
207	299	85	57	71	39	4347.5
208	300	88	57	72.5	40.5	4388
209	301	78	59	68.5	36.5	4424.5
210	302	86	57	71.5	39.5	4464
211	303	78	55	66.5	34.5	4498.5
212	304	85	54	69.5	37.5	4536
213	305	84	60	72	40	4576
214	306	83	61	72	40	4616
215	307	86	56	71	39	4655
216	308	87	55	71	39	4694
217	309	91	56	73.5	41.5	4735.5
218	310	93	58	75.5	43.5	4779
219	311	91	54	72.5	40.5	4819.5
220	312	88	58	73	41	4860.5
221	313	90	56	73	41	4901.5
222	314	90	58	74	42	4943.5
223	315	85	57	71	39	4982.5
224	316	86	50	68	36	5018.5
225	317	87	47	67	35	5053.5
226	318	88	53	70.5	38.5	5092
227	319	89	52	70.5	38.5	5130.5
228	320	89	47	68	36	5166.5
229	321	89	51	70	38	5204.5
230	322	87	52	69.5	37.5	5242
231	323	88	55	71.5	39.5	5281.5
232	324	85	54	69.5	37.5	5319
233	325	86	53	69.5	37.5	5356.5
234	326	90	55	72.5	40.5	5397
235	327	94	57	75.5	43.5	5440.5
236	328	94	56	75	43	5483.5
237	329	93	53	73	41	5524.5
238	330	93	56	74.5	42.5	5567
239	331	88	64	76	44	5611
240	332	90	60	75	43	5654
241	333	93	58	75.5	43.5	5697.5
242	334	92	58	75	43	5740.5
243	335	90	60	75	43	5783.5
244	336	89	63	76	44	5827.5
245	337	82	57	69.5	37.5	5865
246	338	79	55	67	35	5900
247	339	78	52	65	33	5933
248	340	76	44	60	28	5961
249	341	77	42	59.5	27.5	5988.5
250	342	67	48	57.5	25.5	6014
251	343	77	45	61	29	6043
252	344	76	44	60	28	6071
253	345	68	46	57	25	6096
254	346	64	39	51.5	19.5	6115.5
255	347	68	33	50.5	18.5	6134
256	348	74	40	57	25	6159
257	349	80	49	64.5	32.5	6191.5
258	350	76	50	63	31	6222.5



259	351	78	48	63	31	6253.5
260	352	78	46	62	30	6283.5
261	353	63	50	56.5	24.5	6308
262	354	64	43	53.5	21.5	6329.5
263	355	62	45	53.5	21.5	6351
264	356	64	45	54.5	22.5	6373.5
265	357	65	46	55.5	23.5	6397
266	358	69	33	51	19	6416
267	359	75	38	56.5	24.5	6440.5
268	360	66	46	56	24	6464.5
269	361	73	40	56.5	24.5	6489
270	362	72	41	56.5	24.5	6513.5
271	363	65	44	54.5	22.5	6536
272	364	60	32	46	14	6550
273	365	65	30	47.5	15.5	6565.5



92	633.5	length of freeze (day)	43
135	410.5	frost depth (^oF-day)	223
		average temperature	50.0

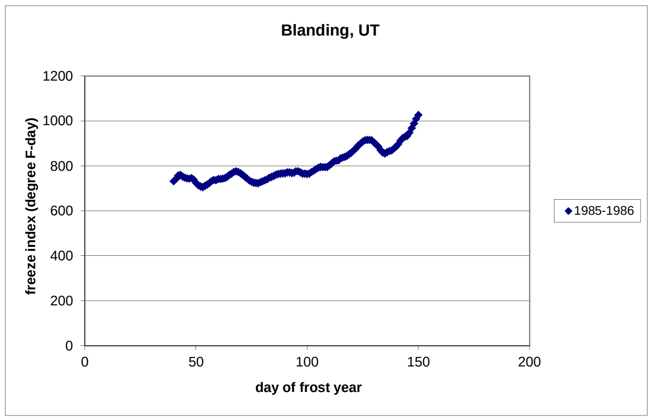
1985-1986

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	69	36	52.5	20.5	20.5
275	2	70	40	55	23	43.5
276	3	74	41	57.5	25.5	69
277	4	74	41	57.5	25.5	94.5
278	5	74	42	58	26	120.5
279	6	73	40	56.5	24.5	145
280	7	62	45	53.5	21.5	166.5
281	8	57	39	48	16	182.5
282	9	63	41	52	20	202.5
283	10	60	43	51.5	19.5	222
284	11	58	40	49	17	239
285	12	60	35	47.5	15.5	254.5
286	13	54	36	45	13	267.5
287	14	56	30	43	11	278.5
288	15	61	29	45	13	291.5
289	16	65	35	50	18	309.5
290	17	64	40	52	20	329.5
291	18	64	36	50	18	347.5
292	19	65	38	51.5	19.5	367
293	20	66	38	52	20	387
294	21	64	41	52.5	20.5	407.5
295	22	57	38	47.5	15.5	423
296	23	64	33	48.5	16.5	439.5
297	24	68	35	51.5	19.5	459
298	25	68	41	54.5	22.5	481.5
299	26	70	41	55.5	23.5	505
300	27	71	41	56	24	529
301	28	68	44	56	24	553
302	29	65	41	53	21	574
303	30	64	39	51.5	19.5	593.5
304	31	55	36	45.5	13.5	607
305	32	58	30	44	12	619
306	33	60	30	45	13	632
307	34	65	34	49.5	17.5	649.5
308	35	65	35	50	18	667.5
309	36	60	39	49.5	17.5	685
310	37	54	32	43	11	696
311	38	55	28	41.5	9.5	705.5
312	39	62	34	48	16	721.5
313	40	56	28	42	10	731.5
314	41	56	28	42	10	741.5
315	42	54	41	47.5	15.5	757
316	43	46	26	36	4	761
317	44	35	13	24	-8	753
318	45	36	16	26	-6	747
319	46	43	17	30	-2	745
320	47	42	20	31	-1	744
321	48	39	30	34.5	2.5	746.5
322	49	34	16	25	-7	739.5
323	50	29	5	17	-15	724.5
324	51	34	10	22	-10	714.5
325	52	36	17	26.5	-5.5	709
326	53	44	16	30	-2	707
327	54	48	25	36.5	4.5	711.5
328	55	45	31	38	6	717.5
329	56	42	36	39	7	724.5
330	57	49	31	40	8	732.5
331	58	45	28	36.5	4.5	737
332	59	36	26	31	-1	736
333	60	43	32	37.5	5.5	741.5
334	61	37	28	32.5	0.5	742
335	62	40	26	33	1	743
336	63	40	30	35	3	746
337	64	46	31	38.5	6.5	752.5
338	65	52	28	40	8	760.5
339	66	47	28	37.5	5.5	766
340	67	48	30	39	7	773
341	68	45	25	35	3	776
342	69	37	23	30	-2	774
343	70	35	16	25.5	-6.5	767.5
344	71	32	18	25	-7	760.5
345	72	31	16	23.5	-8.5	752
346	73	34	13	23.5	-8.5	743.5
347	74	35	11	23	-9	734.5
348	75	38	16	27	-5	729.5
349	76	40	17	28.5	-3.5	726
350	77	45	17	31	-1	725
351	78	44	18	31	-1	724
352	79	48	23	35.5	3.5	727.5
353	80	52	22	37	5	732.5
354	81	50	21	35.5	3.5	736
355	82	50	22	36	4	740
356	83	56	23	39.5	7.5	747.5
357	84	50	22	36	4	751.5
358	85	50	23	36.5	4.5	756
359	86	53	24	38.5	6.5	762.5
360	87	47	21	34	2	764.5
361	88	47	19	33	1	765.5
362	89	48	21	34.5	2.5	768

363	90	44	20	32	0	768
364	91	44	28	36	4	772
365	92	41	24	32.5	0.5	772.5
1	93	36	21	28.5	-3.5	769
2	94	45	21	33	1	770
3	95	48	29	38.5	6.5	776.5
4	96	42	20	31	-1	775.5
5	97	38	19	28.5	-3.5	772
6	98	34	18	26	-6	766
7	99	43	21	32	0	766
8	100	44	17	30.5	-1.5	764.5
9	101	50	17	33.5	1.5	766
10	102	51	29	40	8	774
11	103	52	23	37.5	5.5	779.5
12	104	53	23	38	6	785.5
13	105	51	25	38	6	791.5
14	106	50	23	36.5	4.5	796
15	107	36	24	30	-2	794
16	108	41	23	32	0	794
17	109	45	23	34	2	796
18	110	52	27	39.5	7.5	803.5
19	111	54	26	40	8	811.5
20	112	55	28	41.5	9.5	821
21	113	46	23	34.5	2.5	823.5
22	114	46	21	33.5	1.5	825
23	115	52	29	40.5	8.5	833.5
24	116	47	25	36	4	837.5
25	117	50	19	34.5	2.5	840
26	118	54	22	38	6	846
27	119	54	23	38.5	6.5	852.5
28	120	55	24	39.5	7.5	860
29	121	58	26	42	10	870
30	122	52	31	41.5	9.5	879.5
31	123	52	35	43.5	11.5	891
32	124	54	29	41.5	9.5	900.5
33	125	53	28	40.5	8.5	909
34	126	49	25	37	5	914
35	127	46	22	34	2	916
36	128	44	20	32	0	916
37	129	37	24	30.5	-1.5	914.5
38	130	32	12	22	-10	904.5
39	131	32	15	23.5	-8.5	896
40	132	34	10	22	-10	886
41	133	30	3	16.5	-15.5	870.5
42	134	37	8	22.5	-9.5	861
43	135	38	17	27.5	-4.5	856.5
44	136	45	30	37.5	5.5	862
45	137	42	29	35.5	3.5	865.5
46	138	40	32	36	4	869.5
47	139	48	32	40	8	877.5
48	140	48	33	40.5	8.5	886
49	141	55	32	43.5	11.5	897.5
50	142	56	39	47.5	15.5	913
51	143	52	35	43.5	11.5	924.5
52	144	49	26	37.5	5.5	930
53	145	50	24	37	5	935
54	146	62	30	46	14	949
55	147	70	34	52	20	969
56	148	69	35	52	20	989
57	149	68	37	52.5	20.5	1009.5
58	150	64	36	50	18	1027.5
59	151	62	33	47.5	15.5	1043
60	152	66	29	47.5	15.5	1058.5
61	153	65	35	50	18	1076.5
62	154	66	37	51.5	19.5	1096
63	155	64	33	48.5	16.5	1112.5
64	156	67	31	49	17	1129.5
65	157	67	34	50.5	18.5	1148
66	158	64	37	50.5	18.5	1166.5
67	159	59	34	46.5	14.5	1181
68	160	49	32	40.5	8.5	1189.5
69	161	38	32	35	3	1192.5
70	162	41	23	32	0	1192.5
71	163	48	26	37	5	1197.5
72	164	48	27	37.5	5.5	1203
73	165	42	30	36	4	1207
74	166	47	26	36.5	4.5	1211.5
75	167	48	30	39	7	1218.5
76	168	35	30	32.5	0.5	1219
77	169	45	24	34.5	2.5	1221.5
78	170	52	22	37	5	1226.5
79	171	58	29	43.5	11.5	1238
80	172	61	30	45.5	13.5	1251.5
81	173	64	30	47	15	1266.5
82	174	66	33	49.5	17.5	1284
83	175	61	34	47.5	15.5	1299.5
84	176	68	35	51.5	19.5	1319
85	177	70	33	51.5	19.5	1338.5
86	178	73	37	55	23	1361.5
87	179	74	40	57	25	1386.5
88	180	70	40	55	23	1409.5
89	181	70	38	54	22	1431.5
90	182	67	40	53.5	21.5	1453
91	183	52	42	47	15	1468
92	184	45	31	38	6	1474
93	185	45	30	37.5	5.5	1479.5
94	186	49	24	36.5	4.5	1484
95	187	62	35	48.5	16.5	1500.5
96	188	68	36	52	20	1520.5
97	189	63	39	51	19	1539.5
98	190	62	34	48	16	1555.5
99	191	62	33	47.5	15.5	1571
100	192	63	31	47	15	1586
101	193	64	40	52	20	1606
102	194	63	36	49.5	17.5	1623.5
103	195	49	33	41	9	1632.5
104	196	58	23	40.5	8.5	1641
105	197	66	36	51	19	1660
106	198	66	46	56	24	1684

107	199	55	33	44	12	1696
108	200	51	25	38	6	1702
109	201	59	30	44.5	12.5	1714.5
110	202	72	33	52.5	20.5	1735
111	203	79	47	63	31	1766
112	204	76	45	60.5	28.5	1794.5
113	205	65	42	53.5	21.5	1816
114	206	70	38	54	22	1838
115	207	65	37	51	19	1857
116	208	47	32	39.5	7.5	1864.5
117	209	59	25	42	10	1874.5
118	210	74	34	54	22	1896.5
119	211	75	38	56.5	24.5	1921
120	212	75	41	58	26	1947
121	213	75	41	58	26	1973
122	214	81	48	64.5	32.5	2005.5
123	215	78	44	61	29	2034.5
124	216	73	40	56.5	24.5	2059
125	217	63	30	46.5	14.5	2073.5
126	218	62	40	51	19	2092.5
127	219	46	32	39	7	2099.5
128	220	51	31	41	9	2108.5
129	221	55	34	44.5	12.5	2121
130	222	68	31	49.5	17.5	2138.5
131	223	72	38	55	23	2161.5
132	224	74	40	57	25	2186.5
133	225	74	40	57	25	2211.5
134	226	73	43	58	26	2237.5
135	227	70	42	56	24	2261.5
136	228	61	34	47.5	15.5	2277
137	229	67	35	51	19	2296
138	230	76	39	57.5	25.5	2321.5
139	231	82	43	62.5	30.5	2352
140	232	82	48	65	33	2385
141	233	76	45	60.5	28.5	2413.5
142	234	74	42	58	26	2439.5
143	235	77	44	60.5	28.5	2468
144	236	81	47	64	32	2500
145	237	84	54	69	37	2537
146	238	82	56	69	37	2574
147	239	83	50	66.5	34.5	2608.5
148	240	80	49	64.5	32.5	2641
149	241	75	54	64.5	32.5	2673.5
150	242	76	49	62.5	30.5	2704
151	243	78	48	63	31	2735
152	244	77	47	62	30	2765
153	245	73	49	61	29	2794
154	246	83	52	67.5	35.5	2829.5
155	247	87	53	70	38	2867.5
156	248	85	56	70.5	38.5	2906
157	249	84	49	66.5	34.5	2940.5
158	250	83	49	66	34	2974.5
159	251	81	48	64.5	32.5	3007
160	252	65	48	56.5	24.5	3031.5
161	253	73	44	58.5	26.5	3058
162	254	85	49	67	35	3093
163	255	87	49	68	36	3129
164	256	87	52	69.5	37.5	3166.5
165	257	89	51	70	38	3204.5
166	258	90	51	70.5	38.5	3243
167	259	92	52	72	40	3283
168	260	92	57	74.5	42.5	3325.5
169	261	88	58	73	41	3366.5
170	262	89	57	73	41	3407.5
171	263	88	55	71.5	39.5	3447
172	264	88	52	70	38	3485
173	265	93	57	75	43	3528
174	266	91	59	75	43	3571
175	267	77	56	66.5	34.5	3605.5
176	268	72	55	63.5	31.5	3637
177	269	87	52	69.5	37.5	3674.5
178	270	91	58	74.5	42.5	3717
179	271	91	60	75.5	43.5	3760.5
180	272	89	62	75.5	43.5	3804
181	273	86	64	75	43	3847
182	274	91	60	75.5	43.5	3890.5
183	275	92	60	76	44	3934.5
184	276	89	60	74.5	42.5	3977
185	277	82	63	72.5	40.5	4017.5
186	278	82	55	68.5	36.5	4054
187	279	85	52	68.5	36.5	4090.5
188	280	81	58	69.5	37.5	4128
189	281	84	59	71.5	39.5	4167.5
190	282	86	55	70.5	38.5	4206
191	283	89	55	72	40	4246
192	284	92	57	74.5	42.5	4288.5
193	285	93	57	75	43	4331.5
194	286	95	62	78.5	46.5	4378
195	287	94	62	78	46	4424
196	288	81	59	70	38	4462
197	289	76	54	65	33	4495
198	290	84	53	68.5	36.5	4531.5
199	291	90	59	74.5	42.5	4574
200	292	84	57	70.5	38.5	4612.5
201	293	81	53	67	35	4647.5
202	294	80	53	66.5	34.5	4682
203	295	74	55	64.5	32.5	4714.5
204	296	69	52	60.5	28.5	4743
205	297	80	49	64.5	32.5	4775.5
206	298	84	52	68	36	4811.5
207	299	85	57	71	39	4850.5
208	300	85	49	67	35	4885.5
209	301	88	52	70	38	4923.5
210	302	89	55	72	40	4963.5
211	303	91	56	73.5	41.5	5005
212	304	95	58	76.5	44.5	5049.5
213	305	95	59	77	45	5094.5
214	306	94	64	79	47	5141.5
215	307	92	60	76	44	5185.5

216	308	92	59	75.5	43.5	5229
217	309	87	60	73.5	41.5	5270.5
218	310	85	59	72	40	5310.5
219	311	92	57	74.5	42.5	5353
220	312	90	65	77.5	45.5	5398.5
221	313	89	59	74	42	5440.5
222	314	87	57	72	40	5480.5
223	315	88	59	73.5	41.5	5522
224	316	88	59	73.5	41.5	5563.5
225	317	83	53	68	36	5599.5
226	318	81	53	67	35	5634.5
227	319	88	53	70.5	38.5	5673
228	320	93	60	76.5	44.5	5717.5
229	321	95	60	77.5	45.5	5763
230	322	95	64	79.5	47.5	5810.5
231	323	90	60	75	43	5853.5
232	324	89	61	75	43	5896.5
233	325	89	59	74	42	5938.5
234	326	90	57	73.5	41.5	5980
235	327	82	61	71.5	39.5	6019.5
236	328	78	58	68	36	6055.5
237	329	80	55	67.5	35.5	6091
238	330	86	54	70	38	6129
239	331	90	55	72.5	40.5	6169.5
240	332	70	56	63	31	6200.5
241	333	72	55	63.5	31.5	6232
242	334	77	51	64	32	6264
243	335	81	52	66.5	34.5	6298.5
244	336	77	48	62.5	30.5	6329
245	337	78	48	63	31	6360
246	338	81	47	64	32	6392
247	339	84	50	67	35	6427
248	340	86	50	68	36	6463
249	341	87	53	70	38	6501
250	342	83	54	68.5	36.5	6537.5
251	343	67	52	59.5	27.5	6565
252	344	70	50	60	28	6593
253	345	68	45	56.5	24.5	6617.5
254	346	72	39	55.5	23.5	6641
255	347	73	44	58.5	26.5	6667.5
256	348	74	50	62	30	6697.5
257	349	76	44	60	28	6725.5
258	350	78	44	61	29	6754.5
259	351	77	44	60.5	28.5	6783
260	352	74	42	58	26	6809
261	353	73	45	59	27	6836
262	354	74	42	58	26	6862
263	355	72	54	63	31	6893
264	356	73	52	62.5	30.5	6923.5
265	357	62	50	56	24	6947.5
266	358	59	48	53.5	21.5	6969
267	359	51	40	45.5	13.5	6982.5
268	360	52	40	46	14	6996.5
269	361	60	34	47	15	7011.5
270	362	64	35	49.5	17.5	7029
271	363	60	44	52	20	7049
272	364	58	38	48	16	7065
273	365	62	33	47.5	15.5	7080.5



128	916	length of freeze (day)	7
135	856.5	frost depth (°F-day)	59.5
		average temperature	51.4

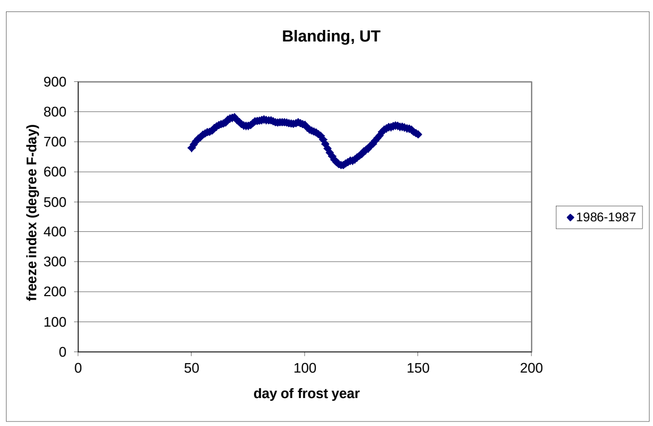
1986-1987

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (°F)	cumulative degree day (°F)
274	1	67	37	52	20	20
275	2	58	46	52	20	40
276	3	55	36	45.5	13.5	53.5
277	4	64	32	48	16	69.5
278	5	70	41	55.5	23.5	93
279	6	64	43	53.5	21.5	114.5
280	7	68	39	53.5	21.5	136
281	8	70	41	55.5	23.5	159.5
282	9	72	40	56	24	183.5
283	10	57	44	50.5	18.5	202
284	11	47	33	40	8	210
285	12	42	29	35.5	3.5	213.5
286	13	54	22	38	6	219.5
287	14	59	29	44	12	231.5
288	15	64	31	47.5	15.5	247
289	16	67	40	53.5	21.5	268.5
290	17	68	38	53	21	289.5
291	18	67	40	53.5	21.5	311
292	19	61	45	53	21	332
293	20	58	33	45.5	13.5	345.5
294	21	56	34	45	13	358.5
295	22	61	31	46	14	372.5
296	23	64	34	49	17	389.5
297	24	67	34	50.5	18.5	408
298	25	64	39	51.5	19.5	427.5
299	26	70	38	54	22	449.5
300	27	63	36	49.5	17.5	467
301	28	67	35	51	19	486
302	29	69	40	54.5	22.5	508.5
303	30	64	37	50.5	18.5	527
304	31	53	35	44	12	539
305	32	45	35	40	8	547
306	33	51	38	44.5	12.5	559.5
307	34	58	35	46.5	14.5	574
308	35	55	30	42.5	10.5	584.5
309	36	55	30	42.5	10.5	595
310	37	50	29	39.5	7.5	602.5
311	38	38	21	29.5	-2.5	600
312	39	40	18	29	-3	597
313	40	41	15	28	-4	593
314	41	46	20	33	1	594
315	42	51	21	36	4	598
316	43	55	26	40.5	8.5	606.5
317	44	52	25	38.5	6.5	613
318	45	54	28	41	9	622
319	46	55	28	41.5	9.5	631.5

320	47	55	28	41.5	9.5	641
321	48	56	30	43	11	652
322	49	53	35	44	12	664
323	50	56	40	48	16	680
324	51	55	32	43.5	11.5	691.5
325	52	53	33	43	11	702.5
326	53	49	33	41	9	711.5
327	54	46	27	36.5	4.5	716
328	55	55	24	39.5	7.5	723.5
329	56	48	25	36.5	4.5	728
330	57	45	27	36	4	732
331	58	45	23	34	2	734
332	59	49	23	36	4	738
333	60	50	30	40	8	746
334	61	48	28	38	6	752
335	62	52	19	35.5	3.5	755.5
336	63	49	22	35.5	3.5	759
337	64	48	21	34.5	2.5	761.5
338	65	46	23	34.5	2.5	764
339	66	52	32	42	10	774
340	67	40	32	36	4	778
341	68	41	28	34.5	2.5	780.5
342	69	44	25	34.5	2.5	783
343	70	32	14	23	-9	774
344	71	38	12	25	-7	767
345	72	38	11	24.5	-7.5	759.5
346	73	41	14	27.5	-4.5	755
347	74	44	17	30.5	-1.5	753.5
348	75	44	21	32.5	0.5	754
349	76	45	23	34	2	756
350	77	50	26	38	6	762
351	78	50	28	39	7	769
352	79	36	30	33	1	770
353	80	40	26	33	1	771
354	81	42	26	34	2	773
355	82	44	24	34	2	775
356	83	40	20	30	-2	773
357	84	40	21	30.5	-1.5	771.5
358	85	44	20	32	0	771.5
359	86	43	16	29.5	-2.5	769
360	87	41	15	28	-4	765
361	88	41	22	31.5	-0.5	764.5
362	89	47	18	32.5	0.5	765
363	90	45	20	32.5	0.5	765.5
364	91	45	20	32.5	0.5	766
365	92	43	17	30	-2	764
1	93	42	18	30	-2	762
2	94	41	22	31.5	-0.5	761.5
3	95	40	21	30.5	-1.5	760
4	96	45	23	34	2	762
5	97	40	30	35	3	765
6	98	38	20	29	-3	762
7	99	33	26	29.5	-2.5	759.5
8	100	40	19	29.5	-2.5	757
9	101	37	9	23	-9	748
10	102	40	12	26	-6	742
11	103	43	12	27.5	-4.5	737.5
12	104	44	14	29	-3	734.5
13	105	43	14	28.5	-3.5	731
14	106	39	16	27.5	-4.5	726.5
15	107	38	15	26.5	-5.5	721
16	108	28	10	19	-13	708
17	109	29	5	17	-15	693
18	110	32	3	17.5	-14.5	678.5
19	111	27	8	17.5	-14.5	664
20	112	33	7	20	-12	652
21	113	37	4	20.5	-11.5	640.5
22	114	38	10	24	-8	632.5
23	115	38	13	25.5	-6.5	626
24	116	43	14	28.5	-3.5	622.5
25	117	46	19	32.5	0.5	623
26	118	52	21	36.5	4.5	627.5
27	119	50	23	36.5	4.5	632
28	120	47	28	37.5	5.5	637.5
29	121	41	24	32.5	0.5	638
30	122	46	26	36	4	642
31	123	44	33	38.5	6.5	648.5
32	124	52	23	37.5	5.5	654
33	125	49	24	36.5	4.5	658.5
34	126	52	31	41.5	9.5	668
35	127	45	30	37.5	5.5	673.5
36	128	50	24	37	5	678.5
37	129	55	27	41	9	687.5
38	130	51	25	38	6	693.5
39	131	56	29	42.5	10.5	704
40	132	54	29	41.5	9.5	713.5
41	133	50	30	40	8	721.5
42	134	54	33	43.5	11.5	733
43	135	48	31	39.5	7.5	740.5
44	136	46	28	37	5	745.5
45	137	42	31	36.5	4.5	750
46	138	41	23	32	0	750
47	139	40	29	34.5	2.5	752.5
48	140	45	23	34	2	754.5
49	141	41	22	31.5	-0.5	754
50	142	36	22	29	-3	751
51	143	40	24	32	0	751
52	144	42	16	29	-3	748
53	145	41	17	29	-3	745
54	146	40	22	31	-1	744
55	147	34	25	29.5	-2.5	741.5
56	148	35	13	24	-8	733.5
57	149	34	22	28	-4	729.5
58	150	38	17	27.5	-4.5	725
59	151	45	8	26.5	-5.5	719.5
60	152	45	15	30	-2	717.5
61	153	52	18	35	3	720.5
62	154	55	26	40.5	8.5	729
63	155	58	23	40.5	8.5	737.5

64	156	60	30	45	13	750.5
65	157	62	30	46	14	764.5
66	158	63	32	47.5	15.5	780
67	159	49	35	42	10	790
68	160	50	33	41.5	9.5	799.5
69	161	57	30	43.5	11.5	811
70	162	56	29	42.5	10.5	821.5
71	163	60	29	44.5	12.5	834
72	164	61	33	47	15	849
73	165	59	25	42	10	859
74	166	45	31	38	6	865
75	167	42	21	31.5	-0.5	864.5
76	168	49	23	36	4	868.5
77	169	57	24	40.5	8.5	877
78	170	50	31	40.5	8.5	885.5
79	171	43	23	33	1	886.5
80	172	46	25	35.5	3.5	890
81	173	33	26	29.5	-2.5	887.5
82	174	44	21	32.5	0.5	888
83	175	46	25	35.5	3.5	891.5
84	176	48	22	35	3	894.5
85	177	51	20	35.5	3.5	898
86	178	41	23	32	0	898
87	179	41	19	30	-2	896
88	180	40	19	29.5	-2.5	893.5
89	181	55	13	34	2	895.5
90	182	62	23	42.5	10.5	906
91	183	64	28	46	14	920
92	184	64	37	50.5	18.5	938.5
93	185	67	28	47.5	15.5	954
94	186	47	31	39	7	961
95	187	52	32	42	10	971
96	188	57	33	45	13	984
97	189	57	33	45	13	997
98	190	61	32	46.5	14.5	1011.5
99	191	64	38	51	19	1030.5
100	192	65	39	52	20	1050.5
101	193	63	37	50	18	1068.5
102	194	54	35	44.5	12.5	1081
103	195	56	27	41.5	9.5	1090.5
104	196	69	30	49.5	17.5	1108
105	197	73	37	55	23	1131
106	198	78	43	60.5	28.5	1159.5
107	199	79	45	62	30	1189.5
108	200	71	40	55.5	23.5	1213
109	201	58	31	44.5	12.5	1225.5
110	202	58	23	40.5	8.5	1234
111	203	68	33	50.5	18.5	1252.5
112	204	71	33	52	20	1272.5
113	205	77	42	59.5	27.5	1300
114	206	79	46	62.5	30.5	1330.5
115	207	79	47	63	31	1361.5
116	208	78	45	61.5	29.5	1391
117	209	78	46	62	30	1421
118	210	76	47	61.5	29.5	1450.5
119	211	78	44	61	29	1479.5
120	212	74	46	60	28	1507.5
121	213	69	44	56.5	24.5	1532
122	214	62	40	51	19	1551
123	215	65	39	52	20	1571
124	216	70	43	56.5	24.5	1595.5
125	217	75	43	59	27	1622.5
126	218	75	45	60	28	1650.5
127	219	76	46	61	29	1679.5
128	220	78	44	61	29	1708.5
129	221	81	47	64	32	1740.5
130	222	80	47	63.5	31.5	1772
131	223	81	46	63.5	31.5	1803.5
132	224	79	47	63	31	1834.5
133	225	76	48	62	30	1864.5
134	226	84	49	66.5	34.5	1899
135	227	75	50	62.5	30.5	1929.5
136	228	73	46	59.5	27.5	1957
137	229	75	47	61	29	1986
138	230	72	49	60.5	28.5	2014.5
139	231	72	47	59.5	27.5	2042
140	232	66	46	56	24	2066
141	233	67	59	63	31	2097
142	234	71	42	56.5	24.5	2121.5
143	235	72	46	59	27	2148.5
144	236	68	41	54.5	22.5	2171
145	237	62	42	52	20	2191
146	238	59	39	49	17	2208
147	239	62	36	49	17	2225
148	240	66	37	51.5	19.5	2244.5
149	241	68	38	53	21	2265.5
150	242	77	41	59	27	2292.5
151	243	82	45	63.5	31.5	2324
152	244	80	49	64.5	32.5	2356.5
153	245	80	47	63.5	31.5	2388
154	246	87	54	70.5	38.5	2426.5
155	247	86	54	70	38	2464.5
156	248	84	54	69	37	2501.5
157	249	85	53	69	37	2538.5
158	250	85	54	69.5	37.5	2576
159	251	75	56	65.5	33.5	2609.5
160	252	81	49	65	33	2642.5
161	253	84	51	67.5	35.5	2678
162	254	88	53	70.5	38.5	2716.5
163	255	90	58	74	42	2758.5
164	256	91	62	76.5	44.5	2803
165	257	96	58	77	45	2848
166	258	89	60	74.5	42.5	2890.5
167	259	84	50	67	35	2925.5
168	260	85	49	67	35	2960.5
169	261	85	50	67.5	35.5	2996
170	262	88	50	69	37	3033
171	263	87	50	68.5	36.5	3069.5
172	264	89	51	70	38	3107.5

173	265	88	51	69.5	37.5	3145
174	266	88	57	72.5	40.5	3185.5
175	267	92	57	74.5	42.5	3228
176	268	90	59	74.5	42.5	3270.5
177	269	91	60	75.5	43.5	3314
178	270	90	56	73	41	3355
179	271	89	57	73	41	3396
180	272	79	53	66	34	3430
181	273	88	52	70	38	3468
182	274	90	58	74	42	3510
183	275	88	53	70.5	38.5	3548.5
184	276	90	51	70.5	38.5	3587
185	277	86	50	68	36	3623
186	278	90	50	70	38	3661
187	279	89	50	69.5	37.5	3698.5
188	280	90	54	72	40	3738.5
189	281	89	54	71.5	39.5	3778
190	282	90	52	71	39	3817
191	283	91	47	69	37	3854
192	284	86	57	71.5	39.5	3893.5
193	285	86	55	70.5	38.5	3932
194	286	89	55	72	40	3972
195	287	91	57	74	42	4014
196	288	93	58	75.5	43.5	4057.5
197	289	89	57	73	41	4098.5
198	290	77	54	65.5	33.5	4132
199	291	79	53	66	34	4166
200	292	84	49	66.5	34.5	4200.5
201	293	77	52	64.5	32.5	4233
202	294	89	58	73.5	41.5	4274.5
203	295	91	58	74.5	42.5	4317
204	296	92	53	72.5	40.5	4357.5
205	297	95	59	77	45	4402.5
206	298	88	62	75	43	4445.5
207	299	89	60	74.5	42.5	4488
208	300	90	59	74.5	42.5	4530.5
209	301	86	59	72.5	40.5	4571
210	302	79	61	70	38	4609
211	303	80	62	71	39	4648
212	304	76	59	67.5	35.5	4683.5
213	305	90	53	71.5	39.5	4723
214	306	91	57	74	42	4765
215	307	85	63	74	42	4807
216	308	90	58	74	42	4849
217	309	90	58	74	42	4891
218	310	88	59	73.5	41.5	4932.5
219	311	76	59	67.5	35.5	4968
220	312	80	53	66.5	34.5	5002.5
221	313	84	54	69	37	5039.5
222	314	88	57	72.5	40.5	5080
223	315	87	56	71.5	39.5	5119.5
224	316	85	59	72	40	5159.5
225	317	83	54	68.5	36.5	5196
226	318	81	52	66.5	34.5	5230.5
227	319	81	55	68	36	5266.5
228	320	83	47	65	33	5299.5
229	321	88	49	68.5	36.5	5336
230	322	90	55	72.5	40.5	5376.5
231	323	91	54	72.5	40.5	5417
232	324	85	59	72	40	5457
233	325	85	57	71	39	5496
234	326	85	58	71.5	39.5	5535.5
235	327	73	57	65	33	5568.5
236	328	71	56	63.5	31.5	5600
237	329	74	54	64	32	5632
238	330	76	46	61	29	5661
239	331	76	46	61	29	5690
240	332	81	49	65	33	5723
241	333	81	49	65	33	5756
242	334	86	52	69	37	5793
243	335	87	53	70	38	5831
244	336	89	55	72	40	5871
245	337	86	56	71	39	5910
246	338	83	54	68.5	36.5	5946.5
247	339	79	54	66.5	34.5	5981
248	340	76	52	64	32	6013
249	341	76	49	62.5	30.5	6043.5
250	342	77	49	63	31	6074.5
251	343	79	50	64.5	32.5	6107
252	344	80	51	65.5	33.5	6140.5
253	345	82	50	66	34	6174.5
254	346	81	50	65.5	33.5	6208
255	347	80	48	64	32	6240
256	348	70	47	58.5	26.5	6266.5
257	349	64	41	52.5	20.5	6287
258	350	76	38	57	25	6312
259	351	77	45	61	29	6341
260	352	78	52	65	33	6374
261	353	79	46	62.5	30.5	6404.5
262	354	80	48	64	32	6436.5
263	355	81	54	67.5	35.5	6472
264	356	81	56	68.5	36.5	6508.5
265	357	82	48	65	33	6541.5
266	358	84	49	66.5	34.5	6576
267	359	77	48	62.5	30.5	6606.5
268	360	76	53	64.5	32.5	6639
269	361	77	48	62.5	30.5	6669.5
270	362	78	50	64	32	6701.5
271	363	78	47	62.5	30.5	6732
272	364	80	41	60.5	28.5	6760.5
273	365	78	42	60	28	6788.5



82	775	length of freeze (day)	34
116	622	frost depth (^oF-day)	153
		average temperature	50.6

1987-1988

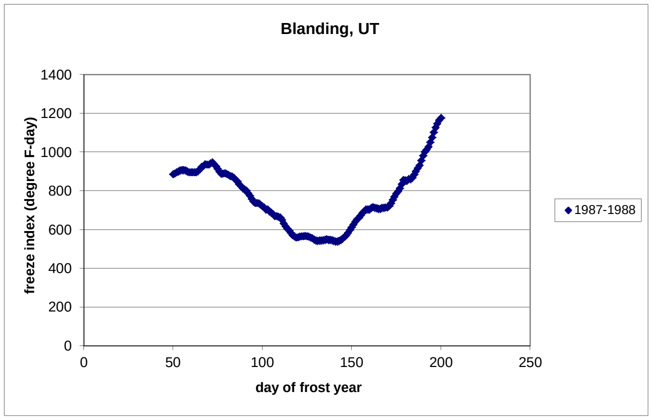
day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	80	44	62	30	30
275	2	82	48	65	33	63
276	3	81	45	63	31	94

277	4	81	45	63	31	125
278	5	79	52	65.5	33.5	158.5
279	6	80	47	63.5	31.5	190
280	7	80	44	62	30	220
281	8	78	44	61	29	249
282	9	76	43	59.5	27.5	276.5
283	10	76	45	60.5	28.5	305
284	11	76	46	61	29	334
285	12	70	52	61	29	363
286	13	52	42	47	15	378
287	14	53	39	46	14	392
288	15	59	36	47.5	15.5	407.5
289	16	64	36	50	18	425.5
290	17	66	37	51.5	19.5	445
291	18	67	37	52	20	465
292	19	67	39	53	21	486
293	20	65	35	50	18	504
294	21	64	34	49	17	521
295	22	68	39	53.5	21.5	542.5
296	23	62	42	52	20	562.5
297	24	55	43	49	17	579.5
298	25	61	42	51.5	19.5	599
299	26	67	34	50.5	18.5	617.5
300	27	66	38	52	20	637.5
301	28	67	42	54.5	22.5	660
302	29	51	42	46.5	14.5	674.5
303	30	53	39	46	14	688.5
304	31	57	36	46.5	14.5	703
305	32	50	44	47	15	718
306	33	52	41	46.5	14.5	732.5
307	34	62	42	52	20	752.5
308	35	65	41	53	21	773.5
309	36	60	43	51.5	19.5	793
310	37	50	34	42	10	803
311	38	53	34	43.5	11.5	814.5
312	39	58	32	45	13	827.5
313	40	56	33	44.5	12.5	840
314	41	51	33	42	10	850
315	42	54	33	43.5	11.5	861.5
316	43	53	28	40.5	8.5	870
317	44	51	29	40	8	878
318	45	47	35	41	9	887
319	46	42	23	32.5	0.5	887.5
320	47	42	19	30.5	-1.5	886
321	48	44	21	32.5	0.5	886.5
322	49	46	16	31	-1	885.5
323	50	46	19	32.5	0.5	886
324	51	52	20	36	4	890
325	52	49	28	38.5	6.5	896.5
326	53	48	24	36	4	900.5
327	54	48	25	36.5	4.5	905
328	55	48	21	34.5	2.5	907.5
329	56	44	21	32.5	0.5	908
330	57	38	22	30	-2	906
331	58	39	16	27.5	-4.5	901.5
332	59	38	15	26.5	-5.5	896
333	60	41	21	31	-1	895
334	61	47	19	33	1	896
335	62	42	21	31.5	-0.5	895.5
336	63	43	23	33	1	896.5
337	64	51	25	38	6	902.5
338	65	54	31	42.5	10.5	913
339	66	52	33	42.5	10.5	923.5
340	67	48	28	38	6	929.5
341	68	48	30	39	7	936.5
342	69	41	20	30.5	-1.5	935
343	70	44	20	32	0	935
344	71	50	27	38.5	6.5	941.5
345	72	50	24	37	5	946.5
346	73	34	16	25	-7	939.5
347	74	23	16	19.5	-12.5	927
348	75	26	11	18.5	-13.5	913.5
349	76	24	11	17.5	-14.5	899
350	77	30	12	21	-11	888
351	78	40	25	32.5	0.5	888.5
352	79	38	30	34	2	890.5
353	80	32	26	29	-3	887.5
354	81	35	19	27	-5	882.5
355	82	34	18	26	-6	876.5
356	83	42	19	30.5	-1.5	875
357	84	34	15	24.5	-7.5	867.5
358	85	31	15	23	-9	858.5
359	86	31	16	23.5	-8.5	850
360	87	27	7	17	-15	835
361	88	36	6	21	-11	824
362	89	32	12	22	-10	814
363	90	38	15	26.5	-5.5	808.5
364	91	32	17	24.5	-7.5	801
365	92	31	7	19	-13	788
1	93	32	5	18.5	-13.5	774.5
2	94	29	5	17	-15	759.5
3	95	29	7	18	-14	745.5
4	96	29	20	24.5	-7.5	738
5	97	35	26	30.5	-1.5	736.5
6	98	39	24	31.5	-0.5	736
7	99	35	14	24.5	-7.5	728.5
8	100	35	15	25	-7	721.5
9	101	32	16	24	-8	713.5
10	102	34	13	23.5	-8.5	705
11	103	43	18	30.5	-1.5	703.5
12	104	34	12	23	-9	694.5
13	105	38	11	24.5	-7.5	687
14	106	38	11	24.5	-7.5	679.5
15	107	32	13	22.5	-9.5	670
16	108	38	25	31.5	-0.5	669.5
17	109	30	26	28	-4	665.5
18	110	32	26	29	-3	662.5
19	111	26	13	19.5	-12.5	650
20	112	28	-1	13.5	-18.5	631.5

21	113	29	4	16.5	-15.5	616
22	114	38	4	21	-11	605
23	115	35	9	22	-10	595
24	116	35	6	20.5	-11.5	583.5
25	117	33	6	19.5	-12.5	571
26	118	40	11	25.5	-6.5	564.5
27	119	42	12	27	-5	559.5
28	120	45	21	33	1	560.5
29	121	48	23	35.5	3.5	564
30	122	45	22	33.5	1.5	565.5
31	123	39	25	32	0	565.5
32	124	41	25	33	1	566.5
33	125	35	28	31.5	-0.5	566
34	126	41	19	30	-2	564
35	127	42	12	27	-5	559
36	128	44	12	28	-4	555
37	129	40	11	25.5	-6.5	548.5
38	130	39	16	27.5	-4.5	544
39	131	45	17	31	-1	543
40	132	44	21	32.5	0.5	543.5
41	133	44	21	32.5	0.5	544
42	134	47	19	33	1	545
43	135	49	21	35	3	548
44	136	47	23	35	3	551
45	137	42	16	29	-3	548
46	138	43	18	30.5	-1.5	546.5
47	139	40	21	30.5	-1.5	545
48	140	42	17	29.5	-2.5	542.5
49	141	40	16	28	-4	538.5
50	142	45	21	33	1	539.5
51	143	51	20	35.5	3.5	543
52	144	51	22	36.5	4.5	547.5
53	145	55	22	38.5	6.5	554
54	146	54	26	40	8	562
55	147	57	28	42.5	10.5	572.5
56	148	58	28	43	11	583.5
57	149	60	33	46.5	14.5	598
58	150	54	36	45	13	611
59	151	57	37	47	15	626
60	152	60	34	47	15	641
61	153	54	33	43.5	11.5	652.5
62	154	54	29	41.5	9.5	662
63	155	57	30	43.5	11.5	673.5
64	156	57	31	44	12	685.5
65	157	52	29	40.5	8.5	694
66	158	56	27	41.5	9.5	703.5
67	159	38	26	32	0	703.5
68	160	49	16	32.5	0.5	704
69	161	57	24	40.5	8.5	712.5
70	162	46	23	34.5	2.5	715
71	163	39	21	30	-2	713
72	164	39	21	30	-2	711
73	165	38	18	28	-4	707
74	166	47	17	32	0	707
75	167	53	22	37.5	5.5	712.5
76	168	41	24	32.5	0.5	713
77	169	45	20	32.5	0.5	713.5
78	170	48	18	33	1	714.5
79	171	58	22	40	8	722.5
80	172	66	25	45.5	13.5	736
81	173	66	33	49.5	17.5	753.5
82	174	65	34	49.5	17.5	771
83	175	66	30	48	16	787
84	176	54	33	43.5	11.5	798.5
85	177	66	29	47.5	15.5	814
86	178	70	35	52.5	20.5	834.5
87	179	72	34	53	21	855.5
88	180	40	23	31.5	-0.5	855
89	181	48	13	30.5	-1.5	853.5
90	182	47	31	39	7	860.5
91	183	44	20	32	0	860.5
92	184	54	26	40	8	868.5
93	185	65	29	47	15	883.5
94	186	66	32	49	17	900.5
95	187	63	35	49	17	917.5
96	188	63	31	47	15	932.5
97	189	73	39	56	24	956.5
98	190	75	40	57.5	25.5	982
99	191	69	35	52	20	1002
100	192	56	29	42.5	10.5	1012.5
101	193	69	27	48	16	1028.5
102	194	74	34	54	22	1050.5
103	195	76	38	57	25	1075.5
104	196	77	42	59.5	27.5	1103
105	197	66	47	56.5	24.5	1127.5
106	198	60	43	51.5	19.5	1147
107	199	59	42	50.5	18.5	1165.5
108	200	53	34	43.5	11.5	1177
109	201	50	34	42	10	1187
110	202	61	35	48	16	1203
111	203	61	37	49	17	1220
112	204	52	46	49	17	1237
113	205	45	33	39	7	1244
114	206	53	29	41	9	1253
115	207	56	35	45.5	13.5	1266.5
116	208	62	34	48	16	1282.5
117	209	63	32	47.5	15.5	1298
118	210	71	38	54.5	22.5	1320.5
119	211	67	43	55	23	1343.5
120	212	74	39	56.5	24.5	1368
121	213	73	40	56.5	24.5	1392.5
122	214	49	34	41.5	9.5	1402
123	215	56	31	43.5	11.5	1413.5
124	216	66	30	48	16	1429.5
125	217	74	40	57	25	1454.5
126	218	73	40	56.5	24.5	1479
127	219	52	35	43.5	11.5	1490.5
128	220	58	27	42.5	10.5	1501
129	221	64	34	49	17	1518

130	222	70	34	52	20	1538
131	223	73	43	58	26	1564
132	224	82	43	62.5	30.5	1594.5
133	225	82	44	63	31	1625.5
134	226	83	47	65	33	1658.5
135	227	83	51	67	35	1693.5
136	228	86	53	69.5	37.5	1731
137	229	85	50	67.5	35.5	1766.5
138	230	74	48	61	29	1795.5
139	231	66	45	55.5	23.5	1819
140	232	61	40	50.5	18.5	1837.5
141	233	64	45	54.5	22.5	1860
142	234	72	40	56	24	1884
143	235	74	44	59	27	1911
144	236	81	44	62.5	30.5	1941.5
145	237	83	47	65	33	1974.5
146	238	80	51	65.5	33.5	2008
147	239	82	50	66	34	2042
148	240	81	50	65.5	33.5	2075.5
149	241	82	50	66	34	2109.5
150	242	76	38	57	25	2134.5
151	243	54	34	44	12	2146.5
152	244	64	33	48.5	16.5	2163
153	245	76	37	56.5	24.5	2187.5
154	246	83	51	67	35	2222.5
155	247	88	59	73.5	41.5	2264
156	248	89	56	72.5	40.5	2304.5
157	249	85	55	70	38	2342.5
158	250	81	48	64.5	32.5	2375
159	251	81	46	63.5	31.5	2406.5
160	252	82	44	63	31	2437.5
161	253	87	53	70	38	2475.5
162	254	85	50	67.5	35.5	2511
163	255	86	58	72	40	2551
164	256	85	48	66.5	34.5	2585.5
165	257	79	50	64.5	32.5	2618
166	258	87	51	69	37	2655
167	259	88	57	72.5	40.5	2695.5
168	260	90	53	71.5	39.5	2735
169	261	90	60	75	43	2778
170	262	92	60	76	44	2822
171	263	90	61	75.5	43.5	2865.5
172	264	92	60	76	44	2909.5
173	265	95	60	77.5	45.5	2955
174	266	94	65	79.5	47.5	3002.5
175	267	94	62	78	46	3048.5
176	268	96	58	77	45	3093.5
177	269	87	58	72.5	40.5	3134
178	270	84	55	69.5	37.5	3171.5
179	271	82	57	69.5	37.5	3209
180	272	67	58	62.5	30.5	3239.5
181	273	72	56	64	32	3271.5
182	274	86	60	73	41	3312.5
183	275	90	60	75	43	3355.5
184	276	90	57	73.5	41.5	3397
185	277	89	59	74	42	3439
186	278	86	55	70.5	38.5	3477.5
187	279	88	57	72.5	40.5	3518
188	280	89	57	73	41	3559
189	281	90	58	74	42	3601
190	282	92	58	75	43	3644
191	283	85	59	72	40	3684
192	284	88	54	71	39	3723
193	285	90	56	73	41	3764
194	286	89	54	71.5	39.5	3803.5
195	287	94	58	76	44	3847.5
196	288	92	59	75.5	43.5	3891
197	289	93	61	77	45	3936
198	290	89	60	74.5	42.5	3978.5
199	291	93	59	76	44	4022.5
200	292	92	60	76	44	4066.5
201	293	94	57	75.5	43.5	4110
202	294	91	59	75	43	4153
203	295	93	59	76	44	4197
204	296	93	63	78	46	4243
205	297	92	59	75.5	43.5	4286.5
206	298	91	62	76.5	44.5	4331
207	299	92	58	75	43	4374
208	300	93	57	75	43	4417
209	301	89	58	73.5	41.5	4458.5
210	302	89	57	73	41	4499.5
211	303	87	63	75	43	4542.5
212	304	86	57	71.5	39.5	4582
213	305	82	56	69	37	4619
214	306	85	55	70	38	4657
215	307	88	58	73	41	4698
216	308	89	60	74.5	42.5	4740.5
217	309	87	58	72.5	40.5	4781
218	310	89	58	73.5	41.5	4822.5
219	311	84	61	72.5	40.5	4863
220	312	83	57	70	38	4901
221	313	87	55	71	39	4940
222	314	89	54	71.5	39.5	4979.5
223	315	88	56	72	40	5019.5
224	316	91	55	73	41	5060.5
225	317	81	53	67	35	5095.5
226	318	87	57	72	40	5135.5
227	319	92	56	74	42	5177.5
228	320	86	61	73.5	41.5	5219
229	321	84	57	70.5	38.5	5257.5
230	322	86	56	71	39	5296.5
231	323	85	57	71	39	5335.5
232	324	92	59	75.5	43.5	5379
233	325	89	59	74	42	5421
234	326	74	58	66	34	5455
235	327	87	58	72.5	40.5	5495.5
236	328	93	57	75	43	5538.5
237	329	87	62	74.5	42.5	5581
238	330	84	57	70.5	38.5	5619.5

239	331	87	67	77	45	5664.5
240	332	84	56	70	38	5702.5
241	333	83	56	69.5	37.5	5740
242	334	83	54	68.5	36.5	5776.5
243	335	85	54	69.5	37.5	5814
244	336	84	54	69	37	5851
245	337	85	53	69	37	5888
246	338	83	54	68.5	36.5	5924.5
247	339	86	57	71.5	39.5	5964
248	340	83	54	68.5	36.5	6000.5
249	341	84	52	68	36	6036.5
250	342	85	48	66.5	34.5	6071
251	343	89	52	70.5	38.5	6109.5
252	344	90	54	72	40	6149.5
253	345	89	55	72	40	6189.5
254	346	75	51	63	31	6220.5
255	347	75	48	61.5	29.5	6250
256	348	57	45	51	19	6269
257	349	63	41	52	20	6289
258	350	66	39	52.5	20.5	6309.5
259	351	72	42	57	25	6334.5
260	352	77	44	60.5	28.5	6363
261	353	81	47	64	32	6395
262	354	76	46	61	29	6424
263	355	70	33	51.5	19.5	6443.5
264	356	77	43	60	28	6471.5
265	357	70	53	61.5	29.5	6501
266	358	68	39	53.5	21.5	6522.5
267	359	75	42	58.5	26.5	6549
268	360	76	43	59.5	27.5	6576.5
269	361	75	46	60.5	28.5	6605
270	362	75	45	60	28	6633
271	363	75	45	60	28	6661
272	364	66	45	55.5	23.5	6684.5
273	365	71	40	55.5	23.5	6708
274	366	78	48	63	31	6739



73	939.5	length of freeze (day)	70
143	543	frost depth (°F-day)	396.5
		average temperature	50.4

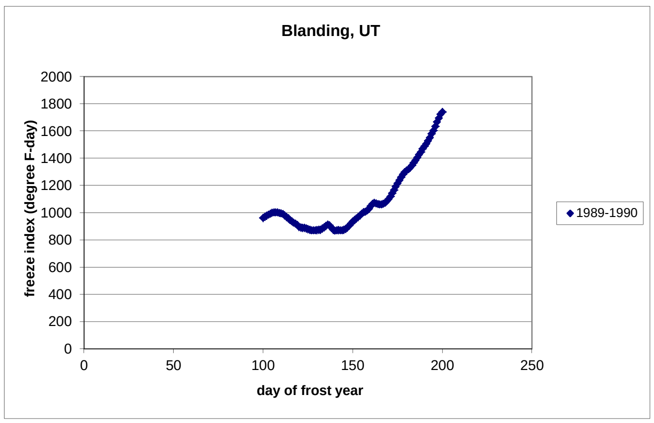
1989-1990

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (°F)	cumulative degree day (°F)
274	1	77	47	62	30	30
275	2	77	48	62.5	30.5	60.5
276	3	77	50	63.5	31.5	92
277	4	62	46	54	22	114
278	5	70	41	55.5	23.5	137.5
279	6	70	40	55	23	160.5
280	7	71	45	58	26	186.5
281	8	73	43	58	26	212.5
282	9	77	45	61	29	241.5
283	10	77	46	61.5	29.5	271
284	11	79	47	63	31	302
285	12	77	47	62	30	332
286	13	76	49	62.5	30.5	362.5
287	14	76	50	63	31	393.5
288	15	72	46	59	27	420.5
289	16	65	39	52	20	440.5
290	17	65	40	52.5	20.5	461
291	18	64	38	51	19	480
292	19	62	32	47	15	495
293	20	60	38	49	17	512
294	21	61	41	51	19	531
295	22	60	39	49.5	17.5	548.5
296	23	62	45	53.5	21.5	570
297	24	69	40	54.5	22.5	592.5
298	25	65	44	54.5	22.5	615
299	26	55	32	43.5	11.5	626.5
300	27	56	31	43.5	11.5	638
301	28	54	31	42.5	10.5	648.5
302	29	47	23	35	3	651.5
303	30	50	21	35.5	3.5	655
304	31	52	26	39	7	662
305	32	49	21	35	3	665
306	33	52	23	37.5	5.5	670.5
307	34	53	25	39	7	677.5
308	35	56	31	43.5	11.5	689
309	36	62	34	48	16	705
310	37	58	35	46.5	14.5	719.5
311	38	58	31	44.5	12.5	732
312	39	56	31	43.5	11.5	743.5
313	40	60	32	46	14	757.5
314	41	62	37	49.5	17.5	775
315	42	65	38	51.5	19.5	794.5
316	43	68	37	52.5	20.5	815
317	44	61	37	49	17	832
318	45	64	33	48.5	16.5	848.5
319	46	51	22	36.5	4.5	853
320	47	55	28	41.5	9.5	862.5
321	48	54	29	41.5	9.5	872
322	49	54	29	41.5	9.5	881.5
323	50	60	33	46.5	14.5	896
324	51	59	35	47	15	911
325	52	60	36	48	16	927
326	53	62	36	49	17	944
327	54	55	34	44.5	12.5	956.5
328	55	49	34	41.5	9.5	966
329	56	55	34	44.5	12.5	978.5
330	57	55	31	43	11	989.5
331	58	38	20	29	-3	986.5
332	59	42	18	30	-2	984.5
333	60	44	20	32	0	984.5
334	61	50	22	36	4	988.5
335	62	55	19	37	5	993.5
336	63	49	23	36	4	997.5
337	64	45	26	35.5	3.5	1001
338	65	53	27	40	8	1009
339	66	57	29	43	11	1020
340	67	51	32	41.5	9.5	1029.5
341	68	49	26	37.5	5.5	1035

342	69	45	24	34.5	2.5	1037.5
343	70	46	24	35	3	1040.5
344	71	40	18	29	-3	1037.5
345	72	32	13	22.5	-9.5	1028
346	73	36	10	23	-9	1019
347	74	39	14	26.5	-5.5	1013.5
348	75	44	16	30	-2	1011.5
349	76	40	23	31.5	-0.5	1011
350	77	43	18	30.5	-1.5	1009.5
351	78	37	16	26.5	-5.5	1004
352	79	42	26	34	2	1006
353	80	42	21	31.5	-0.5	1005.5
354	81	47	20	33.5	1.5	1007
355	82	47	22	34.5	2.5	1009.5
356	83	48	25	36.5	4.5	1014
357	84	49	24	36.5	4.5	1018.5
358	85	48	25	36.5	4.5	1023
359	86	52	22	37	5	1028
360	87	46	20	33	1	1029
361	88	46	20	33	1	1030
362	89	41	26	33.5	1.5	1031.5
363	90	48	26	37	5	1036.5
364	91	41	18	29.5	-2.5	1034
365	92	43	17	30	-2	1032
1	93	42	0	21	-11	1021
2	94	40	26	33	1	1022
3	95	31	10	20.5	-11.5	1010.5
4	96	27	4	15.5	-16.5	994
5	97	38	8	23	-9	985
6	98	31	12	21.5	-10.5	974.5
7	99	35	15	25	-7	967.5
8	100	37	18	27.5	-4.5	963
9	101	52	29	40.5	8.5	971.5
10	102	51	28	39.5	7.5	979
11	103	51	28	39.5	7.5	986.5
12	104	50	29	39.5	7.5	994
13	105	47	30	38.5	6.5	1000.5
14	106	41	28	34.5	2.5	1003
15	107	39	25	32	0	1003
16	108	40	21	30.5	-1.5	1001.5
17	109	34	21	27.5	-4.5	997
18	110	36	25	30.5	-1.5	995.5
19	111	30	22	26	-6	989.5
20	112	35	14	24.5	-7.5	982
21	113	30	11	20.5	-11.5	970.5
22	114	32	12	22	-10	960.5
23	115	30	6	18	-14	946.5
24	116	32	10	21	-11	935.5
25	117	35	11	23	-9	926.5
26	118	39	14	26.5	-5.5	921
27	119	30	14	22	-10	911
28	120	29	8	18.5	-13.5	897.5
29	121	37	17	27	-5	892.5
30	122	40	18	29	-3	889.5
31	123	35	29	32	0	889.5
32	124	32	24	28	-4	885.5
33	125	39	16	27.5	-4.5	881
34	126	37	14	25.5	-6.5	874.5
35	127	39	16	27.5	-4.5	870
36	128	44	22	33	1	871
37	129	42	20	31	-1	870
38	130	45	24	34.5	2.5	872.5
39	131	40	30	35	3	875.5
40	132	47	19	33	1	876.5
41	133	49	31	40	8	884.5
42	134	52	33	42.5	10.5	895
43	135	46	33	39.5	7.5	902.5
44	136	55	30	42.5	10.5	913
45	137	36	18	27	-5	908
46	138	26	5	15.5	-16.5	891.5
47	139	27	4	15.5	-16.5	875
48	140	41	11	26	-6	869
49	141	40	26	33	1	870
50	142	39	30	34.5	2.5	872.5
51	143	37	23	30	-2	870.5
52	144	47	17	32	0	870.5
53	145	50	25	37.5	5.5	876
54	146	56	20	38	6	882
55	147	56	30	43	11	893
56	148	57	33	45	13	906
57	149	61	34	47.5	15.5	921.5
58	150	56	39	47.5	15.5	937
59	151	55	34	44.5	12.5	949.5
60	152	50	32	41	9	958.5
61	153	55	32	43.5	11.5	970
62	154	48	37	42.5	10.5	980.5
63	155	57	34	45.5	13.5	994
64	156	53	34	43.5	11.5	1005.5
65	157	42	27	34.5	2.5	1008
66	158	54	27	40.5	8.5	1016.5
67	159	58	32	45	13	1029.5
68	160	65	37	51	19	1048.5
69	161	58	39	48.5	16.5	1065
70	162	45	35	40	8	1073
71	163	33	23	28	-4	1069
72	164	34	21	27.5	-4.5	1064.5
73	165	39	17	28	-4	1060.5
74	166	43	24	33.5	1.5	1062
75	167	48	24	36	4	1066
76	168	55	23	39	7	1073
77	169	61	27	44	12	1085
78	170	62	34	48	16	1101
79	171	62	40	51	19	1120
80	172	70	40	55	23	1143
81	173	73	37	55	23	1166
82	174	73	47	60	28	1194
83	175	71	39	55	23	1217
84	176	70	40	55	23	1240
85	177	68	40	54	22	1262

86	178	64	42	53	21	1283
87	179	60	37	48.5	16.5	1299.5
88	180	54	34	44	12	1311.5
89	181	47	32	39.5	7.5	1319
90	182	57	32	44.5	12.5	1331.5
91	183	65	34	49.5	17.5	1349
92	184	64	37	50.5	18.5	1367.5
93	185	64	36	50	18	1385.5
94	186	67	38	52.5	20.5	1406
95	187	68	42	55	23	1429
96	188	67	35	51	19	1448
97	189	68	40	54	22	1470
98	190	61	41	51	19	1489
99	191	63	38	50.5	18.5	1507.5
100	192	71	37	54	22	1529.5
101	193	72	40	56	24	1553.5
102	194	74	44	59	27	1580.5
103	195	70	41	55.5	23.5	1604
104	196	78	50	64	32	1636
105	197	81	47	64	32	1668
106	198	76	46	61	29	1697
107	199	71	48	59.5	27.5	1724.5
108	200	57	40	48.5	16.5	1741
109	201	61	39	50	18	1759
110	202	72	40	56	24	1783
111	203	78	44	61	29	1812
112	204	74	42	58	26	1838
113	205	72	42	57	25	1863
114	206	52	36	44	12	1875
115	207	61	35	48	16	1891
116	208	66	37	51.5	19.5	1910.5
117	209	71	35	53	21	1931.5
118	210	80	47	63.5	31.5	1963
119	211	41	33	37	5	1968
120	212	51	31	41	9	1977
121	213	48	34	41	9	1986
122	214	61	36	48.5	16.5	2002.5
123	215	68	35	51.5	19.5	2022
124	216	67	42	54.5	22.5	2044.5
125	217	73	44	58.5	26.5	2071
126	218	77	44	60.5	28.5	2099.5
127	219	79	47	63	31	2130.5
128	220	77	48	62.5	30.5	2161
129	221	65	32	48.5	16.5	2177.5
130	222	78	42	60	28	2205.5
131	223	70	44	57	25	2230.5
132	224	73	40	56.5	24.5	2255
133	225	77	44	60.5	28.5	2283.5
134	226	77	47	62	30	2313.5
135	227	74	45	59.5	27.5	2341
136	228	71	38	54.5	22.5	2363.5
137	229	81	45	63	31	2394.5
138	230	78	45	61.5	29.5	2424
139	231	74	56	65	33	2457
140	232	78	57	67.5	35.5	2492.5
141	233	83	47	65	33	2525.5
142	234	87	54	70.5	38.5	2564
143	235	84	52	68	36	2600
144	236	79	51	65	33	2633
145	237	79	46	62.5	30.5	2663.5
146	238	76	47	61.5	29.5	2693
147	239	82	49	65.5	33.5	2726.5
148	240	78	48	63	31	2757.5
149	241	67	42	54.5	22.5	2780
150	242	73	44	58.5	26.5	2806.5
151	243	76	45	60.5	28.5	2835
152	244	70	46	58	26	2861
153	245	76	33	54.5	22.5	2883.5
154	246	87	50	68.5	36.5	2920
155	247	93	56	74.5	42.5	2962.5
156	248	94	59	76.5	44.5	3007
157	249	92	58	75	43	3050
158	250	89	56	72.5	40.5	3090.5
159	251	95	57	76	44	3134.5
160	252	94	61	77.5	45.5	3180
161	253	77	56	66.5	34.5	3214.5
162	254	82	51	66.5	34.5	3249
163	255	85	54	69.5	37.5	3286.5
164	256	87	51	69	37	3323.5
165	257	85	53	69	37	3360.5
166	258	82	52	67	35	3395.5
167	259	79	46	62.5	30.5	3426
168	260	89	50	69.5	37.5	3463.5
169	261	93	56	74.5	42.5	3506
170	262	87	57	72	40	3546
171	263	90	54	72	40	3586
172	264	90	57	73.5	41.5	3627.5
173	265	96	58	77	45	3672.5
174	266	97	60	78.5	46.5	3719
175	267	100	64	82	50	3769
176	268	101	66	83.5	51.5	3820.5
177	269	102	65	83.5	51.5	3872
178	270	102	65	83.5	51.5	3923.5
179	271	100	63	81.5	49.5	3973
180	272	101	65	83	51	4024
181	273	102	68	85	53	4077
182	274	97	59	78	46	4123
183	275	98	66	82	50	4173
184	276	90	60	75	43	4216
185	277	92	60	76	44	4260
186	278	85	61	73	41	4301
187	279	93	58	75.5	43.5	4344.5
188	280	86	56	71	39	4383.5
189	281	77	55	66	34	4417.5
190	282	86	51	68.5	36.5	4454
191	283	90	56	73	41	4495
192	284	93	60	76.5	44.5	4539.5
193	285	94	57	75.5	43.5	4583
194	286	91	60	75.5	43.5	4626.5

195	287	85	59	72	40	4666.5
196	288	85	55	70	38	4704.5
197	289	92	56	74	42	4746.5
198	290	93	59	76	44	4790.5
199	291	94	60	77	45	4835.5
200	292	90	60	75	43	4878.5
201	293	92	58	75	43	4921.5
202	294	90	61	75.5	43.5	4965
203	295	92	57	74.5	42.5	5007.5
204	296	93	59	76	44	5051.5
205	297	88	59	73.5	41.5	5093
206	298	90	55	72.5	40.5	5133.5
207	299	91	56	73.5	41.5	5175
208	300	93	58	75.5	43.5	5218.5
209	301	96	60	78	46	5264.5
210	302	93	59	76	44	5308.5
211	303	92	55	73.5	41.5	5350
212	304	90	55	72.5	40.5	5390.5
213	305	89	57	73	41	5431.5
214	306	86	58	72	40	5471.5
215	307	90	53	71.5	39.5	5511
216	308	91	57	74	42	5553
217	309	88	58	73	41	5594
218	310	88	50	69	37	5631
219	311	91	52	71.5	39.5	5670.5
220	312	96	57	76.5	44.5	5715
221	313	94	61	77.5	45.5	5760.5
222	314	95	60	77.5	45.5	5806
223	315	95	60	77.5	45.5	5851.5
224	316	88	55	71.5	39.5	5891
225	317	69	50	59.5	27.5	5918.5
226	318	76	53	64.5	32.5	5951
227	319	79	51	65	33	5984
228	320	74	54	64	32	6016
229	321	85	52	68.5	36.5	6052.5
230	322	86	54	70	38	6090.5
231	323	85	51	68	36	6126.5
232	324	87	52	69.5	37.5	6164
233	325	85	52	68.5	36.5	6200.5
234	326	87	55	71	39	6239.5
235	327	87	53	70	38	6277.5
236	328	87	55	71	39	6316.5
237	329	86	54	70	38	6354.5
238	330	87	53	70	38	6392.5
239	331	90	57	73.5	41.5	6434
240	332	94	61	77.5	45.5	6479.5
241	333	95	62	78.5	46.5	6526
242	334	93	64	78.5	46.5	6572.5
243	335	91	63	77	45	6617.5
244	336	92	63	77.5	45.5	6663
245	337	85	59	72	40	6703
246	338	90	59	74.5	42.5	6745.5
247	339	82	58	70	38	6783.5
248	340	81	58	69.5	37.5	6821
249	341	81	59	70	38	6859
250	342	86	56	71	39	6898
251	343	88	57	72.5	40.5	6938.5
252	344	91	59	75	43	6981.5
253	345	91	57	74	42	7023.5
254	346	92	61	76.5	44.5	7068
255	347	94	62	78	46	7114
256	348	94	61	77.5	45.5	7159.5
257	349	94	59	76.5	44.5	7204
258	350	88	60	74	42	7246
259	351	75	59	67	35	7281
260	352	80	53	66.5	34.5	7315.5
261	353	69	51	60	28	7343.5
262	354	70	45	57.5	25.5	7369
263	355	60	50	55	23	7392
264	356	74	51	62.5	30.5	7422.5
265	357	82	52	67	35	7457.5
266	358	68	56	62	30	7487.5
267	359	77	55	66	34	7521.5
268	360	78	51	64.5	32.5	7554
269	361	78	51	64.5	32.5	7586.5
270	362	78	55	66.5	34.5	7621
271	363	76	53	64.5	32.5	7653.5
272	364	76	49	62.5	30.5	7684
273	365	74	48	61	29	7713



107	1003		length of freeze (day)	34
141	870		frost depth (^oF-day)	133
			average temperature	53.1

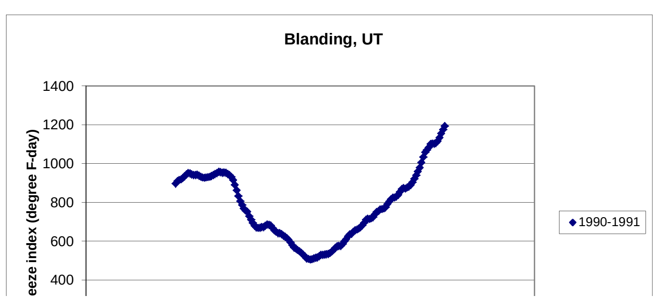
1990-1991

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	71	54	62.5	30.5	30.5
275	2	56	49	52.5	20.5	51
276	3	68	42	55	23	74
277	4	73	44	58.5	26.5	100.5
278	5	73	47	60	28	128.5
279	6	75	47	61	29	157.5
280	7	68	49	58.5	26.5	184
281	8	54	35	44.5	12.5	196.5
282	9	59	31	45	13	209.5
283	10	64	35	49.5	17.5	227
284	11	70	39	54.5	22.5	249.5
285	12	66	31	48.5	16.5	266
286	13	69	40	54.5	22.5	288.5
287	14	73	43	58	26	314.5
288	15	73	44	58.5	26.5	341
289	16	73	45	59	27	368
290	17	65	41	53	21	389
291	18	68	36	52	20	409
292	19	59	43	51	19	428
293	20	54	35	44.5	12.5	440.5
294	21	54	29	41.5	9.5	450
295	22	56	32	44	12	462
296	23	63	39	51	19	481
297	24	69	40	54.5	22.5	503.5
298	25	67	44	55.5	23.5	527

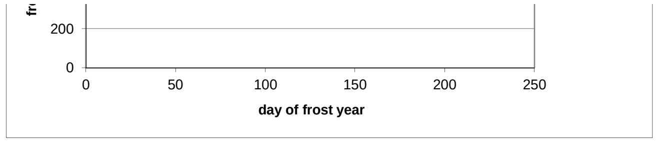
299	26	69	42	55.5	23.5	550.5
300	27	73	44	58.5	26.5	577
301	28	70	46	58	26	603
302	29	69	44	56.5	24.5	627.5
303	30	69	40	54.5	22.5	650
304	31	62	45	53.5	21.5	671.5
305	32	58	40	49	17	688.5
306	33	58	40	49	17	705.5
307	34	42	32	37	5	710.5
308	35	50	25	37.5	5.5	716
309	36	49	31	40	8	724
310	37	38	30	34	2	726
311	38	35	28	31.5	-0.5	725.5
312	39	48	24	36	4	729.5
313	40	55	30	42.5	10.5	740
314	41	65	33	49	17	757
315	42	60	33	46.5	14.5	771.5
316	43	64	34	49	17	788.5
317	44	62	36	49	17	805.5
318	45	62	37	49.5	17.5	823
319	46	63	38	50.5	18.5	841.5
320	47	56	38	47	15	856.5
321	48	58	41	49.5	17.5	874
322	49	57	33	45	13	887
323	50	54	31	42.5	10.5	897.5
324	51	52	39	45.5	13.5	911
325	52	50	24	37	5	916
326	53	48	23	35.5	3.5	919.5
327	54	53	24	38.5	6.5	926
328	55	54	29	41.5	9.5	935.5
329	56	53	31	42	10	945.5
330	57	44	33	38.5	6.5	952
331	58	37	23	30	-2	950
332	59	39	15	27	-5	945
333	60	42	17	29.5	-2.5	942.5
334	61	41	23	32	0	942.5
335	62	44	21	32.5	0.5	943
336	63	34	20	27	-5	938
337	64	40	14	27	-5	933
338	65	40	17	28.5	-3.5	929.5
339	66	42	19	30.5	-1.5	928
340	67	44	23	33.5	1.5	929.5
341	68	44	22	33	1	930.5
342	69	47	21	34	2	932.5
343	70	49	23	36	4	936.5
344	71	50	25	37.5	5.5	942
345	72	50	24	37	5	947
346	73	41	32	36.5	4.5	951.5
347	74	44	33	38.5	6.5	958
348	75	36	26	31	-1	957
349	76	38	20	29	-3	954
350	77	40	25	32.5	0.5	954.5
351	78	38	25	31.5	-0.5	954
352	79	32	18	25	-7	947
353	80	38	17	27.5	-4.5	942.5
354	81	25	20	22.5	-9.5	933
355	82	23	6	14.5	-17.5	915.5
356	83	19	-3	8	-24	891.5
357	84	19	-13	3	-29	862.5
358	85	15	-9	3	-29	833.5
359	86	15	-5	5	-27	806.5
360	87	27	-1	13	-19	787.5
361	88	28	-1	13.5	-18.5	769
362	89	34	6	20	-12	757
363	90	36	19	27.5	-4.5	752.5
364	91	23	-5	9	-23	729.5
365	92	26	2	14	-18	711.5
1	93	27	4	15.5	-16.5	695
2	94	28	7	17.5	-14.5	680.5
3	95	35	11	23	-9	671.5
4	96	36	21	28.5	-3.5	668
5	97	43	27	35	3	671
6	98	44	25	34.5	2.5	673.5
7	99	38	28	33	1	674.5
8	100	48	29	38.5	6.5	681
9	101	50	25	37.5	5.5	686.5
10	102	40	23	31.5	-0.5	686
11	103	42	14	28	-4	682
12	104	29	7	18	-14	668
13	105	28	11	19.5	-12.5	655.5
14	106	40	12	26	-6	649.5
15	107	35	15	25	-7	642.5
16	108	41	23	32	0	642.5
17	109	39	14	26.5	-5.5	637
18	110	35	15	25	-7	630
19	111	35	18	26.5	-5.5	624.5
20	112	35	11	23	-9	615.5
21	113	31	17	24	-8	607.5
22	114	30	7	18.5	-13.5	594
23	115	29	7	18	-14	580
24	116	32	9	20.5	-11.5	568.5
25	117	35	14	24.5	-7.5	561
26	118	39	14	26.5	-5.5	555.5
27	119	37	12	24.5	-7.5	548
28	120	36	14	25	-7	541
29	121	34	13	23.5	-8.5	532.5
30	122	37	8	22.5	-9.5	523
31	123	34	8	21	-11	512
32	124	40	18	29	-3	509
33	125	43	16	29.5	-2.5	506.5
34	126	42	23	32.5	0.5	507
35	127	49	26	37.5	5.5	512.5
36	128	49	23	36	4	516.5
37	129	44	21	32.5	0.5	517
38	130	51	28	39.5	7.5	524.5
39	131	44	32	38	6	530.5
40	132	40	25	32.5	0.5	531
41	133	48	20	34	2	533
42	134	46	21	33.5	1.5	534.5

43	135	43	24	33.5	1.5	536
44	136	48	20	34	2	538
45	137	54	28	41	9	547
46	138	53	32	42.5	10.5	557.5
47	139	51	31	41	9	566.5
48	140	49	31	40	8	574.5
49	141	42	25	33.5	1.5	576
50	142	45	21	33	1	577
51	143	56	28	42	10	587
52	144	60	30	45	13	600
53	145	55	33	44	12	612
54	146	56	36	46	14	626
55	147	53	30	41.5	9.5	635.5
56	148	50	23	36.5	4.5	640
57	149	51	30	40.5	8.5	648.5
58	150	53	27	40	8	656.5
59	151	41	32	36.5	4.5	661
60	152	42	32	37	5	666
61	153	48	31	39.5	7.5	673.5
62	154	53	29	41	9	682.5
63	155	54	35	44.5	12.5	695
64	156	54	44	49	17	712
65	157	45	27	36	4	716
66	158	39	23	31	-1	715
67	159	49	20	34.5	2.5	717.5
68	160	53	26	39.5	7.5	725
69	161	54	38	46	14	739
70	162	51	37	44	12	751
71	163	50	23	36.5	4.5	755.5
72	164	54	26	40	8	763.5
73	165	39	29	34	2	765.5
74	166	42	28	35	3	768.5
75	167	50	29	39.5	7.5	776
76	168	53	44	48.5	16.5	792.5
77	169	59	32	45.5	13.5	806
78	170	57	30	43.5	11.5	817.5
79	171	49	30	39.5	7.5	825
80	172	38	28	33	1	826
81	173	50	25	37.5	5.5	831.5
82	174	53	27	40	8	839.5
83	175	61	33	47	15	854.5
84	176	58	35	46.5	14.5	869
85	177	44	31	37.5	5.5	874.5
86	178	40	19	29.5	-2.5	872
87	179	48	27	37.5	5.5	877.5
88	180	45	28	36.5	4.5	882
89	181	57	26	41.5	9.5	891.5
90	182	61	27	44	12	903.5
91	183	64	37	50.5	18.5	922
92	184	66	34	50	18	940
93	185	66	37	51.5	19.5	959.5
94	186	70	36	53	21	980.5
95	187	73	44	58.5	26.5	1007
96	188	74	44	59	27	1034
97	189	71	43	57	25	1059
98	190	56	32	44	12	1071
99	191	60	28	44	12	1083
100	192	67	35	51	19	1102
101	193	45	21	33	1	1103
102	194	44	21	32.5	0.5	1103.5
103	195	48	24	36	4	1107.5
104	196	57	24	40.5	8.5	1116
105	197	65	35	50	18	1134
106	198	70	39	54.5	22.5	1156.5
107	199	66	37	51.5	19.5	1176
108	200	64	35	49.5	17.5	1193.5
109	201	67	36	51.5	19.5	1213
110	202	72	44	58	26	1239
111	203	68	36	52	20	1259
112	204	52	38	45	13	1272
113	205	61	35	48	16	1288
114	206	69	36	52.5	20.5	1308.5
115	207	67	42	54.5	22.5	1331
116	208	53	28	40.5	8.5	1339.5
117	209	50	28	39	7	1346.5
118	210	53	26	39.5	7.5	1354
119	211	60	25	42.5	10.5	1364.5
120	212	59	26	42.5	10.5	1375
121	213	73	35	54	22	1397
122	214	60	43	51.5	19.5	1416.5
123	215	59	32	45.5	13.5	1430
124	216	63	31	47	15	1445
125	217	67	32	49.5	17.5	1462.5
126	218	69	39	54	22	1484.5
127	219	73	45	59	27	1511.5
128	220	81	45	63	31	1542.5
129	221	77	54	65.5	33.5	1576
130	222	74	42	58	26	1602
131	223	63	33	48	16	1618
132	224	66	33	49.5	17.5	1635.5
133	225	79	38	58.5	26.5	1662
134	226	70	44	57	25	1687
135	227	65	39	52	20	1707
136	228	73	40	56.5	24.5	1731.5
137	229	78	46	62	30	1761.5
138	230	79	34	56.5	24.5	1786
139	231	83	45	64	32	1818
140	232	82	47	64.5	32.5	1850.5
141	233	78	52	65	33	1883.5
142	234	75	43	59	27	1910.5
143	235	70	42	56	24	1934.5
144	236	80	44	62	30	1964.5
145	237	82	49	65.5	33.5	1998
146	238	83	50	66.5	34.5	2032.5
147	239	81	49	65	33	2065.5
148	240	78	46	62	30	2095.5
149	241	80	43	61.5	29.5	2125
150	242	79	46	62.5	30.5	2155.5
151	243	60	47	53.5	21.5	2177

152	244	65	39	52	20	2197
153	245	67	43	55	23	2220
154	246	75	43	59	27	2247
155	247	84	50	67	35	2282
156	248	84	52	68	36	2318
157	249	79	50	64.5	32.5	2350.5
158	250	83	49	66	34	2384.5
159	251	87	51	69	37	2421.5
160	252	89	55	72	40	2461.5
161	253	86	53	69.5	37.5	2499
162	254	85	53	69	37	2536
163	255	86	51	68.5	36.5	2572.5
164	256	82	49	65.5	33.5	2606
165	257	82	52	67	35	2641
166	258	85	51	68	36	2677
167	259	87	56	71.5	39.5	2716.5
168	260	91	54	72.5	40.5	2757
169	261	93	57	75	43	2800
170	262	90	63	76.5	44.5	2844.5
171	263	85	55	70	38	2882.5
172	264	87	52	69.5	37.5	2920
173	265	85	62	73.5	41.5	2961.5
174	266	86	52	69	37	2998.5
175	267	86	54	70	38	3036.5
176	268	85	56	70.5	38.5	3075
177	269	83	53	68	36	3111
178	270	81	52	66.5	34.5	3145.5
179	271	88	54	71	39	3184.5
180	272	89	58	73.5	41.5	3226
181	273	86	52	69	37	3263
182	274	92	54	73	41	3304
183	275	96	58	77	45	3349
184	276	95	62	78.5	46.5	3395.5
185	277	94	63	78.5	46.5	3442
186	278	98	61	79.5	47.5	3489.5
187	279	99	63	81	49	3538.5
188	280	97	67	82	50	3588.5
189	281	92	61	76.5	44.5	3633
190	282	84	58	71	39	3672
191	283	88	61	74.5	42.5	3714.5
192	284	88	55	71.5	39.5	3754
193	285	91	58	74.5	42.5	3796.5
194	286	92	58	75	43	3839.5
195	287	93	62	77.5	45.5	3885
196	288	91	63	77	45	3930
197	289	95	61	78	46	3976
198	290	93	59	76	44	4020
199	291	88	62	75	43	4063
200	292	91	67	79	47	4110
201	293	75	56	65.5	33.5	4143.5
202	294	83	53	68	36	4179.5
203	295	90	58	74	42	4221.5
204	296	90	59	74.5	42.5	4264
205	297	87	58	72.5	40.5	4304.5
206	298	85	55	70	38	4342.5
207	299	85	57	71	39	4381.5
208	300	91	56	73.5	41.5	4423
209	301	96	64	80	48	4471
210	302	93	63	78	46	4517
211	303	95	59	77	45	4562
212	304	95	63	79	47	4609
213	305	90	61	75.5	43.5	4652.5
214	306	87	62	74.5	42.5	4695
215	307	84	59	71.5	39.5	4734.5
216	308	88	55	71.5	39.5	4774
217	309	90	60	75	43	4817
218	310	73	55	64	32	4849
219	311	85	54	69.5	37.5	4886.5
220	312	91	57	74	42	4928.5
221	313	90	57	73.5	41.5	4970
222	314	89	59	74	42	5012
223	315	88	60	74	42	5054
224	316	82	59	70.5	38.5	5092.5
225	317	89	58	73.5	41.5	5134
226	318	91	60	75.5	43.5	5177.5
227	319	91	61	76	44	5221.5
228	320	93	60	76.5	44.5	5266
229	321	95	61	78	46	5312
230	322	87	62	74.5	42.5	5354.5
231	323	89	53	71	39	5393.5
232	324	91	62	76.5	44.5	5438
233	325	95	67	81	49	5487
234	326	95	60	77.5	45.5	5532.5
235	327	93	60	76.5	44.5	5577
236	328	91	58	74.5	42.5	5619.5
237	329	92	58	75	43	5662.5
238	330	91	60	75.5	43.5	5706
239	331	88	61	74.5	42.5	5748.5
240	332	86	58	72	40	5788.5
241	333	93	59	76	44	5832.5
242	334	93	59	76	44	5876.5
243	335	91	63	77	45	5921.5
244	336	89	60	74.5	42.5	5964
245	337	89	55	72	40	6004
246	338	91	60	75.5	43.5	6047.5
247	339	87	60	73.5	41.5	6089
248	340	79	55	67	35	6124
249	341	76	56	66	34	6158
250	342	72	54	63	31	6189
251	343	78	51	64.5	32.5	6221.5
252	344	84	54	69	37	6258.5
253	345	81	58	69.5	37.5	6296
254	346	79	52	65.5	33.5	6329.5
255	347	78	50	64	32	6361.5
256	348	77	50	63.5	31.5	6393
257	349	80	48	64	32	6425
258	350	75	47	61	29	6454
259	351	76	45	60.5	28.5	6482.5
260	352	80	42	61	29	6511.5



261	353	84	51	67.5	35.5	6547
262	354	77	50	63.5	31.5	6578.5
263	355	79	47	63	31	6609.5
264	356	84	40	62	30	6639.5
265	357	85	51	68	36	6675.5
266	358	83	49	66	34	6709.5
267	359	83	53	68	36	6745.5
268	360	85	51	68	36	6781.5
269	361	85	52	68.5	36.5	6818
270	362	84	55	69.5	37.5	6855.5
271	363	81	51	66	34	6889.5
272	364	78	52	65	33	6922.5
273	365	80	50	65	33	6955.5



77	954.5	length of freeze (day)	35
112	506.5	frost depth (^oF-day)	448
		average temperature	51.1

1991-1992

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	81	49	65	33	33
275	2	83	49	66	34	67
276	3	84	48	66	34	101
277	4	75	47	61	29	130
278	5	75	40	57.5	25.5	155.5
279	6	78	46	62	30	185.5
280	7	80	45	62.5	30.5	216
281	8	80	49	64.5	32.5	248.5
282	9	82	53	67.5	35.5	284
283	10	83	47	65	33	317
284	11	82	50	66	34	351
285	12	77	50	63.5	31.5	382.5
286	13	82	48	65	33	415.5
287	14	81	47	64	32	447.5
288	15	84	51	67.5	35.5	483
289	16	84	48	66	34	517
290	17	81	48	64.5	32.5	549.5
291	18	81	49	65	33	582.5
292	19	76	44	60	28	610.5
293	20	71	48	59.5	27.5	638
294	21	73	44	58.5	26.5	664.5
295	22	69	42	55.5	23.5	688
296	23	66	41	53.5	21.5	709.5
297	24	58	38	48	16	725.5
298	25	59	37	48	16	741.5
299	26	51	36	43.5	11.5	753
300	27	49	35	42	10	763
301	28	36	25	30.5	-1.5	761.5
302	29	34	23	28.5	-3.5	758
303	30	42	25	33.5	1.5	759.5
304	31	42	17	29.5	-2.5	757
305	32	43	23	33	1	758
306	33	42	20	31	-1	757
307	34	45	15	30	-2	755
308	35	51	24	37.5	5.5	760.5
309	36	59	30	44.5	12.5	773
310	37	64	34	49	17	790
311	38	68	39	53.5	21.5	811.5
312	39	62	37	49.5	17.5	829
313	40	63	41	52	20	849
314	41	51	41	46	14	863
315	42	61	38	49.5	17.5	880.5
316	43	58	33	45.5	13.5	894
317	44	55	28	41.5	9.5	903.5
318	45	55	35	45	13	916.5
319	46	40	31	35.5	3.5	920
320	47	45	31	38	6	926
321	48	43	29	36	4	930
322	49	48	30	39	7	937
323	50	46	27	36.5	4.5	941.5
324	51	45	23	34	2	943.5
325	52	44	28	36	4	947.5
326	53	39	26	32.5	0.5	948
327	54	40	13	26.5	-5.5	942.5
328	55	46	20	33	1	943.5
329	56	50	26	38	6	949.5
330	57	45	27	36	4	953.5
331	58	52	29	40.5	8.5	962
332	59	51	32	41.5	9.5	971.5
333	60	51	30	40.5	8.5	980
334	61	42	27	34.5	2.5	982.5
335	62	34	15	24.5	-7.5	975
336	63	32	13	22.5	-9.5	965.5
337	64	40	16	28	-4	961.5
338	65	41	16	28.5	-3.5	958
339	66	40	17	28.5	-3.5	954.5
340	67	42	19	30.5	-1.5	953
341	68	45	21	33	1	954
342	69	49	26	37.5	5.5	959.5
343	70	49	25	37	5	964.5
344	71	40	30	35	3	967.5
345	72	40	25	32.5	0.5	968
346	73	49	21	35	3	971
347	74	40	27	33.5	1.5	972.5
348	75	39	26	32.5	0.5	973
349	76	30	21	25.5	-6.5	966.5
350	77	25	18	21.5	-10.5	956
351	78	33	20	26.5	-5.5	950.5
352	79	39	25	32	0	950.5
353	80	35	26	30.5	-1.5	949
354	81	47	25	36	4	953
355	82	47	27	37	5	958
356	83	38	25	31.5	-0.5	957.5
357	84	37	20	28.5	-3.5	954
358	85	44	20	32	0	954
359	86	32	18	25	-7	947
360	87	27	22	24.5	-7.5	939.5
361	88	30	19	24.5	-7.5	932
362	89	29	23	26	-6	926
363	90	37	23	30	-2	924
364	91	37	24	30.5	-1.5	922.5

365	92	38	19	28.5	-3.5	919
1	93	35	12	23.5	-8.5	910.5
2	94	28	13	20.5	-11.5	899
3	95	27	11	19	-13	886
4	96	38	20	29	-3	883
5	97	38	26	32	0	883
6	98	37	25	31	-1	882
7	99	35	20	27.5	-4.5	877.5
8	100	38	14	26	-6	871.5
9	101	40	10	25	-7	864.5
10	102	34	9	21.5	-10.5	854
11	103	23	9	16	-16	838
12	104	39	11	25	-7	831
13	105	38	9	23.5	-8.5	822.5
14	106	37	11	24	-8	814.5
15	107	39	15	27	-5	809.5
16	108	34	10	22	-10	799.5
17	109	39	8	23.5	-8.5	791
18	110	41	17	29	-3	788
19	111	39	17	28	-4	784
20	112	42	15	28.5	-3.5	780.5
21	113	39	15	27	-5	775.5
22	114	40	17	28.5	-3.5	772
23	115	39	16	27.5	-4.5	767.5
24	116	44	21	32.5	0.5	768
25	117	47	22	34.5	2.5	770.5
26	118	45	26	35.5	3.5	774
27	119	45	24	34.5	2.5	776.5
28	120	46	23	34.5	2.5	779
29	121	43	21	32	0	779
30	122	43	23	33	1	780
31	123	-	-	-	-	780
32	124	47	25	36	4	784
33	125	50	28	39	7	791
34	126	45	32	38.5	6.5	797.5
35	127	46	29	37.5	5.5	803
36	128	46	24	35	3	806
37	129	44	26	35	3	809
38	130	45	29	37	5	814
39	131	43	32	37.5	5.5	819.5
40	132	43	32	37.5	5.5	825
41	133	40	32	36	4	829
42	134	38	30	34	2	831
43	135	42	31	36.5	4.5	835.5
44	136	38	32	35	3	838.5
45	137	43	27	35	3	841.5
46	138	43	28	35.5	3.5	845
47	139	38	19	28.5	-3.5	841.5
48	140	44	17	30.5	-1.5	840
49	141	42	20	31	-1	839
50	142	44	22	33	1	840
51	143	40	27	33.5	1.5	841.5
52	144	55	31	43	11	852.5
53	145	52	32	42	10	862.5
54	146	48	31	39.5	7.5	870
55	147	53	23	38	6	876
56	148	52	29	40.5	8.5	884.5
57	149	55	27	41	9	893.5
58	150	58	30	44	12	905.5
59	151	61	32	46.5	14.5	920
60	152	60	33	46.5	14.5	934.5
61	153	60	30	45	13	947.5
62	154	60	38	49	17	964.5
63	155	52	34	43	11	975.5
64	156	51	31	41	9	984.5
65	157	57	36	46.5	14.5	999
66	158	55	31	43	11	1010
67	159	62	34	48	16	1026
68	160	42	31	36.5	4.5	1030.5
69	161	47	30	38.5	6.5	1037
70	162	53	25	39	7	1044
71	163	58	31	44.5	12.5	1056.5
72	164	63	33	48	16	1072.5
73	165	64	34	49	17	1089.5
74	166	65	37	51	19	1108.5
75	167	63	37	50	18	1126.5
76	168	61	34	47.5	15.5	1142
77	169	58	34	46	14	1156
78	170	51	28	39.5	7.5	1163.5
79	171	56	28	42	10	1173.5
80	172	59	29	44	12	1185.5
81	173	54	34	44	12	1197.5
82	174	53	31	42	10	1207.5
83	175	52	33	42.5	10.5	1218
84	176	56	29	42.5	10.5	1228.5
85	177	60	31	45.5	13.5	1242
86	178	65	38	51.5	19.5	1261.5
87	179	51	34	42.5	10.5	1272
88	180	47	34	40.5	8.5	1280.5
89	181	55	33	44	12	1292.5
90	182	56	38	47	15	1307.5
91	183	45	38	41.5	9.5	1317
92	184	55	35	45	13	1330
93	185	64	33	48.5	16.5	1346.5
94	186	67	37	52	20	1366.5
95	187	70	39	54.5	22.5	1389
96	188	70	40	55	23	1412
97	189	69	42	55.5	23.5	1435.5
98	190	70	40	55	23	1458.5
99	191	71	42	56.5	24.5	1483
100	192	73	43	58	26	1509
101	193	75	43	59	27	1536
102	194	74	47	60.5	28.5	1564.5
103	195	76	48	62	30	1594.5
104	196	75	48	61.5	29.5	1624
105	197	72	46	59	27	1651
106	198	70	43	56.5	24.5	1675.5
107	199	66	39	52.5	20.5	1696
108	200	73	43	58	26	1722

109	201	57	39	48	16	1738
110	202	60	33	46.5	14.5	1752.5
111	203	63	35	49	17	1769.5
112	204	69	35	52	20	1789.5
113	205	68	42	55	23	1812.5
114	206	73	40	56.5	24.5	1837
115	207	75	41	58	26	1863
116	208	77	44	60.5	28.5	1891.5
117	209	79	45	62	30	1921.5
118	210	83	52	67.5	35.5	1957
119	211	86	51	68.5	36.5	1993.5
120	212	85	51	68	36	2029.5
121	213	83	48	65.5	33.5	2063
122	214	82	48	65	33	2096
123	215	80	44	62	30	2126
124	216	81	49	65	33	2159
125	217	75	44	59.5	27.5	2186.5
126	218	80	47	63.5	31.5	2218
127	219	75	48	61.5	29.5	2247.5
128	220	68	45	56.5	24.5	2272
129	221	75	46	60.5	28.5	2300.5
130	222	66	42	54	22	2322.5
131	223	65	35	50	18	2340.5
132	224	77	42	59.5	27.5	2368
133	225	77	48	62.5	30.5	2398.5
134	226	79	48	63.5	31.5	2430
135	227	80	50	65	33	2463
136	228	81	49	65	33	2496
137	229	80	46	63	31	2527
138	230	84	50	67	35	2562
139	231	84	53	68.5	36.5	2598.5
140	232	79	53	66	34	2632.5
141	233	65	50	57.5	25.5	2658
142	234	70	46	58	26	2684
143	235	75	40	57.5	25.5	2709.5
144	236	73	40	56.5	24.5	2734
145	237	65	47	56	24	2758
146	238	74	45	59.5	27.5	2785.5
147	239	71	50	60.5	28.5	2814
148	240	74	47	60.5	28.5	2842.5
149	241	74	42	58	26	2868.5
150	242	70	49	59.5	27.5	2896
151	243	75	41	58	26	2922
152	244	79	46	62.5	30.5	2952.5
153	245	73	49	61	29	2981.5
154	246	82	46	64	32	3013.5
155	247	79	55	67	35	3048.5
156	248	88	52	70	38	3086.5
157	249	85	54	69.5	37.5	3124
158	250	85	51	68	36	3160
159	251	83	51	67	35	3195
160	252	73	51	62	30	3225
161	253	79	47	63	31	3256
162	254	84	51	67.5	35.5	3291.5
163	255	86	55	70.5	38.5	3330
164	256	84	53	68.5	36.5	3366.5
165	257	82	48	65	33	3399.5
166	258	77	45	61	29	3428.5
167	259	74	37	55.5	23.5	3452
168	260	74	45	59.5	27.5	3479.5
169	261	80	45	62.5	30.5	3510
170	262	87	52	69.5	37.5	3547.5
171	263	88	52	70	38	3585.5
172	264	90	54	72	40	3625.5
173	265	90	56	73	41	3666.5
174	266	95	57	76	44	3710.5
175	267	93	56	74.5	42.5	3753
176	268	89	55	72	40	3793
177	269	88	57	72.5	40.5	3833.5
178	270	84	53	68.5	36.5	3870
179	271	86	51	68.5	36.5	3906.5
180	272	93	57	75	43	3949.5
181	273	90	56	73	41	3990.5
182	274	88	52	70	38	4028.5
183	275	82	51	66.5	34.5	4063
184	276	80	46	63	31	4094
185	277	89	51	70	38	4132
186	278	92	60	76	44	4176
187	279	96	62	79	47	4223
188	280	96	64	80	48	4271
189	281	86	64	75	43	4314
190	282	75	57	66	34	4348
191	283	85	55	70	38	4386
192	284	87	59	73	41	4427
193	285	83	55	69	37	4464
194	286	67	54	60.5	28.5	4492.5
195	287	78	54	66	34	4526.5
196	288	81	53	67	35	4561.5
197	289	87	58	72.5	40.5	4602
198	290	88	57	72.5	40.5	4642.5
199	291	87	60	73.5	41.5	4684
200	292	89	69	79	47	4731
201	293	90	70	80	48	4779
202	294	91	63	77	45	4824
203	295	91	61	76	44	4868
204	296	90	60	75	43	4911
205	297	86	60	73	41	4952
206	298	77	58	67.5	35.5	4987.5
207	299	84	58	71	39	5026.5
208	300	87	54	70.5	38.5	5065
209	301	91	60	75.5	43.5	5108.5
210	302	90	59	74.5	42.5	5151
211	303	93	61	77	45	5196
212	304	94	60	77	45	5241
213	305	94	58	76	44	5285
214	306	92	60	76	44	5329
215	307	95	61	78	46	5375
216	308	94	61	77.5	45.5	5420.5
217	309	94	64	79	47	5467.5

218	310	90	62	76	44	5511.5
219	311	83	61	72	40	5551.5
220	312	88	55	71.5	39.5	5591
221	313	90	59	74.5	42.5	5633.5
222	314	94	61	77.5	45.5	5679
223	315	94	63	78.5	46.5	5725.5
224	316	88	67	77.5	45.5	5771
225	317	87	57	72	40	5811
226	318	93	62	77.5	45.5	5856.5
227	319	96	61	78.5	46.5	5903
228	320	93	61	77	45	5948
229	321	94	66	80	48	5996
230	322	90	63	76.5	44.5	6040.5
231	323	93	60	76.5	44.5	6085
232	324	95	64	79.5	47.5	6132.5
233	325	93	58	75.5	43.5	6176
234	326	93	62	77.5	45.5	6221.5
235	327	73	61	67	35	6256.5
236	328	67	55	61	29	6285.5
237	329	76	53	64.5	32.5	6318
238	330	78	52	65	33	6351
239	331	80	47	63.5	31.5	6382.5
240	332	82	47	64.5	32.5	6415
241	333	86	52	69	37	6452
242	334	85	54	69.5	37.5	6489.5
243	335	85	54	69.5	37.5	6527
244	336	65	50	57.5	25.5	6552.5
245	337	79	47	63	31	6583.5
246	338	82	50	66	34	6617.5
247	339	82	54	68	36	6653.5
248	340	81	53	67	35	6688.5
249	341	73	45	59	27	6715.5
250	342	82	55	68.5	36.5	6752
251	343	84	57	70.5	38.5	6790.5
252	344	86	54	70	38	6828.5
253	345	89	54	71.5	39.5	6868
254	346	89	53	71	39	6907
255	347	87	56	71.5	39.5	6946.5
256	348	89	55	72	40	6986.5
257	349	85	58	71.5	39.5	7026
258	350	85	54	69.5	37.5	7063.5
259	351	78	55	66.5	34.5	7098
260	352	82	54	68	36	7134
261	353	85	54	69.5	37.5	7171.5
262	354	78	53	65.5	33.5	7205
263	355	72	50	61	29	7234
264	356	78	49	63.5	31.5	7265.5
265	357	81	51	66	34	7299.5
266	358	79	49	64	32	7331.5
267	359	82	52	67	35	7366.5
268	360	81	55	68	36	7402.5
269	361	72	53	62.5	30.5	7433
270	362	75	38	56.5	24.5	7457.5
271	363	78	45	61.5	29.5	7487
272	364	80	48	64	32	7519
273	365	80	50	65	33	7552
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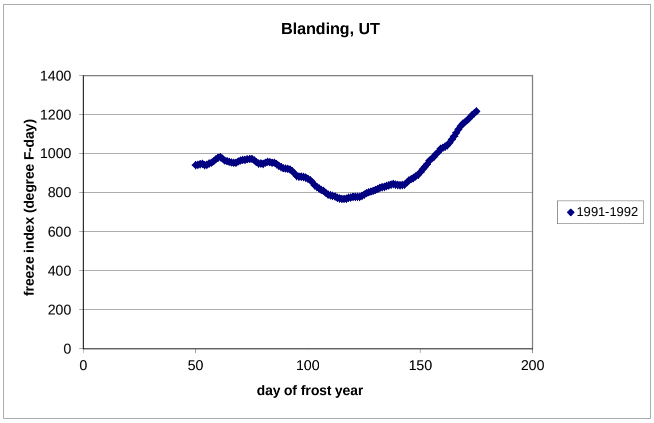


61	982.5	length of freeze (day)	54
115	767.5	frost depth (^oF-day)	215
		average temperature	52.8

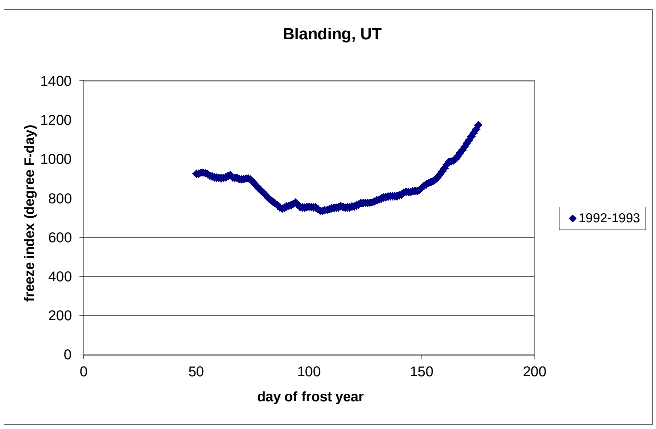
1992-1993

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	84	52	68	36	36
275	2	80	52	66	34	70
276	3	73	47	60	28	98
277	4	75	42	58.5	26.5	124.5
278	5	76	44	60	28	152.5
279	6	75	47	61	29	181.5
280	7	60	35	47.5	15.5	197
281	8	66	32	49	17	214
282	9	75	39	57	25	239
283	10	76	40	58	26	265
284	11	78	41	59.5	27.5	292.5
285	12	77	46	61.5	29.5	322
286	13	77	45	61	29	351
287	14	77	47	62	30	381
288	15	71	43	57	25	406
289	16	72	42	57	25	431
290	17	72	43	57.5	25.5	456.5
291	18	74	44	59	27	483.5
292	19	75	47	61	29	512.5
293	20	75	45	60	28	540.5
294	21	70	45	57.5	25.5	566
295	22	73	48	60.5	28.5	594.5
296	23	75	45	60	28	622.5
297	24	73	51	62	30	652.5
298	25	63	44	53.5	21.5	674
299	26	63	38	50.5	18.5	692.5
300	27	62	40	51	19	711.5
301	28	52	44	48	16	727.5
302	29	52	41	46.5	14.5	742
303	30	51	39	45	13	755
304	31	50	38	44	12	767
305	32	54	29	41.5	9.5	776.5
306	33	57	31	44	12	788.5
307	34	43	29	36	4	792.5
308	35	46	22	34	2	794.5
309	36	50	24	37	5	799.5
310	37	50	24	37	5	804.5
311	38	53	28	40.5	8.5	813
312	39	54	30	42	10	823
313	40	56	34	45	13	836
314	41	48	33	40.5	8.5	844.5
315	42	45	26	35.5	3.5	848
316	43	50	23	36.5	4.5	852.5
317	44	51	26	38.5	6.5	859
318	45	56	29	42.5	10.5	869.5
319	46	58	31	44.5	12.5	882
320	47	58	31	44.5	12.5	894.5

321	48	51	34	42.5	10.5	905
322	49	52	33	42.5	10.5	915.5
323	50	52	31	41.5	9.5	925
324	51	35	30	32.5	0.5	925.5
325	52	48	25	36.5	4.5	930
326	53	42	24	33	1	931
327	54	39	21	30	-2	929
328	55	36	17	26.5	-5.5	923.5
329	56	36	12	24	-8	915.5
330	57	43	15	29	-3	912.5
331	58	40	15	27.5	-4.5	908
332	59	42	19	30.5	-1.5	906.5
333	60	43	18	30.5	-1.5	905
334	61	42	18	30	-2	903
335	62	48	19	33.5	1.5	904.5
336	63	47	23	35	3	907.5
337	64	50	29	39.5	7.5	915
338	65	42	29	35.5	3.5	918.5
339	66	23	20	21.5	-10.5	908
340	67	39	19	29	-3	905
341	68	42	21	31.5	-0.5	904.5
342	69	40	12	26	-6	898.5
343	70	37	24	30.5	-1.5	897
344	71	46	19	32.5	0.5	897.5
345	72	47	24	35.5	3.5	901
346	73	39	25	32	0	901
347	74	35	20	27.5	-4.5	896.5
348	75	35	6	20.5	-11.5	885
349	76	29	9	19	-13	872
350	77	28	11	19.5	-12.5	859.5
351	78	33	6	19.5	-12.5	847
352	79	28	15	21.5	-10.5	836.5
353	80	35	9	22	-10	826.5
354	81	37	2	19.5	-12.5	814
355	82	35	5	20	-12	802
356	83	34	9	21.5	-10.5	791.5
357	84	35	9	22	-10	781.5
358	85	38	9	23.5	-8.5	773
359	86	37	8	22.5	-9.5	763.5
360	87	36	9	22.5	-9.5	754
361	88	40	11	25.5	-6.5	747.5
362	89	38	35	36.5	4.5	752
363	90	43	34	38.5	6.5	758.5
364	91	41	30	35.5	3.5	762
365	92	48	23	35.5	3.5	765.5
1	93	47	29	38	6	771.5
2	94	46	33	39.5	7.5	779
3	95	27	16	21.5	-10.5	768.5
4	96	33	6	19.5	-12.5	756
5	97	43	16	29.5	-2.5	753.5
6	98	38	25	31.5	-0.5	753
7	99	38	30	34	2	755
8	100	38	31	34.5	2.5	757.5
9	101	36	24	30	-2	755.5
10	102	32	29	30.5	-1.5	754
11	103	35	29	32	0	754
12	104	37	7	22	-10	744
13	105	33	14	23.5	-8.5	735.5
14	106	38	28	33	1	736.5
15	107	39	31	35	3	739.5
16	108	37	31	34	2	741.5
17	109	37	31	34	2	743.5
18	110	43	32	37.5	5.5	749
19	111	39	30	34.5	2.5	751.5
20	112	46	19	32.5	0.5	752
21	113	45	23	34	2	754
22	114	51	25	38	6	760
23	115	38	18	28	-4	756
24	116	40	18	29	-3	753
25	117	47	18	32.5	0.5	753.5
26	118	45	20	32.5	0.5	754
27	119	48	25	36.5	4.5	758.5
28	120	43	23	33	1	759.5
29	121	49	24	36.5	4.5	764
30	122	41	32	36.5	4.5	768.5
31	123	47	32	39.5	7.5	776
32	124	36	28	32	0	776
33	125	42	23	32.5	0.5	776.5
34	126	45	20	32.5	0.5	777
35	127	46	18	32	0	777
36	128	47	19	33	1	778
37	129	52	23	37.5	5.5	783.5
38	130	49	29	39	7	790.5
39	131	38	31	34.5	2.5	793
40	132	43	33	38	6	799
41	133	47	27	37	5	804
42	134	44	26	35	3	807
43	135	46	24	35	3	810
44	136	43	24	33.5	1.5	811.5
45	137	42	23	32.5	0.5	812
46	138	39	23	31	-1	811
47	139	43	22	32.5	0.5	811.5
48	140	45	28	36.5	4.5	816
49	141	46	26	36	4	820
50	142	48	34	41	9	829
51	143	40	31	35.5	3.5	832.5
52	144	41	24	32.5	0.5	833
53	145	42	19	30.5	-1.5	831.5
54	146	47	25	36	4	835.5
55	147	39	29	34	2	837.5
56	148	40	24	32	0	837.5
57	149	45	27	36	4	841.5
58	150	57	31	44	12	853.5
59	151	50	35	42.5	10.5	864
60	152	50	29	39.5	7.5	871.5
61	153	50	26	38	6	877.5
62	154	50	24	37	5	882.5
63	155	51	23	37	5	887.5
64	156	55	25	40	8	895.5

65	157	58	30	44	12	907.5
66	158	62	31	46.5	14.5	922
67	159	63	32	47.5	15.5	937.5
68	160	63	33	48	16	953.5
69	161	64	37	50.5	18.5	972
70	162	55	36	45.5	13.5	985.5
71	163	45	24	34.5	2.5	988
72	164	51	23	37	5	993
73	165	52	29	40.5	8.5	1001.5
74	166	59	33	46	14	1015.5
75	167	63	33	48	16	1031.5
76	168	56	38	47	15	1046.5
77	169	60	38	49	17	1063.5
78	170	63	35	49	17	1080.5
79	171	62	35	48.5	16.5	1097
80	172	63	38	50.5	18.5	1115.5
81	173	67	32	49.5	17.5	1133
82	174	69	36	52.5	20.5	1153.5
83	175	68	38	53	21	1174.5
84	176	66	37	51.5	19.5	1194
85	177	65	43	54	22	1216
86	178	43	31	37	5	1221
87	179	47	33	40	8	1229
88	180	56	31	43.5	11.5	1240.5
89	181	54	31	42.5	10.5	1251
90	182	58	29	43.5	11.5	1262.5
91	183	62	33	47.5	15.5	1278
92	184	57	38	47.5	15.5	1293.5
93	185	62	30	46	14	1307.5
94	186	66	36	51	19	1326.5
95	187	60	38	49	17	1343.5
96	188	50	31	40.5	8.5	1352
97	189	50	28	39	7	1359
98	190	60	28	44	12	1371
99	191	66	34	50	18	1389
100	192	68	39	53.5	21.5	1410.5
101	193	69	39	54	22	1432.5
102	194	62	40	51	19	1451.5
103	195	52	25	38.5	6.5	1458
104	196	55	30	42.5	10.5	1468.5
105	197	64	51	57.5	25.5	1494
106	198	63	38	50.5	18.5	1512.5
107	199	70	36	53	21	1533.5
108	200	69	43	56	24	1557.5
109	201	55	28	41.5	9.5	1567
110	202	65	30	47.5	15.5	1582.5
111	203	73	38	55.5	23.5	1606
112	204	76	43	59.5	27.5	1633.5
113	205	71	43	57	25	1658.5
114	206	62	41	51.5	19.5	1678
115	207	67	33	50	18	1696
116	208	75	35	55	23	1719
117	209	75	43	59	27	1746
118	210	73	44	58.5	26.5	1772.5
119	211	75	39	57	25	1797.5
120	212	69	41	55	23	1820.5
121	213	64	39	51.5	19.5	1840
122	214	68	38	53	21	1861
123	215	76	46	61	29	1890
124	216	72	46	59	27	1917
125	217	50	31	40.5	8.5	1925.5
126	218	62	34	48	16	1941.5
127	219	62	42	52	20	1961.5
128	220	54	33	43.5	11.5	1973
129	221	63	36	49.5	17.5	1990.5
130	222	75	40	57.5	25.5	2016
131	223	80	46	63	31	2047
132	224	80	47	63.5	31.5	2078.5
133	225	79	50	64.5	32.5	2111
134	226	77	46	61.5	29.5	2140.5
135	227	80	49	64.5	32.5	2173
136	228	75	52	63.5	31.5	2204.5
137	229	64	49	56.5	24.5	2229
138	230	75	46	60.5	28.5	2257.5
139	231	80	51	65.5	33.5	2291
140	232	79	49	64	32	2323
141	233	79	53	66	34	2357
142	234	76	51	63.5	31.5	2388.5
143	235	79	48	63.5	31.5	2420
144	236	80	52	66	34	2454
145	237	83	52	67.5	35.5	2489.5
146	238	83	54	68.5	36.5	2526
147	239	78	54	66	34	2560
148	240	76	52	64	32	2592
149	241	78	50	64	32	2624
150	242	82	51	66.5	34.5	2658.5
151	243	83	53	68	36	2694.5
152	244	80	52	66	34	2728.5
153	245	78	49	63.5	31.5	2760
154	246	70	45	57.5	25.5	2785.5
155	247	70	40	55	23	2808.5
156	248	76	51	63.5	31.5	2840
157	249	65	48	56.5	24.5	2864.5
158	250	67	35	51	19	2883.5
159	251	66	42	54	22	2905.5
160	252	72	44	58	26	2931.5
161	253	79	47	63	31	2962.5
162	254	84	51	67.5	35.5	2998
163	255	87	53	70	38	3036
164	256	88	54	71	39	3075
165	257	92	60	76	44	3119
166	258	92	59	75.5	43.5	3162.5
167	259	89	59	74	42	3204.5
168	260	80	53	66.5	34.5	3239
169	261	76	44	60	28	3267
170	262	82	42	62	30	3297
171	263	89	54	71.5	39.5	3336.5
172	264	88	58	73	41	3377.5
173	265	86	53	69.5	37.5	3415

174	266	87	54	70.5	38.5	3453.5
175	267	80	45	62.5	30.5	3484
176	268	89	51	70	38	3522
177	269	93	55	74	42	3564
178	270	93	59	76	44	3608
179	271	96	62	79	47	3655
180	272	94	60	77	45	3700
181	273	91	57	74	42	3742
182	274	93	58	75.5	43.5	3785.5
183	275	94	62	78	46	3831.5
184	276	87	61	74	42	3873.5
185	277	86	50	68	36	3909.5
186	278	83	51	67	35	3944.5
187	279	90	54	72	40	3984.5
188	280	93	53	73	41	4025.5
189	281	93	61	77	45	4070.5
190	282	95	59	77	45	4115.5
191	283	93	61	77	45	4160.5
192	284	93	59	76	44	4204.5
193	285	90	62	76	44	4248.5
194	286	89	57	73	41	4289.5
195	287	89	57	73	41	4330.5
196	288	90	56	73	41	4371.5
197	289	89	56	72.5	40.5	4412
198	290	87	53	70	38	4450
199	291	90	54	72	40	4490
200	292	89	57	73	41	4531
201	293	88	58	73	41	4572
202	294	86	56	71	39	4611
203	295	84	57	70.5	38.5	4649.5
204	296	89	54	71.5	39.5	4689
205	297	85	55	70	38	4727
206	298	90	56	73	41	4768
207	299	90	54	72	40	4808
208	300	91	58	74.5	42.5	4850.5
209	301	96	62	79	47	4897.5
210	302	93	65	79	47	4944.5
211	303	92	62	77	45	4989.5
212	304	95	62	78.5	46.5	5036
213	305	98	58	78	46	5082
214	306	95	60	77.5	45.5	5127.5
215	307	89	63	76	44	5171.5
216	308	89	62	75.5	43.5	5215
217	309	86	54	70	38	5253
218	310	88	60	74	42	5295
219	311	89	59	74	42	5337
220	312	86	59	72.5	40.5	5377.5
221	313	88	57	72.5	40.5	5418
222	314	86	57	71.5	39.5	5457.5
223	315	89	53	71	39	5496.5
224	316	90	59	74.5	42.5	5539
225	317	90	58	74	42	5581
226	318	80	56	68	36	5617
227	319	84	55	69.5	37.5	5654.5
228	320	90	53	71.5	39.5	5694
229	321	90	57	73.5	41.5	5735.5
230	322	90	54	72	40	5775.5
231	323	86	58	72	40	5815.5
232	324	80	57	68.5	36.5	5852
233	325	81	56	68.5	36.5	5888.5
234	326	86	53	69.5	37.5	5926
235	327	88	53	70.5	38.5	5964.5
236	328	90	57	73.5	41.5	6006
237	329	73	58	65.5	33.5	6039.5
238	330	75	54	64.5	32.5	6072
239	331	69	57	63	31	6103
240	332	78	54	66	34	6137
241	333	82	55	68.5	36.5	6173.5
242	334	80	43	61.5	29.5	6203
243	335	76	53	64.5	32.5	6235.5
244	336	85	53	69	37	6272.5
245	337	85	54	69.5	37.5	6310
246	338	87	55	71	39	6349
247	339	89	57	73	41	6390
248	340	88	54	71	39	6429
249	341	86	54	70	38	6467
250	342	85	56	70.5	38.5	6505.5
251	343	83	54	68.5	36.5	6542
252	344	86	53	69.5	37.5	6579.5
253	345	87	56	71.5	39.5	6619
254	346	86	53	69.5	37.5	6656.5
255	347	85	55	70	38	6694.5
256	348	69	48	58.5	26.5	6721
257	349	67	37	52	20	6741
258	350	73	43	58	26	6767
259	351	77	49	63	31	6798
260	352	74	46	60	28	6826
261	353	62	42	52	20	6846
262	354	73	39	56	24	6870
263	355	76	45	60.5	28.5	6898.5
264	356	79	48	63.5	31.5	6930
265	357	83	51	67	35	6965
266	358	81	50	65.5	33.5	6998.5
267	359	75	45	60	28	7026.5
268	360	78	44	61	29	7055.5
269	361	79	48	63.5	31.5	7087
270	362	78	47	62.5	30.5	7117.5
271	363	81	47	64	32	7149.5
272	364	80	47	63.5	31.5	7181
273	365	82	47	64.5	32.5	7213.5



54	929	length of freeze (day)	52
106	736.5	frost depth (°F-day)	192.5
		average temperature	51.8

1993-1994

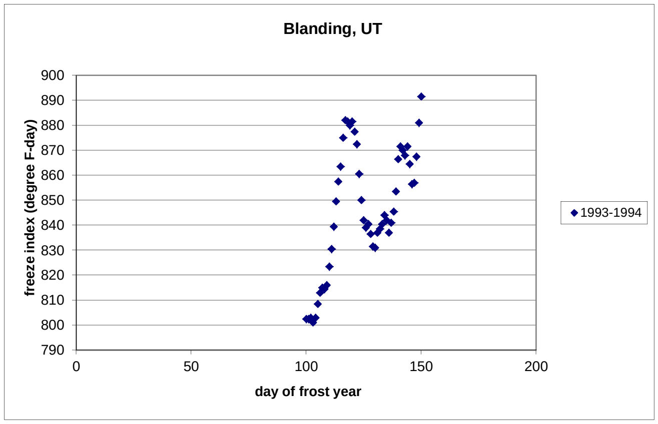
day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (°F)	cumulative degree day (°F)
274	1	82	51	66.5	34.5	34.5
275	2	82	47	64.5	32.5	67
276	3	81	47	64	32	99
277	4	81	50	65.5	33.5	132.5

278	5	81	52	66.5	34.5	167
279	6	62	50	56	24	191
280	7	60	44	52	20	211
281	8	64	41	52.5	20.5	231.5
282	9	64	36	50	18	249.5
283	10	69	41	55	23	272.5
284	11	64	43	53.5	21.5	294
285	12	66	43	54.5	22.5	316.5
286	13	65	41	53	21	337.5
287	14	68	44	56	24	361.5
288	15	65	42	53.5	21.5	383
289	16	59	38	48.5	16.5	399.5
290	17	55	41	48	16	415.5
291	18	56	35	45.5	13.5	429
292	19	62	34	48	16	445
293	20	63	35	49	17	462
294	21	64	34	49	17	479
295	22	66	38	52	20	499
296	23	67	37	52	20	519
297	24	66	39	52.5	20.5	539.5
298	25	68	40	54	22	561.5
299	26	60	38	49	17	578.5
300	27	53	29	41	9	587.5
301	28	55	29	42	10	597.5
302	29	53	33	43	11	608.5
303	30	46	19	32.5	0.5	609
304	31	54	25	39.5	7.5	616.5
305	32	60	33	46.5	14.5	631
306	33	55	28	41.5	9.5	640.5
307	34	54	28	41	9	649.5
308	35	60	30	45	13	662.5
309	36	45	26	35.5	3.5	666
310	37	49	17	33	1	667
311	38	52	27	39.5	7.5	674.5
312	39	54	26	40	8	682.5
313	40	57	26	41.5	9.5	692
314	41	55	32	43.5	11.5	703.5
315	42	54	40	47	15	718.5
316	43	44	30	37	5	723.5
317	44	40	31	35.5	3.5	727
318	45	43	26	34.5	2.5	729.5
319	46	49	29	39	7	736.5
320	47	49	26	37.5	5.5	742
321	48	48	27	37.5	5.5	747.5
322	49	48	30	39	7	754.5
323	50	50	22	36	4	758.5
324	51	47	23	35	3	761.5
325	52	49	25	37	5	766.5
326	53	46	34	40	8	774.5
327	54	59	37	48	16	790.5
328	55	33	23	28	-4	786.5
329	56	28	10	19	-13	773.5
330	57	35	10	22.5	-9.5	764
331	58	46	14	30	-2	762
332	59	46	21	33.5	1.5	763.5
333	60	49	23	36	4	767.5
334	61	52	22	37	5	772.5
335	62	53	26	39.5	7.5	780
336	63	49	24	36.5	4.5	784.5
337	64	45	21	33	1	785.5
338	65	45	22	33.5	1.5	787
339	66	47	24	35.5	3.5	790.5
340	67	47	25	36	4	794.5
341	68	49	23	36	4	798.5
342	69	50	26	38	6	804.5
343	70	49	27	38	6	810.5
344	71	55	27	41	9	819.5
345	72	53	26	39.5	7.5	827
346	73	40	28	34	2	829
347	74	41	18	29.5	-2.5	826.5
348	75	45	18	31.5	-0.5	826
349	76	56	27	41.5	9.5	835.5
350	77	36	23	29.5	-2.5	833
351	78	38	14	26	-6	827
352	79	41	19	30	-2	825
353	80	40	22	31	-1	824
354	81	40	12	26	-6	818
355	82	40	13	26.5	-5.5	812.5
356	83	36	10	23	-9	803.5
357	84	34	20	27	-5	798.5
358	85	40	12	26	-6	792.5
359	86	39	19	29	-3	789.5
360	87	44	19	31.5	-0.5	789
361	88	35	29	32	0	789
362	89	41	23	32	0	789
363	90	43	18	30.5	-1.5	787.5
364	91	41	19	30	-2	785.5
365	92	45	20	32.5	0.5	786
1	93	41	22	31.5	-0.5	785.5
2	94	48	26	37	5	790.5
3	95	51	24	37.5	5.5	796
4	96	47	29	38	6	802
5	97	55	33	44	12	814
6	98	37	23	30	-2	812
7	99	36	14	25	-7	805
8	100	42	17	29.5	-2.5	802.5
9	101	43	21	32	0	802.5
10	102	46	19	32.5	0.5	803
11	103	41	19	30	-2	801
12	104	48	20	34	2	803
13	105	53	22	37.5	5.5	808.5
14	106	50	23	36.5	4.5	813
15	107	45	23	34	2	815
16	108	43	20	31.5	-0.5	814.5
17	109	47	20	33.5	1.5	816
18	110	54	25	39.5	7.5	823.5
19	111	53	25	39	7	830.5
20	112	55	27	41	9	839.5
21	113	57	27	42	10	849.5

22	114	55	25	40	8	857.5
23	115	52	24	38	6	863.5
24	116	54	33	43.5	11.5	875
25	117	49	29	39	7	882
26	118	39	24	31.5	-0.5	881.5
27	119	36	25	30.5	-1.5	880
28	120	40	27	33.5	1.5	881.5
29	121	39	17	28	-4	877.5
30	122	35	19	27	-5	872.5
31	123	32	8	20	-12	860.5
32	124	35	8	21.5	-10.5	850
33	125	39	9	24	-8	842
34	126	40	18	29	-3	839
35	127	35	32	33.5	1.5	840.5
36	128	38	18	28	-4	836.5
37	129	35	19	27	-5	831.5
38	130	42	21	31.5	-0.5	831
39	131	45	31	38	6	837
40	132	45	22	33.5	1.5	838.5
41	133	45	23	34	2	840.5
42	134	40	31	35.5	3.5	844
43	135	40	20	30	-2	842
44	136	40	14	27	-5	837
45	137	50	22	36	4	841
46	138	50	23	36.5	4.5	845.5
47	139	52	28	40	8	853.5
48	140	55	35	45	13	866.5
49	141	43	31	37	5	871.5
50	142	38	23	30.5	-1.5	870
51	143	40	20	30	-2	868
52	144	45	26	35.5	3.5	871.5
53	145	36	14	25	-7	864.5
54	146	35	13	24	-8	856.5
55	147	46	19	32.5	0.5	857
56	148	56	29	42.5	10.5	867.5
57	149	58	33	45.5	13.5	881
58	150	51	34	42.5	10.5	891.5
59	151	54	29	41.5	9.5	901
60	152	57	28	42.5	10.5	911.5
61	153	61	29	45	13	924.5
62	154	62	34	48	16	940.5
63	155	65	34	49.5	17.5	958
64	156	64	35	49.5	17.5	975.5
65	157	64	39	51.5	19.5	995
66	158	66	36	51	19	1014
67	159	58	36	47	15	1029
68	160	56	28	42	10	1039
69	161	58	28	43	11	1050
70	162	60	32	46	14	1064
71	163	62	31	46.5	14.5	1078.5
72	164	63	30	46.5	14.5	1093
73	165	68	33	50.5	18.5	1111.5
74	166	70	36	53	21	1132.5
75	167	72	39	55.5	23.5	1156
76	168	68	42	55	23	1179
77	169	60	39	49.5	17.5	1196.5
78	170	61	36	48.5	16.5	1213
79	171	57	39	48	16	1229
80	172	61	31	46	14	1243
81	173	62	36	49	17	1260
82	174	55	30	42.5	10.5	1270.5
83	175	53	32	42.5	10.5	1281
84	176	60	32	46	14	1295
85	177	58	33	45.5	13.5	1308.5
86	178	42	36	39	7	1315.5
87	179	59	20	39.5	7.5	1323
88	180	61	33	47	15	1338
89	181	57	23	40	8	1346
90	182	65	31	48	16	1362
91	183	68	36	52	20	1382
92	184	66	36	51	19	1401
93	185	71	37	54	22	1423
94	186	62	36	49	17	1440
95	187	52	32	42	10	1450
96	188	60	28	44	12	1462
97	189	60	40	50	18	1480
98	190	56	32	44	12	1492
99	191	44	33	38.5	6.5	1498.5
100	192	45	31	38	6	1504.5
101	193	50	32	41	9	1513.5
102	194	61	32	46.5	14.5	1528
103	195	69	37	53	21	1549
104	196	69	41	55	23	1572
105	197	70	36	53	21	1593
106	198	75	43	59	27	1620
107	199	80	49	64.5	32.5	1652.5
108	200	80	48	64	32	1684.5
109	201	79	53	66	34	1718.5
110	202	79	51	65	33	1751.5
111	203	79	48	63.5	31.5	1783
112	204	80	53	66.5	34.5	1817.5
113	205	75	46	60.5	28.5	1846
114	206	63	47	55	23	1869
115	207	55	30	42.5	10.5	1879.5
116	208	48	30	39	7	1886.5
117	209	41	28	34.5	2.5	1889
118	210	53	29	41	9	1898
119	211	50	35	42.5	10.5	1908.5
120	212	59	31	45	13	1921.5
121	213	64	41	52.5	20.5	1942
122	214	68	36	52	20	1962
123	215	69	43	56	24	1986
124	216	75	42	58.5	26.5	2012.5
125	217	80	49	64.5	32.5	2045
126	218	77	48	62.5	30.5	2075.5
127	219	73	46	59.5	27.5	2103
128	220	72	30	51	19	2122
129	221	66	44	55	23	2145
130	222	75	40	57.5	25.5	2170.5

131	223	73	42	57.5	25.5	2196
132	224	74	49	61.5	29.5	2225.5
133	225	73	47	60	28	2253.5
134	226	79	46	62.5	30.5	2284
135	227	81	44	62.5	30.5	2314.5
136	228	80	47	63.5	31.5	2346
137	229	78	45	61.5	29.5	2375.5
138	230	79	48	63.5	31.5	2407
139	231	75	46	60.5	28.5	2435.5
140	232	70	39	54.5	22.5	2458
141	233	75	42	58.5	26.5	2484.5
142	234	82	48	65	33	2517.5
143	235	83	50	66.5	34.5	2552
144	236	81	53	67	35	2587
145	237	53	45	49	17	2604
146	238	68	43	55.5	23.5	2627.5
147	239	78	48	63	31	2658.5
148	240	81	53	67	35	2693.5
149	241	84	48	66	34	2727.5
150	242	87	53	70	38	2765.5
151	243	88	58	73	41	2806.5
152	244	84	50	67	35	2841.5
153	245	88	54	71	39	2880.5
154	246	90	60	75	43	2923.5
155	247	87	52	69.5	37.5	2961
156	248	88	54	71	39	3000
157	249	87	53	70	38	3038
158	250	84	51	67.5	35.5	3073.5
159	251	83	50	66.5	34.5	3108
160	252	88	52	70	38	3146
161	253	92	56	74	42	3188
162	254	94	59	76.5	44.5	3232.5
163	255	93	57	75	43	3275.5
164	256	92	58	75	43	3318.5
165	257	93	55	74	42	3360.5
166	258	90	52	71	39	3399.5
167	259	89	50	69.5	37.5	3437
168	260	90	53	71.5	39.5	3476.5
169	261	92	65	78.5	46.5	3523
170	262	88	64	76	44	3567
171	263	88	58	73	41	3608
172	264	87	59	73	41	3649
173	265	87	57	72	40	3689
174	266	95	59	77	45	3734
175	267	100	63	81.5	49.5	3783.5
176	268	100	67	83.5	51.5	3835
177	269	100	65	82.5	50.5	3885.5
178	270	98	90	94	62	3947.5
179	271	100	64	82	50	3997.5
180	272	99	65	82	50	4047.5
181	273	101	64	82.5	50.5	4098
182	274	99	68	83.5	51.5	4149.5
183	275	95	66	80.5	48.5	4198
184	276	95	59	77	45	4243
185	277	92	53	72.5	40.5	4283.5
186	278	90	57	73.5	41.5	4325
187	279	91	56	73.5	41.5	4366.5
188	280	85	51	68	36	4402.5
189	281	91	59	75	43	4445.5
190	282	96	56	76	44	4489.5
191	283	97	63	80	48	4537.5
192	284	97	63	80	48	4585.5
193	285	96	60	78	46	4631.5
194	286	98	60	79	47	4678.5
195	287	97	61	79	47	4725.5
196	288	95	61	78	46	4771.5
197	289	95	60	77.5	45.5	4817
198	290	95	59	77	45	4862
199	291	90	61	75.5	43.5	4905.5
200	292	90	59	74.5	42.5	4948
201	293	95	60	77.5	45.5	4993.5
202	294	92	61	76.5	44.5	5038
203	295	93	60	76.5	44.5	5082.5
204	296	95	62	78.5	46.5	5129
205	297	92	61	76.5	44.5	5173.5
206	298	94	61	77.5	45.5	5219
207	299	98	67	82.5	50.5	5269.5
208	300	91	64	77.5	45.5	5315
209	301	98	63	80.5	48.5	5363.5
210	302	97	63	80	48	5411.5
211	303	94	63	78.5	46.5	5458
212	304	96	66	81	49	5507
213	305	90	62	76	44	5551
214	306	93	58	75.5	43.5	5594.5
215	307	95	64	79.5	47.5	5642
216	308	97	62	79.5	47.5	5689.5
217	309	97	65	81	49	5738.5
218	310	98	62	80	48	5786.5
219	311	96	63	79.5	47.5	5834
220	312	90	64	77	45	5879
221	313	84	61	72.5	40.5	5919.5
222	314	92	59	75.5	43.5	5963
223	315	94	63	78.5	46.5	6009.5
224	316	90	61	75.5	43.5	6053
225	317	94	62	78	46	6099
226	318	93	63	78	46	6145
227	319	91	56	73.5	41.5	6186.5
228	320	93	59	76	44	6230.5
229	321	96	65	80.5	48.5	6279
230	322	94	64	79	47	6326
231	323	91	61	76	44	6370
232	324	87	58	72.5	40.5	6410.5
233	325	90	58	74	42	6452.5
234	326	91	59	75	43	6495.5
235	327	94	58	76	44	6539.5
236	328	92	63	77.5	45.5	6585
237	329	92	59	75.5	43.5	6628.5
238	330	95	59	77	45	6673.5
239	331	91	61	76	44	6717.5

240	332	89	60	74.5	42.5	6760
241	333	88	58	73	41	6801
242	334	87	56	71.5	39.5	6840.5
243	335	88	56	72	40	6880.5
244	336	88	56	72	40	6920.5
245	337	89	57	73	41	6961.5
246	338	76	55	65.5	33.5	6995
247	339	86	53	69.5	37.5	7032.5
248	340	89	55	72	40	7072.5
249	341	88	54	71	39	7111.5
250	342	88	53	70.5	38.5	7150
251	343	90	55	72.5	40.5	7190.5
252	344	91	50	70.5	38.5	7229
253	345	88	56	72	40	7269
254	346	85	54	69.5	37.5	7306.5
255	347	79	54	66.5	34.5	7341
256	348	78	53	65.5	33.5	7374.5
257	349	73	45	59	27	7401.5
258	350	75	44	59.5	27.5	7429
259	351	80	44	62	30	7459
260	352	83	52	67.5	35.5	7494.5
261	353	79	55	67	35	7529.5
262	354	82	52	67	35	7564.5
263	355	75	-	-	-	7564.5
264	356	80	45	62.5	30.5	7595
265	357	81	48	64.5	32.5	7627.5
266	358	84	40	62	30	7657.5
267	359	85	48	66.5	34.5	7692
268	360	83	48	65.5	33.5	7725.5
269	361	85	48	66.5	34.5	7760
270	362	86	53	69.5	37.5	7797.5
271	363	86	49	67.5	35.5	7833
272	364	78	55	66.5	34.5	7867.5
273	365	72	48	60	28	7895.5



118	881.5	length of freeze (day)	12
130	831	frost depth (^{o}F-day)	50.5
		average temperature	53.7

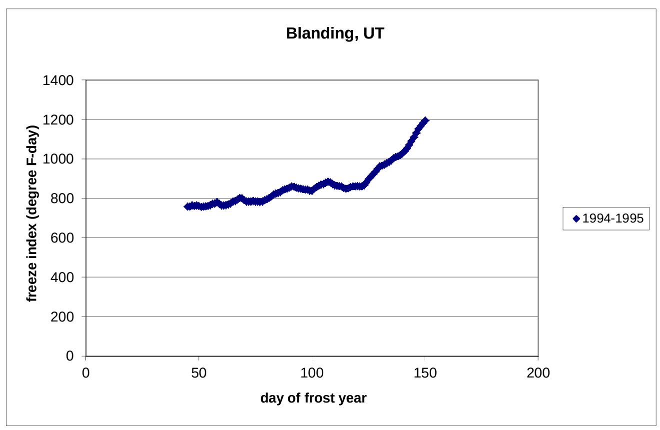
1994-1995

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	68	45	56.5	24.5	24.5
275	2	72	41	56.5	24.5	49
276	3	75	44	59.5	27.5	76.5
277	4	73	48	60.5	28.5	105
278	5	63	50	56.5	24.5	129.5
279	6	60	35	47.5	15.5	145
280	7	62	37	49.5	17.5	162.5
281	8	69	41	55	23	185.5
282	9	70	45	57.5	25.5	211
283	10	74	42	58	26	237
284	11	71	41	56	24	261
285	12	72	41	56.5	24.5	285.5
286	13	74	43	58.5	26.5	312
287	14	56	48	52	20	332
288	15	40	30	35	3	335
289	16	49	28	38.5	6.5	341.5
290	17	47	29	38	6	347.5
291	18	54	34	44	12	359.5
292	19	60	35	47.5	15.5	375
293	20	64	34	49	17	392
294	21	65	39	52	20	412
295	22	68	38	53	21	433
296	23	68	37	52.5	20.5	453.5
297	24	62	39	50.5	18.5	472
298	25	66	37	51.5	19.5	491.5
299	26	65	37	51	19	510.5
300	27	68	38	53	21	531.5
301	28	69	37	53	21	552.5
302	29	68	38	53	21	573.5
303	30	59	38	48.5	16.5	590
304	31	61	27	44	12	602
305	32	64	31	47.5	15.5	617.5
306	33	63	39	51	19	636.5
307	34	47	33	40	8	644.5
308	35	45	26	35.5	3.5	648
309	36	51	26	38.5	6.5	654.5
310	37	63	33	48	16	670.5
311	38	64	36	50	18	688.5
312	39	57	45	51	19	707.5
313	40	55	29	42	10	717.5
314	41	59	33	46	14	731.5
315	42	57	38	47.5	15.5	747
316	43	49	39	44	12	759
317	44	44	26	35	3	762
318	45	43	15	29	-3	759
319	46	45	19	32	0	759
320	47	46	29	37.5	5.5	764.5
321	48	41	19	30	-2	762.5
322	49	43	27	35	3	765.5
323	50	33	25	29	-3	762.5
324	51	39	15	27	-5	757.5
325	52	45	22	33.5	1.5	759
326	53	46	19	32.5	0.5	759.5
327	54	49	20	34.5	2.5	762
328	55	48	26	37	5	767
329	56	49	28	38.5	6.5	773.5
330	57	44	24	34	2	775.5
331	58	49	25	37	5	780.5
332	59	36	14	25	-7	773.5
333	60	38	10	24	-8	765.5
334	61	44	18	31	-1	764.5
335	62	49	19	34	2	766.5
336	63	49	23	36	4	770.5
337	64	49	25	37	5	775.5
338	65	52	30	41	9	784.5
339	66	39	31	35	3	787.5
340	67	45	33	39	7	794.5
341	68	49	30	39.5	7.5	802
342	69	37	23	30	-2	800
343	70	35	12	23.5	-8.5	791.5

344	71	36	13	24.5	-7.5	784
345	72	42	22	32	0	784
346	73	43	23	33	1	785
347	74	42	26	34	2	787
348	75	42	18	30	-2	785
349	76	41	21	31	-1	784
350	77	42	20	31	-1	783
351	78	47	21	34	2	785
352	79	51	24	37.5	5.5	790.5
353	80	50	26	38	6	796.5
354	81	53	24	38.5	6.5	803
355	82	50	28	39	7	810
356	83	56	28	42	10	820
357	84	43	32	37.5	5.5	825.5
358	85	40	31	35.5	3.5	829
359	86	40	33	36.5	4.5	833.5
360	87	53	27	40	8	841.5
361	88	47	25	36	4	845.5
362	89	46	25	35.5	3.5	849
363	90	47	28	37.5	5.5	854.5
364	91	47	31	39	7	861.5
365	92	40	20	30	-2	859.5
1	93	39	13	26	-6	853.5
2	94	40	20	30	-2	851.5
3	95	42	18	30	-2	849.5
4	96	33	25	29	-3	846.5
5	97	34	27	30.5	-1.5	845
6	98	45	19	32	0	845
7	99	35	19	27	-5	840
8	100	37	26	31.5	-0.5	839.5
9	101	51	32	41.5	9.5	849
10	102	52	30	41	9	858
11	103	46	31	38.5	6.5	864.5
12	104	47	28	37.5	5.5	870
13	105	47	23	35	3	873
14	106	50	28	39	7	880
15	107	44	31	37.5	5.5	885.5
16	108	41	16	28.5	-3.5	882
17	109	36	13	24.5	-7.5	874.5
18	110	37	11	24	-8	866.5
19	111	43	16	29.5	-2.5	864
20	112	41	19	30	-2	862
21	113	39	22	30.5	-1.5	860.5
22	114	37	12	24.5	-7.5	853
23	115	40	17	28.5	-3.5	849.5
24	116	43	25	34	2	851.5
25	117	46	29	37.5	5.5	857
26	118	41	29	35	3	860
27	119	43	24	33.5	1.5	861.5
28	120	45	21	33	1	862.5
29	121	42	20	31	-1	861.5
30	122	48	16	32	0	861.5
31	123	52	24	38	6	867.5
32	124	61	31	46	14	881.5
33	125	63	33	48	16	897.5
34	126	60	30	45	13	910.5
35	127	58	29	43.5	11.5	922
36	128	60	31	45.5	13.5	935.5
37	129	61	31	46	14	949.5
38	130	61	31	46	14	963.5
39	131	40	30	35	3	966.5
40	132	49	28	38.5	6.5	973
41	133	52	25	38.5	6.5	979.5
42	134	47	28	37.5	5.5	985
43	135	52	29	40.5	8.5	993.5
44	136	55	28	41.5	9.5	1003
45	137	49	30	39.5	7.5	1010.5
46	138	47	22	34.5	2.5	1013
47	139	54	25	39.5	7.5	1020.5
48	140	55	26	40.5	8.5	1029
49	141	58	26	42	10	1039
50	142	64	30	47	15	1054
51	143	67	33	50	18	1072
52	144	66	37	51.5	19.5	1091.5
53	145	67	36	51.5	19.5	1111
54	146	67	40	53.5	21.5	1132.5
55	147	66	39	52.5	20.5	1153
56	148	62	31	46.5	14.5	1167.5
57	149	59	33	46	14	1181.5
58	150	59	33	46	14	1195.5
59	151	55	36	45.5	13.5	1209
60	152	55	36	45.5	13.5	1222.5
61	153	48	34	41	9	1231.5
62	154	49	33	41	9	1240.5
63	155	56	34	45	13	1253.5
64	156	48	34	41	9	1262.5
65	157	45	24	34.5	2.5	1265
66	158	48	20	34	2	1267
67	159	53	25	39	7	1274
68	160	60	30	45	13	1287
69	161	64	32	48	16	1303
70	162	51	36	43.5	11.5	1314.5
71	163	55	33	44	12	1326.5
72	164	58	30	44	12	1338.5
73	165	69	35	52	20	1358.5
74	166	67	38	52.5	20.5	1379
75	167	69	37	53	21	1400
76	168	68	44	56	24	1424
77	169	67	35	51	19	1443
78	170	66	39	52.5	20.5	1463.5
79	171	65	33	49	17	1480.5
80	172	69	41	55	23	1503.5
81	173	54	33	43.5	11.5	1515
82	174	65	31	48	16	1531
83	175	47	24	35.5	3.5	1534.5
84	176	38	25	31.5	-0.5	1534
85	177	48	21	34.5	2.5	1536.5
86	178	53	23	38	6	1542.5
87	179	53	27	40	8	1550.5

88	180	45	24	34.5	2.5	1553
89	181	50	20	35	3	1556
90	182	56	24	40	8	1564
91	183	60	32	46	14	1578
92	184	65	36	50.5	18.5	1596.5
93	185	65	32	48.5	16.5	1613
94	186	66	37	51.5	19.5	1632.5
95	187	72	37	54.5	22.5	1655
96	188	71	39	55	23	1678
97	189	71	39	55	23	1701
98	190	69	39	54	22	1723
99	191	39	28	33.5	1.5	1724.5
100	192	49	27	38	6	1730.5
101	193	58	23	40.5	8.5	1739
102	194	67	31	49	17	1756
103	195	72	40	56	24	1780
104	196	57	36	46.5	14.5	1794.5
105	197	54	35	44.5	12.5	1807
106	198	65	20	42.5	10.5	1817.5
107	199	43	28	35.5	3.5	1821
108	200	47	26	36.5	4.5	1825.5
109	201	54	29	41.5	9.5	1835
110	202	46	30	38	6	1841
111	203	49	30	39.5	7.5	1848.5
112	204	50	31	40.5	8.5	1857
113	205	57	31	44	12	1869
114	206	60	30	45	13	1882
115	207	69	34	51.5	19.5	1901.5
116	208	65	35	50	18	1919.5
117	209	70	39	54.5	22.5	1942
118	210	70	44	57	25	1967
119	211	73	41	57	25	1992
120	212	65	43	54	22	2014
121	213	68	35	51.5	19.5	2033.5
122	214	64	39	51.5	19.5	2053
123	215	66	37	51.5	19.5	2072.5
124	216	74	40	57	25	2097.5
125	217	63	39	51	19	2116.5
126	218	55	37	46	14	2130.5
127	219	48	31	39.5	7.5	2138
128	220	63	31	47	15	2153
129	221	71	37	54	22	2175
130	222	68	42	55	23	2198
131	223	71	42	56.5	24.5	2222.5
132	224	66	47	56.5	24.5	2247
133	225	70	33	51.5	19.5	2266.5
134	226	75	41	58	26	2292.5
135	227	77	48	62.5	30.5	2323
136	228	70	40	55	23	2346
137	229	60	35	47.5	15.5	2361.5
138	230	70	40	55	23	2384.5
139	231	72	41	56.5	24.5	2409
140	232	81	46	63.5	31.5	2440.5
141	233	79	49	64	32	2472.5
142	234	78	47	62.5	30.5	2503
143	235	69	43	56	24	2527
144	236	65	42	53.5	21.5	2548.5
145	237	63	40	51.5	19.5	2568
146	238	65	41	53	21	2589
147	239	68	36	52	20	2609
148	240	60	42	51	19	2628
149	241	55	40	47.5	15.5	2643.5
150	242	68	37	52.5	20.5	2664
151	243	76	46	61	29	2693
152	244	81	45	63	31	2724
153	245	78	53	65.5	33.5	2757.5
154	246	73	47	60	28	2785.5
155	247	75	45	60	28	2813.5
156	248	82	45	63.5	31.5	2845
157	249	74	50	62	30	2875
158	250	74	43	58.5	26.5	2901.5
159	251	64	41	52.5	20.5	2922
160	252	70	34	52	20	2942
161	253	76	41	58.5	26.5	2968.5
162	254	84	49	66.5	34.5	3003
163	255	90	53	71.5	39.5	3042.5
164	256	90	56	73	41	3083.5
165	257	90	56	73	41	3124.5
166	258	89	56	72.5	40.5	3165
167	259	74	56	65	33	3198
168	260	72	42	57	25	3223
169	261	73	34	53.5	21.5	3244.5
170	262	83	40	61.5	29.5	3274
171	263	85	49	67	35	3309
172	264	84	50	67	35	3344
173	265	82	47	64.5	32.5	3376.5
174	266	84	53	68.5	36.5	3413
175	267	85	48	66.5	34.5	3447.5
176	268	90	58	74	42	3489.5
177	269	89	53	71	39	3528.5
178	270	91	52	71.5	39.5	3568
179	271	82	54	68	36	3604
180	272	86	53	69.5	37.5	3641.5
181	273	85	53	69	37	3678.5
182	274	85	53	69	37	3715.5
183	275	85	53	69	37	3752.5
184	276	82	47	64.5	32.5	3785
185	277	78	43	60.5	28.5	3813.5
186	278	85	50	67.5	35.5	3849
187	279	91	55	73	41	3890
188	280	94	58	76	44	3934
189	281	97	61	79	47	3981
190	282	97	66	81.5	49.5	4030.5
191	283	97	64	80.5	48.5	4079
192	284	96	60	78	46	4125
193	285	93	58	75.5	43.5	4168.5
194	286	87	55	71	39	4207.5
195	287	86	51	68.5	36.5	4244
196	288	86	51	68.5	36.5	4280.5

197	289	91	55	73	41	4321.5
198	290	79	58	68.5	36.5	4358
199	291	87	55	71	39	4397
200	292	87	55	71	39	4436
201	293	92	55	73.5	41.5	4477.5
202	294	90	57	73.5	41.5	4519
203	295	91	54	72.5	40.5	4559.5
204	296	90	55	72.5	40.5	4600
205	297	93	56	74.5	42.5	4642.5
206	298	95	57	76	44	4686.5
207	299	98	57	77.5	45.5	4732
208	300	99	64	81.5	49.5	4781.5
209	301	100	65	82.5	50.5	4832
210	302	102	65	83.5	51.5	4883.5
211	303	99	68	83.5	51.5	4935
212	304	92	64	78	46	4981
213	305	93	58	75.5	43.5	5024.5
214	306	98	59	78.5	46.5	5071
215	307	96	59	77.5	45.5	5116.5
216	308	97	67	82	50	5166.5
217	309	98	61	79.5	47.5	5214
218	310	99	63	81	49	5263
219	311	99	63	81	49	5312
220	312	98	63	80.5	48.5	5360.5
221	313	97	61	79	47	5407.5
222	314	98	60	79	47	5454.5
223	315	95	59	77	45	5499.5
224	316	93	61	77	45	5544.5
225	317	91	58	74.5	42.5	5587
226	318	90	58	74	42	5629
227	319	91	54	72.5	40.5	5669.5
228	320	85	60	72.5	40.5	5710
229	321	86	59	72.5	40.5	5750.5
230	322	91	55	73	41	5791.5
231	323	88	57	72.5	40.5	5832
232	324	86	56	71	39	5871
233	325	88	56	72	40	5911
234	326	90	58	74	42	5953
235	327	89	57	73	41	5994
236	328	80	58	69	37	6031
237	329	86	55	70.5	38.5	6069.5
238	330	92	56	74	42	6111.5
239	331	90	58	74	42	6153.5
240	332	88	59	73.5	41.5	6195
241	333	93	59	76	44	6239
242	334	96	60	78	46	6285
243	335	97	59	78	46	6331
244	336	97	61	79	47	6378
245	337	96	63	79.5	47.5	6425.5
246	338	95	63	79	47	6472.5
247	339	94	62	78	46	6518.5
248	340	95	59	77	45	6563.5
249	341	92	61	76.5	44.5	6608
250	342	85	57	71	39	6647
251	343	72	54	63	31	6678
252	344	79	52	65.5	33.5	6711.5
253	345	84	50	67	35	6746.5
254	346	87	47	67	35	6781.5
255	347	83	47	65	33	6814.5
256	348	85	49	67	35	6849.5
257	349	86	51	68.5	36.5	6886
258	350	87	50	68.5	36.5	6922.5
259	351	88	50	69	37	6959.5
260	352	88	55	71.5	39.5	6999
261	353	80	51	65.5	33.5	7032.5
262	354	83	46	64.5	32.5	7065
263	355	86	49	67.5	35.5	7100.5
264	356	69	44	56.5	24.5	7125
265	357	71	35	53	21	7146
266	358	80	41	60.5	28.5	7174.5
267	359	79	47	63	31	7205.5
268	360	72	39	55.5	23.5	7229
269	361	77	48	62.5	30.5	7259.5
270	362	82	48	65	33	7292.5
271	363	68	51	59.5	27.5	7320
272	364	69	43	56	24	7344
273	365	68	34	51	19	7363



108	882	length of freeze (day)	7
115	849.5	frost depth (^{o}F-day)	32.5
		average temperature	52.2

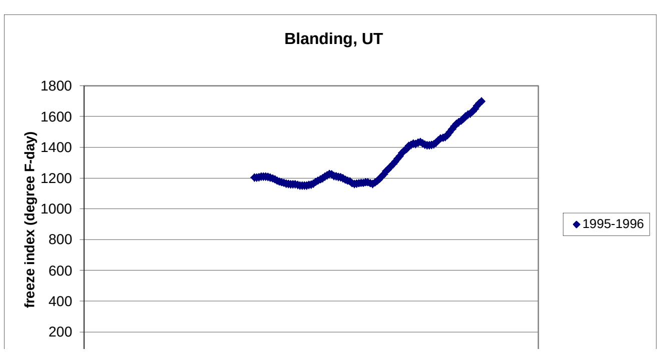
1995-1996

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	71	39	55	23	23
275	2	72	38	55	23	46
276	3	74	40	57	25	71
277	4	57	40	48.5	16.5	87.5
278	5	61	30	45.5	13.5	101
279	6	64	27	45.5	13.5	114.5
280	7	73	37	55	23	137.5
281	8	74	38	56	24	161.5
282	9	74	39	56.5	24.5	186
283	10	77	41	59	27	213
284	11	79	43	61	29	242
285	12	78	46	62	30	272
286	13	71	39	55	23	295
287	14	76	37	56.5	24.5	319.5
288	15	75	41	58	26	345.5
289	16	76	43	59.5	27.5	373
290	17	76	44	60	28	401
291	18	77	41	59	27	428
292	19	71	41	56	24	452
293	20	69	37	53	21	473
294	21	72	37	54.5	22.5	495.5
295	22	49	26	37.5	5.5	501
296	23	54	21	37.5	5.5	506.5
297	24	62	29	45.5	13.5	520
298	25	65	31	48	16	536
299	26	72	35	53.5	21.5	557.5
300	27	72	37	54.5	22.5	580

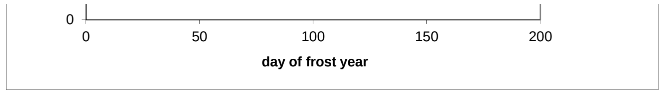
301	28	69	38	53.5	21.5	601.5
302	29	72	44	58	26	627.5
303	30	71	42	56.5	24.5	652
304	31	68	38	53	21	673
305	32	57	36	46.5	14.5	687.5
306	33	56	28	42	10	697.5
307	34	55	23	39	7	704.5
308	35	57	28	42.5	10.5	715
309	36	58	28	43	11	726
310	37	58	33	45.5	13.5	739.5
311	38	65	32	48.5	16.5	756
312	39	65	34	49.5	17.5	773.5
313	40	60	35	47.5	15.5	789
314	41	45	25	35	3	792
315	42	54	22	38	6	798
316	43	61	28	44.5	12.5	810.5
317	44	67	35	51	19	829.5
318	45	71	37	54	22	851.5
319	46	64	34	49	17	868.5
320	47	65	35	50	18	886.5
321	48	68	36	52	20	906.5
322	49	61	34	47.5	15.5	922
323	50	63	35	49	17	939
324	51	64	35	49.5	17.5	956.5
325	52	59	32	45.5	13.5	970
326	53	58	34	46	14	984
327	54	64	32	48	16	1000
328	55	60	31	45.5	13.5	1013.5
329	56	60	30	45	13	1026.5
330	57	60	26	43	11	1037.5
331	58	44	20	32	0	1037.5
332	59	44	18	31	-1	1036.5
333	60	58	26	42	10	1046.5
334	61	58	30	44	12	1058.5
335	62	59	30	44.5	12.5	1071
336	63	58	30	44	12	1083
337	64	57	29	43	11	1094
338	65	59	32	45.5	13.5	1107.5
339	66	61	32	46.5	14.5	1122
340	67	62	33	47.5	15.5	1137.5
341	68	47	32	39.5	7.5	1145
342	69	54	26	40	8	1153
343	70	52	24	38	6	1159
344	71	53	27	40	8	1167
345	72	54	27	40.5	8.5	1175.5
346	73	53	35	44	12	1187.5
347	74	55	34	44.5	12.5	1200
348	75	48	27	37.5	5.5	1205.5
349	76	41	22	31.5	-0.5	1205
350	77	45	22	33.5	1.5	1206.5
351	78	50	23	36.5	4.5	1211
352	79	47	19	33	1	1212
353	80	45	18	31.5	-0.5	1211.5
354	81	39	20	29.5	-2.5	1209
355	82	39	15	27	-5	1204
356	83	40	15	27.5	-4.5	1199.5
357	84	39	11	25	-7	1192.5
358	85	39	10	24.5	-7.5	1185
359	86	38	12	25	-7	1178
360	87	42	15	28.5	-3.5	1174.5
361	88	41	14	27.5	-4.5	1170
362	89	39	17	28	-4	1166
363	90	43	14	28.5	-3.5	1162.5
364	91	45	15	30	-2	1160.5
365	92	38	27	32.5	0.5	1161
1	93	43	23	33	1	1162
2	94	40	14	27	-5	1157
3	95	39	15	27	-5	1152
4	96	47	18	32.5	0.5	1152.5
5	97	44	21	32.5	0.5	1153
6	98	47	17	32	0	1153
7	99	51	20	35.5	3.5	1156.5
8	100	50	21	35.5	3.5	1160
9	101	52	24	38	6	1166
10	102	53	29	41	9	1175
11	103	59	23	41	9	1184
12	104	54	26	40	8	1192
13	105	54	27	40.5	8.5	1200.5
14	106	56	28	42	10	1210.5
15	107	56	27	41.5	9.5	1220
16	108	53	25	39	7	1227
17	109	42	18	30	-2	1225
18	110	33	12	22.5	-9.5	1215.5
19	111	40	18	29	-3	1212.5
20	112	40	18	29	-3	1209.5
21	113	39	20	29.5	-2.5	1207
22	114	38	12	25	-7	1200
23	115	37	7	22	-10	1190
24	116	40	14	27	-5	1185
25	117	42	10	26	-6	1179
26	118	35	7	21	-11	1168
27	119	45	8	26.5	-5.5	1162.5
28	120	48	22	35	3	1165.5
29	121	45	23	34	2	1167.5
30	122	40	28	34	2	1169.5
31	123	41	29	-	-	1169.5
32	124	45	28	36.5	4.5	1174
33	125	41	23	32	0	1174
34	126	37	12	24.5	-7.5	1166.5
35	127	43	16	29.5	-2.5	1164
36	128	52	25	38.5	6.5	1170.5
37	129	57	30	43.5	11.5	1182
38	130	58	31	44.5	12.5	1194.5
39	131	66	30	48	16	1210.5
40	132	64	32	48	16	1226.5
41	133	66	36	51	19	1245.5
42	134	56	35	45.5	13.5	1259
43	135	63	34	48.5	16.5	1275.5
44	136	65	32	48.5	16.5	1292

45	137	68	31	49.5	17.5	1309.5
46	138	67	34	50.5	18.5	1328
47	139	65	33	49	17	1345
48	140	62	43	52.5	20.5	1365.5
49	141	59	34	46.5	14.5	1380
50	142	54	31	42.5	10.5	1390.5
51	143	57	46	51.5	19.5	1410
52	144	38	39	38.5	6.5	1416.5
53	145	54	26	40	8	1424.5
54	146	47	15	31	-1	1423.5
55	147	56	23	39.5	7.5	1431
56	148	52	23	37.5	5.5	1436.5
57	149	34	13	23.5	-8.5	1428
58	150	34	10	22	-10	1418
59	151	42	14	28	-4	1414
60	152	46	20	33	1	1415
61	153	48	18	33	1	1416
62	154	55	19	37	5	1421
63	155	57	27	42	10	1431
64	156	59	35	47	15	1446
65	157	59	31	45	13	1459
66	158	48	24	36	4	1463
67	159	55	21	38	6	1469
68	160	62	28	45	13	1482
69	161	70	29	49.5	17.5	1499.5
70	162	67	36	51.5	19.5	1519
71	163	67	35	51	19	1538
72	164	63	34	48.5	16.5	1554.5
73	165	54	30	42	10	1564.5
74	166	55	24	39.5	7.5	1572
75	167	61	28	44.5	12.5	1584.5
76	168	63	38	50.5	18.5	1603
77	169	56	31	43.5	11.5	1614.5
78	170	55	23	39	7	1621.5
79	171	58	28	43	11	1632.5
80	172	67	30	48.5	16.5	1649
81	173	71	38	54.5	22.5	1671.5
82	174	70	26	48	16	1687.5
83	175	62	28	45	13	1700.5
84	176	22	49	35.5	3.5	1704
85	177	31	56	43.5	11.5	1715.5
86	178	26	59	42.5	10.5	1726
87	179	62	36	49	17	1743
88	180	66	33	49.5	17.5	1760.5
89	181	51	31	41	9	1769.5
90	182	60	27	43.5	11.5	1781
91	183	68	32	50	18	1799
92	184	74	37	55.5	23.5	1822.5
93	185	69	39	54	22	1844.5
94	186	65	33	49	17	1861.5
95	187	63	34	48.5	16.5	1878
96	188	61	30	45.5	13.5	1891.5
97	189	70	30	50	18	1909.5
98	190	75	40	57.5	25.5	1935
99	191	80	46	63	31	1966
100	192	83	46	64.5	32.5	1998.5
101	193	74	46	60	28	2026.5
102	194	67	37	52	20	2046.5
103	195	63	31	47	15	2061.5
104	196	49	28	38.5	6.5	2068
105	197	55	25	40	8	2076
106	198	65	29	47	15	2091
107	199	72	39	55.5	23.5	2114.5
108	200	67	36	51.5	19.5	2134
109	201	61	35	48	16	2150
110	202	57	23	40	8	2158
111	203	60	31	45.5	13.5	2171.5
112	204	60	25	42.5	10.5	2182
113	205	65	30	47.5	15.5	2197.5
114	206	76	37	56.5	24.5	2222
115	207	82	47	64.5	32.5	2254.5
116	208	71	50	60.5	28.5	2283
117	209	81	41	61	29	2312
118	210	80	46	63	31	2343
119	211	65	38	51.5	19.5	2362.5
120	212	62	29	45.5	13.5	2376
121	213	75	39	57	25	2401
122	214	78	45	61.5	29.5	2430.5
123	215	81	47	64	32	2462.5
124	216	81	49	65	33	2495.5
125	217	83	46	64.5	32.5	2528
126	218	84	46	65	33	2561
127	219	84	49	66.5	34.5	2595.5
128	220	86	49	67.5	35.5	2631
129	221	83	48	65.5	33.5	2664.5
130	222	82	47	64.5	32.5	2697
131	223	81	46	63.5	31.5	2728.5
132	224	88	47	67.5	35.5	2764
133	225	92	54	73	41	2805
134	226	92	54	73	41	2846
135	227	89	55	72	40	2886
136	228	88	52	70	38	2924
137	229	87	53	70	38	2962
138	230	84	50	67	35	2997
139	231	89	63	76	44	3041
140	232	86	53	69.5	37.5	3078.5
141	233	79	45	62	30	3108.5
142	234	85	47	66	34	3142.5
143	235	83	50	66.5	34.5	3177
144	236	72	46	59	27	3204
145	237	69	42	55.5	23.5	3227.5
146	238	60	37	48.5	16.5	3244
147	239	65	35	50	18	3262
148	240	76	39	57.5	25.5	3287.5
149	241	75	45	60	28	3315.5
150	242	80	46	63	31	3346.5
151	243	80	49	64.5	32.5	3379
152	244	82	47	64.5	32.5	3411.5
153	245	80	49	64.5	32.5	3444

154	246	88	51	69.5	37.5	3481.5
155	247	89	56	72.5	40.5	3522
156	248	96	58	77	45	3567
157	249	95	59	77	45	3612
158	250	91	61	76	44	3656
159	251	92	64	78	46	3702
160	252	95	59	77	45	3747
161	253	95	59	77	45	3792
162	254	95	58	76.5	44.5	3836.5
163	255	93	58	75.5	43.5	3880
164	256	91	59	75	43	3923
165	257	89	60	74.5	42.5	3965.5
166	258	85	57	71	39	4004.5
167	259	85	57	71	39	4043.5
168	260	91	53	72	40	4083.5
169	261	93	56	74.5	42.5	4126
170	262	91	55	73	41	4167
171	263	91	60	75.5	43.5	4210.5
172	264	92	60	76	44	4254.5
173	265	85	55	70	38	4292.5
174	266	86	55	70.5	38.5	4331
175	267	88	54	71	39	4370
176	268	90	54	72	40	4410
177	269	91	57	74	42	4452
178	270	82	55	68.5	36.5	4488.5
179	271	76	55	65.5	33.5	4522
180	272	83	56	69.5	37.5	4559.5
181	273	88	55	71.5	39.5	4599
182	274	89	64	76.5	44.5	4643.5
183	275	93	57	75	43	4686.5
184	276	96	60	78	46	4732.5
185	277	95	64	79.5	47.5	4780
186	278	94	65	79.5	47.5	4827.5
187	279	96	70	83	51	4878.5
188	280	99	59	79	47	4925.5
189	281	95	68	81.5	49.5	4975
190	282	92	64	78	46	5021
191	283	88	61	74.5	42.5	5063.5
192	284	93	64	78.5	46.5	5110
193	285	92	63	77.5	45.5	5155.5
194	286	96	65	80.5	48.5	5204
195	287	90	67	78.5	46.5	5250.5
196	288	95	62	78.5	46.5	5297
197	289	95	63	79	47	5344
198	290	88	59	73.5	41.5	5385.5
199	291	88	63	75.5	43.5	5429
200	292	93	63	78	46	5475
201	293	95	66	80.5	48.5	5523.5
202	294	96	65	80.5	48.5	5572
203	295	98	66	82	50	5622
204	296	100	70	85	53	5675
205	297	96	71	83.5	51.5	5726.5
206	298	97	67	82	50	5776.5
207	299	96	69	82.5	50.5	5827
208	300	96	63	79.5	47.5	5874.5
209	301	95	65	80	48	5922.5
210	302	91	63	77	45	5967.5
211	303	89	64	76.5	44.5	6012
212	304	95	65	80	48	6060
213	305	100	66	83	51	6111
214	306	97	65	81	49	6160
215	307	96	65	80.5	48.5	6208.5
216	308	91	65	78	46	6254.5
217	309	88	62	75	43	6297.5
218	310	90	57	73.5	41.5	6339
219	311	89	57	73	41	6380
220	312	94	61	77.5	45.5	6425.5
221	313	90	60	75	43	6468.5
222	314	87	61	74	42	6510.5
223	315	90	56	73	41	6551.5
224	316	94	62	78	46	6597.5
225	317	98	61	79.5	47.5	6645
226	318	101	67	84	52	6697
227	319	100	69	84.5	52.5	6749.5
228	320	94	70	82	50	6799.5
229	321	94	63	78.5	46.5	6846
230	322	92	64	78	46	6892
231	323	91	59	75	43	6935
232	324	91	59	75	43	6978
233	325	89	66	77.5	45.5	7023.5
234	326	88	59	73.5	41.5	7065
235	327	89	62	75.5	43.5	7108.5
236	328	86	56	71	39	7147.5
237	329	84	60	72	40	7187.5
238	330	86	61	73.5	41.5	7229
239	331	83	58	70.5	38.5	7267.5
240	332	87	59	73	41	7308.5
241	333	90	61	75.5	43.5	7352
242	334	93	63	78	46	7398
243	335	91	59	75	43	7441
244	336	92	62	77	45	7486
245	337	93	62	77.5	45.5	7531.5
246	338	88	59	73.5	41.5	7573
247	339	92	60	76	44	7617
248	340	92	61	76.5	44.5	7661.5
249	341	81	57	69	37	7698.5
250	342	80	56	68	36	7734.5
251	343	83	53	68	36	7770.5
252	344	88	54	71	39	7809.5
253	345	89	56	72.5	40.5	7850
254	346	86	58	72	40	7890
255	347	77	56	66.5	34.5	7924.5
256	348	78	56	67	35	7959.5
257	349	70	50	60	28	7987.5
258	350	60	47	53.5	21.5	8009
259	351	73	41	57	25	8034
260	352	71	43	57	25	8059
261	353	61	41	51	19	8078
262	354	50	35	42.5	10.5	8088.5



263	355	61	33	47	15	8103.5
264	356	73	39	56	24	8127.5
265	357	78	44	61	29	8156.5
266	358	79	50	64.5	32.5	8189
267	359	80	50	65	33	8222
268	360	79	50	64.5	32.5	8254.5
269	361	80	46	63	31	8285.5
270	362	65	45	55	23	8308.5
271	363	60	33	46.5	14.5	8323
272	364	74	40	57	25	8348
273	365	75	44	59.5	27.5	8375.5
274	366	79	48	63.5	31.5	8407



109	1225	length of freeze (day)	18
127	1164	frost depth (^oF-day)	61
		average temperature	55.0

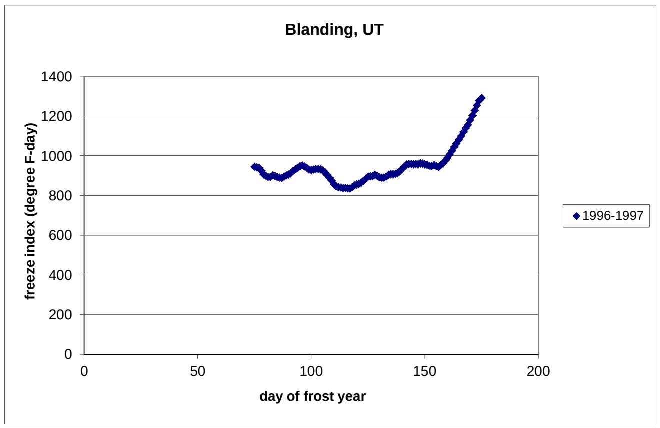
1996-1997

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	79	49	64	32	32
275	2	77	52	64.5	32.5	64.5
276	3	62	46	54	22	86.5
277	4	69	47	58	26	112.5
278	5	68	45	56.5	24.5	137
279	6	79	48	63.5	31.5	168.5
280	7	80	50	65	33	201.5
281	8	81	51	66	34	235.5
282	9	79	52	65.5	33.5	269
283	10	79	54	66.5	34.5	303.5
284	11	78	50	64	32	335.5
285	12	77	49	63	31	366.5
286	13	76	49	62.5	30.5	397
287	14	76	52	64	32	429
288	15	72	46	59	27	456
289	16	70	44	57	25	481
290	17	59	36	47.5	15.5	496.5
291	18	65	35	50	18	514.5
292	19	69	40	54.5	22.5	537
293	20	47	32	39.5	7.5	544.5
294	21	43	26	34.5	2.5	547
295	22	55	20	37.5	5.5	552.5
296	23	59	29	44	12	564.5
297	24	59	31	45	13	577.5
298	25	48	26	37	5	582.5
299	26	47	23	35	3	585.5
300	27	45	33	39	7	592.5
301	28	44	31	37.5	5.5	598
302	29	46	30	38	6	604
303	30	53	30	41.5	9.5	613.5
304	31	51	33	42	10	623.5
305	32	57	28	42.5	10.5	634
306	33	58	31	44.5	12.5	646.5
307	34	51	39	45	13	659.5
308	35	49	34	41.5	9.5	669
309	36	53	33	43	11	680
310	37	48	28	38	6	686
311	38	49	22	35.5	3.5	689.5
312	39	57	27	42	10	699.5
313	40	66	34	50	18	717.5
314	41	60	32	46	14	731.5
315	42	59	32	45.5	13.5	745
316	43	60	35	47.5	15.5	760.5
317	44	60	34	47	15	775.5
318	45	53	38	45.5	13.5	789
319	46	45	31	38	6	795
320	47	43	22	32.5	0.5	795.5
321	48	33	22	27.5	-4.5	791
322	49	50	35	42.5	10.5	801.5
323	50	56	34	45	13	814.5
324	51	59	38	48.5	16.5	831
325	52	56	37	46.5	14.5	845.5
326	53	49	38	43.5	11.5	857
327	54	51	34	42.5	10.5	867.5
328	55	51	30	40.5	8.5	876
329	56	53	30	41.5	9.5	885.5
330	57	49	32	40.5	8.5	894
331	58	45	25	35	3	897
332	59	47	27	37	5	902
333	60	36	27	31.5	-0.5	901.5
334	61	42	25	33.5	1.5	903
335	62	40	15	27.5	-4.5	898.5
336	63	38	16	27	-5	893.5
337	64	39	14	26.5	-5.5	888
338	65	42	19	30.5	-1.5	886.5
339	66	37	19	28	-4	882.5
340	67	44	27	35.5	3.5	886
341	68	49	25	37	5	891
342	69	51	20	35.5	3.5	894.5
343	70	53	32	42.5	10.5	905
344	71	50	35	42.5	10.5	915.5
345	72	45	36	40.5	8.5	924
346	73	51	33	42	10	934
347	74	52	34	43	11	945
348	75	40	24	32	0	945
349	76	39	20	29.5	-2.5	942.5
350	77	42	19	30.5	-1.5	941
351	78	26	9	17.5	-14.5	926.5
352	79	25	2	13.5	-18.5	908
353	80	39	9	24	-8	900
354	81	36	16	26	-6	894
355	82	37	25	31	-1	893
356	83	50	30	40	8	901
357	84	39	20	29.5	-2.5	898.5
358	85	37	16	26.5	-5.5	893
359	86	39	18	28.5	-3.5	889.5
360	87	40	23	31.5	-0.5	889
361	88	43	32	37.5	5.5	894.5
362	89	47	30	38.5	6.5	901
363	90	45	29	37	5	906
364	91	46	32	39	7	913
365	92	53	32	42.5	10.5	923.5

1	93	49	33	41	9	932.5
2	94	45	35	40	8	940.5
3	95	47	33	40	8	948.5
4	96	43	26	34.5	2.5	951
5	97	33	24	28.5	-3.5	947.5
6	98	32	16	24	-8	939.5
7	99	35	10	22.5	-9.5	930
8	100	41	22	31.5	-0.5	929.5
9	101	48	19	33.5	1.5	931
10	102	45	24	34.5	2.5	933.5
11	103	40	24	32	0	933.5
12	104	37	25	31	-1	932.5
13	105	29	24	26.5	-5.5	927
14	106	32	12	22	-10	917
15	107	32	3	17.5	-14.5	902.5
16	108	33	6	19.5	-12.5	890
17	109	30	4	17	-15	875
18	110	30	0	15	-17	858
19	111	35	7	21	-11	847
20	112	43	12	27.5	-4.5	842.5
21	113	40	20	30	-2	840.5
22	114	37	20	28.5	-3.5	837
23	115	39	28	33.5	1.5	838.5
24	116	42	19	30.5	-1.5	837
25	117	36	25	30.5	-1.5	835.5
26	118	46	32	39	7	842.5
27	119	53	30	41.5	9.5	852
28	120	47	25	36	4	856
29	121	42	30	36	4	860
30	122	52	25	38.5	6.5	866.5
31	123	51	27	39	7	873.5
32	124	57	32	44.5	12.5	886
33	125	51	31	41	9	895
34	126	43	24	33.5	1.5	896.5
35	127	46	23	34.5	2.5	899
36	128	50	27	38.5	6.5	905.5
37	129	35	18	26.5	-5.5	900
38	130	36	12	24	-8	892
39	131	45	16	30.5	-1.5	890.5
40	132	43	22	32.5	0.5	891
41	133	50	22	36	4	895
42	134	56	28	42	10	905
43	135	46	25	35.5	3.5	908.5
44	136	40	24	32	0	908.5
45	137	48	19	33.5	1.5	910
46	138	49	25	37	5	915
47	139	53	26	39.5	7.5	922.5
48	140	54	34	44	12	934.5
49	141	57	32	44.5	12.5	947
50	142	56	27	41.5	9.5	956.5
51	143	43	27	35	3	959.5
52	144	42	21	31.5	-0.5	959
53	145	44	18	31	-1	958
54	146	42	26	34	2	960
55	147	37	24	30.5	-1.5	958.5
56	148	47	26	36.5	4.5	963
57	149	42	18	30	-2	961
58	150	31	28	29.5	-2.5	958.5
59	151	41	18	29.5	-2.5	956
60	152	40	12	26	-6	950
61	153	44	18	31	-1	949
62	154	49	23	36	4	953
63	155	38	17	27.5	-4.5	948.5
64	156	43	11	27	-5	943.5
65	157	54	32	43	11	954.5
66	158	54	28	41	9	963.5
67	159	57	31	44	12	975.5
68	160	58	34	46	14	989.5
69	161	65	35	50	18	1007.5
70	162	65	34	49.5	17.5	1025
71	163	67	38	52.5	20.5	1045.5
72	164	61	36	48.5	16.5	1062
73	165	61	42	51.5	19.5	1081.5
74	166	65	35	50	18	1099.5
75	167	66	39	52.5	20.5	1120
76	168	62	41	51.5	19.5	1139.5
77	169	65	34	49.5	17.5	1157
78	170	70	40	55	23	1180
79	171	72	39	55.5	23.5	1203.5
80	172	73	42	57.5	25.5	1229
81	173	72	44	58	26	1255
82	174	70	40	55	23	1278
83	175	58	33	45.5	13.5	1291.5
84	176	56	28	42	10	1301.5
85	177	62	33	47.5	15.5	1317
86	178	67	33	50	18	1335
87	179	68	37	52.5	20.5	1355.5
88	180	57	34	45.5	13.5	1369
89	181	64	32	48	16	1385
90	182	63	40	51.5	19.5	1404.5
91	183	43	30	36.5	4.5	1409
92	184	58	30	44	12	1421
93	185	62	35	48.5	16.5	1437.5
94	186	42	33	37.5	5.5	1443
95	187	43	26	34.5	2.5	1445.5
96	188	49	23	36	4	1449.5
97	189	56	32	44	12	1461.5
98	190	56	32	44	12	1473.5
99	191	62	35	48.5	16.5	1490
100	192	51	20	35.5	3.5	1493.5
101	193	43	22	32.5	0.5	1494
102	194	42	20	31	-1	1493
103	195	51	20	35.5	3.5	1496.5
104	196	60	29	44.5	12.5	1509
105	197	66	37	51.5	19.5	1528.5
106	198	71	43	57	25	1553.5
107	199	74	40	57	25	1578.5
108	200	73	41	57	25	1603.5
109	201	74	42	58	26	1629.5

110	202	73	45	59	27	1656.5
111	203	73	47	60	28	1684.5
112	204	67	39	53	21	1705.5
113	205	55	34	44.5	12.5	1718
114	206	52	32	42	10	1728
115	207	61	33	47	15	1743
116	208	64	35	49.5	17.5	1760.5
117	209	68	38	53	21	1781.5
118	210	73	46	59.5	27.5	1809
119	211	68	47	57.5	25.5	1834.5
120	212	66	35	50.5	18.5	1853
121	213	62	35	48.5	16.5	1869.5
122	214	59	26	42.5	10.5	1880
123	215	72	37	54.5	22.5	1902.5
124	216	79	48	63.5	31.5	1934
125	217	81	48	64.5	32.5	1966.5
126	218	83	52	67.5	35.5	2002
127	219	80	50	65	33	2035
128	220	76	49	62.5	30.5	2065.5
129	221	77	46	61.5	29.5	2095
130	222	73	43	58	26	2121
131	223	80	43	61.5	29.5	2150.5
132	224	79	50	64.5	32.5	2183
133	225	84	48	66	34	2217
134	226	86	51	68.5	36.5	2253.5
135	227	85	54	69.5	37.5	2291
136	228	88	55	71.5	39.5	2330.5
137	229	88	52	70	38	2368.5
138	230	86	56	71	39	2407.5
139	231	82	53	67.5	35.5	2443
140	232	78	40	59	27	2470
141	233	63	47	55	23	2493
142	234	69	48	58.5	26.5	2519.5
143	235	78	44	61	29	2548.5
144	236	62	44	53	21	2569.5
145	237	69	39	54	22	2591.5
146	238	64	37	50.5	18.5	2610
147	239	72	43	57.5	25.5	2635.5
148	240	80	49	64.5	32.5	2668
149	241	89	56	72.5	40.5	2708.5
150	242	87	57	72	40	2748.5
151	243	93	60	76.5	44.5	2793
152	244	91	50	70.5	38.5	2831.5
153	245	92	58	75	43	2874.5
154	246	91	57	74	42	2916.5
155	247	89	57	73	41	2957.5
156	248	88	54	71	39	2996.5
157	249	79	54	66.5	34.5	3031
158	250	64	48	56	24	3055
159	251	73	43	58	26	3081
160	252	72	48	60	28	3109
161	253	78	51	64.5	32.5	3141.5
162	254	83	51	67	35	3176.5
163	255	81	50	65.5	33.5	3210
164	256	80	48	64	32	3242
165	257	80	55	67.5	35.5	3277.5
166	258	78	50	64	32	3309.5
167	259	86	49	67.5	35.5	3345
168	260	86	49	67.5	35.5	3380.5
169	261	92	54	73	41	3421.5
170	262	92	60	76	44	3465.5
171	263	92	57	74.5	42.5	3508
172	264	91	56	73.5	41.5	3549.5
173	265	91	57	74	42	3591.5
174	266	88	56	72	40	3631.5
175	267	91	55	73	41	3672.5
176	268	93	57	75	43	3715.5
177	269	93	59	76	44	3759.5
178	270	91	60	75.5	43.5	3803
179	271	89	56	72.5	40.5	3843.5
180	272	88	55	71.5	39.5	3883
181	273	90	53	71.5	39.5	3922.5
182	274	87	52	69.5	37.5	3960
183	275	94	53	73.5	41.5	4001.5
184	276	88	53	70.5	38.5	4040
185	277	91	56	73.5	41.5	4081.5
186	278	92	58	75	43	4124.5
187	279	94	58	76	44	4168.5
188	280	95	60	77.5	45.5	4214
189	281	95	60	77.5	45.5	4259.5
190	282	94	59	76.5	44.5	4304
191	283	92	61	76.5	44.5	4348.5
192	284	87	58	72.5	40.5	4389
193	285	89	56	72.5	40.5	4429.5
194	286	92	56	74	42	4471.5
195	287	97	62	79.5	47.5	4519
196	288	98	62	80	48	4567
197	289	101	64	82.5	50.5	4617.5
198	290	98	63	80.5	48.5	4666
199	291	95	65	80	48	4714
200	292	92	61	76.5	44.5	4758.5
201	293	88	57	72.5	40.5	4799
202	294	91	59	75	43	4842
203	295	92	60	76	44	4886
204	296	87	57	72	40	4926
205	297	91	58	74.5	42.5	4968.5
206	298	96	62	79	47	5015.5
207	299	86	63	74.5	42.5	5058
208	300	89	57	73	41	5099
209	301	75	58	66.5	34.5	5133.5
210	302	85	57	71	39	5172.5
211	303	69	60	64.5	32.5	5205
212	304	81	56	68.5	36.5	5241.5
213	305	88	58	73	41	5282.5
214	306	88	62	75	43	5325.5
215	307	91	63	77	45	5370.5
216	308	79	59	69	37	5407.5
217	309	82	60	71	39	5446.5
218	310	82	59	70.5	38.5	5485

219	311	85	55	70	38	5523
220	312	88	59	73.5	41.5	5564.5
221	313	88	63	75.5	43.5	5608
222	314	72	52	62	30	5638
223	315	77	56	66.5	34.5	5672.5
224	316	88	55	71.5	39.5	5712
225	317	86	58	72	40	5752
226	318	86	57	71.5	39.5	5791.5
227	319	92	56	74	42	5833.5
228	320	87	57	72	40	5873.5
229	321	85	58	71.5	39.5	5913
230	322	84	56	70	38	5951
231	323	88	58	73	41	5992
232	324	90	59	74.5	42.5	6034.5
233	325	92	62	77	45	6079.5
234	326	91	64	77.5	45.5	6125
235	327	89	62	75.5	43.5	6168.5
236	328	90	59	74.5	42.5	6211
237	329	87	59	73	41	6252
238	330	85	59	72	40	6292
239	331	87	57	72	40	6332
240	332	89	59	74	42	6374
241	333	88	62	75	43	6417
242	334	82	58	70	38	6455
243	335	80	57	68.5	36.5	6491.5
244	336	85	58	71.5	39.5	6531
245	337	88	60	74	42	6573
246	338	86	61	73.5	41.5	6614.5
247	339	83	56	69.5	37.5	6652
248	340	88	55	71.5	39.5	6691.5
249	341	82	60	71	39	6730.5
250	342	89	56	72.5	40.5	6771
251	343	92	60	76	44	6815
252	344	87	55	71	39	6854
253	345	87	55	71	39	6893
254	346	80	54	67	35	6928
255	347	80	51	65.5	33.5	6961.5
256	348	84	56	70	38	6999.5
257	349	79	53	66	34	7033.5
258	350	72	56	64	32	7065.5
259	351	73	55	64	32	7097.5
260	352	79	54	66.5	34.5	7132
261	353	82	57	69.5	37.5	7169.5
262	354	81	53	67	35	7204.5
263	355	84	55	69.5	37.5	7242
264	356	70	53	61.5	29.5	7271.5
265	357	72	48	60	28	7299.5
266	358	75	44	59.5	27.5	7327
267	359	77	48	62.5	30.5	7357.5
268	360	80	51	65.5	33.5	7391
269	361	80	52	66	34	7425
270	362	80	50	65	33	7458
271	363	82	60	71	39	7497
272	364	82	48	65	33	7530
273	365	83	52	67.5	35.5	7565.5



96	951	length of freeze (day)	21
117	835.5	frost depth (^oF-day)	115.5
		average temperature	52.7

1997-1998

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	84	53	68.5	36.5	36.5
275	2	76	53	64.5	32.5	69
276	3	72	47	59.5	27.5	96.5
277	4	69	47	58	26	122.5
278	5	77	46	61.5	29.5	152
279	6	78	50	64	32	184
280	7	66	43	54.5	22.5	206.5
281	8	58	35	46.5	14.5	221
282	9	67	37	52	20	241
283	10	75	49	62	30	271
284	11	60	36	48	16	287
285	12	49	29	39	7	294
286	13	59	25	42	10	304
287	14	67	34	50.5	18.5	322.5
288	15	72	38	55	23	345.5
289	16	71	48	59.5	27.5	373
290	17	72	41	56.5	24.5	397.5
291	18	72	42	57	25	422.5
292	19	71	43	57	25	447.5
293	20	69	43	56	24	471.5
294	21	69	41	55	23	494.5
295	22	65	41	53	21	515.5
296	23	57	35	46	14	529.5
297	24	44	28	36	4	533.5
298	25	43	24	33.5	1.5	535
299	26	57	24	40.5	8.5	543.5
300	27	54	24	39	7	550.5
301	28	60	31	45.5	13.5	564
302	29	60	33	46.5	14.5	578.5
303	30	65	37	51	19	597.5
304	31	70	38	54	22	619.5
305	32	58	34	46	14	633.5
306	33	60	30	45	13	646.5
307	34	60	32	46	14	660.5
308	35	66	34	50	18	678.5
309	36	66	39	52.5	20.5	699
310	37	65	36	50.5	18.5	717.5
311	38	65	37	51	19	736.5
312	39	62	39	50.5	18.5	755
313	40	52	33	42.5	10.5	765.5
314	41	47	30	38.5	6.5	772
315	42	56	33	44.5	12.5	784.5
316	43	47	28	37.5	5.5	790
317	44	49	32	40.5	8.5	798.5
318	45	46	23	34.5	2.5	801
319	46	44	18	31	-1	800
320	47	43	24	33.5	1.5	801.5
321	48	47	22	34.5	2.5	804
322	49	48	24	36	4	808

323	50	51	30	40.5	8.5	816.5
324	51	54	30	42	10	826.5
325	52	44	23	33.5	1.5	828
326	53	49	23	36	4	832
327	54	51	25	38	6	838
328	55	56	29	42.5	10.5	848.5
329	56	54	35	44.5	12.5	861
330	57	53	42	47.5	15.5	876.5
331	58	46	28	37	5	881.5
332	59	50	22	36	4	885.5
333	60	50	28	39	7	892.5
334	61	50	29	39.5	7.5	900
335	62	49	32	40.5	8.5	908.5
336	63	47	28	37.5	5.5	914
337	64	43	23	33	1	915
338	65	43	20	31.5	-0.5	914.5
339	66	43	21	32	0	914.5
340	67	49	25	37	5	919.5
341	68	40	30	35	3	922.5
342	69	38	20	29	-3	919.5
343	70	38	15	26.5	-5.5	914
344	71	36	23	29.5	-2.5	911.5
345	72	36	15	25.5	-6.5	905
346	73	43	15	29	-3	902
347	74	42	14	28	-4	898
348	75	42	20	31	-1	897
349	76	46	25	35.5	3.5	900.5
350	77	48	22	35	3	903.5
351	78	46	22	34	2	905.5
352	79	48	29	38.5	6.5	912
353	80	52	24	38	6	918
354	81	48	26	37	5	923
355	82	33	22	27.5	-4.5	918.5
356	83	47	27	37	5	923.5
357	84	45	22	33.5	1.5	925
358	85	30	19	24.5	-7.5	917.5
359	86	36	16	26	-6	911.5
360	87	40	9	24.5	-7.5	904
361	88	32	11	21.5	-10.5	893.5
362	89	38	11	24.5	-7.5	886
363	90	48	18	33	1	887
364	91	57	23	40	8	895
365	92	48	25	36.5	4.5	899.5
1	93	48	28	38	6	905.5
2	94	55	31	43	11	916.5
3	95	50	32	41	9	925.5
4	96	45	32	38.5	6.5	932
5	97	39	25	32	0	932
6	98	44	21	32.5	0.5	932.5
7	99	36	16	26	-6	926.5
8	100	49	18	33.5	1.5	928
9	101	42	21	31.5	-0.5	927.5
10	102	32	28	30	-2	925.5
11	103	36	30	33	1	926.5
12	104	44	30	37	5	931.5
13	105	38	6	22	-10	921.5
14	106	44	21	32.5	0.5	922
15	107	40	24	32	0	922
16	108	49	24	36.5	4.5	926.5
17	109	45	29	37	5	931.5
18	110	53	29	41	9	940.5
19	111	48	29	38.5	6.5	947
20	112	42	19	30.5	-1.5	945.5
21	113	44	21	32.5	0.5	946
22	114	39	18	28.5	-3.5	942.5
23	115	50	21	35.5	3.5	946
24	116	51	23	37	5	951
25	117	51	25	38	6	957
26	118	53	28	40.5	8.5	965.5
27	119	51	31	41	9	974.5
28	120	55	28	41.5	9.5	984
29	121	54	27	40.5	8.5	992.5
30	122	51	29	40	8	1000.5
31	123	50	26	38	6	1006.5
32	124	48	22	35	3	1009.5
33	125	39	29	34	2	1011.5
34	126	52	33	42.5	10.5	1022
35	127	45	33	39	7	1029
36	128	48	31	39.5	7.5	1036.5
37	129	46	27	36.5	4.5	1041
38	130	46	29	37.5	5.5	1046.5
39	131	35	28	31.5	-0.5	1046
40	132	45	22	33.5	1.5	1047.5
41	133	46	22	34	2	1049.5
42	134	44	21	32.5	0.5	1050
43	135	48	23	35.5	3.5	1053.5
44	136	45	25	35	3	1056.5
45	137	45	26	35.5	3.5	1060
46	138	44	29	36.5	4.5	1064.5
47	139	47	21	34	2	1066.5
48	140	44	20	32	0	1066.5
49	141	48	22	35	3	1069.5
50	142	46	22	34	2	1071.5
51	143	47	29	38	6	1077.5
52	144	49	24	36.5	4.5	1082
53	145	46	28	37	5	1087
54	146	53	33	43	11	1098
55	147	58	31	44.5	12.5	1110.5
56	148	43	22	32.5	0.5	1111
57	149	39	18	28.5	-3.5	1107.5
58	150	38	15	26.5	-5.5	1102
59	151	38	15	26.5	-5.5	1096.5
60	152	45	16	30.5	-1.5	1095
61	153	52	23	37.5	5.5	1100.5
62	154	55	28	41.5	9.5	1110
63	155	54	31	42.5	10.5	1120.5
64	156	54	29	41.5	9.5	1130
65	157	49	31	40	8	1138
66	158	40	19	29.5	-2.5	1135.5

67	159	41	15	28	-4	1131.5
68	160	43	21	32	0	1131.5
69	161	52	23	37.5	5.5	1137
70	162	56	27	41.5	9.5	1146.5
71	163	59	31	45	13	1159.5
72	164	64	35	49.5	17.5	1177
73	165	60	36	48	16	1193
74	166	65	36	50.5	18.5	1211.5
75	167	65	35	50	18	1229.5
76	168	63	35	49	17	1246.5
77	169	42	22	32	0	1246.5
78	170	53	23	38	6	1252.5
79	171	59	27	43	11	1263.5
80	172	65	27	46	14	1277.5
81	173	70	38	54	22	1299.5
82	174	74	40	57	25	1324.5
83	175	76	45	60.5	28.5	1353
84	176	71	43	57	25	1378
85	177	56	39	47.5	15.5	1393.5
86	178	54	32	43	11	1404.5
87	179	47	31	39	7	1411.5
88	180	41	24	32.5	0.5	1412
89	181	44	19	31.5	-0.5	1411.5
90	182	54	24	39	7	1418.5
91	183	57	29	43	11	1429.5
92	184	51	28	39.5	7.5	1437
93	185	59	31	45	13	1450
94	186	60	33	46.5	14.5	1464.5
95	187	57	29	43	11	1475.5
96	188	53	32	42.5	10.5	1486
97	189	50	28	39	7	1493
98	190	54	28	41	9	1502
99	191	59	31	45	13	1515
100	192	68	37	52.5	20.5	1535.5
101	193	73	43	58	26	1561.5
102	194	54	-	-	-	1561.5
103	195	56	29	42.5	10.5	1572
104	196	54	35	44.5	12.5	1584.5
105	197	49	28	38.5	6.5	1591
106	198	50	26	38	6	1597
107	199	56	26	41	9	1606
108	200	55	29	42	10	1616
109	201	67	31	49	17	1633
110	202	67	36	51.5	19.5	1652.5
111	203	72	39	55.5	23.5	1676
112	204	74	41	57.5	25.5	1701.5
113	205	80	46	63	31	1732.5
114	206	72	42	57	25	1757.5
115	207	64	36	50	18	1775.5
116	208	63	36	49.5	17.5	1793
117	209	61	37	49	17	1810
118	210	69	35	52	20	1830
119	211	71	37	54	22	1852
120	212	78	41	59.5	27.5	1879.5
121	213	79	44	61.5	29.5	1909
122	214	77	44	60.5	28.5	1937.5
123	215	76	44	60	28	1965.5
124	216	75	45	60	28	1993.5
125	217	72	41	56.5	24.5	2018
126	218	61	38	49.5	17.5	2035.5
127	219	69	38	53.5	21.5	2057
128	220	72	43	57.5	25.5	2082.5
129	221	72	41	56.5	24.5	2107
130	222	74	41	57.5	25.5	2132.5
131	223	70	39	54.5	22.5	2155
132	224	72	39	55.5	23.5	2178.5
133	225	66	41	53.5	21.5	2200
134	226	59	37	48	16	2216
135	227	67	33	50	18	2234
136	228	78	41	59.5	27.5	2261.5
137	229	82	44	63	31	2292.5
138	230	83	47	65	33	2325.5
139	231	83	51	67	35	2360.5
140	232	80	51	65.5	33.5	2394
141	233	71	46	58.5	26.5	2420.5
142	234	71	39	55	23	2443.5
143	235	74	38	56	24	2467.5
144	236	78	47	62.5	30.5	2498
145	237	78	50	64	32	2530
146	238	80	49	64.5	32.5	2562.5
147	239	80	45	62.5	30.5	2593
148	240	84	50	67	35	2628
149	241	84	52	68	36	2664
150	242	82	53	67.5	35.5	2699.5
151	243	88	52	70	38	2737.5
152	244	89	52	70.5	38.5	2776
153	245	89	53	71	39	2815
154	246	84	54	69	37	2852
155	247	74	46	60	28	2880
156	248	75	41	58	26	2906
157	249	87	49	68	36	2942
158	250	82	51	66.5	34.5	2976.5
159	251	76	42	59	27	3003.5
160	252	76	46	61	29	3032.5
161	253	75	46	60.5	28.5	3061
162	254	78	45	61.5	29.5	3090.5
163	255	82	46	64	32	3122.5
164	256	74	52	63	31	3153.5
165	257	79	49	64	32	3185.5
166	258	81	44	62.5	30.5	3216
167	259	88	52	70	38	3254
168	260	70	44	57	25	3279
169	261	79	44	61.5	29.5	3308.5
170	262	89	52	70.5	38.5	3347
171	263	89	58	73.5	41.5	3388.5
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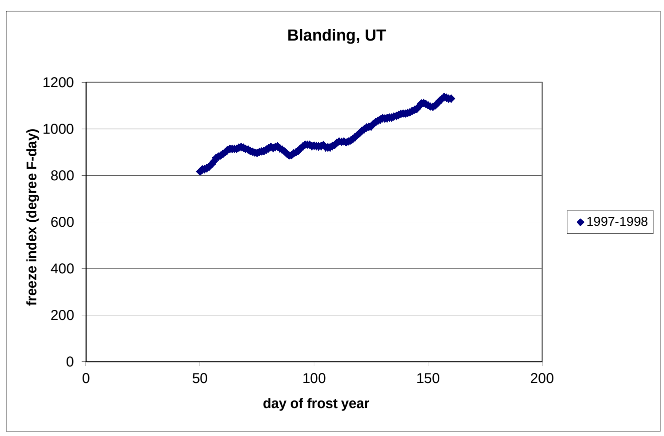
174	266	88	51	69.5	37.5	3505
175	267	87	48	67.5	35.5	3540.5

176	268	91	54	72.5	40.5	3581
177	269	91	55	73	41	3622
178	270	93	58	75.5	43.5	3665.5
179	271	97	63	80	48	3713.5
180	272	99	64	81.5	49.5	3763
181	273	98	63	80.5	48.5	3811.5
182	274	96	61	78.5	46.5	3858
183	275	93	61	77	45	3903
184	276	96	66	81	49	3952
185	277	95	62	78.5	46.5	3998.5
186	278	96	65	80.5	48.5	4047
187	279	89	60	74.5	42.5	4089.5
188	280	87	63	75	43	4132.5
189	281	88	60	74	42	4174.5
190	282	86	60	73	41	4215.5
191	283	92	59	75.5	43.5	4259
192	284	96	63	79.5	47.5	4306.5
193	285	96	64	80	48	4354.5
194	286	99	66	82.5	50.5	4405
195	287	98	66	82	50	4455
196	288	100	76	88	56	4511
197	289	97	70	83.5	51.5	4562.5
198	290	96	63	79.5	47.5	4610
199	291	100	65	82.5	50.5	4660.5
200	292	102	63	82.5	50.5	4711
201	293	102	64	83	51	4762
202	294	93	67	80	48	4810
203	295	94	64	79	47	4857
204	296	90	61	75.5	43.5	4900.5
205	297	83	58	70.5	38.5	4939
206	298	83	59	71	39	4978
207	299	85	61	73	41	5019
208	300	87	62	74.5	42.5	5061.5
209	301	85	61	73	41	5102.5
210	302	89	59	74	42	5144.5
211	303	90	63	76.5	44.5	5189
212	304	91	62	76.5	44.5	5233.5
213	305	88	61	74.5	42.5	5276
214	306	91	58	74.5	42.5	5318.5
215	307	90	62	76	44	5362.5
216	308	88	49	68.5	36.5	5399
217	309	89	57	73	41	5440
218	310	94	59	76.5	44.5	5484.5
219	311	96	62	79	47	5531.5
220	312	96	64	80	48	5579.5
221	313	92	62	77	45	5624.5
222	314	83	65	74	42	5666.5
223	315	90	62	76	44	5710.5
224	316	90	60	75	43	5753.5
225	317	88	59	73.5	41.5	5795
226	318	92	59	75.5	43.5	5838.5
227	319	92	61	76.5	44.5	5883
228	320	92	61	76.5	44.5	5927.5
229	321	92	63	77.5	45.5	5973
230	322	83	60	71.5	39.5	6012.5
231	323	90	58	74	42	6054.5
232	324	93	63	78	46	6100.5
233	325	81	58	69.5	37.5	6138
234	326	90	60	75	43	6181
235	327	96	63	79.5	47.5	6228.5
236	328	92	64	78	46	6274.5
237	329	87	64	75.5	43.5	6318
238	330	91	62	76.5	44.5	6362.5
239	331	92	63	77.5	45.5	6408
240	332	94	62	78	46	6454
241	333	93	61	77	45	6499
242	334	95	63	79	47	6546
243	335	85	62	73.5	41.5	6587.5
244	336	82	54	68	36	6623.5
245	337	88	56	72	40	6663.5
246	338	91	61	76	44	6707.5
247	339	89	64	76.5	44.5	6752
248	340	85	65	75	43	6795
249	341	89	60	74.5	42.5	6837.5
250	342	89	60	74.5	42.5	6880
251	343	91	60	75.5	43.5	6923.5
252	344	87	62	74.5	42.5	6966
253	345	82	56	69	37	7003
254	346	78	55	66.5	34.5	7037.5
255	347	77	55	66	34	7071.5
256	348	83	52	67.5	35.5	7107
257	349	83	54	68.5	36.5	7143.5
258	350	87	57	72	40	7183.5
259	351	89	54	71.5	39.5	7223
260	352	87	57	72	40	7263
261	353	88	59	73.5	41.5	7304.5
262	354	85	56	70.5	38.5	7343
263	355	82	54	68	36	7379
264	356	79	50	64.5	32.5	7411.5
265	357	78	50	64	32	7443.5
266	358	80	55	67.5	35.5	7479
267	359	83	50	66.5	34.5	7513.5
268	360	78	48	63	31	7544.5
269	361	75	46	60.5	28.5	7573
270	362	81	48	64.5	32.5	7605.5
271	363	83	52	67.5	35.5	7641
272	364	83	59	71	39	7680
273	365	80	51	65.5	33.5	7713.5



85	917.5	length of freeze (day)	5
90	887	frost depth (^oF-day)	30.5
		average temperature	53.2

1998-1999

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	74	48	61	29	29
275	2	76	43	59.5	27.5	56.5
276	3	77	46	61.5	29.5	86
277	4	60	46	53	21	107
278	5	60	34	47	15	122
279	6	70	32	51	19	141

280	7	73	40	56.5	24.5	165.5
281	8	75	44	59.5	27.5	193
282	9	76	44	60	28	221
283	10	74	44	59	27	248
284	11	74	43	58.5	26.5	274.5
285	12	78	46	62	30	304.5
286	13	79	46	62.5	30.5	335
287	14	77	48	62.5	30.5	365.5
288	15	69	42	55.5	23.5	389
289	16	44	32	38	6	395
290	17	59	32	45.5	13.5	408.5
291	18	62	35	48.5	16.5	425
292	19	70	40	55	23	448
293	20	69	48	58.5	26.5	474.5
294	21	51	44	47.5	15.5	490
295	22	55	44	49.5	17.5	507.5
296	23	65	45	55	23	530.5
297	24	63	40	51.5	19.5	550
298	25	55	43	49	17	567
299	26	52	42	47	15	582
300	27	54	40	47	15	597
301	28	55	35	45	13	610
302	29	56	36	46	14	624
303	30	56	39	47.5	15.5	639.5
304	31	58	37	47.5	15.5	655
305	32	58	36	47	15	670
306	33	54	39	46.5	14.5	684.5
307	34	54	33	43.5	11.5	696
308	35	46	31	38.5	6.5	702.5
309	36	51	30	40.5	8.5	711
310	37	53	29	41	9	720
311	38	48	27	37.5	5.5	725.5
312	39	47	34	40.5	8.5	734
313	40	36	25	30.5	-1.5	732.5
314	41	37	18	27.5	-4.5	728
315	42	37	26	31.5	-0.5	727.5
316	43	52	29	40.5	8.5	736
317	44	54	29	41.5	9.5	745.5
318	45	59	33	46	14	759.5
319	46	59	33	46	14	773.5
320	47	61	35	48	16	789.5
321	48	59	37	48	16	805.5
322	49	54	29	41.5	9.5	815
323	50	50	26	38	6	821
324	51	48	23	35.5	3.5	824.5
325	52	50	25	37.5	5.5	830
326	53	58	29	43.5	11.5	841.5
327	54	61	34	47.5	15.5	857
328	55	59	35	47	15	872
329	56	58	34	46	14	886
330	57	58	35	46.5	14.5	900.5
331	58	63	37	50	18	918.5
332	59	52	37	44.5	12.5	931
333	60	48	33	40.5	8.5	939.5
334	61	51	31	41	9	948.5
335	62	58	36	47	15	963.5
336	63	60	35	47.5	15.5	979
337	64	60	34	47	15	994
338	65	52	32	42	10	1004
339	66	43	22	32.5	0.5	1004.5
340	67	29	17	23	-9	995.5
341	68	37	17	27	-5	990.5
342	69	37	14	25.5	-6.5	984
343	70	33	22	27.5	-4.5	979.5
344	71	44	21	32.5	0.5	980
345	72	45	17	31	-1	979
346	73	48	21	34.5	2.5	981.5
347	74	50	24	37	5	986.5
348	75	55	27	41	9	995.5
349	76	58	29	43.5	11.5	1007
350	77	63	29	46	14	1021
351	78	55	29	42	10	1031
352	79	50	27	38.5	6.5	1037.5
353	80	54	29	41.5	9.5	1047
354	81	46	29	37.5	5.5	1052.5
355	82	29	8	18.5	-13.5	1039
356	83	34	8	21	-11	1028
357	84	36	10	23	-9	1019
358	85	34	8	21	-11	1008
359	86	41	11	26	-6	1002
360	87	43	20	31.5	-0.5	1001.5
361	88	45	23	34	2	1003.5
362	89	47	24	35.5	3.5	1007
363	90	58	30	44	12	1019
364	91	54	31	42.5	10.5	1029.5
365	92	50	31	40.5	8.5	1038
1	93	49	28	38.5	6.5	1044.5
2	94	49	24	36.5	4.5	1049
3	95	42	19	30.5	-1.5	1047.5
4	96	45	17	31	-1	1046.5
5	97	51	21	36	4	1050.5
6	98	55	28	41.5	9.5	1060
7	99	49	30	39.5	7.5	1067.5
8	100	48	24	36	4	1071.5
9	101	49	22	35.5	3.5	1075
10	102	54	26	40	8	1083
11	103	53	28	40.5	8.5	1091.5
12	104	50	29	39.5	7.5	1099
13	105	51	26	38.5	6.5	1105.5
14	106	50	26	38	6	1111.5
15	107	43	24	33.5	1.5	1113
16	108	45	27	36	4	1117
17	109	52	26	39	7	1124
18	110	54	33	43.5	11.5	1135.5
19	111	57	31	44	12	1147.5
20	112	41	34	37.5	5.5	1153
21	113	38	29	33.5	1.5	1154.5
22	114	46	22	34	2	1156.5
23	115	48	23	35.5	3.5	1160

24	116	52	33	42.5	10.5	1170.5
25	117	51	39	45	13	1183.5
26	118	42	28	35	3	1186.5
27	119	43	22	32.5	0.5	1187
28	120	43	21	32	0	1187
29	121	52	22	37	5	1192
30	122	47	21	34	2	1194
31	123	51	25	38	6	1200
32	124	48	25	36.5	4.5	1204.5
33	125	47	20	33.5	1.5	1206
34	126	58	26	42	10	1216
35	127	51	31	41	9	1225
36	128	45	32	38.5	6.5	1231.5
37	129	41	29	35	3	1234.5
38	130	49	31	40	8	1242.5
39	131	50	30	40	8	1250.5
40	132	62	32	47	15	1265.5
41	133	48	19	33.5	1.5	1267
42	134	34	13	23.5	-8.5	1258.5
43	135	47	15	31	-1	1257.5
44	136	60	23	41.5	9.5	1267
45	137	53	30	41.5	9.5	1276.5
46	138	53	28	40.5	8.5	1285
47	139	52	27	39.5	7.5	1292.5
48	140	56	28	42	10	1302.5
49	141	55	28	41.5	9.5	1312
50	142	56	27	41.5	9.5	1321.5
51	143	52	23	37.5	5.5	1327
52	144	56	30	43	11	1338
53	145	46	24	35	3	1341
54	146	53	23	38	6	1347
55	147	59	29	44	12	1359
56	148	61	32	46.5	14.5	1373.5
57	149	60	35	47.5	15.5	1389
58	150	57	32	44.5	12.5	1401.5
59	151	64	30	47	15	1416.5
60	152	67	32	49.5	17.5	1434
61	153	63	33	48	16	1450
62	154	64	33	48.5	16.5	1466.5
63	155	63	35	49	17	1483.5
64	156	54	28	41	9	1492.5
65	157	59	33	46	14	1506.5
66	158	57	34	45.5	13.5	1520
67	159	52	24	38	6	1526
68	160	57	28	42.5	10.5	1536.5
69	161	55	27	41	9	1545.5
70	162	58	33	45.5	13.5	1559
71	163	50	30	40	8	1567
72	164	63	26	44.5	12.5	1579.5
73	165	62	32	47	15	1594.5
74	166	65	34	49.5	17.5	1612
75	167	66	36	51	19	1631
76	168	65	36	50.5	18.5	1649.5
77	169	65	31	48	16	1665.5
78	170	65	31	48	16	1681.5
79	171	70	37	53.5	21.5	1703
80	172	69	39	54	22	1725
81	173	65	33	49	17	1742
82	174	60	33	46.5	14.5	1756.5
83	175	67	32	49.5	17.5	1774
84	176	68	40	54	22	1796
85	177	68	40	54	22	1818
86	178	67	39	53	21	1839
87	179	66	32	49	17	1856
88	180	69	36	52.5	20.5	1876.5
89	181	70	39	54.5	22.5	1899
90	182	61	36	48.5	16.5	1915.5
91	183	37	27	32	0	1915.5
92	184	36	25	30.5	-1.5	1914
93	185	44	20	32	0	1914
94	186	41	27	34	2	1916
95	187	49	27	38	6	1922
96	188	62	29	45.5	13.5	1935.5
97	189	67	32	49.5	17.5	1953
98	190	52	28	40	8	1961
99	191	42	25	33.5	1.5	1962.5
100	192	50	18	34	2	1964.5
101	193	62	27	44.5	12.5	1977
102	194	69	40	54.5	22.5	1999.5
103	195	70	45	57.5	25.5	2025
104	196	61	41	51	19	2044
105	197	52	31	41.5	9.5	2053.5
106	198	57	24	40.5	8.5	2062
107	199	68	31	49.5	17.5	2079.5
108	200	76	39	57.5	25.5	2105
109	201	77	42	59.5	27.5	2132.5
110	202	74	46	60	28	2160.5
111	203	63	40	51.5	19.5	2180
112	204	43	35	39	7	2187
113	205	60	34	47	15	2202
114	206	43	38	40.5	8.5	2210.5
115	207	53	33	43	11	2221.5
116	208	68	35	51.5	19.5	2241
117	209	73	43	58	26	2267
118	210	62	49	55.5	23.5	2290.5
119	211	58	39	48.5	16.5	2307
120	212	58	34	46	14	2321
121	213	67	38	52.5	20.5	2341.5
122	214	65	33	49	17	2358.5
123	215	54	35	44.5	12.5	2371
124	216	53	32	42.5	10.5	2381.5
125	217	55	32	43.5	11.5	2393
126	218	63	33	48	16	2409
127	219	75	37	56	24	2433
128	220	77	47	62	30	2463
129	221	73	47	60	28	2491
130	222	61	39	50	18	2509
131	223	63	39	51	19	2528
132	224	73	37	55	23	2551

133	225	81	46	63.5	31.5	2582.5
134	226	72	47	59.5	27.5	2610
135	227	74	43	58.5	26.5	2636.5
136	228	68	40	54	22	2658.5
137	229	72	35	53.5	21.5	2680
138	230	80	44	62	30	2710
139	231	80	49	64.5	32.5	2742.5
140	232	79	47	63	31	2773.5
141	233	81	50	65.5	33.5	2807
142	234	86	52	69	37	2844
143	235	83	55	69	37	2881
144	236	77	48	62.5	30.5	2911.5
145	237	72	46	59	27	2938.5
146	238	77	44	60.5	28.5	2967
147	239	77	51	64	32	2999
148	240	79	49	64	32	3031
149	241	79	50	64.5	32.5	3063.5
150	242	80	49	64.5	32.5	3096
151	243	79	48	63.5	31.5	3127.5
152	244	78	46	62	30	3157.5
153	245	66	52	59	27	3184.5
154	246	75	44	59.5	27.5	3212
155	247	68	40	54	22	3234
156	248	51	36	43.5	11.5	3245.5
157	249	73	38	55.5	23.5	3269
158	250	82	49	65.5	33.5	3302.5
159	251	82	48	65	33	3335.5
160	252	80	49	64.5	32.5	3368
161	253	80	49	64.5	32.5	3400.5
162	254	81	54	67.5	35.5	3436
163	255	85	53	69	37	3473
164	256	86	51	68.5	36.5	3509.5
165	257	84	56	70	38	3547.5
166	258	88	53	70.5	38.5	3586
167	259	91	56	73.5	41.5	3627.5
168	260	77	55	66	34	3661.5
169	261	85	52	68.5	36.5	3698
170	262	89	56	72.5	40.5	3738.5
171	263	91	57	74	42	3780.5
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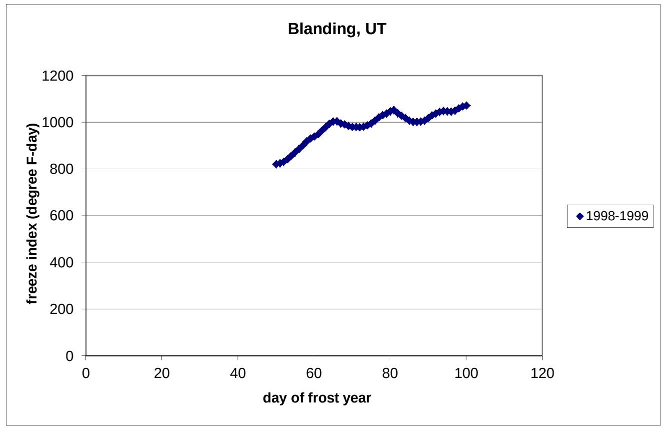
176	268	92	61	76.5	44.5	3990.5
177	269	93	59	76	44	4034.5
178	270	92	57	74.5	42.5	4077
179	271	95	56	75.5	43.5	4120.5
180	272	94	61	77.5	45.5	4166
181	273	95	59	77	45	4211
182	274	101	61	81	49	4260
183	275	100	65	82.5	50.5	4310.5
184	276	93	60	76.5	44.5	4355
185	277	94	60	77	45	4400
186	278	99	61	80	48	4448
187	279	94	64	79	47	4495
188	280	91	66	78.5	46.5	4541.5
189	281	79	62	70.5	38.5	4580
190	282	88	60	74	42	4622
191	283	88	59	73.5	41.5	4663.5
192	284	88	64	76	44	4707.5
193	285	90	59	74.5	42.5	4750
194	286	91	64	77.5	45.5	4795.5
195	287	80	59	69.5	37.5	4833
196	288	82	56	69	37	4870
197	289	89	56	72.5	40.5	4910.5
198	290	91	59	75	43	4953.5
199	291	84	59	71.5	39.5	4993
200	292	76	57	66.5	34.5	5027.5
201	293	91	57	74	42	5069.5
202	294	91	60	75.5	43.5	5113
203	295	89	58	73.5	41.5	5154.5
204	296	92	60	76	44	5198.5
205	297	91	60	75.5	43.5	5242
206	298	89	61	75	43	5285
207	299	91	62	76.5	44.5	5329.5
208	300	89	60	74.5	42.5	5372
209	301	88	60	74	42	5414
210	302	88	61	74.5	42.5	5456.5
211	303	82	58	70	38	5494.5
212	304	86	55	70.5	38.5	5533
213	305	89	59	74	42	5575
214	306	90	58	74	42	5617
215	307	74	58	66	34	5651
216	308	80	55	67.5	35.5	5686.5
217	309	73	58	65.5	33.5	5720
218	310	80	52	66	34	5754
219	311	87	57	72	40	5794
220	312	92	62	77	45	5839
221	313	90	61	75.5	43.5	5882.5
222	314	73	60	66.5	34.5	5917
223	315	84	58	71	39	5956
224	316	86	51	68.5	36.5	5992.5
225	317	87	54	70.5	38.5	6031
226	318	84	60	72	40	6071
227	319	82	55	68.5	36.5	6107.5
228	320	86	55	70.5	38.5	6146
229	321	89	56	72.5	40.5	6186.5
230	322	90	59	74.5	42.5	6229
231	323	88	59	73.5	41.5	6270.5
232	324	87	61	74	42	6312.5
233	325	80	57	68.5	36.5	6349
234	326	83	57	70	38	6387
235	327	91	58	74.5	42.5	6429.5
236	328	90	68	79	47	6476.5
237	329	87	61	74	42	6518.5
238	330	89	61	75	43	6561.5
239	331	87	63	75	43	6604.5
240	332	88	57	72.5	40.5	6645
241	333	87	58	72.5	40.5	6685.5

242	334	90	62	76	44	6729.5
243	335	82	56	69	37	6766.5
244	336	65	56	60.5	28.5	6795
245	337	77	55	66	34	6829
246	338	78	54	66	34	6863
247	339	80	49	64.5	32.5	6895.5
248	340	84	54	69	37	6932.5
249	341	87	55	71	39	6971.5
250	342	89	55	72	40	7011.5
251	343	88	57	72.5	40.5	7052
252	344	85	54	69.5	37.5	7089.5
253	345	86	53	69.5	37.5	7127
254	346	76	55	65.5	33.5	7160.5
255	347	82	50	66	34	7194.5
256	348	83	52	67.5	35.5	7230
257	349	74	56	65	33	7263
258	350	68	50	59	27	7290
259	351	76	49	62.5	30.5	7320.5
260	352	78	47	62.5	30.5	7351
261	353	79	50	64.5	32.5	7383.5
262	354	76	50	63	31	7414.5
263	355	77	47	62	30	7444.5
264	356	78	47	62.5	30.5	7475
265	357	77	44	60.5	28.5	7503.5
266	358	62	52	57	25	7528.5
267	359	76	52	64	32	7560.5
268	360	83	50	66.5	34.5	7595
269	361	87	52	69.5	37.5	7632.5
270	362	73	50	61.5	29.5	7662
271	363	61	36	48.5	16.5	7678.5
272	364	69	36	52.5	20.5	7699
273	365	75	42	58.5	26.5	7725.5



81	1052.5	length of freeze (day)	5
86	1002	frost depth (^{o}F-day)	50.5
		average temperature	53.2

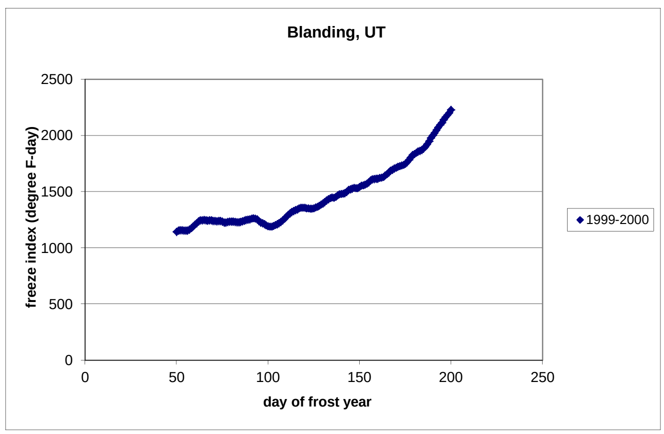
1999-2000

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	81	44	62.5	30.5	30.5
275	2	80	46	63	31	61.5
276	3	81	47	64	32	93.5
277	4	78	46	62	30	123.5
278	5	80	45	62.5	30.5	154
279	6	79	47	63	31	185
280	7	63	46	54.5	22.5	207.5
281	8	77	44	60.5	28.5	236
282	9	78	46	62	30	266
283	10	79	45	62	30	296
284	11	80	47	63.5	31.5	327.5
285	12	80	46	63	31	358.5
286	13	79	50	64.5	32.5	391
287	14	78	44	61	29	420
288	15	77	46	61.5	29.5	449.5
289	16	53	37	45	13	462.5
290	17	59	28	43.5	11.5	474
291	18	65	32	48.5	16.5	490.5
292	19	66	39	52.5	20.5	511
293	20	68	36	52	20	531
294	21	72	40	56	24	555
295	22	70	40	55	23	578
296	23	71	39	55	23	601
297	24	69	40	54.5	22.5	623.5
298	25	72	41	56.5	24.5	648
299	26	71	40	55.5	23.5	671.5
300	27	73	40	56.5	24.5	696
301	28	65	39	52	20	716
302	29	55	36	45.5	13.5	729.5
303	30	66	29	47.5	15.5	745
304	31	65	35	50	18	763
305	32	72	38	55	23	786
306	33	62	37	49.5	17.5	803.5
307	34	66	35	50.5	18.5	822
308	35	67	38	52.5	20.5	842.5
309	36	68	38	53	21	863.5
310	37	74	40	57	25	888.5
311	38	71	44	57.5	25.5	914
312	39	68	42	55	23	937
313	40	63	35	49	17	954
314	41	64	37	50.5	18.5	972.5
315	42	69	39	54	22	994.5
316	43	67	36	51.5	19.5	1014
317	44	69	37	53	21	1035
318	45	66	37	51.5	19.5	1054.5
319	46	68	38	53	21	1075.5
320	47	69	41	55	23	1098.5
321	48	66	40	53	21	1119.5
322	49	56	30	43	11	1130.5
323	50	53	35	44	12	1142.5
324	51	57	31	44	12	1154.5
325	52	43	30	36.5	4.5	1159
326	53	41	23	32	0	1159
327	54	41	17	29	-3	1156
328	55	44	17	30.5	-1.5	1154.5
329	56	48	19	33.5	1.5	1156
330	57	53	28	40.5	8.5	1164.5
331	58	51	33	42	10	1174.5
332	59	60	33	46.5	14.5	1189
333	60	63	36	49.5	17.5	1206.5
334	61	60	34	47	15	1221.5
335	62	61	37	49	17	1238.5
336	63	50	31	40.5	8.5	1247
337	64	36	28	32	0	1247
338	65	46	20	33	1	1248
339	66	41	17	29	-3	1245
340	67	43	19	31	-1	1244
341	68	44	25	34.5	2.5	1246.5
342	69	40	24	32	0	1246.5
343	70	35	18	26.5	-5.5	1241
344	71	39	26	32.5	0.5	1241.5
345	72	41	17	29	-3	1238.5

346	73	48	18	33	1	1239.5
347	74	43	23	33	1	1240.5
348	75	36	16	26	-6	1234.5
349	76	37	12	24.5	-7.5	1227
350	77	44	18	31	-1	1226
351	78	52	23	37.5	5.5	1231.5
352	79	43	25	34	2	1233.5
353	80	43	23	33	1	1234.5
354	81	43	21	32	0	1234.5
355	82	36	21	28.5	-3.5	1231
356	83	42	18	30	-2	1229
357	84	43	20	31.5	-0.5	1228.5
358	85	53	19	36	4	1232.5
359	86	50	22	36	4	1236.5
360	87	50	29	39.5	7.5	1244
361	88	47	26	36.5	4.5	1248.5
362	89	46	24	35	3	1251.5
363	90	48	24	36	4	1255.5
364	91	49	23	36	4	1259.5
365	92	47	22	34.5	2.5	1262
1	93	33	25	29	-3	1259
2	94	32	22	27	-5	1254
3	95	27	10	18.5	-13.5	1240.5
4	96	28	9	18.5	-13.5	1227
5	97	37	12	24.5	-7.5	1219.5
6	98	34	14	24	-8	1211.5
7	99	32	12	22	-10	1201.5
8	100	32	13	22.5	-9.5	1192
9	101	41	17	29	-3	1189
10	102	43	21	32	0	1189
11	103	49	28	38.5	6.5	1195.5
12	104	49	29	39	7	1202.5
13	105	50	30	40	8	1210.5
14	106	52	32	42	10	1220.5
15	107	55	32	43.5	11.5	1232
16	108	54	37	45.5	13.5	1245.5
17	109	49	43	46	14	1259.5
18	110	58	41	49.5	17.5	1277
19	111	61	37	49	17	1294
20	112	54	37	45.5	13.5	1307.5
21	113	55	34	44.5	12.5	1320
22	114	53	30	41.5	9.5	1329.5
23	115	51	27	39	7	1336.5
24	116	45	32	38.5	6.5	1343
25	117	45	36	40.5	8.5	1351.5
26	118	40	33	36.5	4.5	1356
27	119	41	25	33	1	1357
28	120	39	23	31	-1	1356
29	121	39	17	28	-4	1352
30	122	41	19	30	-2	1350
31	123	34	25	29.5	-2.5	1347.5
32	124	47	20	33.5	1.5	1349
33	125	45	23	34	2	1351
34	126	52	27	39.5	7.5	1358.5
35	127	47	32	39.5	7.5	1366
36	128	50	31	40.5	8.5	1374.5
37	129	55	33	44	12	1386.5
38	130	57	30	43.5	11.5	1398
39	131	55	31	43	11	1409
40	132	53	37	45	13	1422
41	133	50	35	42.5	10.5	1432.5
42	134	52	33	42.5	10.5	1443
43	135	41	33	37	5	1448
44	136	34	27	30.5	-1.5	1446.5
45	137	47	33	40	8	1454.5
46	138	57	33	45	13	1467.5
47	139	51	32	41.5	9.5	1477
48	140	37	31	34	2	1479
49	141	46	25	35.5	3.5	1482.5
50	142	50	27	38.5	6.5	1489
51	143	52	34	43	11	1500
52	144	58	38	48	16	1516
53	145	49	29	39	7	1523
54	146	48	28	38	6	1529
55	147	46	27	36.5	4.5	1533.5
56	148	40	20	30	-2	1531.5
57	149	45	18	31.5	-0.5	1531
58	150	59	28	43.5	11.5	1542.5
59	151	53	31	42	10	1552.5
60	152	49	25	37	5	1557.5
61	153	41	32	36.5	4.5	1562
62	154	55	28	41.5	9.5	1571.5
63	155	58	30	44	12	1583.5
64	156	65	35	50	18	1601.5
65	157	48	32	40	8	1609.5
66	158	40	31	35.5	3.5	1613
67	159	41	29	35	3	1616
68	160	40	27	33.5	1.5	1617.5
69	161	43	27	35	3	1620.5
70	162	46	24	35	3	1623.5
71	163	55	23	39	7	1630.5
72	164	57	33	45	13	1643.5
73	165	60	32	46	14	1657.5
74	166	65	33	49	17	1674.5
75	167	59	32	45.5	13.5	1688
76	168	56	24	40	8	1696
77	169	53	31	42	10	1706
78	170	49	29	39	7	1713
79	171	56	26	41	9	1722
80	172	46	29	37.5	5.5	1727.5
81	173	45	29	37	5	1732.5
82	174	49	29	39	7	1739.5
83	175	51	31	41	9	1748.5
84	176	60	34	47	15	1763.5
85	177	64	41	52.5	20.5	1784
86	178	68	39	53.5	21.5	1805.5
87	179	68	39	53.5	21.5	1827
88	180	45	37	41	9	1836
89	181	55	32	43.5	11.5	1847.5

90	182	50	34	42	10	1857.5
91	183	42	33	37.5	5.5	1863
92	184	52	32	42	10	1873
93	185	59	29	44	12	1885
94	186	62	35	48.5	16.5	1901.5
95	187	71	38	54.5	22.5	1924
96	188	74	42	58	26	1950
97	189	74	45	59.5	27.5	1977.5
98	190	70	41	55.5	23.5	2001
99	191	69	41	55	23	2024
100	192	74	43	58.5	26.5	2050.5
101	193	69	40	54.5	22.5	2073
102	194	66	41	53.5	21.5	2094.5
103	195	70	36	53	21	2115.5
104	196	73	43	58	26	2141.5
105	197	67	43	55	23	2164.5
106	198	63	36	49.5	17.5	2182
107	199	67	39	53	21	2203
108	200	75	41	58	26	2229
109	201	57	37	47	15	2244
110	202	61	30	45.5	13.5	2257.5
111	203	69	40	54.5	22.5	2280
112	204	72	48	60	28	2308
113	205	61	42	51.5	19.5	2327.5
114	206	72	44	58	26	2353.5
115	207	69	44	56.5	24.5	2378
116	208	75	40	57.5	25.5	2403.5
117	209	81	41	61	29	2432.5
118	210	84	51	67.5	35.5	2468
119	211	81	53	67	35	2503
120	212	73	50	61.5	29.5	2532.5
121	213	69	42	55.5	23.5	2556
122	214	78	41	59.5	27.5	2583.5
123	215	83	46	64.5	32.5	2616
124	216	85	50	67.5	35.5	2651.5
125	217	85	53	69	37	2688.5
126	218	84	50	67	35	2723.5
127	219	81	47	64	32	2755.5
128	220	78	51	64.5	32.5	2788
129	221	69	48	58.5	26.5	2814.5
130	222	76	41	58.5	26.5	2841
131	223	85	49	67	35	2876
132	224	70	43	56.5	24.5	2900.5
133	225	60	32	46	14	2914.5
134	226	67	46	56.5	24.5	2939
135	227	77	43	60	28	2967
136	228	81	50	65.5	33.5	3000.5
137	229	78	51	64.5	32.5	3033
138	230	65	41	53	21	3054
139	231	66	40	53	21	3075
140	232	76	40	58	26	3101
141	233	79	49	64	32	3133
142	234	84	52	68	36	3169
143	235	89	52	70.5	38.5	3207.5
144	236	94	58	76	44	3251.5
145	237	92	65	78.5	46.5	3298
146	238	82	55	68.5	36.5	3334.5
147	239	79	50	64.5	32.5	3367
148	240	85	49	67	35	3402
149	241	94	57	75.5	43.5	3445.5
150	242	97	62	79.5	47.5	3493
151	243	95	59	77	45	3538
152	244	91	56	73.5	41.5	3579.5
153	245	90	56	73	41	3620.5
154	246	89	47	68	36	3656.5
155	247	90	56	73	41	3697.5
156	248	93	58	75.5	43.5	3741
157	249	93	60	76.5	44.5	3785.5
158	250	92	59	75.5	43.5	3829
159	251	93	58	75.5	43.5	3872.5
160	252	88	60	74	42	3914.5
161	253	80	57	68.5	36.5	3951
162	254	82	50	66	34	3985
163	255	84	52	68	36	4021
164	256	88	52	70	38	4059
165	257	84	56	70	38	4097
166	258	89	52	70.5	38.5	4135.5
167	259	94	59	76.5	44.5	4180
168	260	89	58	73.5	41.5	4221.5
169	261	84	49	66.5	34.5	4256
170	262	86	58	72	40	4296
171	263	86	53	69.5	37.5	4333.5
172	264	85	57	71	39	4372.5
173	265	91	51	71	39	4411.5
174	266	89	58	73.5	41.5	4453
175	267	87	60	73.5	41.5	4494.5
176	268	84	57	70.5	38.5	4533
177	269	90	57	73.5	41.5	4574.5
178	270	85	57	71	39	4613.5
179	271	90	57	73.5	41.5	4655
180	272	86	60	73	41	4696
181	273	85	61	73	41	4737
182	274	90	59	74.5	42.5	4779.5
183	275	92	58	75	43	4822.5
184	276	92	59	75.5	43.5	4866
185	277	90	57	73.5	41.5	4907.5
186	278	89	55	72	40	4947.5
187	279	89	57	73	41	4988.5
188	280	91	56	73.5	41.5	5030
189	281	90	60	75	43	5073
190	282	88	60	74	42	5115
191	283	89	56	72.5	40.5	5155.5
192	284	89	57	73	41	5196.5
193	285	94	61	77.5	45.5	5242
194	286	95	67	81	49	5291
195	287	92	64	78	46	5337
196	288	94	62	78	46	5383
197	289	90	55	72.5	40.5	5423.5
198	290	89	59	74	42	5465.5

199	291	93	63	78	46	5511.5
200	292	95	62	78.5	46.5	5558
201	293	97	61	79	47	5605
202	294	98	62	80	48	5653
203	295	100	62	81	49	5702
204	296	100	58	79	47	5749
205	297	98	58	78	46	5795
206	298	96	64	80	48	5843
207	299	91	63	77	45	5888
208	300	95	59	77	45	5933
209	301	93	60	76.5	44.5	5977.5
210	302	100	63	81.5	49.5	6027
211	303	94	67	80.5	48.5	6075.5
212	304	93	62	77.5	45.5	6121
213	305	93	59	76	44	6165
214	306	98	63	80.5	48.5	6213.5
215	307	98	66	82	50	6263.5
216	308	99	71	85	53	6316.5
217	309	97	69	83	51	6367.5
218	310	97	61	79	47	6414.5
219	311	94	66	80	48	6462.5
220	312	94	61	77.5	45.5	6508
221	313	98	63	80.5	48.5	6556.5
222	314	97	68	82.5	50.5	6607
223	315	94	67	80.5	48.5	6655.5
224	316	94	63	78.5	46.5	6702
225	317	91	63	77	45	6747
226	318	91	59	75	43	6790
227	319	91	64	77.5	45.5	6835.5
228	320	95	65	80	48	6883.5
229	321	95	56	75.5	43.5	6927
230	322	93	62	77.5	45.5	6972.5
231	323	87	60	73.5	41.5	7014
232	324	89	63	76	44	7058
233	325	87	59	73	41	7099
234	326	80	62	71	39	7138
235	327	89	59	74	42	7180
236	328	90	63	76.5	44.5	7224.5
237	329	91	66	78.5	46.5	7271
238	330	91	62	76.5	44.5	7315.5
239	331	89	63	76	44	7359.5
240	332	89	61	75	43	7402.5
241	333	86	57	71.5	39.5	7442
242	334	84	61	72.5	40.5	7482.5
243	335	79	58	68.5	36.5	7519
244	336	78	57	67.5	35.5	7554.5
245	337	72	55	63.5	31.5	7586
246	338	82	51	66.5	34.5	7620.5
247	339	83	53	68	36	7656.5
248	340	89	54	71.5	39.5	7696
249	341	86	63	74.5	42.5	7738.5
250	342	76	56	66	34	7772.5
251	343	83	50	66.5	34.5	7807
252	344	70	59	64.5	32.5	7839.5
253	345	82	49	65.5	33.5	7873
254	346	85	53	69	37	7910
255	347	86	54	70	38	7948
256	348	89	56	72.5	40.5	7988.5
257	349	92	58	75	43	8031.5
258	350	91	60	75.5	43.5	8075
259	351	92	61	76.5	44.5	8119.5
260	352	93	61	77	45	8164.5
261	353	90	57	73.5	41.5	8206
262	354	78	53	65.5	33.5	8239.5
263	355	87	50	68.5	36.5	8276
264	356	84	50	67	35	8311
265	357	86	50	68	36	8347
266	358	83	58	70.5	38.5	8385.5
267	359	70	47	58.5	26.5	8412
268	360	63	32	47.5	15.5	8427.5
269	361	69	35	52	20	8447.5
270	362	78	44	61	29	8476.5
271	363	80	52	66	34	8510.5
272	364	82	53	67.5	35.5	8546
273	365	80	53	66.5	34.5	8580.5
274	366	83	51	67	35	8615.5



94	1254	length of freeze (day)	8
102	1189	frost depth (°F-day)	65
		average temperature	55.5

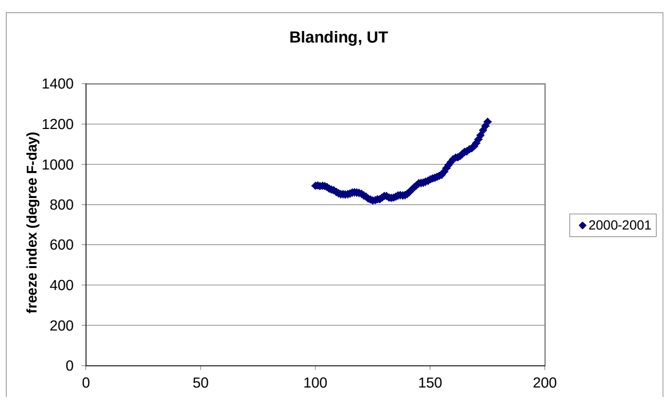
2000-2001

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (°F)	cumulative degree day (°F)
274	1	85	49	67	35	35
275	2	85	53	69	37	72
276	3	83	55	69	37	109
277	4	70	48	59	27	136
278	5	73	45	59	27	163
279	6	81	47	64	32	195
280	7	76	51	63.5	31.5	226.5
281	8	59	46	52.5	20.5	247
282	9	60	41	50.5	18.5	265.5
283	10	59	41	50	18	283.5
284	11	63	46	54.5	22.5	306
285	12	56	35	45.5	13.5	319.5
286	13	60	37	48.5	16.5	336
287	14	64	37	50.5	18.5	354.5
288	15	66	36	51	19	373.5
289	16	69	40	54.5	22.5	396
290	17	70	42	56	24	420
291	18	72	43	57.5	25.5	445.5
292	19	71	45	58	26	471.5
293	20	73	45	59	27	498.5
294	21	63	43	53	21	519.5
295	22	58	44	51	19	538.5
296	23	52	43	47.5	15.5	554
297	24	50	40	45	13	567
298	25	53	37	45	13	580
299	26	58	38	48	16	596
300	27	54	43	48.5	16.5	612.5
301	28	51	36	43.5	11.5	624

302	29	51	34	42.5	10.5	634.5
303	30	53	38	45.5	13.5	648
304	31	41	32	36.5	4.5	652.5
305	32	48	32	40	8	660.5
306	33	48	28	38	6	666.5
307	34	49	35	42	10	676.5
308	35	55	39	47	15	691.5
309	36	47	31	39	7	698.5
310	37	41	27	34	2	700.5
311	38	41	23	32	0	700.5
312	39	41	21	31	-1	699.5
313	40	45	25	35	3	702.5
314	41	39	29	34	2	704.5
315	42	38	27	32.5	0.5	705
316	43	34	16	25	-7	698
317	44	37	14	25.5	-6.5	691.5
318	45	42	18	30	-2	689.5
319	46	43	22	32.5	0.5	690
320	47	35	18	26.5	-5.5	684.5
321	48	36	14	25	-7	677.5
322	49	40	15	27.5	-4.5	673
323	50	43	19	31	-1	672
324	51	48	25	36.5	4.5	676.5
325	52	51	27	39	7	683.5
326	53	53	32	42.5	10.5	694
327	54	49	31	40	8	702
328	55	48	28	38	6	708
329	56	48	25	36.5	4.5	712.5
330	57	43	26	34.5	2.5	715
331	58	50	26	38	6	721
332	59	53	31	42	10	731
333	60	50	31	40.5	8.5	739.5
334	61	54	31	42.5	10.5	750
335	62	50	27	38.5	6.5	756.5
336	63	46	31	38.5	6.5	763
337	64	51	28	39.5	7.5	770.5
338	65	50	29	39.5	7.5	778
339	66	50	27	38.5	6.5	784.5
340	67	56	28	42	10	794.5
341	68	56	29	42.5	10.5	805
342	69	47	34	40.5	8.5	813.5
343	70	42	32	37	5	818.5
344	71	41	32	36.5	4.5	823
345	72	40	24	32	0	823
346	73	37	30	33.5	1.5	824.5
347	74	32	23	27.5	-4.5	820
348	75	39	24	31.5	-0.5	819.5
349	76	46	25	35.5	3.5	823
350	77	45	21	33	1	824
351	78	44	23	33.5	1.5	825.5
352	79	38	16	27	-5	820.5
353	80	38	14	26	-6	814.5
354	81	46	19	32.5	0.5	815
355	82	46	22	34	2	817
356	83	45	23	34	2	819
357	84	46	27	36.5	4.5	823.5
358	85	44	26	35	3	826.5
359	86	40	26	33	1	827.5
360	87	43	22	32.5	0.5	828
361	88	43	22	32.5	0.5	828.5
362	89	51	20	35.5	3.5	832
363	90	46	25	35.5	3.5	835.5
364	91	46	25	35.5	3.5	839
365	92	54	25	39.5	7.5	846.5
1	93	45	24	34.5	2.5	849
2	94	50	24	37	5	854
3	95	56	25	40.5	8.5	862.5
4	96	51	25	38	6	868.5
5	97	52	24	38	6	874.5
6	98	50	27	38.5	6.5	881
7	99	55	28	41.5	9.5	890.5
8	100	47	24	35.5	3.5	894
9	101	39	29	34	2	896
10	102	34	24	29	-3	893
11	103	41	24	32.5	0.5	893.5
12	104	36	27	31.5	-0.5	893
13	105	36	18	27	-5	888
14	106	34	14	24	-8	880
15	107	37	18	27.5	-4.5	875.5
16	108	35	20	27.5	-4.5	871
17	109	35	16	25.5	-6.5	864.5
18	110	37	13	25	-7	857.5
19	111	39	17	28	-4	853.5
20	112	46	18	32	0	853.5
21	113	40	19	29.5	-2.5	851
22	114	44	23	33.5	1.5	852.5
23	115	42	28	35	3	855.5
24	116	47	26	36.5	4.5	860
25	117	40	28	34	2	862
26	118	37	23	30	-2	860
27	119	34	29	31.5	-0.5	859.5
28	120	29	25	27	-5	854.5
29	121	36	13	24.5	-7.5	847
30	122	33	18	25.5	-6.5	840.5
31	123	35	10	22.5	-9.5	831
32	124	44	10	27	-5	826
33	125	36	17	26.5	-5.5	820.5
34	126	48	20	34	2	822.5
35	127	49	26	37.5	5.5	828
36	128	40	23	31.5	-0.5	827.5
37	129	50	29	39.5	7.5	835
38	130	48	32	40	8	843
39	131	38	26	32	0	843
40	132	33	16	24.5	-7.5	835.5
41	133	42	19	30.5	-1.5	834
42	134	41	25	33	1	835
43	135	48	25	36.5	4.5	839.5
44	136	48	31	39.5	7.5	847
45	137	39	26	32.5	0.5	847.5

46	138	41	20	30.5	-1.5	846
47	139	43	24	33.5	1.5	847.5
48	140	50	27	38.5	6.5	854
49	141	49	35	42	10	864
50	142	53	32	42.5	10.5	874.5
51	143	53	33	43	11	885.5
52	144	54	33	43.5	11.5	897
53	145	53	32	42.5	10.5	907.5
54	146	35	30	32.5	0.5	908
55	147	43	24	33.5	1.5	909.5
56	148	44	30	37	5	914.5
57	149	42	31	36.5	4.5	919
58	150	47	32	39.5	7.5	926.5
59	151	42	30	36	4	930.5
60	152	43	29	36	4	934.5
61	153	45	26	35.5	3.5	938
62	154	44	30	37	5	943
63	155	50	28	39	7	950
64	156	56	35	45.5	13.5	963.5
65	157	62	38	50	18	981.5
66	158	58	39	48.5	16.5	998
67	159	59	33	46	14	1012
68	160	55	37	46	14	1026
69	161	48	32	40	8	1034
70	162	38	30	34	2	1036
71	163	48	28	38	6	1042
72	164	55	30	42.5	10.5	1052.5
73	165	55	29	42	10	1062.5
74	166	48	24	36	4	1066.5
75	167	50	30	40	8	1074.5
76	168	50	26	38	6	1080.5
77	169	55	28	41.5	9.5	1090
78	170	62	32	47	15	1105
79	171	67	37	52	20	1125
80	172	68	38	53	21	1146
81	173	70	43	56.5	24.5	1170.5
82	174	63	43	53	21	1191.5
83	175	66	39	52.5	20.5	1212
84	176	67	46	56.5	24.5	1236.5
85	177	65	40	52.5	20.5	1257
86	178	60	35	47.5	15.5	1272.5
87	179	60	32	46	14	1286.5
88	180	58	37	47.5	15.5	1302
89	181	60	35	47.5	15.5	1317.5
90	182	66	36	51	19	1336.5
91	183	71	39	55	23	1359.5
92	184	69	41	55	23	1382.5
93	185	65	40	52.5	20.5	1403
94	186	64	39	51.5	19.5	1422.5
95	187	59	40	49.5	17.5	1440
96	188	50	34	42	10	1450
97	189	50	32	41	9	1459
98	190	49	32	40.5	8.5	1467.5
99	191	57	29	43	11	1478.5
100	192	49	31	40	8	1486.5
101	193	50	23	36.5	4.5	1491
102	194	49	32	40.5	8.5	1499.5
103	195	55	28	41.5	9.5	1509
104	196	63	36	49.5	17.5	1526.5
105	197	68	37	52.5	20.5	1547
106	198	72	41	56.5	24.5	1571.5
107	199	76	45	60.5	28.5	1600
108	200	76	46	61	29	1629
109	201	77	48	62.5	30.5	1659.5
110	202	69	45	57	25	1684.5
111	203	56	41	48.5	16.5	1701
112	204	53	33	43	11	1712
113	205	62	29	45.5	13.5	1725.5
114	206	68	38	53	21	1746.5
115	207	75	44	59.5	27.5	1774
116	208	79	47	63	31	1805
117	209	78	49	63.5	31.5	1836.5
118	210	75	45	60	28	1864.5
119	211	76	44	60	28	1892.5
120	212	80	47	63.5	31.5	1924
121	213	83	46	64.5	32.5	1956.5
122	214	71	33	52	20	1976.5
123	215	51	33	42	10	1986.5
124	216	55	31	43	11	1997.5
125	217	65	34	49.5	17.5	2015
126	218	71	41	56	24	2039
127	219	74	43	58.5	26.5	2065.5
128	220	81	46	63.5	31.5	2097
129	221	85	48	66.5	34.5	2131.5
130	222	83	49	66	34	2165.5
131	223	83	52	67.5	35.5	2201
132	224	83	49	66	34	2235
133	225	78	49	63.5	31.5	2266.5
134	226	75	47	61	29	2295.5
135	227	83	47	65	33	2328.5
136	228	84	53	68.5	36.5	2365
137	229	79	55	67	35	2400
138	230	83	45	64	32	2432
139	231	70	49	59.5	27.5	2459.5
140	232	80	44	62	30	2489.5
141	233	68	40	54	22	2511.5
142	234	81	41	61	29	2540.5
143	235	88	52	70	38	2578.5
144	236	87	58	72.5	40.5	2619
145	237	90	55	72.5	40.5	2659.5
146	238	91	52	71.5	39.5	2699
147	239	88	57	72.5	40.5	2739.5
148	240	84	52	68	36	2775.5
149	241	84	49	66.5	34.5	2810
150	242	85	56	70.5	38.5	2848.5
151	243	85	54	69.5	37.5	2886
152	244	91	56	73.5	41.5	2927.5
153	245	89	57	73	41	2968.5
154	246	84	52	68	36	3004.5

155	247	82	59	70.5	38.5	3043
156	248	81	46	63.5	31.5	3074.5
157	249	93	51	72	40	3114.5
158	250	93	64	78.5	46.5	3161
159	251	92	64	78	46	3207
160	252	93	63	78	46	3253
161	253	92	59	75.5	43.5	3296.5
162	254	91	55	73	41	3337.5
163	255	87	55	71	39	3376.5
164	256	65	43	54	22	3398.5
165	257	72	36	54	22	3420.5
166	258	83	45	64	32	3452.5
167	259	90	54	72	40	3492.5
168	260	93	56	74.5	42.5	3535
169	261	93	59	76	44	3579
170	262	92	58	75	43	3622
171	263	93	60	76.5	44.5	3666.5
172	264	93	61	77	45	3711.5
173	265	94	60	77	45	3756.5
174	266	95	62	78.5	46.5	3803
175	267	88	59	73.5	41.5	3844.5
176	268	91	59	75	43	3887.5
177	269	74	57	65.5	33.5	3921
178	270	85	53	69	37	3958
179	271	93	60	76.5	44.5	4002.5
180	272	97	62	79.5	47.5	4050
181	273	98	62	80	48	4098
182	274	95	54	74.5	42.5	4140.5
183	275	96	61	78.5	46.5	4187
184	276	96	57	76.5	44.5	4231.5
185	277	98	67	82.5	50.5	4282
186	278	98	66	82	50	4332
187	279	94	64	79	47	4379
188	280	90	64	77	45	4424
189	281	94	63	78.5	46.5	4470.5
190	282	92	61	76.5	44.5	4515
191	283	87	57	72	40	4555
192	284	87	57	72	40	4595
193	285	87	61	74	42	4637
194	286	88	63	75.5	43.5	4680.5
195	287	80	63	71.5	39.5	4720
196	288	82	57	69.5	37.5	4757.5
197	289	85	56	70.5	38.5	4796
198	290	88	56	72	40	4836
199	291	88	59	73.5	41.5	4877.5
200	292	89	59	74	42	4919.5
201	293	89	60	74.5	42.5	4962
202	294	91	62	76.5	44.5	5006.5
203	295	92	60	76	44	5050.5
204	296	90	61	75.5	43.5	5094
205	297	89	66	77.5	45.5	5139.5
206	298	91	62	76.5	44.5	5184
207	299	84	61	72.5	40.5	5224.5
208	300	90	57	73.5	41.5	5266
209	301	95	61	78	46	5312
210	302	97	62	79.5	47.5	5359.5
211	303	88	63	75.5	43.5	5403
212	304	88	60	74	42	5445
213	305	90	61	75.5	43.5	5488.5
214	306	90	62	76	44	5532.5
215	307	93	62	77.5	45.5	5578
216	308	86	60	73	41	5619
217	309	90	61	75.5	43.5	5662.5
218	310	94	62	78	46	5708.5
219	311	81	63	72	40	5748.5
220	312	81	60	70.5	38.5	5787
221	313	81	57	69	37	5824
222	314	83	63	73	41	5865
223	315	87	58	72.5	40.5	5905.5
224	316	90	59	74.5	42.5	5948
225	317	76	58	67	35	5983
226	318	81	58	69.5	37.5	6020.5
227	319	88	59	73.5	41.5	6062
228	320	88	58	73	41	6103
229	321	88	55	71.5	39.5	6142.5
230	322	92	61	76.5	44.5	6187
231	323	94	63	78.5	46.5	6233.5
232	324	83	59	71	39	6272.5
233	325	80	58	69	37	6309.5
234	326	81	55	68	36	6345.5
235	327	86	52	69	37	6382.5
236	328	89	58	73.5	41.5	6424
237	329	93	63	78	46	6470
238	330	94	60	77	45	6515
239	331	95	63	79	47	6562
240	332	93	65	79	47	6609
241	333	90	63	76.5	44.5	6653.5
242	334	85	58	71.5	39.5	6693
243	335	85	54	69.5	37.5	6730.5
244	336	88	54	71	39	6769.5
245	337	89	58	73.5	41.5	6811
246	338	91	57	74	42	6853
247	339	92	61	76.5	44.5	6897.5
248	340	89	62	75.5	43.5	6941
249	341	87	59	73	41	6982
250	342	79	47	63	31	7013
251	343	70	49	59.5	27.5	7040.5
252	344	77	46	61.5	29.5	7070
253	345	85	48	66.5	34.5	7104.5
254	346	88	56	72	40	7144.5
255	347	89	58	73.5	41.5	7186
256	348	83	59	71	39	7225
257	349	86	55	70.5	38.5	7263.5
258	350	88	57	72.5	40.5	7304
259	351	82	57	69.5	37.5	7341.5
260	352	80	52	66	34	7375.5
261	353	80	51	65.5	33.5	7409
262	354	85	53	69	37	7446
263	355	86	54	70	38	7484



264	356	86	55	70.5	38.5	7522.5
265	357	86	56	71	39	7561.5
266	358	86	56	71	39	7600.5
267	359	86	56	71	39	7639.5
268	360	88	56	72	40	7679.5
269	361	86	55	70.5	38.5	7718
270	362	87	57	72	40	7758
271	363	87	56	71.5	39.5	7797.5
272	364	86	56	71	39	7836.5
273	365	86	59	72.5	40.5	7877

day of frost year

104	893
126	822.5

length of freeze (day)	22
frost depth (^{o}F-day)	70.5
average temperature	53.6

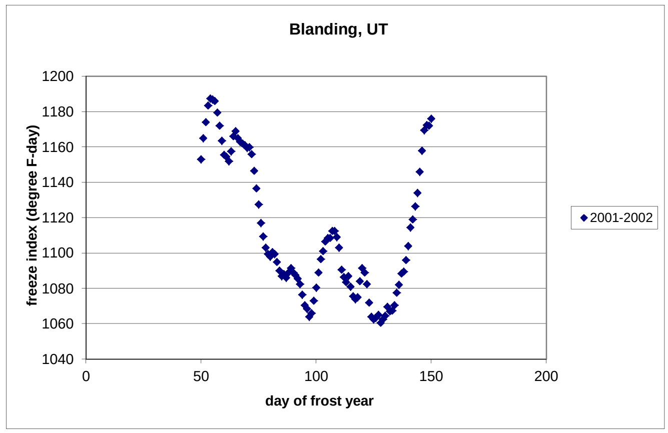
2001-2002

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	81	55	68	36	36
275	2	80	50	65	33	69
276	3	83	51	67	35	104
277	4	82	50	66	34	138
278	5	79	48	63.5	31.5	169.5
279	6	77	51	64	32	201.5
280	7	70	50	60	28	229.5
281	8	71	45	58	26	255.5
282	9	69	44	56.5	24.5	280
283	10	61	33	47	15	295
284	11	59	33	46	14	309
285	12	54	34	44	12	321
286	13	68	36	52	20	341
287	14	73	41	57	25	366
288	15	74	47	60.5	28.5	394.5
289	16	72	41	56.5	24.5	419
290	17	72	44	58	26	445
291	18	77	45	61	29	474
292	19	74	43	58.5	26.5	500.5
293	20	73	44	58.5	26.5	527
294	21	62	47	54.5	22.5	549.5
295	22	73	44	58.5	26.5	576
296	23	73	40	56.5	24.5	600.5
297	24	65	32	48.5	16.5	617
298	25	65	36	50.5	18.5	635.5
299	26	71	39	55	23	658.5
300	27	72	45	58.5	26.5	685
301	28	73	50	61.5	29.5	714.5
302	29	72	47	59.5	27.5	742
303	30	68	49	58.5	26.5	768.5
304	31	64	43	53.5	21.5	790
305	32	64	36	50	18	808
306	33	67	39	53	21	829
307	34	70	39	54.5	22.5	851.5
308	35	70	46	58	26	877.5
309	36	68	48	58	26	903.5
310	37	68	48	58	26	929.5
311	38	67	43	55	23	952.5
312	39	60	38	49	17	969.5
313	40	63	36	49.5	17.5	987
314	41	63	41	52	20	1007
315	42	65	41	53	21	1028
316	43	64	39	51.5	19.5	1047.5
317	44	58	38	48	16	1063.5
318	45	65	35	50	18	1081.5
319	46	64	38	51	19	1100.5
320	47	63	39	51	19	1119.5
321	48	61	38	49.5	17.5	1137
322	49	62	34	48	16	1153
323	50	60	-	-	-	1153
324	51	57	31	44	12	1165
325	52	53	29	41	9	1174
326	53	48	35	41.5	9.5	1183.5
327	54	43	29	36	4	1187.5
328	55	41	22	31.5	-0.5	1187
329	56	40	22	31	-1	1186
330	57	36	15	25.5	-6.5	1179.5
331	58	34	15	24.5	-7.5	1172
332	59	33	14	23.5	-8.5	1163.5
333	60	28	20	24	-8	1155.5
334	61	37	25	31	-1	1154.5
335	62	41	18	29.5	-2.5	1152
336	63	43	32	37.5	5.5	1157.5
337	64	44	37	40.5	8.5	1166
338	65	40	30	35	3	1169
339	66	38	18	28	-4	1165
340	67	40	20	30	-2	1163
341	68	39	23	31	-1	1162
342	69	42	20	31	-1	1161
343	70	43	18	30.5	-1.5	1159.5
344	71	42	23	32.5	0.5	1160
345	72	37	19	28	-4	1156
346	73	32	13	22.5	-9.5	1146.5
347	74	34	10	22	-10	1136.5
348	75	35	11	23	-9	1127.5
349	76	32	11	21.5	-10.5	1117
350	77	39	10	24.5	-7.5	1109.5
351	78	36	15	25.5	-6.5	1103
352	79	40	17	28.5	-3.5	1099.5
353	80	42	19	30.5	-1.5	1098
354	81	48	21	34.5	2.5	1100.5
355	82	40	22	31	-1	1099.5
356	83	38	17	27.5	-4.5	1095
357	84	37	17	27	-5	1090
358	85	41	17	29	-3	1087
359	86	49	17	33	1	1088
360	87	40	20	30	-2	1086
361	88	46	24	35	3	1089
362	89	46	23	34.5	2.5	1091.5
363	90	32	27	29.5	-2.5	1089
364	91	36	25	30.5	-1.5	1087.5
365	92	36	24	30	-2	1085.5
1	93	42	16	29	-3	1082.5
2	94	36	16	26	-6	1076.5

3	95	36	16	26	-6	1070.5
4	96	38	22	30	-2	1068.5
5	97	39	16	27.5	-4.5	1064
6	98	45	23	34	2	1066
7	99	49	29	39	7	1073
8	100	49	30	39.5	7.5	1080.5
9	101	48	33	40.5	8.5	1089
10	102	49	30	39.5	7.5	1096.5
11	103	50	23	36.5	4.5	1101
12	104	46	29	37.5	5.5	1106.5
13	105	43	25	34	2	1108.5
14	106	44	20	32	0	1108.5
15	107	46	26	36	4	1112.5
16	108	42	22	32	0	1112.5
17	109	39	18	28.5	-3.5	1109
18	110	37	15	26	-6	1103
19	111	32	7	19.5	-12.5	1090.5
20	112	39	17	28	-4	1086.5
21	113	41	17	29	-3	1083.5
22	114	47	24	35.5	3.5	1087
23	115	36	16	26	-6	1081
24	116	43	10	26.5	-5.5	1075.5
25	117	44	17	30.5	-1.5	1074
26	118	51	15	33	1	1075
27	119	53	29	41	9	1084
28	120	48	31	39.5	7.5	1091.5
29	121	35	24	29.5	-2.5	1089
30	122	35	16	25.5	-6.5	1082.5
31	123	34	9	21.5	-10.5	1072
32	124	39	9	24	-8	1064
33	125	41	20	30.5	-1.5	1062.5
34	126	46	20	33	1	1063.5
35	127	48	19	33.5	1.5	1065
36	128	38	17	27.5	-4.5	1060.5
37	129	50	18	34	2	1062.5
38	130	47	21	34	2	1064.5
39	131	52	22	37	5	1069.5
40	132	43	16	29.5	-2.5	1067
41	133	48	17	32.5	0.5	1067.5
42	134	49	21	35	3	1070.5
43	135	53	25	39	7	1077.5
44	136	48	25	36.5	4.5	1082
45	137	45	32	38.5	6.5	1088.5
46	138	48	18	33	1	1089.5
47	139	52	25	38.5	6.5	1096
48	140	50	30	40	8	1104
49	141	48	37	42.5	10.5	1114.5
50	142	50	23	36.5	4.5	1119
51	143	53	26	39.5	7.5	1126.5
52	144	54	25	39.5	7.5	1134
53	145	59	29	44	12	1146
54	146	54	34	44	12	1158
55	147	54	33	43.5	11.5	1169.5
56	148	42	28	35	3	1172.5
57	149	42	21	31.5	-0.5	1172
58	150	54	18	36	4	1176
59	151	54	23	38.5	6.5	1182.5
60	152	34	14	24	-8	1174.5
61	153	31	10	20.5	-11.5	1163
62	154	39	6	22.5	-9.5	1153.5
63	155	48	15	31.5	-0.5	1153
64	156	51	22	36.5	4.5	1157.5
65	157	58	28	43	11	1168.5
66	158	59	46	52.5	20.5	1189
67	159	47	15	31	-1	1188
68	160	43	13	28	-4	1184
69	161	53	29	41	9	1193
70	162	57	33	45	13	1206
71	163	57	32	44.5	12.5	1218.5
72	164	68	35	51.5	19.5	1238
73	165	42	24	33	1	1239
74	166	45	19	32	0	1239
75	167	44	20	32	0	1239
76	168	42	30	36	4	1243
77	169	46	27	36.5	4.5	1247.5
78	170	55	23	39	7	1254.5
79	171	63	30	46.5	14.5	1269
80	172	67	35	51	19	1288
81	173	70	39	54.5	22.5	1310.5
82	174	64	38	51	19	1329.5
83	175	54	33	43.5	11.5	1341
84	176	50	32	41	9	1350
85	177	59	31	45	13	1363
86	178	68	37	52.5	20.5	1383.5
87	179	72	36	54	22	1405.5
88	180	70	42	56	24	1429.5
89	181	68	36	52	20	1449.5
90	182	74	39	56.5	24.5	1474
91	183	77	42	59.5	27.5	1501.5
92	184	78	42	60	28	1529.5
93	185	77	43	60	28	1557.5
94	186	77	44	60.5	28.5	1586
95	187	75	45	60	28	1614
96	188	67	40	53.5	21.5	1635.5
97	189	70	40	55	23	1658.5
98	190	66	39	52.5	20.5	1679
99	191	75	41	58	26	1705
100	192	67	48	57.5	25.5	1730.5
101	193	72	39	55.5	23.5	1754
102	194	63	46	-	-	1561.5
103	195	76	39	57.5	25.5	1587
104	196	73	45	59	27	1614
105	197	76	48	62	30	1644
106	198	61	44	52.5	20.5	1664.5
107	199	70	41	55.5	23.5	1688
108	200	69	38	53.5	21.5	1709.5
109	201	69	36	52.5	20.5	1730
110	202	58	34	46	14	1744
111	203	62	28	45	13	1757

112	204	70	30	50	18	1775
113	205	77	42	59.5	27.5	1802.5
114	206	79	43	61	29	1831.5
115	207	73	52	62.5	30.5	1862
116	208	74	48	61	29	1891
117	209	67	38	52.5	20.5	1911.5
118	210	71	36	53.5	21.5	1933
119	211	76	44	60	28	1961
120	212	78	43	60.5	28.5	1989.5
121	213	65	40	52.5	20.5	2010
122	214	64	36	50	18	2028
123	215	71	37	54	22	2050
124	216	73	43	58	26	2076
125	217	76	46	61	29	2105
126	218	79	47	63	31	2136
127	219	77	46	61.5	29.5	2165.5
128	220	68	44	56	24	2189.5
129	221	73	35	54	22	2211.5
130	222	73	49	61	29	2240.5
131	223	75	46	60.5	28.5	2269
132	224	70	48	59	27	2296
133	225	76	47	61.5	29.5	2325.5
134	226	84	56	70	38	2363.5
135	227	84	51	67.5	35.5	2399
136	228	86	51	68.5	36.5	2435.5
137	229	85	51	68	36	2471.5
138	230	87	54	70.5	38.5	2510
139	231	86	54	70	38	2548
140	232	83	68	75.5	43.5	2591.5
141	233	68	44	56	24	2615.5
142	234	66	33	49.5	17.5	2633
143	235	68	39	53.5	21.5	2654.5
144	236	71	41	56	24	2678.5
145	237	79	41	60	28	2706.5
146	238	82	51	66.5	34.5	2741
147	239	85	52	68.5	36.5	2777.5
148	240	87	52	69.5	37.5	2815
149	241	92	54	73	41	2856
150	242	96	62	79	47	2903
151	243	98	61	79.5	47.5	2950.5
152	244	93	64	78.5	46.5	2997
153	245	86	55	70.5	38.5	3035.5
154	246	78	51	64.5	32.5	3068
155	247	79	46	62.5	30.5	3098.5
156	248	86	50	68	36	3134.5
157	249	91	55	73	41	3175.5
158	250	94	56	75	43	3218.5
159	251	93	57	75	43	3261.5
160	252	87	60	73.5	41.5	3303
161	253	82	48	65	33	3336
162	254	85	52	68.5	36.5	3372.5
163	255	90	54	72	40	3412.5
164	256	92	60	76	44	3456.5
165	257	94	60	77	45	3501.5
166	258	95	59	77	45	3546.5
167	259	95	62	78.5	46.5	3593
168	260	96	60	78	46	3639
169	261	95	61	78	46	3685
170	262	94	60	77	45	3730
171	263	95	60	77.5	45.5	3775.5
172	264	89	78	83.5	51.5	3827
173	265	91	63	77	45	3872
174	266	93	59	76	44	3916
175	267	96	61	78.5	46.5	3962.5
176	268	99	61	80	48	4010.5
177	269	96	63	79.5	47.5	4058
178	270	95	66	80.5	48.5	4106.5
179	271	95	65	80	48	4154.5
180	272	96	60	78	46	4200.5
181	273	99	64	81.5	49.5	4250
182	274	101	66	83.5	51.5	4301.5
183	275	101	67	84	52	4353.5
184	276	88	69	78.5	46.5	4400
185	277	86	60	73	41	4441
186	278	91	69	80	48	4489
187	279	95	62	78.5	46.5	4535.5
188	280	98	65	81.5	49.5	4585
189	281	99	66	82.5	50.5	4635.5
190	282	97	66	81.5	49.5	4685
191	283	93	65	79	47	4732
192	284	97	62	79.5	47.5	4779.5
193	285	98	63	80.5	48.5	4828
194	286	101	69	85	53	4881
195	287	100	71	85.5	53.5	4934.5
196	288	97	65	81	49	4983.5
197	289	94	63	78.5	46.5	5030
198	290	94	62	78	46	5076
199	291	94	62	78	46	5122
200	292	91	61	76	44	5166
201	293	87	58	72.5	40.5	5206.5
202	294	94	58	76	44	5250.5
203	295	89	68	78.5	46.5	5297
204	296	91	58	74.5	42.5	5339.5
205	297	93	63	78	46	5385.5
206	298	90	68	79	47	5432.5
207	299	93	59	76	44	5476.5
208	300	89	57	73	41	5517.5
209	301	94	59	76.5	44.5	5562
210	302	97	61	79	47	5609
211	303	95	64	79.5	47.5	5656.5
212	304	97	64	80.5	48.5	5705
213	305	96	69	82.5	50.5	5755.5
214	306	75	64	69.5	37.5	5793
215	307	87	60	73.5	41.5	5834.5
216	308	87	60	73.5	41.5	5876
217	309	87	61	74	42	5918
218	310	87	61	74	42	5960
219	311	86	67	76.5	44.5	6004.5
220	312	91	60	75.5	43.5	6048

221	313	94	59	76.5	44.5	6092.5
222	314	96	60	78	46	6138.5
223	315	96	62	79	47	6185.5
224	316	98	64	81	49	6234.5
225	317	89	60	74.5	42.5	6277
226	318	94	59	76.5	44.5	6321.5
227	319	98	62	80	48	6369.5
228	320	98	62	80	48	6417.5
229	321	99	63	81	49	6466.5
230	322	99	64	81.5	49.5	6516
231	323	95	64	79.5	47.5	6563.5
232	324	78	58	68	36	6599.5
233	325	85	58	71.5	39.5	6639
234	326	86	58	72	40	6679
235	327	86	59	72.5	40.5	6719.5
236	328	88	56	72	40	6759.5
237	329	91	56	73.5	41.5	6801
238	330	93	58	75.5	43.5	6844.5
239	331	90	56	73	41	6885.5
240	332	92	59	75.5	43.5	6929
241	333	72	55	63.5	31.5	6960.5
242	334	84	51	67.5	35.5	6996
243	335	89	60	74.5	42.5	7038.5
244	336	91	62	76.5	44.5	7083
245	337	91	59	75	43	7126
246	338	83	64	73.5	41.5	7167.5
247	339	90	57	73.5	41.5	7209
248	340	91	60	75.5	43.5	7252.5
249	341	79	56	67.5	35.5	7288
250	342	73	54	63.5	31.5	7319.5
251	343	72	53	62.5	30.5	7350
252	344	77	51	64	32	7382
253	345	76	57	66.5	34.5	7416.5
254	346	69	53	61	29	7445.5
255	347	69	53	61	29	7474.5
256	348	75	51	63	31	7505.5
257	349	79	50	64.5	32.5	7538
258	350	79	53	66	34	7572
259	351	77	53	65	33	7605
260	352	79	51	65	33	7638
261	353	64	47	55.5	23.5	7661.5
262	354	72	45	58.5	26.5	7688
263	355	78	45	61.5	29.5	7717.5
264	356	81	51	66	34	7751.5
265	357	83	51	67	35	7786.5
266	358	81	52	66.5	34.5	7821
267	359	82	51	66.5	34.5	7855.5
268	360	79	53	66	34	7889.5
269	361	78	49	63.5	31.5	7921
270	362	75	53	64	32	7953
271	363	78	50	64	32	7985
272	364	66	46	56	24	8009
273	365	70	44	57	25	8034



55	1187	length of freeze (day)	42
97	1064	frost depth (^{o}F-day)	123
		average temperature	54.7

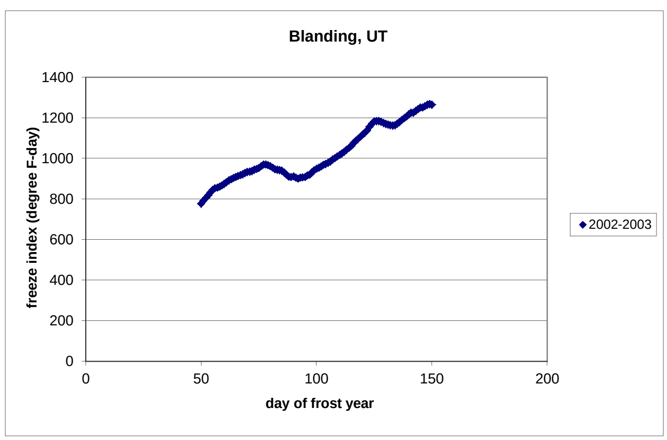
2002-2003

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	70	43	56.5	24.5	24.5
275	2	59	43	51	19	43.5
276	3	49	35	42	10	53.5
277	4	58	35	46.5	14.5	68
278	5	66	42	54	22	90
279	6	73	42	57.5	25.5	115.5
280	7	73	43	58	26	141.5
281	8	76	46	61	29	170.5
282	9	73	46	59.5	27.5	198
283	10	74	45	59.5	27.5	225.5
284	11	72	46	59	27	252.5
285	12	73	42	57.5	25.5	278
286	13	69	40	54.5	22.5	300.5
287	14	70	42	56	24	324.5
288	15	70	40	55	23	347.5
289	16	72	41	56.5	24.5	372
290	17	69	42	55.5	23.5	395.5
291	18	69	39	54	22	417.5
292	19	67	38	52.5	20.5	438
293	20	67	39	53	21	459
294	21	67	39	53	21	480
295	22	63	43	53	21	501
296	23	54	39	46.5	14.5	515.5
297	24	58	39	48.5	16.5	532
298	25	58	37	47.5	15.5	547.5
299	26	58	40	49	17	564.5
300	27	52	36	44	12	576.5
301	28	51	34	42.5	10.5	587
302	29	42	32	37	5	592
303	30	50	30	40	8	600
304	31	54	36	45	13	613
305	32	56	36	46	14	627
306	33	56	35	45.5	13.5	640.5
307	34	48	23	35.5	3.5	644
308	35	49	31	40	8	652
309	36	56	27	41.5	9.5	661.5
310	37	57	30	43.5	11.5	673
311	38	58	31	44.5	12.5	685.5
312	39	49	37	43	11	696.5
313	40	59	38	48.5	16.5	713
314	41	49	30	39.5	7.5	720.5
315	42	47	32	39.5	7.5	728
316	43	45	27	36	4	732
317	44	49	30	39.5	7.5	739.5
318	45	49	32	40.5	8.5	748
319	46	45	28	36.5	4.5	752.5
320	47	45	25	35	3	755.5
321	48	47	27	37	5	760.5
322	49	53	28	40.5	8.5	769
323	50	53	27	40	8	777
324	51	59	32	45.5	13.5	790.5

325	52	59	34	46.5	14.5	805
326	53	58	33	45.5	13.5	818.5
327	54	57	33	45	13	831.5
328	55	56	34	45	13	844.5
329	56	50	30	40	8	852.5
330	57	48	24	36	4	856.5
331	58	49	23	36	4	860.5
332	59	51	25	38	6	866.5
333	60	54	27	40.5	8.5	875
334	61	52	29	40.5	8.5	883.5
335	62	48	33	40.5	8.5	892
336	63	47	28	37.5	5.5	897.5
337	64	46	30	38	6	903.5
338	65	48	26	37	5	908.5
339	66	48	26	37	5	913.5
340	67	47	25	36	4	917.5
341	68	47	26	36.5	4.5	922
342	69	51	27	39	7	929
343	70	48	26	37	5	934
344	71	44	23	33.5	1.5	935.5
345	72	46	23	34.5	2.5	938
346	73	50	27	38.5	6.5	944.5
347	74	46	24	35	3	947.5
348	75	48	25	36.5	4.5	952
349	76	51	32	41.5	9.5	961.5
350	77	48	31	39.5	7.5	969
351	78	40	26	33	1	970
352	79	38	20	29	-3	967
353	80	38	16	27	-5	962
354	81	33	15	24	-8	954
355	82	34	15	24.5	-7.5	946.5
356	83	40	19	29.5	-2.5	944
357	84	34	26	30	-2	942
358	85	33	26	29.5	-2.5	939.5
359	86	31	13	22	-10	929.5
360	87	32	10	21	-11	918.5
361	88	33	14	23.5	-8.5	910
362	89	43	18	30.5	-1.5	908.5
363	90	42	26	34	2	910.5
364	91	38	16	27	-5	905.5
365	92	33	21	27	-5	900.5
1	93	46	27	36.5	4.5	905
2	94	45	21	33	1	906
3	95	44	25	34.5	2.5	908.5
4	96	49	29	39	7	915.5
5	97	41	30	35.5	3.5	919
6	98	55	34	44.5	12.5	931.5
7	99	52	30	41	9	940.5
8	100	51	29	40	8	948.5
9	101	42	32	37	5	953.5
10	102	43	34	38.5	6.5	960
11	103	44	37	40.5	8.5	968.5
12	104	47	26	36.5	4.5	973
13	105	48	29	38.5	6.5	979.5
14	106	48	29	38.5	6.5	986
15	107	49	33	41	9	995
16	108	50	26	38	6	1001
17	109	53	28	40.5	8.5	1009.5
18	110	51	27	39	7	1016.5
19	111	52	29	40.5	8.5	1025
20	112	52	28	40	8	1033
21	113	52	29	40.5	8.5	1041.5
22	114	53	30	41.5	9.5	1051
23	115	54	30	42	10	1061
24	116	58	35	46.5	14.5	1075.5
25	117	53	32	42.5	10.5	1086
26	118	53	30	41.5	9.5	1095.5
27	119	54	32	43	11	1106.5
28	120	56	31	43.5	11.5	1118
29	121	53	31	42	10	1128
30	122	56	30	43	11	1139
31	123	63	34	48.5	16.5	1155.5
32	124	61	35	48	16	1171.5
33	125	53	34	43.5	11.5	1183
34	126	44	24	34	2	1185
35	127	44	19	31.5	-0.5	1184.5
36	128	38	20	29	-3	1181.5
37	129	37	15	26	-6	1175.5
38	130	40	14	27	-5	1170.5
39	131	42	15	28.5	-3.5	1167
40	132	41	16	28.5	-3.5	1163.5
41	133	46	17	31.5	-0.5	1163
42	134	44	23	33.5	1.5	1164.5
43	135	51	29	40	8	1172.5
44	136	44	34	39	7	1179.5
45	137	50	33	41.5	9.5	1189
46	138	52	30	41	9	1198
47	139	50	31	40.5	8.5	1206.5
48	140	52	34	43	11	1217.5
49	141	41	38	39.5	7.5	1225
50	142	44	22	33	1	1226
51	143	51	31	41	9	1235
52	144	51	30	40.5	8.5	1243.5
53	145	50	27	38.5	6.5	1250
54	146	45	19	32	0	1250
55	147	51	28	39.5	7.5	1257.5
56	148	47	31	39	7	1264.5
57	149	40	31	35.5	3.5	1268
58	150	34	25	29.5	-2.5	1265.5
59	151	38	26	32	0	1265.5
60	152	37	23	30	-2	1263.5
61	153	41	18	29.5	-2.5	1261
62	154	42	21	31.5	-0.5	1260.5
63	155	36	30	33	1	1261.5
64	156	45	23	34	2	1263.5
65	157	50	24	37	5	1268.5
66	158	55	30	42.5	10.5	1279
67	159	59	32	45.5	13.5	1292.5
68	160	61	33	47	15	1307.5

69	161	64	36	50	18	1325.5
70	162	65	39	52	20	1345.5
71	163	68	38	53	21	1366.5
72	164	69	40	54.5	22.5	1389
73	165	63	41	52	20	1409
74	166	61	36	48.5	16.5	1425.5
75	167	53	37	45	13	1438.5
76	168	41	32	36.5	4.5	1443
77	169	45	32	38.5	6.5	1449.5
78	170	48	33	40.5	8.5	1458
79	171	50	32	41	9	1467
80	172	54	32	43	11	1478
81	173	61	32	46.5	14.5	1492.5
82	174	65	36	50.5	18.5	1511
83	175	63	39	51	19	1530
84	176	63	41	52	20	1550
85	177	64	36	50	18	1568
86	178	46	28	37	5	1573
87	179	44	25	34.5	2.5	1575.5
88	180	50	24	37	5	1580.5
89	181	63	27	45	13	1593.5
90	182	67	38	52.5	20.5	1614
91	183	71	40	55.5	23.5	1637.5
92	184	65	41	53	21	1658.5
93	185	53	31	42	10	1668.5
94	186	52	24	38	6	1674.5
95	187	51	29	40	8	1682.5
96	188	48	23	35.5	3.5	1686
97	189	52	26	39	7	1693
98	190	62	31	46.5	14.5	1707.5
99	191	70	34	52	20	1727.5
100	192	74	33	53.5	21.5	1749
101	193	74	35	54.5	22.5	1771.5
102	194	68	41	54.5	22.5	1794
103	195	73	42	57.5	25.5	1819.5
104	196	69	44	56.5	24.5	1844
105	197	52	34	43	11	1855
106	198	62	29	45.5	13.5	1868.5
107	199	66	38	52	20	1888.5
108	200	56	32	44	12	1900.5
109	201	59	31	45	13	1913.5
110	202	64	33	48.5	16.5	1930
111	203	69	46	57.5	25.5	1955.5
112	204	64	36	50	18	1973.5
113	205	57	29	43	11	1984.5
114	206	68	35	51.5	19.5	2004
115	207	72	40	56	24	2028
116	208	74	41	57.5	25.5	2053.5
117	209	74	43	58.5	26.5	2080
118	210	73	45	59	27	2107
119	211	67	42	54.5	22.5	2129.5
120	212	63	37	50	18	2147.5
121	213	66	35	50.5	18.5	2166
122	214	70	41	55.5	23.5	2189.5
123	215	74	49	61.5	29.5	2219
124	216	62	37	49.5	17.5	2236.5
125	217	62	39	50.5	18.5	2255
126	218	64	37	50.5	18.5	2273.5
127	219	69	44	56.5	24.5	2298
128	220	63	42	52.5	20.5	2318.5
129	221	58	35	46.5	14.5	2333
130	222	63	31	47	15	2348
131	223	71	39	55	23	2371
132	224	78	45	61.5	29.5	2400.5
133	225	79	51	65	33	2433.5
134	226	76	52	64	32	2465.5
135	227	68	48	58	26	2491.5
136	228	82	46	64	32	2523.5
137	229	82	54	68	36	2559.5
138	230	78	57	67.5	35.5	2595
139	231	80	48	64	32	2627
140	232	80	49	64.5	32.5	2659.5
141	233	83	49	66	34	2693.5
142	234	89	48	68.5	36.5	2730
143	235	89	53	71	39	2769
144	236	90	57	73.5	41.5	2810.5
145	237	89	59	74	42	2852.5
146	238	87	53	70	38	2890.5
147	239	93	58	75.5	43.5	2934
148	240	93	63	78	46	2980
149	241	93	60	76.5	44.5	3024.5
150	242	94	64	79	47	3071.5
151	243	89	60	74.5	42.5	3114
152	244	88	58	73	41	3155
153	245	92	55	73.5	41.5	3196.5
154	246	89	62	75.5	43.5	3240
155	247	88	59	73.5	41.5	3281.5
156	248	80	55	67.5	35.5	3317
157	249	83	54	68.5	36.5	3353.5
158	250	82	53	67.5	35.5	3389
159	251	88	55	71.5	39.5	3428.5
160	252	89	53	71	39	3467.5
161	253	87	57	72	40	3507.5
162	254	86	52	69	37	3544.5
163	255	82	53	67.5	35.5	3580
164	256	86	53	69.5	37.5	3617.5
165	257	89	58	73.5	41.5	3659
166	258	92	61	76.5	44.5	3703.5
167	259	93	64	78.5	46.5	3750
168	260	89	59	74	42	3792
169	261	86	55	70.5	38.5	3830.5
170	262	85	56	70.5	38.5	3869
171	263	80	56	68	36	3905
172	264	83	51	67	35	3940
173	265	85	59	72	40	3980
174	266	86	56	71	39	4019
175	267	80	55	67.5	35.5	4054.5
176	268	80	45	62.5	30.5	4085
177	269	85	53	69	37	4122

178	270	89	54	71.5	39.5	4161.5
179	271	93	52	72.5	40.5	4202
180	272	93	55	74	42	4244
181	273	94	61	77.5	45.5	4289.5
182	274	94	64	79	47	4336.5
183	275	94	60	77	45	4381.5
184	276	95	61	78	46	4427.5
185	277	100	62	81	49	4476.5
186	278	100	67	83.5	51.5	4528
187	279	98	65	81.5	49.5	4577.5
188	280	95	64	79.5	47.5	4625
189	281	98	62	80	48	4673
190	282	98	64	81	49	4722
191	283	101	57	79	47	4769
192	284	101	63	82	50	4819
193	285	101	66	83.5	51.5	4870.5
194	286	102	66	84	52	4922.5
195	287	104	70	87	55	4977.5
196	288	102	70	86	54	5031.5
197	289	97	70	83.5	51.5	5083
198	290	97	70	83.5	51.5	5134.5
199	291	97	66	81.5	49.5	5184
200	292	99	67	83	51	5235
201	293	95	69	82	50	5285
202	294	95	66	80.5	48.5	5333.5
203	295	100	65	82.5	50.5	5384
204	296	96	72	84	52	5436
205	297	97	69	83	51	5487
206	298	96	65	80.5	48.5	5535.5
207	299	99	68	83.5	51.5	5587
208	300	95	65	80	48	5635
209	301	88	59	73.5	41.5	5676.5
210	302	90	62	76	44	5720.5
211	303	93	63	78	46	5766.5
212	304	91	66	78.5	46.5	5813
213	305	90	65	77.5	45.5	5858.5
214	306	92	60	76	44	5902.5
215	307	90	60	75	43	5945.5
216	308	93	61	77	45	5990.5
217	309	94	64	79	47	6037.5
218	310	94	65	79.5	47.5	6085
219	311	94	67	80.5	48.5	6133.5
220	312	90	60	75	43	6176.5
221	313	96	64	80	48	6224.5
222	314	97	66	81.5	49.5	6274
223	315	97	66	81.5	49.5	6323.5
224	316	95	66	80.5	48.5	6372
225	317	95	68	81.5	49.5	6421.5
226	318	95	65	80	48	6469.5
227	319	82	58	70	38	6507.5
228	320	80	55	67.5	35.5	6543
229	321	86	58	72	40	6583
230	322	93	61	77	45	6628
231	323	96	61	78.5	46.5	6674.5
232	324	92	63	77.5	45.5	6720
233	325	93	64	78.5	46.5	6766.5
234	326	88	62	75	43	6809.5
235	327	87	59	73	41	6850.5
236	328	83	58	70.5	38.5	6889
237	329	91	61	76	44	6933
238	330	90	60	75	43	6976
239	331	79	63	71	39	7015
240	332	89	59	74	42	7057
241	333	87	59	73	41	7098
242	334	84	60	72	40	7138
243	335	88	57	72.5	40.5	7178.5
244	336	91	62	76.5	44.5	7223
245	337	91	62	76.5	44.5	7267.5
246	338	86	66	76	44	7311.5
247	339	84	70	77	45	7356.5
248	340	80	60	70	38	7394.5
249	341	73	55	64	32	7426.5
250	342	78	52	65	33	7459.5
251	343	83	56	69.5	37.5	7497
252	344	72	59	65.5	33.5	7530.5
253	345	68	49	58.5	26.5	7557
254	346	71	44	57.5	25.5	7582.5
255	347	78	47	62.5	30.5	7613
256	348	72	52	62	30	7643
257	349	76	42	59	27	7670
258	350	81	50	65.5	33.5	7703.5
259	351	84	54	69	37	7740.5
260	352	83	50	66.5	34.5	7775
261	353	70	38	54	22	7797
262	354	76	43	59.5	27.5	7824.5
263	355	80	51	65.5	33.5	7858
264	356	79	47	63	31	7889
265	357	82	52	67	35	7924
266	358	84	52	68	36	7960
267	359	84	54	69	37	7997
268	360	85	56	70.5	38.5	8035.5
269	361	90	50	70	38	8073.5
270	362	88	58	73	41	8114.5
271	363	86	57	71.5	39.5	8154
272	364	85	55	70	38	8192
273	365	86	55	70.5	38.5	8230.5



78	970	length of freeze (day)	14
92	900.5	frost depth (^oF-day)	69.5
		average temperature	54.5

2003-2004

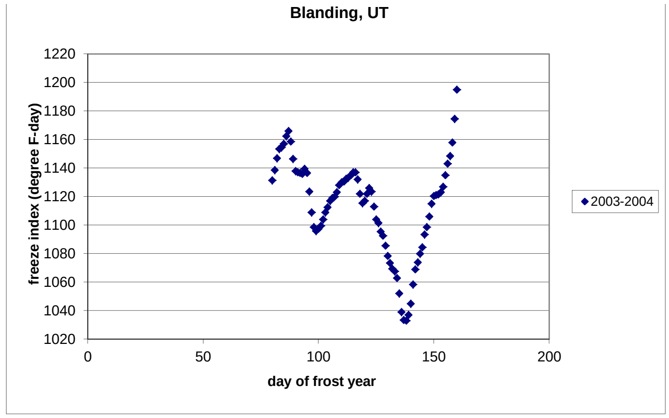
day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	85	55	70	38	38
275	2	69	50	59.5	27.5	65.5
276	3	59	57	58	26	91.5
277	4	67	49	58	26	117.5
278	5	72	47	59.5	27.5	145
279	6	75	49	62	30	175
280	7	75	50	62.5	30.5	205.5
281	8	76	48	62	30	235.5

282	9	79	49	64	32	267.5
283	10	76	52	64	32	299.5
284	11	77	42	59.5	27.5	327
285	12	72	42	57	25	352
286	13	66	45	55.5	23.5	375.5
287	14	69	38	53.5	21.5	397
288	15	73	41	57	25	422
289	16	78	45	61.5	29.5	451.5
290	17	78	47	62.5	30.5	482
291	18	79	48	63.5	31.5	513.5
292	19	79	47	63	31	544.5
293	20	80	50	65	33	577.5
294	21	81	49	65	33	610.5
295	22	80	49	64.5	32.5	643
296	23	77	48	62.5	30.5	673.5
297	24	73	46	59.5	27.5	701
298	25	57	39	48	16	717
299	26	65	35	50	18	735
300	27	68	40	54	22	757
301	28	73	46	59.5	27.5	784.5
302	29	72	42	57	25	809.5
303	30	68	45	56.5	24.5	834
304	31	64	43	53.5	21.5	855.5
305	32	61	43	52	20	875.5
306	33	59	38	48.5	16.5	892
307	34	52	31	41.5	9.5	901.5
308	35	48	26	37	5	906.5
309	36	50	29	39.5	7.5	914
310	37	51	29	40	8	922
311	38	56	34	45	13	935
312	39	57	33	45	13	948
313	40	55	39	47	15	963
314	41	44	39	41.5	9.5	972.5
315	42	54	38	46	14	986.5
316	43	49	37	43	11	997.5
317	44	44	38	41	9	1006.5
318	45	50	33	41.5	9.5	1016
319	46	49	33	41	9	1025
320	47	44	33	38.5	6.5	1031.5
321	48	45	33	39	7	1038.5
322	49	49	26	37.5	5.5	1044
323	50	50	30	40	8	1052
324	51	54	32	43	11	1063
325	52	53	34	43.5	11.5	1074.5
326	53	47	15	31	-1	1073.5
327	54	33	9	21	-11	1062.5
328	55	37	15	26	-6	1056.5
329	56	45	25	35	3	1059.5
330	57	39	23	31	-1	1058.5
331	58	41	20	30.5	-1.5	1057
332	59	38	18	28	-4	1053
333	60	48	15	31.5	-0.5	1052.5
334	61	53	21	37	5	1057.5
335	62	58	33	45.5	13.5	1071
336	63	56	31	43.5	11.5	1082.5
337	64	52	28	40	8	1090.5
338	65	54	28	41	9	1099.5
339	66	48	28	38	6	1105.5
340	67	52	32	42	10	1115.5
341	68	54	38	46	14	1129.5
342	69	42	36	39	7	1136.5
343	70	43	22	32.5	0.5	1137
344	71	41	19	30	-2	1135
345	72	44	23	33.5	1.5	1136.5
346	73	44	21	32.5	0.5	1137
347	74	45	21	33	1	1138
348	75	44	24	34	2	1140
349	76	33	17	25	-7	1133
350	77	35	13	24	-8	1125
351	78	43	18	30.5	-1.5	1123.5
352	79	45	21	33	1	1124.5
353	80	52	26	39	7	1131.5
354	81	50	28	39	7	1138.5
355	82	51	30	40.5	8.5	1147
356	83	49	28	38.5	6.5	1153.5
357	84	45	21	33	1	1154.5
358	85	43	26	34.5	2.5	1157
359	86	45	30	37.5	5.5	1162.5
360	87	42	29	35.5	3.5	1166
361	88	31	18	24.5	-7.5	1158.5
362	89	31	9	20	-12	1146.5
363	90	33	14	23.5	-8.5	1138
364	91	38	24	31	-1	1137
365	92	40	23	31.5	-0.5	1136.5
1	93	40	23	31.5	-0.5	1136
2	94	39	32	35.5	3.5	1139.5
3	95	36	22	29	-3	1136.5
4	96	31	7	19	-13	1123.5
5	97	30	5	17.5	-14.5	1109
6	98	34	9	21.5	-10.5	1098.5
7	99	37	22	29.5	-2.5	1096
8	100	45	22	33.5	1.5	1097.5
9	101	45	23	34	2	1099.5
10	102	49	24	36.5	4.5	1104
11	103	48	26	37	5	1109
12	104	45	26	35.5	3.5	1112.5
13	105	48	25	36.5	4.5	1117
14	106	43	25	34	2	1119
15	107	37	29	33	1	1120
16	108	41	29	35	3	1123
17	109	47	27	37	5	1128
18	110	44	24	34	2	1130
19	111	40	25	32.5	0.5	1130.5
20	112	42	26	34	2	1132.5
21	113	45	21	33	1	1133.5
22	114	45	22	33.5	1.5	1135
23	115	46	22	34	2	1137
24	116	43	21	32	0	1137
25	117	36	18	27	-5	1132

26	118	32	12	22	-10	1122
27	119	37	14	25.5	-6.5	1115.5
28	120	46	21	33.5	1.5	1117
29	121	50	24	37	5	1122
30	122	46	26	36	4	1126
31	123	36	23	29.5	-2.5	1123.5
32	124	32	11	21.5	-10.5	1113
33	125	32	14	23	-9	1104
34	126	33	26	29.5	-2.5	1101.5
35	127	34	18	26	-6	1095.5
36	128	39	19	29	-3	1092.5
37	129	38	12	25	-7	1085.5
38	130	35	15	25	-7	1078.5
39	131	38	16	27	-5	1073.5
40	132	41	15	28	-4	1069.5
41	133	43	17	30	-2	1067.5
42	134	38	17	27.5	-4.5	1063
43	135	32	10	21	-11	1052
44	136	31	7	19	-13	1039
45	137	38	15	26.5	-5.5	1033.5
46	138	43	20	31.5	-0.5	1033
47	139	48	24	36	4	1037
48	140	51	29	40	8	1045
49	141	54	37	45.5	13.5	1058.5
50	142	53	32	42.5	10.5	1069
51	143	47	27	37	5	1074
52	144	45	31	38	6	1080
53	145	43	30	36.5	4.5	1084.5
54	146	49	33	41	9	1093.5
55	147	43	31	37	5	1098.5
56	148	49	30	39.5	7.5	1106
57	149	49	33	41	9	1115
58	150	41	34	37.5	5.5	1120.5
59	151	40	25	32.5	0.5	1121
60	152	42	23	32.5	0.5	1121.5
61	153	43	24	33.5	1.5	1123
62	154	43	29	36	4	1127
63	155	50	30	40	8	1135
64	156	50	30	40	8	1143
65	157	48	27	37.5	5.5	1148.5
66	158	56	27	41.5	9.5	1158
67	159	64	33	48.5	16.5	1174.5
68	160	69	36	52.5	20.5	1195
69	161	67	40	53.5	21.5	1216.5
70	162	68	39	53.5	21.5	1238
71	163	66	39	52.5	20.5	1258.5
72	164	66	36	51	19	1277.5
73	165	67	38	52.5	20.5	1298
74	166	68	38	53	21	1319
75	167	69	36	52.5	20.5	1339.5
76	168	67	36	51.5	19.5	1359
77	169	69	36	52.5	20.5	1379.5
78	170	70	38	54	22	1401.5
79	171	74	40	57	25	1426.5
80	172	80	47	63.5	31.5	1458
81	173	76	47	61.5	29.5	1487.5
82	174	77	44	60.5	28.5	1516
83	175	76	47	61.5	29.5	1545.5
84	176	71	43	57	25	1570.5
85	177	71	44	57.5	25.5	1596
86	178	68	41	54.5	22.5	1618.5
87	179	55	37	46	14	1632.5
88	180	58	30	44	12	1644.5
89	181	68	33	50.5	18.5	1663
90	182	71	37	54	22	1685
91	183	75	41	58	26	1711
92	184	70	47	58.5	26.5	1737.5
93	185	61	42	51.5	19.5	1757
94	186	55	36	45.5	13.5	1770.5
95	187	55	38	46.5	14.5	1785
96	188	53	37	45	13	1798
97	189	61	35	48	16	1814
98	190	61	41	51	19	1833
99	191	60	39	49.5	17.5	1850.5
100	192	65	40	52.5	20.5	1871
101	193	53	33	43	11	1882
102	194	58	34	46	14	1896
103	195	66	34	50	18	1914
104	196	70	39	54.5	22.5	1936.5
105	197	70	42	56	24	1960.5
106	198	71	41	56	24	1984.5
107	199	71	41	56	24	2008.5
108	200	71	45	58	26	2034.5
109	201	58	31	44.5	12.5	2047
110	202	63	37	50	18	2065
111	203	65	36	50.5	18.5	2083.5
112	204	60	38	49	17	2100.5
113	205	54	38	46	14	2114.5
114	206	57	34	45.5	13.5	2128
115	207	61	34	47.5	15.5	2143.5
116	208	68	38	53	21	2164.5
117	209	75	41	58	26	2190.5
118	210	78	36	57	25	2215.5
119	211	78	46	62	30	2245.5
120	212	64	35	49.5	17.5	2263
121	213	54	38	46	14	2277
122	214	68	37	52.5	20.5	2297.5
123	215	75	43	59	27	2324.5
124	216	80	46	63	31	2355.5
125	217	85	50	67.5	35.5	2391
126	218	83	54	68.5	36.5	2427.5
127	219	81	51	66	34	2461.5
128	220	80	49	64.5	32.5	2494
129	221	82	50	66	34	2528
130	222	83	55	69	37	2565
131	223	83	49	66	34	2599
132	224	73	46	59.5	27.5	2626.5
133	225	67	45	56	24	2650.5
134	226	65	37	51	19	2669.5

135	227	74	40	57	25	2694.5
136	228	81	52	66.5	34.5	2729
137	229	82	54	68	36	2765
138	230	76	53	64.5	32.5	2797.5
139	231	82	51	66.5	34.5	2832
140	232	82	53	67.5	35.5	2867.5
141	233	80	54	67	35	2902.5
142	234	77	48	62.5	30.5	2933
143	235	73	46	59.5	27.5	2960.5
144	236	75	44	59.5	27.5	2988
145	237	75	44	59.5	27.5	3015.5
146	238	77	45	61	29	3044.5
147	239	78	45	61.5	29.5	3074
148	240	83	50	66.5	34.5	3108.5
149	241	83	53	68	36	3144.5
150	242	70	50	60	28	3172.5
151	243	71	38	54.5	22.5	3195
152	244	81	44	62.5	30.5	3225.5
153	245	89	55	72	40	3265.5
154	246	90	58	74	42	3307.5
155	247	92	55	73.5	41.5	3349
156	248	92	59	75.5	43.5	3392.5
157	249	94	59	76.5	44.5	3437
158	250	95	60	77.5	45.5	3482.5
159	251	95	59	77	45	3527.5
160	252	95	55	75	43	3570.5
161	253	83	50	66.5	34.5	3605
162	254	80	52	66	34	3639
163	255	79	45	62	30	3669
164	256	83	52	67.5	35.5	3704.5
165	257	90	53	71.5	39.5	3744
166	258	94	59	76.5	44.5	3788.5
167	259	95	63	79	47	3835.5
168	260	89	53	71	39	3874.5
169	261	87	54	70.5	38.5	3913
170	262	89	54	71.5	39.5	3952.5
171	263	89	58	73.5	41.5	3994
172	264	90	56	73	41	4035
173	265	87	57	72	40	4075
174	266	83	48	65.5	33.5	4108.5
175	267	88	52	70	38	4146.5
176	268	90	59	74.5	42.5	4189
177	269	87	59	73	41	4230
178	270	85	57	71	39	4269
179	271	87	56	71.5	39.5	4308.5
180	272	86	56	71	39	4347.5
181	273	80	56	68	36	4383.5
182	274	81	51	66	34	4417.5
183	275	87	56	71.5	39.5	4457
184	276	89	55	72	40	4497
185	277	89	57	73	41	4538
186	278	88	58	73	41	4579
187	279	93	62	77.5	45.5	4624.5
188	280	94	60	77	45	4669.5
189	281	95	56	75.5	43.5	4713
190	282	93	60	76.5	44.5	4757.5
191	283	91	60	75.5	43.5	4801
192	284	92	59	75.5	43.5	4844.5
193	285	96	56	76	44	4888.5
194	286	98	65	81.5	49.5	4938
195	287	97	67	82	50	4988
196	288	99	68	83.5	51.5	5039.5
197	289	93	64	78.5	46.5	5086
198	290	94	64	79	47	5133
199	291	92	62	77	45	5178
200	292	92	63	77.5	45.5	5223.5
201	293	87	62	74.5	42.5	5266
202	294	88	64	76	44	5310
203	295	92	62	77	45	5355
204	296	93	67	80	48	5403
205	297	86	65	75.5	43.5	5446.5
206	298	86	57	71.5	39.5	5486
207	299	86	57	71.5	39.5	5525.5
208	300	86	58	72	40	5565.5
209	301	83	56	69.5	37.5	5603
210	302	87	57	72	40	5643
211	303	91	57	74	42	5685
212	304	94	64	79	47	5732
213	305	95	61	78	46	5778
214	306	95	68	81.5	49.5	5827.5
215	307	84	58	71	39	5866.5
216	308	87	59	73	41	5907.5
217	309	94	65	79.5	47.5	5955
218	310	86	61	73.5	41.5	5996.5
219	311	87	58	72.5	40.5	6037
220	312	92	54	73	41	6078
221	313	94	63	78.5	46.5	6124.5
222	314	95	63	79	47	6171.5
223	315	93	63	78	46	6217.5
224	316	95	64	79.5	47.5	6265
225	317	96	63	79.5	47.5	6312.5
226	318	93	62	77.5	45.5	6358
227	319	88	58	73	41	6399
228	320	89	59	74	42	6441
229	321	86	59	72.5	40.5	6481.5
230	322	82	57	69.5	37.5	6519
231	323	82	56	69	37	6556
232	324	79	59	69	37	6593
233	325	82	55	68.5	36.5	6629.5
234	326	82	55	68.5	36.5	6666
235	327	88	58	73	41	6707
236	328	82	55	68.5	36.5	6743.5
237	329	81	55	68	36	6779.5
238	330	84	63	73.5	41.5	6821
239	331	88	55	71.5	39.5	6860.5
240	332	80	52	66	34	6894.5
241	333	87	53	70	38	6932.5
242	334	90	55	72.5	40.5	6973
243	335	90	55	72.5	40.5	7013.5

244	336	91	57	74	42	7055.5
245	337	90	57	73.5	41.5	7097
246	338	90	55	72.5	40.5	7137.5
247	339	85	61	73	41	7178.5
248	340	66	40	53	21	7199.5
249	341	73	43	58	26	7225.5
250	342	81	50	65.5	33.5	7259
251	343	83	53	68	36	7295
252	344	86	54	70	38	7333
253	345	88	53	70.5	38.5	7371.5
254	346	86	61	73.5	41.5	7413
255	347	89	58	73.5	41.5	7454.5
256	348	88	57	72.5	40.5	7495
257	349	87	56	71.5	39.5	7534.5
258	350	85	55	70	38	7572.5
259	351	79	47	63	31	7603.5
260	352	84	51	67.5	35.5	7639
261	353	85	55	70	38	7677
262	354	80	61	70.5	38.5	7715.5
263	355	63	48	55.5	23.5	7739
264	356	63	47	55	23	7762
265	357	51	39	45	13	7775
266	358	60	34	47	15	7790
267	359	68	39	53.5	21.5	7811.5
268	360	74	45	59.5	27.5	7839
269	361	74	46	60	28	7867
270	362	75	47	61	29	7896
271	363	79	49	64	32	7928
272	364	77	48	62.5	30.5	7958.5
273	365	58	45	51.5	19.5	7978
274	366	61	44	52.5	20.5	7998.5



87	1166	length of freeze (day)	51
138	1033	frost depth (^{o}F-day)	133
		average temperature	53.9

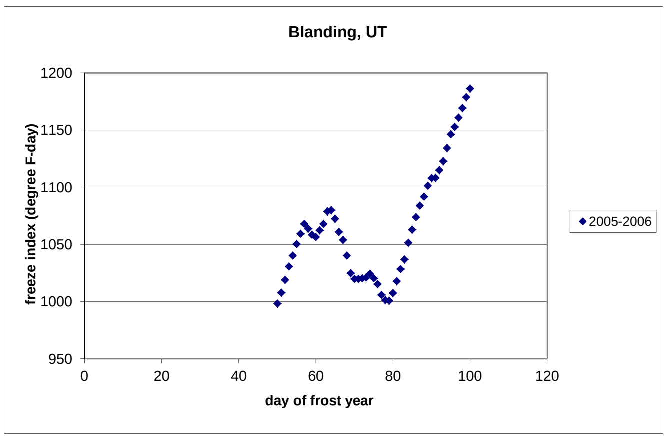
2005-2006

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	78	50	64	32	32
275	2	80	51	65.5	33.5	65.5
276	3	80	52	66	34	99.5
277	4	72	57	64.5	32.5	132
278	5	66	36	51	19	151
279	6	70	46	58	26	177
280	7	74	42	58	26	203
281	8	77	39	58	26	229
282	9	65	47	56	24	253
283	10	53	40	46.5	14.5	267.5
284	11	61	34	47.5	15.5	283
285	12	65	39	52	20	303
286	13	69	42	55.5	23.5	326.5
287	14	73	41	57	25	351.5
288	15	69	45	57	25	376.5
289	16	68	46	57	25	401.5
290	17	69	45	57	25	426.5
291	18	65	45	55	23	449.5
292	19	55	39	47	15	464.5
293	20	65	38	51.5	19.5	484
294	21	69	42	55.5	23.5	507.5
295	22	68	41	54.5	22.5	530
296	23	71	43	57	25	555
297	24	68	41	54.5	22.5	577.5
298	25	70	43	56.5	24.5	602
299	26	68	40	54	22	624
300	27	66	42	54	22	646
301	28	58	43	50.5	18.5	664.5
302	29	59	41	50	18	682.5
303	30	61	37	49	17	699.5
304	31	59	33	46	14	713.5
305	32	63	35	49	17	730.5
306	33	61	38	49.5	17.5	748
307	34	67	44	55.5	23.5	771.5
308	35	63	37	50	18	789.5
309	36	59	35	47	15	804.5
310	37	62	35	48.5	16.5	821
311	38	61	43	52	20	841
312	39	59	41	50	18	859
313	40	67	43	55	23	882
314	41	71	43	57	25	907
315	42	56	41	48.5	16.5	923.5
316	43	58	33	45.5	13.5	937
317	44	56	35	45.5	13.5	950.5
318	45	58	36	47	15	965.5
319	46	44	22	33	1	966.5
320	47	50	23	36.5	4.5	971
321	48	56	28	42	10	981
322	49	54	27	40.5	8.5	989.5
323	50	53	29	41	9	998.5
324	51	55	28	41.5	9.5	1008
325	52	57	29	43	11	1019
326	53	59	29	44	12	1031
327	54	54	29	41.5	9.5	1040.5
328	55	55	29	42	10	1050.5
329	56	55	27	41	9	1059.5
330	57	52	29	40.5	8.5	1068
331	58	36	20	28	-4	1064
332	59	39	14	26.5	-5.5	1058.5
333	60	41	19	30	-2	1056.5
334	61	50	26	38	6	1062.5
335	62	47	28	37.5	5.5	1068
336	63	54	32	43	11	1079
337	64	43	23	33	1	1080
338	65	34	15	24.5	-7.5	1072.5
339	66	32	9	20.5	-11.5	1061
340	67	36	14	25	-7	1054
341	68	29	8	18.5	-13.5	1040.5
342	69	31	2	16.5	-15.5	1025
343	70	42	12	27	-5	1020
344	71	45	19	32	0	1020
345	72	46	19	32.5	0.5	1020.5
346	73	44	21	32.5	0.5	1021

347	74	47	24	35.5	3.5	1024.5
348	75	40	16	28	-4	1020.5
349	76	42	12	27	-5	1015.5
350	77	32	13	22.5	-9.5	1006
351	78	40	15	27.5	-4.5	1001.5
352	79	41	22	31.5	-0.5	1001
353	80	49	28	38.5	6.5	1007.5
354	81	55	30	42.5	10.5	1018
355	82	54	31	42.5	10.5	1028.5
356	83	52	29	40.5	8.5	1037
357	84	60	33	46.5	14.5	1051.5
358	85	58	29	43.5	11.5	1063
359	86	53	33	43	11	1074
360	87	53	31	42	10	1084
361	88	53	27	40	8	1092
362	89	55	28	41.5	9.5	1101.5
363	90	49	28	38.5	6.5	1108
364	91	43	22	32.5	0.5	1108.5
365	92	47	30	38.5	6.5	1115
1	93	51	29	40	8	1123
2	94	56	31	43.5	11.5	1134.5
3	95	52	36	44	12	1146.5
4	96	50	27	38.5	6.5	1153
5	97	56	24	40	8	1161
6	98	54	27	40.5	8.5	1169.5
7	99	54	29	41.5	9.5	1179
8	100	51	28	39.5	7.5	1186.5
9	101	46	16	31	-1	1185.5
10	102	45	20	32.5	0.5	1186
11	103	47	20	33.5	1.5	1187.5
12	104	44	25	34.5	2.5	1190
13	105	48	21	34.5	2.5	1192.5
14	106	53	27	40	8	1200.5
15	107	45	28	36.5	4.5	1205
16	108	41	19	30	-2	1203
17	109	43	15	29	-3	1200
18	110	46	23	34.5	2.5	1202.5
19	111	42	25	33.5	1.5	1204
20	112	41	16	28.5	-3.5	1200.5
21	113	40	17	28.5	-3.5	1197
22	114	44	17	30.5	-1.5	1195.5
23	115	45	18	31.5	-0.5	1195
24	116	50	17	33.5	1.5	1196.5
25	117	44	31	37.5	5.5	1202
26	118	43	24	33.5	1.5	1203.5
27	119	35	20	27.5	-4.5	1199
28	120	37	19	28	-4	1195
29	121	45	21	33	1	1196
30	122	48	26	37	5	1201
31	123	52	29	40.5	8.5	1209.5
32	124	52	29	40.5	8.5	1218
33	125	53	32	42.5	10.5	1228.5
34	126	50	26	38	6	1234.5
35	127	48	26	37	5	1239.5
36	128	45	24	34.5	2.5	1242
37	129	50	19	34.5	2.5	1244.5
38	130	54	25	39.5	7.5	1252
39	131	59	29	44	12	1264
40	132	58	28	43	11	1275
41	133	43	20	31.5	-0.5	1274.5
42	134	45	13	29	-3	1271.5
43	135	51	22	36.5	4.5	1276
44	136	55	24	39.5	7.5	1283.5
45	137	49	26	37.5	5.5	1289
46	138	57	28	42.5	10.5	1299.5
47	139	37	13	25	-7	1292.5
48	140	44	22	33	1	1293.5
49	141	50	23	36.5	4.5	1298
50	142	45	22	33.5	1.5	1299.5
51	143	43	24	33.5	1.5	1301
52	144	46	22	34	2	1303
53	145	48	17	32.5	0.5	1303.5
54	146	55	23	39	7	1310.5
55	147	57	28	42.5	10.5	1321
56	148	58	32	45	13	1334
57	149	58	30	44	12	1346
58	150	64	36	50	18	1364
59	151	59	42	50.5	18.5	1382.5
60	152	57	38	47.5	15.5	1398
61	153	59	38	48.5	16.5	1414.5
62	154	65	34	49.5	17.5	1432
63	155	57	37	47	15	1447
64	156	62	21	41.5	9.5	1456.5
65	157	62	40	51	19	1475.5
66	158	61	33	47	15	1490.5
67	159	39	27	33	1	1491.5
68	160	39	22	30.5	-1.5	1490
69	161	35	21	28	-4	1486
70	162	31	20	25.5	-6.5	1479.5
71	163	33	23	28	-4	1475.5
72	164	38	14	26	-6	1469.5
73	165	45	19	32	0	1469.5
74	166	47	30	38.5	6.5	1476
75	167	53	30	41.5	9.5	1485.5
76	168	58	36	47	15	1500.5
77	169	54	31	42.5	10.5	1511
78	170	47	25	36	4	1515
79	171	50	23	36.5	4.5	1519.5
80	172	41	29	35	3	1522.5
81	173	55	29	42	10	1532.5
82	174	58	29	43.5	11.5	1544
83	175	60	33	46.5	14.5	1558.5
84	176	65	37	51	19	1577.5
85	177	57	35	46	14	1591.5
86	178	59	32	45.5	13.5	1605
87	179	59	40	49.5	17.5	1622.5
88	180	48	35	41.5	9.5	1632
89	181	51	30	40.5	8.5	1640.5
90	182	60	29	44.5	12.5	1653

91	183	56	41	48.5	16.5	1669.5
92	184	59	33	46	14	1683.5
93	185	70	41	55.5	23.5	1707
94	186	71	50	60.5	28.5	1735.5
95	187	60	33	46.5	14.5	1750
96	188	53	30	41.5	9.5	1759.5
97	189	65	33	49	17	1776.5
98	190	70	39	54.5	22.5	1799
99	191	73	41	57	25	1824
100	192	69	40	54.5	22.5	1846.5
101	193	63	39	51	19	1865.5
102	194	74	43	-	-	1865.5
103	195	77	45	61	29	1894.5
104	196	76	46	61	29	1923.5
105	197	65	39	52	20	1943.5
106	198	71	39	55	23	1966.5
107	199	70	36	53	21	1987.5
108	200	54	27	40.5	8.5	1996
109	201	61	27	44	12	2008
110	202	66	29	47.5	15.5	2023.5
111	203	73	40	56.5	24.5	2048
112	204	80	48	64	32	2080
113	205	72	44	58	26	2106
114	206	61	35	48	16	2122
115	207	67	37	52	20	2142
116	208	74	42	58	26	2168
117	209	78	40	59	27	2195
118	210	69	51	60	28	2223
119	211	71	39	55	23	2246
120	212	76	45	60.5	28.5	2274.5
121	213	78	45	61.5	29.5	2304
122	214	76	53	64.5	32.5	2336.5
123	215	80	47	63.5	31.5	2368
124	216	76	49	62.5	30.5	2398.5
125	217	74	47	60.5	28.5	2427
126	218	73	42	57.5	25.5	2452.5
127	219	77	49	63	31	2483.5
128	220	80	48	64	32	2515.5
129	221	62	42	52	20	2535.5
130	222	70	38	54	22	2557.5
131	223	76	47	61.5	29.5	2587
132	224	83	48	65.5	33.5	2620.5
133	225	88	55	71.5	39.5	2660
134	226	86	64	75	43	2703
135	227	81	57	69	37	2740
136	228	85	50	67.5	35.5	2775.5
137	229	88	56	72	40	2815.5
138	230	90	55	72.5	40.5	2856
139	231	87	58	72.5	40.5	2896.5
140	232	88	56	72	40	2936.5
141	233	87	55	71	39	2975.5
142	234	81	52	66.5	34.5	3010
143	235	76	42	59	27	3037
144	236	86	53	69.5	37.5	3074.5
145	237	92	56	74	42	3116.5
146	238	87	55	71	39	3155.5
147	239	81	54	67.5	35.5	3191
148	240	70	47	58.5	26.5	3217.5
149	241	70	35	52.5	20.5	3238
150	242	80	46	63	31	3269
151	243	85	48	66.5	34.5	3303.5
152	244	90	55	72.5	40.5	3344
153	245	92	56	74	42	3386
154	246	94	59	76.5	44.5	3430.5
155	247	97	60	78.5	46.5	3477
156	248	97	60	78.5	46.5	3523.5
157	249	99	64	81.5	49.5	3573
158	250	93	64	78.5	46.5	3619.5
159	251	70	54	62	30	3649.5
160	252	83	61	72	40	3689.5
161	253	88	62	75	43	3732.5
162	254	89	56	72.5	40.5	3773
163	255	92	54	73	41	3814
164	256	90	55	72.5	40.5	3854.5
165	257	92	59	75.5	43.5	3898
166	258	77	55	66	34	3932
167	259	78	48	63	31	3963
168	260	87	53	70	38	4001
169	261	92	57	74.5	42.5	4043.5
170	262	96	62	79	47	4090.5
171	263	93	62	77.5	45.5	4136
172	264	93	61	77	45	4181
173	265	95	65	80	48	4229
174	266	93	64	78.5	46.5	4275.5
175	267	96	65	80.5	48.5	4324
176	268	93	61	77	45	4369
177	269	89	72	80.5	48.5	4417.5
178	270	89	55	72	40	4457.5
179	271	91	57	74	42	4499.5
180	272	88	59	73.5	41.5	4541
181	273	93	60	76.5	44.5	4585.5
182	274	95	66	80.5	48.5	4634
183	275	92	63	77.5	45.5	4679.5
184	276	88	62	75	43	4722.5
185	277	93	66	79.5	47.5	4770
186	278	91	63	77	45	4815
187	279	85	61	73	41	4856
188	280	75	59	67	35	4891
189	281	75	59	67	35	4926
190	282	82	57	69.5	37.5	4963.5
191	283	85	57	71	39	5002.5
192	284	90	59	74.5	42.5	5045
193	285	93	64	78.5	46.5	5091.5
194	286	97	65	81	49	5140.5
195	287	98	65	81.5	49.5	5190
196	288	97	68	82.5	50.5	5240.5
197	289	101	66	83.5	51.5	5292
198	290	101	69	85	53	5345
199	291	96	69	82.5	50.5	5395.5

200	292	97	64	80.5	48.5	5444
201	293	95	66	80.5	48.5	5492.5
202	294	98	66	82	50	5542.5
203	295	94	65	79.5	47.5	5590
204	296	97	63	80	48	5638
205	297	98	65	81.5	49.5	5687.5
206	298	98	65	81.5	49.5	5737
207	299	97	66	81.5	49.5	5786.5
208	300	93	66	79.5	47.5	5834
209	301	90	61	75.5	43.5	5877.5
210	302	92	62	77	45	5922.5
211	303	91	63	77	45	5967.5
212	304	90	63	76.5	44.5	6012
213	305	90	61	75.5	43.5	6055.5
214	306	82	66	74	42	6097.5
215	307	90	59	74.5	42.5	6140
216	308	81	58	69.5	37.5	6177.5
217	309	84	54	69	37	6214.5
218	310	88	59	73.5	41.5	6256
219	311	88	59	73.5	41.5	6297.5
220	312	91	61	76	44	6341.5
221	313	88	63	75.5	43.5	6385
222	314	89	56	72.5	40.5	6425.5
223	315	89	59	74	42	6467.5
224	316	85	60	72.5	40.5	6508
225	317	88	58	73	41	6549
226	318	89	61	75	43	6592
227	319	88	59	73.5	41.5	6633.5
228	320	87	58	72.5	40.5	6674
229	321	89	58	73.5	41.5	6715.5
230	322	93	62	77.5	45.5	6761
231	323	91	61	76	44	6805
232	324	89	61	75	43	6848
233	325	90	59	74.5	42.5	6890.5
234	326	86	60	73	41	6931.5
235	327	89	57	73	41	6972.5
236	328	88	57	72.5	40.5	7013
237	329	82	56	69	37	7050
238	330	84	58	71	39	7089
239	331	80	50	65	33	7122
240	332	84	48	66	34	7156
241	333	87	54	70.5	38.5	7194.5
242	334	88	57	72.5	40.5	7235
243	335	87	59	73	41	7276
244	336	88	57	72.5	40.5	7316.5
245	337	86	59	72.5	40.5	7357
246	338	83	52	67.5	35.5	7392.5
247	339	83	54	68.5	36.5	7429
248	340	81	55	68	36	7465
249	341	80	56	68	36	7501
250	342	68	51	59.5	27.5	7528.5
251	343	69	50	59.5	27.5	7556
252	344	76	49	62.5	30.5	7586.5
253	345	72	48	60	28	7614.5
254	346	78	49	63.5	31.5	7646
255	347	84	54	69	37	7683
256	348	82	54	68	36	7719
257	349	75	50	62.5	30.5	7749.5
258	350	72	50	61	29	7778.5
259	351	66	47	56.5	24.5	7803
260	352	63	38	50.5	18.5	7821.5
261	353	70	34	52	20	7841.5
262	354	75	41	58	26	7867.5
263	355	67	40	53.5	21.5	7889
264	356	65	36	50.5	18.5	7907.5
265	357	59	36	47.5	15.5	7923
266	358	59	32	45.5	13.5	7936.5
267	359	67	35	51	19	7955.5
268	360	73	42	57.5	25.5	7981
269	361	78	47	62.5	30.5	8011.5
270	362	78	47	62.5	30.5	8042
271	363	80	49	64.5	32.5	8074.5
272	364	80	49	64.5	32.5	8107
273	365	81	50	65.5	33.5	8140.5



64	1080		length of freeze (day)	15
79	1001		frost depth (^oF-day)	79
			average temperature	54.4

2006-2007

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	78	52	65	33	33
275	2	79	52	65.5	33.5	66.5
276	3	72	47	59.5	27.5	94
277	4	78	50	64	32	126
278	5	67	52	59.5	27.5	153.5
279	6	63	50	56.5	24.5	178
280	7	68	49	58.5	26.5	204.5
281	8	62	47	54.5	22.5	227
282	9	58	40	49	17	244
283	10	61	40	50.5	18.5	262.5
284	11	66	41	53.5	21.5	284
285	12	68	39	53.5	21.5	305.5
286	13	68	39	53.5	21.5	327
287	14	57	45	51	19	346
288	15	64	40	52	20	366
289	16	62	37	49.5	17.5	383.5
290	17	56	36	46	14	397.5
291	18	53	30	41.5	9.5	407
292	19	55	29	42	10	417
293	20	62	34	48	16	433
294	21	58	34	46	14	447
295	22	60	29	44.5	12.5	459.5
296	23	62	34	48	16	475.5
297	24	63	37	50	18	493.5
298	25	57	31	44	12	505.5
299	26	51	29	40	8	513.5
300	27	64	29	46.5	14.5	528
301	28	62	34	48	16	544
302	29	61	35	48	16	560
303	30	61	35	48	16	576

304	31	59	33	46	14	590
305	32	58	34	46	14	604
306	33	59	34	46.5	14.5	618.5
307	34	59	36	47.5	15.5	634
308	35	63	39	51	19	653
309	36	59	36	47.5	15.5	668.5
310	37	63	34	48.5	16.5	685
311	38	69	40	54.5	22.5	707.5
312	39	67	40	53.5	21.5	729
313	40	65	37	51	19	748
314	41	54	31	42.5	10.5	758.5
315	42	48	28	38	6	764.5
316	43	49	26	37.5	5.5	770
317	44	44	26	35	3	773
318	45	52	30	41	9	782
319	46	53	22	37.5	5.5	787.5
320	47	51	26	38.5	6.5	794
321	48	57	33	45	13	807
322	49	61	33	47	15	822
323	50	58	33	45.5	13.5	835.5
324	51	59	35	47	15	850.5
325	52	59	33	46	14	864.5
326	53	59	33	46	14	878.5
327	54	53	36	44.5	12.5	891
328	55	55	34	44.5	12.5	903.5
329	56	55	35	45	13	916.5
330	57	50	29	39.5	7.5	924
331	58	43	26	34.5	2.5	926.5
332	59	45	22	33.5	1.5	928
333	60	27	12	19.5	-12.5	915.5
334	61	36	6	21	-11	904.5
335	62	38	12	25	-7	897.5
336	63	35	14	24.5	-7.5	890
337	64	36	11	23.5	-8.5	881.5
338	65	42	15	28.5	-3.5	878
339	66	44	18	31	-1	877
340	67	50	22	36	4	881
341	68	50	25	37.5	5.5	886.5
342	69	50	26	38	6	892.5
343	70	47	26	36.5	4.5	897
344	71	41	26	33.5	1.5	898.5
345	72	46	26	36	4	902.5
346	73	42	21	31.5	-0.5	902
347	74	46	24	35	3	905
348	75	47	27	37	5	910
349	76	47	29	38	6	916
350	77	48	32	40	8	924
351	78	44	26	35	3	927
352	79	43	23	33	1	928
353	80	33	22	27.5	-4.5	923.5
354	81	38	19	28.5	-3.5	920
355	82	41	19	30	-2	918
356	83	36	19	27.5	-4.5	913.5
357	84	41	16	28.5	-3.5	910
358	85	47	19	33	1	911
359	86	42	17	29.5	-2.5	908.5
360	87	44	23	33.5	1.5	910
361	88	42	28	35	3	913
362	89	47	32	39.5	7.5	920.5
363	90	45	26	35.5	3.5	924
364	91	53	24	38.5	6.5	930.5
365	92	42	23	32.5	0.5	931
1	93	46	22	34	2	933
2	94	45	22	33.5	1.5	934.5
3	95	42	23	32.5	0.5	935
4	96	44	24	34	2	937
5	97	36	19	27.5	-4.5	932.5
6	98	31	11	21	-11	921.5
7	99	39	14	26.5	-5.5	916
8	100	49	17	33	1	917
9	101	47	23	35	3	920
10	102	45	24	34.5	2.5	922.5
11	103	53	29	41	9	931.5
12	104	42	26	34	2	933.5
13	105	28	21	24.5	-7.5	926
14	106	27	2	14.5	-17.5	908.5
15	107	30	1	15.5	-16.5	892
16	108	34	8	21	-11	881
17	109	35	10	22.5	-9.5	871.5
18	110	42	13	27.5	-4.5	867
19	111	43	15	29	-3	864
20	112	37	21	29	-3	861
21	113	32	19	25.5	-6.5	854.5
22	114	39	15	27	-5	849.5
23	115	41	18	29.5	-2.5	847
24	116	41	16	28.5	-3.5	843.5
25	117	45	20	32.5	0.5	844
26	118	45	20	32.5	0.5	844.5
27	119	43	23	33	1	845.5
28	120	46	24	35	3	848.5
29	121	46	22	34	2	850.5
30	122	42	21	31.5	-0.5	850
31	123	33	17	25	-7	843
32	124	31	11	21	-11	832
33	125	31	8	19.5	-12.5	819.5
34	126	39	13	26	-6	813.5
35	127	48	22	35	3	816.5
36	128	52	27	39.5	7.5	824
37	129	51	29	40	8	832
38	130	54	32	43	11	843
39	131	55	32	43.5	11.5	854.5
40	132	52	33	42.5	10.5	865
41	133	54	37	45.5	13.5	878.5
42	134	47	34	40.5	8.5	887
43	135	56	30	43	11	898
44	136	44	31	37.5	5.5	903.5
45	137	44	24	34	2	905.5
46	138	47	23	35	3	908.5
47	139	58	25	41.5	9.5	918

48	140	57	30	43.5	11.5	929.5
49	141	49	29	39	7	936.5
50	142	54	34	44	12	948.5
51	143	49	25	37	5	953.5
52	144	54	28	41	9	962.5
53	145	60	31	45.5	13.5	976
54	146	45	23	34	2	978
55	147	43	19	31	-1	977
56	148	44	20	32	0	977
57	149	54	24	39	7	984
58	150	52	29	40.5	8.5	992.5
59	151	39	19	29	-3	989.5
60	152	39	15	27	-5	984.5
61	153	40	14	27	-5	979.5
62	154	40	9	24.5	-7.5	972
63	155	50	19	34.5	2.5	974.5
64	156	60	28	44	12	986.5
65	157	57	31	44	12	998.5
66	158	62	31	46.5	14.5	1013
67	159	61	36	48.5	16.5	1029.5
68	160	62	34	48	16	1045.5
69	161	63	40	51.5	19.5	1065
70	162	65	34	49.5	17.5	1082.5
71	163	72	40	56	24	1106.5
72	164	77	42	59.5	27.5	1134
73	165	75	42	58.5	26.5	1160.5
74	166	72	45	58.5	26.5	1187
75	167	73	37	55	23	1210
76	168	76	42	59	27	1237
77	169	76	42	59	27	1264
78	170	72	43	57.5	25.5	1289.5
79	171	70	40	55	23	1312.5
80	172	65	44	54.5	22.5	1335
81	173	60	41	50.5	18.5	1353.5
82	174	58	40	49	17	1370.5
83	175	57	37	47	15	1385.5
84	176	63	37	50	18	1403.5
85	177	69	39	54	22	1425.5
86	178	67	36	51.5	19.5	1445
87	179	42	24	33	1	1446
88	180	42	21	31.5	-0.5	1445.5
89	181	54	21	37.5	5.5	1451
90	182	65	28	46.5	14.5	1465.5
91	183	71	38	54.5	22.5	1488
92	184	73	42	57.5	25.5	1513.5
93	185	75	40	57.5	25.5	1539
94	186	77	43	60	28	1567
95	187	74	47	60.5	28.5	1595.5
96	188	73	44	58.5	26.5	1622
97	189	70	47	58.5	26.5	1648.5
98	190	66	43	54.5	22.5	1671
99	191	64	37	50.5	18.5	1689.5
100	192	52	32	42	10	1699.5
101	193	52	26	39	7	1706.5
102	194	52	32	42	10	1716.5
103	195	58	32	45	13	1729.5
104	196	62	31	46.5	14.5	1744
105	197	67	41	54	22	1766
106	198	65	38	51.5	19.5	1785.5
107	199	65	35	50	18	1803.5
108	200	69	36	52.5	20.5	1824
109	201	56	24	40	8	1832
110	202	63	34	48.5	16.5	1848.5
111	203	59	38	48.5	16.5	1865
112	204	58	36	47	15	1880
113	205	49	34	41.5	9.5	1889.5
114	206	60	34	47	15	1904.5
115	207	68	41	54.5	22.5	1927
116	208	70	43	56.5	24.5	1951.5
117	209	78	45	61.5	29.5	1981
118	210	80	47	63.5	31.5	2012.5
119	211	81	50	65.5	33.5	2046
120	212	85	49	67	35	2081
121	213	83	50	66.5	34.5	2115.5
122	214	59	46	52.5	20.5	2136
123	215	69	44	56.5	24.5	2160.5
124	216	63	40	51.5	19.5	2180
125	217	45	32	38.5	6.5	2186.5
126	218	53	31	42	10	2196.5
127	219	67	33	50	18	2214.5
128	220	73	36	54.5	22.5	2237
129	221	78	43	60.5	28.5	2265.5
130	222	82	48	65	33	2298.5
131	223	85	52	68.5	36.5	2335
132	224	86	55	70.5	38.5	2373.5
133	225	85	59	72	40	2413.5
134	226	85	52	68.5	36.5	2450
135	227	84	50	67	35	2485
136	228	81	49	65	33	2518
137	229	79	46	62.5	30.5	2548.5
138	230	80	49	64.5	32.5	2581
139	231	83	50	66.5	34.5	2615.5
140	232	81	50	65.5	33.5	2649
141	233	79	50	64.5	32.5	2681.5
142	234	67	39	53	21	2702.5
143	235	57	38	47.5	15.5	2718
144	236	66	33	49.5	17.5	2735.5
145	237	77	46	61.5	29.5	2765
146	238	80	49	64.5	32.5	2797.5
147	239	85	53	69	37	2834.5
148	240	84	51	67.5	35.5	2870
149	241	84	52	68	36	2906
150	242	79	43	61	29	2935
151	243	85	48	66.5	34.5	2969.5
152	244	83	53	68	36	3005.5
153	245	86	56	71	39	3044.5
154	246	87	56	71.5	39.5	3084
155	247	88	59	73.5	41.5	3125.5
156	248	88	58	73	41	3166.5

157	249	72	46	59	27	3193.5
158	250	69	35	52	20	3213.5
159	251	79	47	63	31	3244.5
160	252	86	50	68	36	3280.5
161	253	88	53	70.5	38.5	3319
162	254	82	55	68.5	36.5	3355.5
163	255	77	49	63	31	3386.5
164	256	85	49	67	35	3421.5
165	257	92	57	74.5	42.5	3464
166	258	96	62	79	47	3511
167	259	97	63	80	48	3559
168	260	92	61	76.5	44.5	3603.5
169	261	92	59	75.5	43.5	3647
170	262	93	61	77	45	3692
171	263	95	63	79	47	3739
172	264	97	63	80	48	3787
173	265	96	62	79	47	3834
174	266	97	63	80	48	3882
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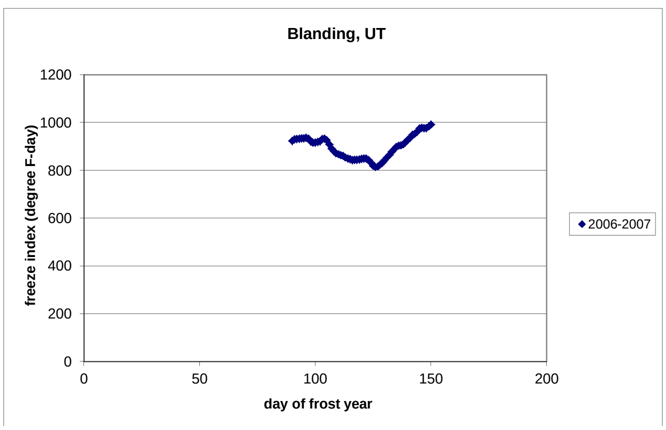
176	268	92	60	76	44	3972
177	269	95	60	77.5	45.5	4017.5
178	270	93	60	76.5	44.5	4062
179	271	93	62	77.5	45.5	4107.5
180	272	95	62	78.5	46.5	4154
181	273	95	63	79	47	4201
182	274	98	62	80	48	4249
183	275	100	51	75.5	43.5	4292.5
184	276	101	63	82	50	4342.5
185	277	100	64	82	50	4392.5
186	278	95	64	79.5	47.5	4440
187	279	93	65	79	47	4487
188	280	92	62	77	45	4532
189	281	97	64	80.5	48.5	4580.5
190	282	93	64	78.5	46.5	4627
191	283	99	65	82	50	4677
192	284	92	68	80	48	4725
193	285	87	63	75	43	4768
194	286	90	62	76	44	4812
195	287	96	60	78	46	4858
196	288	95	60	77.5	45.5	4903.5
197	289	97	61	79	47	4950.5
198	290	98	69	83.5	51.5	5002
199	291	97	67	82	50	5052
200	292	97	65	81	49	5101
201	293	90	61	75.5	43.5	5144.5
202	294	91	67	79	47	5191.5
203	295	92	63	77.5	45.5	5237
204	296	93	65	79	47	5284
205	297	93	62	77.5	45.5	5329.5
206	298	92	62	77	45	5374.5
207	299	88	64	76	44	5418.5
208	300	92	61	76.5	44.5	5463
209	301	87	59	73	41	5504
210	302	92	60	76	44	5548
211	303	89	60	74.5	42.5	5590.5
212	304	90	61	75.5	43.5	5634
213	305	93	64	78.5	46.5	5680.5
214	306	88	61	74.5	42.5	5723
215	307	84	63	73.5	41.5	5764.5
216	308	84	64	74	42	5806.5
217	309	85	62	73.5	41.5	5848
218	310	85	63	74	42	5890
219	311	88	59	73.5	41.5	5931.5
220	312	90	59	74.5	42.5	5974
221	313	93	63	78	46	6020
222	314	92	62	77	45	6065
223	315	95	61	78	46	6111
224	316	97	62	79.5	47.5	6158.5
225	317	97	66	81.5	49.5	6208
226	318	93	65	79	47	6255
227	319	89	62	75.5	43.5	6298.5
228	320	92	62	77	45	6343.5
229	321	91	64	77.5	45.5	6389
230	322	92	64	78	46	6435
231	323	95	64	79.5	47.5	6482.5
232	324	92	62	77	45	6527.5
233	325	95	61	78	46	6573.5
234	326	95	62	78.5	46.5	6620
235	327	93	57	75	43	6663
236	328	94	63	78.5	46.5	6709.5
237	329	95	64	79.5	47.5	6757
238	330	93	62	77.5	45.5	6802.5
239	331	74	57	65.5	33.5	6836
240	332	82	54	68	36	6872
241	333	90	59	74.5	42.5	6914.5
242	334	89	60	74.5	42.5	6957
243	335	92	63	77.5	45.5	7002.5
244	336	89	62	75.5	43.5	7046
245	337	90	59	74.5	42.5	7088.5
246	338	90	59	74.5	42.5	7131
247	339	88	59	73.5	41.5	7172.5
248	340	88	58	73	41	7213.5
249	341	88	61	74.5	42.5	7256
250	342	84	58	71	39	7295
251	343	88	57	72.5	40.5	7335.5
252	344	89	60	74.5	42.5	7378
253	345	84	60	72	40	7418
254	346	87	59	73	41	7459
255	347	88	55	71.5	39.5	7498.5
256	348	89	57	73	41	7539.5
257	349	87	60	73.5	41.5	7581
258	350	88	60	74	42	7623
259	351	78	59	68.5	36.5	7659.5
260	352	75	53	64	32	7691.5
261	353	75	48	61.5	29.5	7721
262	354	80	50	65	33	7754
263	355	80	55	67.5	35.5	7789.5
264	356	81	54	67.5	35.5	7825
265	357	80	55	67.5	35.5	7860.5



266	358	66	50	58	26	7886.5
267	359	64	44	54	22	7908.5
268	360	68	41	54.5	22.5	7931
269	361	72	44	58	26	7957
270	362	74	47	60.5	28.5	7985.5
271	363	74	53	63.5	31.5	8017
272	364	74	41	57.5	25.5	8042.5
273	365	66	32	49	17	8059.5

97	932.5	length of freeze (day)	30
127	816.5	frost depth (^oF-day)	116
		average temperature	54.1

2007-2008

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	67	46	56.5	24.5	24.5
275	2	67	44	55.5	23.5	48
276	3	72	45	58.5	26.5	74.5
277	4	78	49	63.5	31.5	106
278	5	72	52	62	30	136
279	6	64	48	56	24	160
280	7	57	32	44.5	12.5	172.5
281	8	67	33	50	18	190.5
282	9	75	45	60	28	218.5
283	10	77	53	65	33	251.5
284	11	75	50	62.5	30.5	282
285	12	71	50	60.5	28.5	310.5
286	13	67	47	57	25	335.5
287	14	66	40	53	21	356.5
288	15	66	40	53	21	377.5
289	16	67	44	55.5	23.5	401
290	17	59	40	49.5	17.5	418.5
291	18	60	33	46.5	14.5	433
292	19	66	39	52.5	20.5	453.5
293	20	71	44	57.5	25.5	479
294	21	56	31	43.5	11.5	490.5
295	22	58	32	45	13	503.5
296	23	63	36	49.5	17.5	521
297	24	68	38	53	21	542
298	25	71	38	54.5	22.5	564.5
299	26	73	44	58.5	26.5	591
300	27	71	44	57.5	25.5	616.5
301	28	71	44	57.5	25.5	642
302	29	68	47	57.5	25.5	667.5
303	30	71	44	57.5	25.5	693
304	31	66	43	54.5	22.5	715.5
305	32	64	42	53	21	736.5
306	33	64	40	52	20	756.5
307	34	66	36	51	19	775.5
308	35	64	37	50.5	18.5	794
309	36	68	37	52.5	20.5	814.5
310	37	65	40	52.5	20.5	835
311	38	68	40	54	22	857
312	39	67	44	55.5	23.5	880.5
313	40	67	43	55	23	903.5
314	41	65	45	55	23	926.5
315	42	61	40	50.5	18.5	945
316	43	67	43	55	23	968
317	44	64	40	52	20	988
318	45	66	42	54	22	1010
319	46	61	35	48	16	1026
320	47	64	37	50.5	18.5	1044.5
321	48	65	39	52	20	1064.5
322	49	62	40	51	19	1083.5
323	50	65	38	51.5	19.5	1103
324	51	61	41	51	19	1122
325	52	41	24	32.5	0.5	1122.5
326	53	42	19	30.5	-1.5	1121
327	54	41	30	35.5	3.5	1124.5
328	55	45	22	33.5	1.5	1126
329	56	44	20	32	0	1126
330	57	51	28	39.5	7.5	1133.5
331	58	47	24	35.5	3.5	1137
332	59	42	21	31.5	-0.5	1136.5
333	60	47	20	33.5	1.5	1138
334	61	45	32	38.5	6.5	1144.5
335	62	46	31	38.5	6.5	1151
336	63	41	26	33.5	1.5	1152.5
337	64	50	27	38.5	6.5	1159
338	65	50	28	39	7	1166
339	66	43	34	38.5	6.5	1172.5
340	67	43	32	37.5	5.5	1178
341	68	45	35	40	8	1186
342	69	40	25	32.5	0.5	1186.5
343	70	38	34	36	4	1190.5
344	71	36	27	31.5	-0.5	1190
345	72	33	19	26	-6	1184
346	73	36	17	26.5	-5.5	1178.5
347	74	32	20	26	-6	1172.5
348	75	34	12	23	-9	1163.5
349	76	31	10	20.5	-11.5	1152
350	77	33	15	24	-8	1144
351	78	41	17	29	-3	1141
352	79	37	23	30	-2	1139
353	80	38	25	31.5	-0.5	1138.5
354	81	38	24	31	-1	1137.5
355	82	35	26	30.5	-1.5	1136
356	83	32	14	23	-9	1127
357	84	40	17	28.5	-3.5	1123.5
358	85	39	19	29	-3	1120.5
359	86	33	21	27	-5	1115.5
360	87	30	12	21	-11	1104.5
361	88	26	11	18.5	-13.5	1091
362	89	26	7	16.5	-15.5	1075.5
363	90	30	11	20.5	-11.5	1064
364	91	37	16	26.5	-5.5	1058.5
365	92	30	12	21	-11	1047.5
1	93	32	9	20.5	-11.5	1036
2	94	40	14	27	-5	1031
3	95	41	22	31.5	-0.5	1030.5
4	96	42	32	37	5	1035.5

5	97	39	35	37	5	1040.5
6	98	41	29	35	3	1043.5
7	99	36	18	27	-5	1038.5
8	100	30	13	21.5	-10.5	1028
9	101	35	21	28	-4	1024
10	102	33	14	23.5	-8.5	1015.5
11	103	35	15	25	-7	1008.5
12	104	35	15	25	-7	1001.5
13	105	37	18	27.5	-4.5	997
14	106	38	18	28	-4	993
15	107	31	17	24	-8	985
16	108	27	6	16.5	-15.5	969.5
17	109	23	1	12	-20	949.5
18	110	32	8	20	-12	937.5
19	111	30	10	20	-12	925.5
20	112	35	12	23.5	-8.5	917
21	113	37	17	27	-5	912
22	114	38	20	29	-3	909
23	115	40	17	28.5	-3.5	905.5
24	116	35	26	30.5	-1.5	904
25	117	41	18	29.5	-2.5	901.5
26	118	41	20	30.5	-1.5	900
27	119	34	23	28.5	-3.5	896.5
28	120	38	18	28	-4	892.5
29	121	27	6	16.5	-15.5	877
30	122	32	15	23.5	-8.5	868.5
31	123	28	6	-	-	868.5
32	124	33	14	23.5	-8.5	860
33	125	33	20	26.5	-5.5	854.5
34	126	32	20	26	-6	848.5
35	127	39	17	28	-4	844.5
36	128	34	11	22.5	-9.5	835
37	129	30	10	20	-12	823
38	130	47	11	29	-3	820
39	131	43	20	31.5	-0.5	819.5
40	132	48	21	34.5	2.5	822
41	133	44	24	34	2	824
42	134	49	26	37.5	5.5	829.5
43	135	50	25	37.5	5.5	835
44	136	47	26	36.5	4.5	839.5
45	137	41	26	33.5	1.5	841
46	138	46	25	35.5	3.5	844.5
47	139	48	25	36.5	4.5	849
48	140	41	20	30.5	-1.5	847.5
49	141	47	20	33.5	1.5	849
50	142	45	24	34.5	2.5	851.5
51	143	40	30	35	3	854.5
52	144	43	31	37	5	859.5
53	145	36	30	33	1	860.5
54	146	45	30	37.5	5.5	866
55	147	42	30	36	4	870
56	148	49	30	39.5	7.5	877.5
57	149	51	29	40	8	885.5
58	150	50	27	38.5	6.5	892
59	151	58	34	46	14	906
60	152	59	32	45.5	13.5	919.5
61	153	60	34	47	15	934.5
62	154	46	26	36	4	938.5
63	155	44	24	34	2	940.5
64	156	51	25	38	6	946.5
65	157	41	22	31.5	-0.5	946
66	158	42	20	31	-1	945
67	159	48	21	34.5	2.5	947.5
68	160	52	32	42	10	957.5
69	161	52	28	40	8	965.5
70	162	53	30	41.5	9.5	975
71	163	59	27	43	11	986
72	164	59	33	46	14	1000
73	165	63	30	46.5	14.5	1014.5
74	166	54	32	43	11	1025.5
75	167	55	26	40.5	8.5	1034
76	168	49	29	39	7	1041
77	169	47	25	36	4	1045
78	170	54	27	40.5	8.5	1053.5
79	171	58	30	44	12	1065.5
80	172	62	34	48	16	1081.5
81	173	64	33	48.5	16.5	1098
82	174	56	33	44.5	12.5	1110.5
83	175	59	31	45	13	1123.5
84	176	63	32	47.5	15.5	1139
85	177	69	35	52	20	1159
86	178	69	38	53.5	21.5	1180.5
87	179	67	39	53	21	1201.5
88	180	63	33	48	16	1217.5
89	181	68	41	54.5	22.5	1240
90	182	65	36	50.5	18.5	1258.5
91	183	56	32	44	12	1270.5
92	184	59	25	42	10	1280.5
93	185	65	35	50	18	1298.5
94	186	59	36	47.5	15.5	1314
95	187	61	28	44.5	12.5	1326.5
96	188	64	37	50.5	18.5	1345
97	189	66	31	48.5	16.5	1361.5
98	190	63	39	51	19	1380.5
99	191	59	28	43.5	11.5	1392
100	192	53	32	42.5	10.5	1402.5
101	193	50	30	40	8	1410.5
102	194	50	28	39	7	1417.5
103	195	58	27	42.5	10.5	1428
104	196	67	37	52	20	1448
105	197	72	41	56.5	24.5	1472.5
106	198	76	43	59.5	27.5	1500
107	199	53	31	42	10	1510
108	200	55	30	42.5	10.5	1520.5
109	201	65	30	47.5	15.5	1536
110	202	73	41	57	25	1561
111	203	67	40	53.5	21.5	1582.5
112	204	67	35	51	19	1601.5
113	205	69	35	52	20	1621.5

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115	207	67	39	53	21	1667.5
116	208	61	29	45	13	1680.5
117	209	60	37	48.5	16.5	1697
118	210	67	35	51	19	1716
119	211	73	39	56	24	1740
120	212	78	45	61.5	29.5	1769.5
121	213	74	45	59.5	27.5	1797
122	214	50	30	40	8	1805
123	215	59	29	44	12	1817
124	216	64	38	51	19	1836
125	217	73	41	57	25	1861
126	218	76	42	59	27	1888
127	219	74	50	62	30	1918
128	220	79	44	61.5	29.5	1947.5
129	221	68	46	57	25	1972.5
130	222	78	43	60.5	28.5	2001
131	223	68	43	55.5	23.5	2024.5
132	224	78	41	59.5	27.5	2052
133	225	75	38	56.5	24.5	2076.5
134	226	56	37	46.5	14.5	2091
135	227	69	39	54	22	2113
136	228	67	43	55	23	2136
137	229	73	40	56.5	24.5	2160.5
138	230	80	43	61.5	29.5	2190
139	231	85	55	70	38	2228
140	232	90	58	74	42	2270
141	233	93	60	76.5	44.5	2314.5
142	234	77	41	59	27	2341.5
143	235	57	39	48	16	2357.5
144	236	50	37	43.5	11.5	2369
145	237	57	37	47	15	2384
146	238	67	43	55	23	2407
147	239	68	43	55.5	23.5	2430.5
148	240	72	42	57	25	2455.5
149	241	80	50	65	33	2488.5
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151	243	77	45	61	29	2545.5
152	244	87	53	70	38	2583.5
153	245	87	53	70	38	2621.5
154	246	86	55	70.5	38.5	2660
155	247	84	52	68	36	2696
156	248	70	42	56	24	2720
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159	251	83	50	66.5	34.5	2803
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162	254	87	52	69.5	37.5	2902.5
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164	256	75	42	58.5	26.5	2959
165	257	80	47	63.5	31.5	2990.5
166	258	88	53	70.5	38.5	3029
167	259	92	58	75	43	3072
168	260	93	61	77	45	3117
169	261	93	59	76	44	3161
170	262	94	62	78	46	3207
171	263	89	62	75.5	43.5	3250.5
172	264	90	61	75.5	43.5	3294
173	265	92	56	74	42	3336
174	266	94	63	78.5	46.5	3382.5
175	267	92	64	78	46	3428.5
176	268	92	62	77	45	3473.5
177	269	92	60	76	44	3517.5
178	270	90	61	75.5	43.5	3561
179	271	94	59	76.5	44.5	3605.5
180	272	94	62	78	46	3651.5
181	273	91	64	77.5	45.5	3697
182	274	87	59	73	41	3738
183	275	88	59	73.5	41.5	3779.5
184	276	91	61	76	44	3823.5
185	277	96	60	78	46	3869.5
186	278	95	66	80.5	48.5	3918
187	279	91	64	77.5	45.5	3963.5
188	280	88	59	73.5	41.5	4005
189	281	86	60	73	41	4046
190	282	92	61	76.5	44.5	4090.5
191	283	92	60	76	44	4134.5
192	284	93	64	78.5	46.5	4181
193	285	90	63	76.5	44.5	4225.5
194	286	91	61	76	44	4269.5
195	287	89	60	74.5	42.5	4312
196	288	86	60	73	41	4353
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198	290	93	65	79	47	4442.5
199	291	90	64	77	45	4487.5
200	292	92	64	78	46	4533.5
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202	294	92	67	79.5	47.5	4629
203	295	88	62	75	43	4672
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208	300	87	61	74	42	4893
209	301	86	61	73.5	41.5	4934.5
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213	305	97	65	81	49	5121.5
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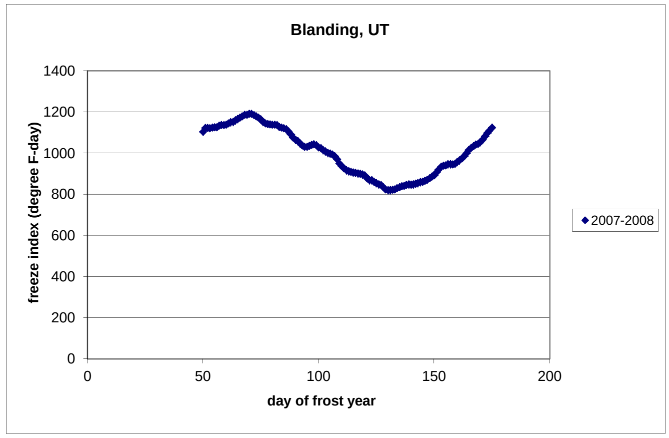
215	307	96	70	83	51	5222
216	308	97	67	82	50	5272
217	309	92	64	78	46	5318
218	310	90	64	77	45	5363
219	311	77	60	68.5	36.5	5399.5
220	312	84	60	72	40	5439.5
221	313	85	60	72.5	40.5	5480
222	314	83	59	71	39	5519

223	315	88	61	74.5	42.5	5561.5
224	316	93	62	77.5	45.5	5607
225	317	92	60	76	44	5651
226	318	91	65	78	46	5697
227	319	93	66	79.5	47.5	5744.5
228	320	88	65	76.5	44.5	5789
229	321	86	52	69	37	5826
230	322	82	53	67.5	35.5	5861.5
231	323	88	59	73.5	41.5	5903
232	324	90	58	74	42	5945
233	325	90	62	76	44	5989
234	326	91	60	75.5	43.5	6032.5
235	327	93	60	76.5	44.5	6077
236	328	94	62	78	46	6123
237	329	93	67	80	48	6171
238	330	89	59	74	42	6213
239	331	88	62	75	43	6256
240	332	93	59	76	44	6300
241	333	93	61	77	45	6345
242	334	91	64	77.5	45.5	6390.5
243	335	86	63	74.5	42.5	6433
244	336	75	57	66	34	6467
245	337	78	58	68	36	6503
246	338	78	48	63	31	6534
247	339	82	52	67	35	6569
248	340	85	55	70	38	6607
249	341	87	55	71	39	6646
250	342	86	53	69.5	37.5	6683.5
251	343	85	55	70	38	6721.5
252	344	87	58	72.5	40.5	6762
253	345	70	54	62	30	6792
254	346	71	52	61.5	29.5	6821.5
255	347	77	50	63.5	31.5	6853
256	348	76	47	61.5	29.5	6882.5
257	349	79	50	64.5	32.5	6915
258	350	81	57	69	37	6952
259	351	81	53	67	35	6987
260	352	80	56	68	36	7023
261	353	81	57	69	37	7060
262	354	80	52	66	34	7094
263	355	80	54	67	35	7129
264	356	82	53	67.5	35.5	7164.5
265	357	83	54	68.5	36.5	7201
266	358	81	54	67.5	35.5	7236.5
267	359	80	51	65.5	33.5	7270
268	360	83	51	67	35	7305
269	361	84	56	70	38	7343
270	362	85	57	71	39	7382
271	363	84	56	70	38	7420
272	364	83	56	69.5	37.5	7457.5
273	365	82	56	69	37	7494.5
274	366	81	52	66.5	34.5	7529



71	1190	length of freeze (day)	59
130	820	frost depth (^{o}F-day)	370
		average temperature	52.6

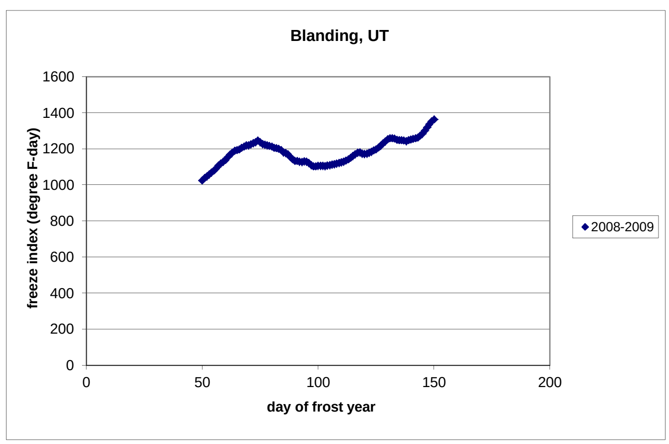
2008-2009

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	83	53	68	36	36
275	2	81	53	67	35	71
276	3	73	55	64	32	103
277	4	59	47	53	21	124
278	5	60	45	52.5	20.5	144.5
279	6	67	41	54	22	166.5
280	7	69	43	56	24	190.5
281	8	74	44	59	27	217.5
282	9	76	47	61.5	29.5	247
283	10	75	49	62	30	277
284	11	69	36	52.5	20.5	297.5
285	12	50	27	38.5	6.5	304
286	13	55	27	41	9	313
287	14	66	32	49	17	330
288	15	67	38	52.5	20.5	350.5
289	16	70	41	55.5	23.5	374
290	17	75	42	58.5	26.5	400.5
291	18	73	42	57.5	25.5	426
292	19	73	45	59	27	453
293	20	73	51	62	30	483
294	21	73	42	57.5	25.5	508.5
295	22	58	32	45	13	521.5
296	23	66	31	48.5	16.5	538
297	24	68	34	51	19	557
298	25	71	38	54.5	22.5	579.5
299	26	74	46	60	28	607.5
300	27	70	43	56.5	24.5	632
301	28	73	44	58.5	26.5	658.5
302	29	72	43	57.5	25.5	684
303	30	73	43	58	26	710
304	31	72	46	59	27	737
305	32	73	46	59.5	27.5	764.5
306	33	70	46	58	26	790.5
307	34	65	40	52.5	20.5	811
308	35	65	38	51.5	19.5	830.5
309	36	45	27	36	4	834.5
310	37	49	18	33.5	1.5	836
311	38	56	23	39.5	7.5	843.5
312	39	59	35	47	15	858.5
313	40	50	37	43.5	11.5	870
314	41	50	32	41	9	879
315	42	54	32	43	11	890
316	43	58	31	44.5	12.5	902.5
317	44	64	35	49.5	17.5	920
318	45	56	36	46	14	934
319	46	61	29	45	13	947
320	47	64	37	50.5	18.5	965.5
321	48	66	39	52.5	20.5	986
322	49	65	37	51	19	1005
323	50	64	38	51	19	1024
324	51	57	36	46.5	14.5	1038.5
325	52	53	30	41.5	9.5	1048

326	53	55	29	42	10	1058
327	54	56	30	43	11	1069
328	55	55	31	43	11	1080
329	56	54	35	44.5	12.5	1092.5
330	57	56	38	47	15	1107.5
331	58	50	35	42.5	10.5	1118
332	59	50	36	43	11	1129
333	60	54	30	42	10	1139
334	61	57	39	48	16	1155
335	62	55	34	44.5	12.5	1167.5
336	63	52	35	43.5	11.5	1179
337	64	53	31	42	10	1189
338	65	43	29	36	4	1193
339	66	48	24	36	4	1197
340	67	54	27	40.5	8.5	1205.5
341	68	50	30	40	8	1213.5
342	69	42	33	37.5	5.5	1219
343	70	41	26	33.5	1.5	1220.5
344	71	51	23	37	5	1225.5
345	72	51	28	39.5	7.5	1233
346	73	45	28	36.5	4.5	1237.5
347	74	50	32	41	9	1246.5
348	75	32	14	23	-9	1237.5
349	76	28	15	21.5	-10.5	1227
350	77	33	22	27.5	-4.5	1222.5
351	78	34	24	29	-3	1219.5
352	79	36	23	29.5	-2.5	1217
353	80	37	20	28.5	-3.5	1213.5
354	81	35	13	24	-8	1205.5
355	82	40	20	30	-2	1203.5
356	83	33	25	29	-3	1200.5
357	84	34	14	24	-8	1192.5
358	85	30	10	20	-12	1180.5
359	86	36	23	29.5	-2.5	1178
360	87	35	14	24.5	-7.5	1170.5
361	88	28	2	15	-17	1153.5
362	89	30	9	19.5	-12.5	1141
363	90	35	13	24	-8	1133
364	91	45	19	32	0	1133
365	92	33	22	27.5	-4.5	1128.5
1	93	42	21	31.5	-0.5	1128
2	94	48	24	36	4	1132
3	95	37	20	28.5	-3.5	1128.5
4	96	35	18	26.5	-5.5	1123
5	97	26	13	19.5	-12.5	1110.5
6	98	37	13	25	-7	1103.5
7	99	45	18	31.5	-0.5	1103
8	100	45	25	35	3	1106
9	101	40	25	32.5	0.5	1106.5
10	102	44	20	32	0	1106.5
11	103	42	19	30.5	-1.5	1105
12	104	47	23	35	3	1108
13	105	44	23	33.5	1.5	1109.5
14	106	48	23	35.5	3.5	1113
15	107	44	25	34.5	2.5	1115.5
16	108	45	25	35	3	1118.5
17	109	46	25	35.5	3.5	1122
18	110	45	25	35	3	1125
19	111	48	24	36	4	1129
20	112	51	25	38	6	1135
21	113	50	29	39.5	7.5	1142.5
22	114	49	33	41	9	1151.5
23	115	46	37	41.5	9.5	1161
24	116	48	36	42	10	1171
25	117	48	33	40.5	8.5	1179.5
26	118	43	22	32.5	0.5	1180
27	119	33	19	26	-6	1174
28	120	42	18	30	-2	1172
29	121	45	21	33	1	1173
30	122	50	25	37.5	5.5	1178.5
31	123	48	27	37.5	5.5	1184
32	124	51	28	39.5	7.5	1191.5
33	125	49	26	37.5	5.5	1197
34	126	55	30	42.5	10.5	1207.5
35	127	56	30	43	11	1218.5
36	128	56	31	43.5	11.5	1230
37	129	53	33	43	11	1241
38	130	58	32	45	13	1254
39	131	46	29	37.5	5.5	1259.5
40	132	40	24	32	0	1259.5
41	133	39	19	29	-3	1256.5
42	134	36	16	26	-6	1250.5
43	135	42	18	30	-2	1248.5
44	136	35	28	31.5	-0.5	1248
45	137	38	23	30.5	-1.5	1246.5
46	138	40	18	29	-3	1243.5
47	139	46	28	37	5	1248.5
48	140	44	28	36	4	1252.5
49	141	46	23	34.5	2.5	1255
50	142	48	22	35	3	1258
51	143	49	24	36.5	4.5	1262.5
52	144	57	27	42	10	1272.5
53	145	53	33	43	11	1283.5
54	146	59	42	50.5	18.5	1302
55	147	61	37	49	17	1319
56	148	63	36	49.5	17.5	1336.5
57	149	60	37	48.5	16.5	1353
58	150	54	30	42	10	1363
59	151	57	23	40	8	1371
60	152	59	32	45.5	13.5	1384.5
61	153	67	37	52	20	1404.5
62	154	69	45	57	25	1429.5
63	155	68	38	53	21	1450.5
64	156	59	32	45.5	13.5	1464
65	157	54	33	43.5	11.5	1475.5
66	158	47	31	39	7	1482.5
67	159	54	27	40.5	8.5	1491
68	160	58	32	45	13	1504
69	161	46	23	34.5	2.5	1506.5

70	162	59	24	41.5	9.5	1516
71	163	60	35	47.5	15.5	1531.5
72	164	57	32	44.5	12.5	1544
73	165	56	32	44	12	1556
74	166	60	29	44.5	12.5	1568.5
75	167	65	31	48	16	1584.5
76	168	68	37	52.5	20.5	1605
77	169	70	41	55.5	23.5	1628.5
78	170	72	41	56.5	24.5	1653
79	171	71	44	57.5	25.5	1678.5
80	172	70	42	56	24	1702.5
81	173	69	36	52.5	20.5	1723
82	174	52	26	39	7	1730
83	175	55	26	40.5	8.5	1738.5
84	176	57	27	42	10	1748.5
85	177	47	33	40	8	1756.5
86	178	48	22	35	3	1759.5
87	179	60	24	42	10	1769.5
88	180	66	25	45.5	13.5	1783
89	181	45	18	31.5	-0.5	1782.5
90	182	55	21	38	6	1788.5
91	183	48	32	40	8	1796.5
92	184	57	25	41	9	1805.5
93	185	64	-	-	-	1805.5
94	186	46	25	35.5	3.5	1809
95	187	54	20	37	5	1814
96	188	63	30	46.5	14.5	1828.5
97	189	68	35	51.5	19.5	1848
98	190	68	40	54	22	1870
99	191	65	30	47.5	15.5	1885.5
100	192	63	39	51	19	1904.5
101	193	53	33	43	11	1915.5
102	194	60	34	47	15	1930.5
103	195	67	39	53	21	1951.5
104	196	68	45	56.5	24.5	1976
105	197	59	29	44	12	1988
106	198	48	25	36.5	4.5	1992.5
107	199	55	33	44	12	2004.5
108	200	63	34	48.5	16.5	2021
109	201	71	41	56	24	2045
110	202	75	43	59	27	2072
111	203	78	46	62	30	2102
112	204	80	45	62.5	30.5	2132.5
113	205	80	42	61	29	2161.5
114	206	73	56	64.5	32.5	2194
115	207	69	40	54.5	22.5	2216.5
116	208	60	32	46	14	2230.5
117	209	65	33	49	17	2247.5
118	210	67	42	54.5	22.5	2270
119	211	74	40	57	25	2295
120	212	77	45	61	29	2324
121	213	79	48	63.5	31.5	2355.5
122	214	63	47	55	23	2378.5
123	215	71	47	59	27	2405.5
124	216	73	48	60.5	28.5	2434
125	217	79	49	64	32	2466
126	218	84	50	67	35	2501
127	219	84	52	68	36	2537
128	220	80	48	64	32	2569
129	221	80	45	62.5	30.5	2599.5
130	222	84	52	68	36	2635.5
131	223	85	51	68	36	2671.5
132	224	85	53	69	37	2708.5
133	225	80	52	66	34	2742.5
134	226	82	52	67	35	2777.5
135	227	82	54	68	36	2813.5
136	228	83	52	67.5	35.5	2849
137	229	85	51	68	36	2885
138	230	90	55	72.5	40.5	2925.5
139	231	82	60	71	39	2964.5
140	232	85	55	70	38	3002.5
141	233	77	52	64.5	32.5	3035
142	234	64	51	57.5	25.5	3060.5
143	235	60	51	55.5	23.5	3084
144	236	72	52	62	30	3114
145	237	68	48	58	26	3140
146	238	68	44	56	24	3164
147	239	75	48	61.5	29.5	3193.5
148	240	78	50	64	32	3225.5
149	241	79	52	65.5	33.5	3259
150	242	79	53	66	34	3293
151	243	79	51	65	33	3326
152	244	80	51	65.5	33.5	3359.5
153	245	77	56	66.5	34.5	3394
154	246	83	53	68	36	3430
155	247	83	55	69	37	3467
156	248	79	58	68.5	36.5	3503.5
157	249	73	51	62	30	3533.5
158	250	78	46	62	30	3563.5
159	251	76	49	62.5	30.5	3594
160	252	73	53	63	31	3625
161	253	71	51	61	29	3654
162	254	77	51	64	32	3686
163	255	79	49	64	32	3718
164	256	81	52	66.5	34.5	3752.5
165	257	82	51	66.5	34.5	3787
166	258	79	55	67	35	3822
167	259	79	56	67.5	35.5	3857.5
168	260	79	56	67.5	35.5	3893
169	261	78	48	63	31	3924
170	262	84	48	66	34	3958
171	263	71	57	64	32	3990
172	264	85	54	69.5	37.5	4027.5
173	265	86	55	70.5	38.5	4066
174	266	94	61	77.5	45.5	4111.5
175	267	90	62	76	44	4155.5
176	268	91	64	77.5	45.5	4201
177	269	80	59	69.5	37.5	4238.5
178	270	84	50	67	35	4273.5

179	271	90	52	71	39	4312.5
180	272	90	59	74.5	42.5	4355
181	273	94	62	78	46	4401
182	274	94	64	79	47	4448
183	275	87	66	76.5	44.5	4492.5
184	276	86	56	71	39	4531.5
185	277	90	63	76.5	44.5	4576
186	278	92	60	76	44	4620
187	279	95	66	80.5	48.5	4668.5
188	280	92	61	76.5	44.5	4713
189	281	94	63	78.5	46.5	4759.5
190	282	93	62	77.5	45.5	4805
191	283	95	63	79	47	4852
192	284	95	66	80.5	48.5	4900.5
193	285	96	68	82	50	4950.5
194	286	95	68	81.5	49.5	5000
195	287	96	65	80.5	48.5	5048.5
196	288	98	68	83	51	5099.5
197	289	96	66	81	49	5148.5
198	290	99	68	83.5	51.5	5200
199	291	99	69	84	52	5252
200	292	99	67	83	51	5303
201	293	95	67	81	49	5352
202	294	94	64	79	47	5399
203	295	91	58	74.5	42.5	5441.5
204	296	93	63	78	46	5487.5
205	297	96	65	80.5	48.5	5536
206	298	95	71	83	51	5587
207	299	88	60	74	42	5629
208	300	89	61	75	43	5672
209	301	91	64	77.5	45.5	5717.5
210	302	89	59	74	42	5759.5
211	303	87	57	72	40	5799.5
212	304	90	57	73.5	41.5	5841
213	305	92	64	78	46	5887
214	306	96	63	79.5	47.5	5934.5
215	307	95	65	80	48	5982.5
216	308	97	66	81.5	49.5	6032
217	309	93	67	80	48	6080
218	310	87	67	77	45	6125
219	311	88	60	74	42	6167
220	312	82	54	68	36	6203
221	313	86	53	69.5	37.5	6240.5
222	314	90	59	74.5	42.5	6283
223	315	93	59	76	44	6327
224	316	93	62	77.5	45.5	6372.5
225	317	87	67	77	45	6417.5
226	318	87	57	72	40	6457.5
227	319	88	57	72.5	40.5	6498
228	320	86	52	69	37	6535
229	321	88	57	72.5	40.5	6575.5
230	322	90	57	73.5	41.5	6617
231	323	90	56	73	41	6658
232	324	96	61	78.5	46.5	6704.5
233	325	95	61	78	46	6750.5
234	326	94	65	79.5	47.5	6798
235	327	85	61	73	41	6839
236	328	85	59	72	40	6879
237	329	85	58	71.5	39.5	6918.5
238	330	88	58	73	41	6959.5
239	331	89	64	76.5	44.5	7004
240	332	90	61	75.5	43.5	7047.5
241	333	92	62	77	45	7092.5
242	334	93	69	81	49	7141.5
243	335	91	62	76.5	44.5	7186
244	336	89	65	77	45	7231
245	337	89	64	76.5	44.5	7275.5
246	338	87	60	73.5	41.5	7317
247	339	87	60	73.5	41.5	7358.5
248	340	77	60	68.5	36.5	7395
249	341	83	54	68.5	36.5	7431.5
250	342	86	57	71.5	39.5	7471
251	343	88	56	72	40	7511
252	344	89	59	74	42	7553
253	345	81	60	70.5	38.5	7591.5
254	346	88	59	73.5	41.5	7633
255	347	85	55	70	38	7671
256	348	80	58	69	37	7708
257	349	79	54	66.5	34.5	7742.5
258	350	69	54	61.5	29.5	7772
259	351	74	52	63	31	7803
260	352	73	52	62.5	30.5	7833.5
261	353	78	53	65.5	33.5	7867
262	354	75	52	63.5	31.5	7898.5
263	355	79	52	65.5	33.5	7932
264	356	68	49	58.5	26.5	7958.5
265	357	68	40	54	22	7980.5
266	358	71	46	58.5	26.5	8007
267	359	73	43	58	26	8033
268	360	80	48	64	32	8065
269	361	85	52	68.5	36.5	8101.5
270	362	88	54	71	39	8140.5
271	363	85	54	69.5	37.5	8178
272	364	84	52	68	36	8214
273	365	72	43	57.5	25.5	8239.5



74	1246.5	length of freeze (day)	25
99	1103	frost depth (^{o}F-day)	143.5
		average temperature	54.6

2009-2010

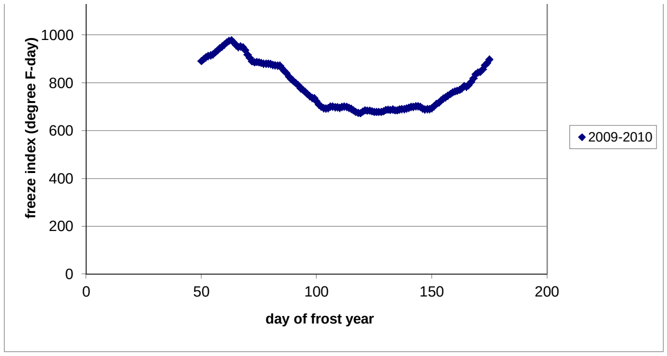
day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	60	33	46.5	14.5	14.5
275	2	66	36	51	19	33.5
276	3	69	41	55	23	56.5
277	4	66	49	57.5	25.5	82
278	5	62	39	50.5	18.5	100.5
279	6	64	31	47.5	15.5	116
280	7	62	42	52	20	136
281	8	67	38	52.5	20.5	156.5
282	9	67	38	52.5	20.5	177

283	10	68	36	52	20	197
284	11	70	42	56	24	221
285	12	66	41	53.5	21.5	242.5
286	13	66	45	55.5	23.5	266
287	14	71	47	59	27	293
288	15	73	43	58	26	319
289	16	78	44	61	29	348
290	17	75	44	59.5	27.5	375.5
291	18	77	48	62.5	30.5	406
292	19	78	49	63.5	31.5	437.5
293	20	64	45	54.5	22.5	460
294	21	64	41	52.5	20.5	480.5
295	22	63	36	49.5	17.5	498
296	23	64	39	51.5	19.5	517.5
297	24	67	41	54	22	539.5
298	25	60	36	48	16	555.5
299	26	57	31	44	12	567.5
300	27	55	34	44.5	12.5	580
301	28	37	26	31.5	-0.5	579.5
302	29	37	29	33	1	580.5
303	30	47	21	34	2	582.5
304	31	58	31	44.5	12.5	595
305	32	60	34	47	15	610
306	33	65	38	51.5	19.5	629.5
307	34	65	39	52	20	649.5
308	35	69	39	54	22	671.5
309	36	70	43	56.5	24.5	696
310	37	68	45	56.5	24.5	720.5
311	38	68	41	54.5	22.5	743
312	39	65	39	52	20	763
313	40	64	38	51	19	782
314	41	66	40	53	21	803
315	42	62	44	53	21	824
316	43	62	43	52.5	20.5	844.5
317	44	53	41	47	15	859.5
318	45	43	29	36	4	863.5
319	46	44	29	36.5	4.5	868
320	47	46	21	33.5	1.5	869.5
321	48	47	25	36	4	873.5
322	49	51	27	39	7	880.5
323	50	58	29	43.5	11.5	892
324	51	51	29	40	8	900
325	52	55	23	39	7	907
326	53	49	27	38	6	913
327	54	45	23	34	2	915
328	55	50	22	36	4	919
329	56	55	25	40	8	927
330	57	53	27	40	8	935
331	58	57	28	42.5	10.5	945.5
332	59	52	28	40	8	953.5
333	60	49	31	40	8	961.5
334	61	48	30	39	7	968.5
335	62	52	27	39.5	7.5	976
336	63	48	22	35	3	979
337	64	33	12	22.5	-9.5	969.5
338	65	33	10	21.5	-10.5	959
339	66	33	15	24	-8	951
340	67	38	29	33.5	1.5	952.5
341	68	33	24	28.5	-3.5	949
342	69	31	9	20	-12	937
343	70	25	1	13	-19	918
344	71	31	6	18.5	-13.5	904.5
345	72	34	2	18	-14	890.5
346	73	32	23	27.5	-4.5	886
347	74	37	31	34	2	888
348	75	40	19	29.5	-2.5	885.5
349	76	40	19	29.5	-2.5	883
350	77	40	20	30	-2	881
351	78	43	20	31.5	-0.5	880.5
352	79	41	24	32.5	0.5	881
353	80	43	18	30.5	-1.5	879.5
354	81	37	19	28	-4	875.5
355	82	39	23	31	-1	874.5
356	83	33	28	30.5	-1.5	873
357	84	43	20	31.5	-0.5	872.5
358	85	30	11	20.5	-11.5	861
359	86	35	7	21	-11	850
360	87	35	10	22.5	-9.5	840.5
361	88	26	9	17.5	-14.5	826
362	89	33	9	21	-11	815
363	90	30	19	24.5	-7.5	807.5
364	91	28	20	24	-8	799.5
365	92	35	11	23	-9	790.5
1	93	27	12	19.5	-12.5	778
2	94	36	14	25	-7	771
3	95	35	14	24.5	-7.5	763.5
4	96	28	16	22	-10	753.5
5	97	33	14	23.5	-8.5	745
6	98	35	15	25	-7	738
7	99	39	20	29.5	-2.5	735.5
8	100	28	10	19	-13	722.5
9	101	30	9	19.5	-12.5	710
10	102	34	12	23	-9	701
11	103	35	16	25.5	-6.5	694.5
12	104	43	19	31	-1	693.5
13	105	43	23	33	1	694.5
14	106	46	31	38.5	6.5	701
15	107	44	21	32.5	0.5	701.5
16	108	38	21	29.5	-2.5	699
17	109	39	25	32	0	699
18	110	34	25	29.5	-2.5	696.5
19	111	40	31	35.5	3.5	700
20	112	38	28	33	1	701
21	113	34	27	30.5	-1.5	699.5
22	114	33	25	29	-3	696.5
23	115	37	18	27.5	-4.5	692
24	116	37	13	25	-7	685
25	117	37	13	25	-7	678
26	118	42	16	29	-3	675

27	119	40	21	30.5	-1.5	673.5
28	120	44	32	38	6	679.5
29	121	44	31	37.5	5.5	685
30	122	37	24	30.5	-1.5	683.5
31	123	38	26	32	0	683.5
32	124	40	19	29.5	-2.5	681
33	125	41	18	29.5	-2.5	678.5
34	126	41	22	31.5	-0.5	678
35	127	42	23	32.5	0.5	678.5
36	128	37	27	32	0	678.5
37	129	40	30	35	3	681.5
38	130	45	30	37.5	5.5	687
39	131	37	28	32.5	0.5	687.5
40	132	40	22	31	-1	686.5
41	133	42	28	35	3	689.5
42	134	38	18	28	-4	685.5
43	135	43	20	31.5	-0.5	685
44	136	47	25	36	4	689
45	137	44	24	34	2	691
46	138	43	21	32	0	691
47	139	45	24	34.5	2.5	693.5
48	140	45	24	34.5	2.5	696
49	141	46	25	35.5	3.5	699.5
50	142	40	26	33	1	700.5
51	143	40	29	34.5	2.5	703
52	144	35	27	31	-1	702
53	145	38	21	29.5	-2.5	699.5
54	146	39	13	26	-6	693.5
55	147	36	20	28	-4	689.5
56	148	43	22	32.5	0.5	690
57	149	44	22	33	1	691
58	150	43	29	36	4	695
59	151	48	32	40	8	703
60	152	52	29	40.5	8.5	711.5
61	153	48	28	38	6	717.5
62	154	51	32	41.5	9.5	727
63	155	50	30	40	8	735
64	156	46	27	36.5	4.5	739.5
65	157	50	29	39.5	7.5	747
66	158	43	34	38.5	6.5	753.5
67	159	45	32	38.5	6.5	760
68	160	42	30	36	4	764
69	161	42	27	34.5	2.5	766.5
70	162	46	26	36	4	770.5
71	163	53	24	38.5	6.5	777
72	164	53	30	41.5	9.5	786.5
73	165	35	25	30	-2	784.5
74	166	53	24	38.5	6.5	791
75	167	59	31	45	13	804
76	168	62	33	47.5	15.5	819.5
77	169	62	36	49	17	836.5
78	170	47	30	38.5	6.5	843
79	171	48	23	35.5	3.5	846.5
80	172	59	25	42	10	856.5
81	173	62	36	49	17	873.5
82	174	52	33	42.5	10.5	884
83	175	55	37	46	14	898
84	176	55	29	42	10	908
85	177	45	32	38.5	6.5	914.5
86	178	51	30	40.5	8.5	923
87	179	60	28	44	12	935
88	180	63	34	48.5	16.5	951.5
89	181	74	39	56.5	24.5	976
90	182	65	42	53.5	21.5	997.5
91	183	41	25	33	1	998.5
92	184	47	25	36	4	1002.5
93	185	55	28	41.5	9.5	1012
94	186	65	31	48	16	1028
95	187	68	37	52.5	20.5	1048.5
96	188	48	25	36.5	4.5	1053
97	189	55	28	41.5	9.5	1062.5
98	190	58	29	43.5	11.5	1074
99	191	68	36	52	20	1094
100	192	69	40	54.5	22.5	1116.5
101	193	70	39	54.5	22.5	1139
102	194	72	41	-	-	1139
103	195	56	33	44.5	12.5	1151.5
104	196	65	33	49	17	1168.5
105	197	71	41	56	24	1192.5
106	198	75	45	60	28	1220.5
107	199	70	46	58	26	1246.5
108	200	75	45	60	28	1274.5
109	201	74	46	60	28	1302.5
110	202	70	49	59.5	27.5	1330
111	203	68	36	52	20	1350
112	204	54	37	45.5	13.5	1363.5
113	205	55	32	43.5	11.5	1375
114	206	65	42	53.5	21.5	1396.5
115	207	72	41	56.5	24.5	1421
116	208	67	40	53.5	21.5	1442.5
117	209	75	40	57.5	25.5	1468
118	210	76	46	61	29	1497
119	211	58	32	45	13	1510
120	212	53	29	41	9	1519
121	213	57	29	43	11	1530
122	214	57	32	44.5	12.5	1542.5
123	215	64	31	47.5	15.5	1558
124	216	75	39	57	25	1583
125	217	77	45	61	29	1612
126	218	73	44	58.5	26.5	1638.5
127	219	63	33	48	16	1654.5
128	220	75	41	58	26	1680.5
129	221	79	47	63	31	1711.5
130	222	61	43	52	20	1731.5
131	223	58	33	45.5	13.5	1745
132	224	60	32	46	14	1759
133	225	61	39	50	18	1777
134	226	66	45	55.5	23.5	1800.5
135	227	67	37	52	20	1820.5

136	228	75	41	58	26	1846.5
137	229	80	53	66.5	34.5	1881
138	230	65	45	55	23	1904
139	231	73	41	57	25	1929
140	232	76	42	59	27	1956
141	233	83	50	66.5	34.5	1990.5
142	234	76	54	65	33	2023.5
143	235	70	45	57.5	25.5	2049
144	236	60	35	47.5	15.5	2064.5
145	237	71	42	56.5	24.5	2089
146	238	80	48	64	32	2121
147	239	85	49	67	35	2156
148	240	86	52	69	37	2193
149	241	74	50	62	30	2223
150	242	76	42	59	27	2250
151	243	82	49	65.5	33.5	2283.5
152	244	80	52	66	34	2317.5
153	245	83	57	70	38	2355.5
154	246	85	55	70	38	2393.5
155	247	89	57	73	41	2434.5
156	248	95	61	78	46	2480.5
157	249	97	64	80.5	48.5	2529
158	250	93	61	77	45	2574
159	251	92	61	76.5	44.5	2618.5
160	252	92	62	77	45	2663.5
161	253	89	59	74	42	2705.5
162	254	77	53	65	33	2738.5
163	255	68	48	58	26	2764.5
164	256	64	43	53.5	21.5	2786
165	257	77	46	61.5	29.5	2815.5
166	258	80	48	64	32	2847.5
167	259	87	56	71.5	39.5	2887
168	260	84	49	66.5	34.5	2921.5
169	261	87	56	71.5	39.5	2961
170	262	88	55	71.5	39.5	3000.5
171	263	88	53	70.5	38.5	3039
172	264	89	54	71.5	39.5	3078.5
173	265	86	53	69.5	37.5	3116
174	266	90	55	72.5	40.5	3156.5
175	267	93	58	75.5	43.5	3200
176	268	90	62	76	44	3244
177	269	89	61	75	43	3287
178	270	91	61	76	44	3331
179	271	91	61	76	44	3375
180	272	88	62	75	43	3418
181	273	87	63	75	43	3461
182	274	89	63	76	44	3505
183	275	84	64	74	42	3547
184	276	89	59	74	42	3589
185	277	86	57	71.5	39.5	3628.5
186	278	85	48	66.5	34.5	3663
187	279	91	58	74.5	42.5	3705.5
188	280	91	61	76	44	3749.5
189	281	90	63	76.5	44.5	3794
190	282	89	63	76	44	3838
191	283	89	62	75.5	43.5	3881.5
192	284	94	64	79	47	3928.5
193	285	95	59	77	45	3973.5
194	286	97	63	80	48	4021.5
195	287	95	65	80	48	4069.5
196	288	96	65	80.5	48.5	4118
197	289	98	68	83	51	4169
198	290	100	68	84	52	4221
199	291	99	70	84.5	52.5	4273.5
200	292	100	68	84	52	4325.5
201	293	95	63	79	47	4372.5
202	294	85	63	74	42	4414.5
203	295	84	63	73.5	41.5	4456
204	296	85	61	73	41	4497
205	297	90	59	74.5	42.5	4539.5
206	298	90	59	74.5	42.5	4582
207	299	86	61	73.5	41.5	4623.5
208	300	89	63	76	44	4667.5
209	301	89	65	77	45	4712.5
210	302	87	63	75	43	4755.5
211	303	90	64	77	45	4800.5
212	304	81	63	72	40	4840.5
213	305	78	61	69.5	37.5	4878
214	306	73	63	68	36	4914
215	307	85	59	72	40	4954
216	308	86	62	74	42	4996
217	309	80	57	68.5	36.5	5032.5
218	310	87	61	74	42	5074.5
219	311	75	58	66.5	34.5	5109
220	312	80	56	68	36	5145
221	313	83	59	71	39	5184
222	314	86	59	72.5	40.5	5224.5
223	315	83	61	72	40	5264.5
224	316	89	60	74.5	42.5	5307
225	317	89	57	73	41	5348
226	318	90	57	73.5	41.5	5389.5
227	319	94	62	78	46	5435.5
228	320	89	64	76.5	44.5	5480
229	321	88	58	73	41	5521
230	322	84	64	74	42	5563
231	323	86	58	72	40	5603
232	324	85	52	68.5	36.5	5639.5
233	325	87	62	74.5	42.5	5682
234	326	88	62	75	43	5725
235	327	85	63	74	42	5767
236	328	88	61	74.5	42.5	5809.5
237	329	86	58	72	40	5849.5
238	330	90	60	75	43	5892.5
239	331	88	60	74	42	5934.5
240	332	80	61	70.5	38.5	5973
241	333	82	55	68.5	36.5	6009.5
242	334	80	55	67.5	35.5	6045
243	335	81	53	67	35	6080
244	336	86	52	69	37	6117

245	337	89	61	75	43	6160
246	338	88	57	72.5	40.5	6200.5
247	339	91	59	75	43	6243.5
248	340	90	56	73	41	6284.5
249	341	85	59	72	40	6324.5
250	342	80	56	68	36	6360.5
251	343	73	55	64	32	6392.5
252	344	75	54	64.5	32.5	6425
253	345	77	49	63	31	6456
254	346	78	52	65	33	6489
255	347	82	54	68	36	6525
256	348	85	57	71	39	6564
257	349	86	55	70.5	38.5	6602.5
258	350	84	56	70	38	6640.5
259	351	86	56	71	39	6679.5
260	352	88	57	72.5	40.5	6720
261	353	87	54	70.5	38.5	6758.5
262	354	89	57	73	41	6799.5
263	355	87	59	73	41	6840.5
264	356	86	56	71	39	6879.5
265	357	64	52	58	26	6905.5
266	358	72	49	60.5	28.5	6934
267	359	76	49	62.5	30.5	6964.5
268	360	83	54	68.5	36.5	7001
269	361	83	54	68.5	36.5	7037.5
270	362	89	59	74	42	7079.5
271	363	87	55	71	39	7118.5
272	364	89	57	73	41	7159.5
273	365	87	56	71.5	39.5	7199



63	979	length of freeze (day)	56
119	673.5	frost depth (°F-day)	305.5
		average temperature	51.8

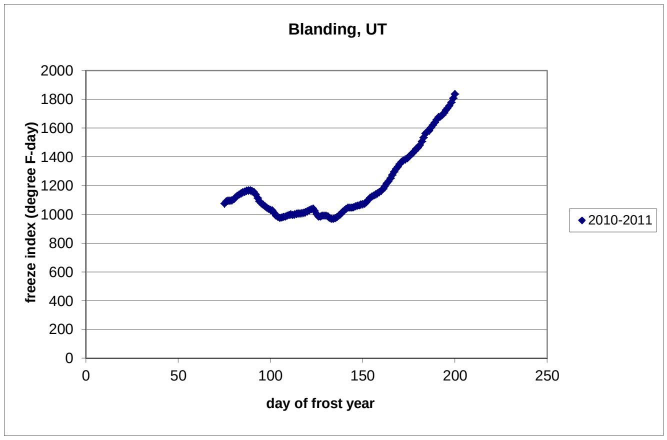
2010-2011

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (°F)	cumulative degree day (°F)
274	1	88	54	71	39	39
275	2	85	54	69.5	37.5	76.5
276	3	80	55	67.5	35.5	112
277	4	75	50	62.5	30.5	142.5
278	5	69	52	60.5	28.5	171
279	6	68	49	58.5	26.5	197.5
280	7	75	51	63	31	228.5
281	8	67	41	54	22	250.5
282	9	67	42	54.5	22.5	273
283	10	69	45	57	25	298
284	11	75	46	60.5	28.5	326.5
285	12	78	47	62.5	30.5	357
286	13	73	44	58.5	26.5	383.5
287	14	74	44	59	27	410.5
288	15	75	48	61.5	29.5	440
289	16	77	47	62	30	470
290	17	73	47	60	28	498
291	18	67	48	57.5	25.5	523.5
292	19	71	47	59	27	550.5
293	20	75	46	60.5	28.5	579
294	21	57	44	50.5	18.5	597.5
295	22	52	43	47.5	15.5	613
296	23	60	48	54	22	635
297	24	58	41	49.5	17.5	652.5
298	25	51	32	41.5	9.5	662
299	26	53	27	40	8	670
300	27	50	30	40	8	678
301	28	57	29	43	11	689
302	29	65	37	51	19	708
303	30	68	40	54	22	730
304	31	60	36	48	16	746
305	32	64	38	51	19	765
306	33	64	38	51	19	784
307	34	72	34	53	21	805
308	35	67	40	53.5	21.5	826.5
309	36	67	41	54	22	848.5
310	37	68	41	54.5	22.5	871
311	38	68	38	53	21	892
312	39	56	40	48	16	908
313	40	49	26	37.5	5.5	913.5
314	41	47	25	36	4	917.5
315	42	48	25	36.5	4.5	922
316	43	49	22	35.5	3.5	925.5
317	44	50	25	37.5	5.5	931
318	45	51	23	37	5	936
319	46	50	30	40	8	944
320	47	55	27	41	9	953
321	48	50	29	39.5	7.5	960.5
322	49	54	27	40.5	8.5	969
323	50	52	33	42.5	10.5	979.5
324	51	56	36	46	14	993.5
325	52	47	25	36	4	997.5
326	53	41	21	31	-1	996.5
327	54	43	21	32	0	996.5
328	55	30	10	20	-12	984.5
329	56	35	5	20	-12	972.5
330	57	40	14	27	-5	967.5
331	58	45	18	31.5	-0.5	967
332	59	37	25	31	-1	966
333	60	37	19	28	-4	962
334	61	38	13	25.5	-6.5	955.5
335	62	44	22	33	1	956.5
336	63	50	25	37.5	5.5	962
337	64	50	33	41.5	9.5	971.5
338	65	54	35	44.5	12.5	984
339	66	54	33	43.5	11.5	995.5
340	67	51	33	42	10	1005.5
341	68	53	29	41	9	1014.5
342	69	48	26	37	5	1019.5
343	70	50	28	39	7	1026.5
344	71	50	31	40.5	8.5	1035
345	72	53	32	42.5	10.5	1045.5
346	73	54	32	43	11	1056.5
347	74	55	32	43.5	11.5	1068
348	75	53	29	41	9	1077

349	76	55	37	46	14	1091
350	77	42	32	37	5	1096
351	78	41	24	32.5	0.5	1096.5
352	79	36	30	33	1	1097.5
353	80	45	32	38.5	6.5	1104
354	81	50	41	45.5	13.5	1117.5
355	82	49	39	44	12	1129.5
356	83	45	38	41.5	9.5	1139
357	84	42	37	39.5	7.5	1146.5
358	85	45	32	38.5	6.5	1153
359	86	45	30	37.5	5.5	1158.5
360	87	45	30	37.5	5.5	1164
361	88	45	26	35.5	3.5	1167.5
362	89	41	22	31.5	-0.5	1167
363	90	32	25	28.5	-3.5	1163.5
364	91	31	20	25.5	-6.5	1157
365	92	24	2	13	-19	1138
1	93	18	-3	7.5	-24.5	1113.5
2	94	19	-1	9	-23	1090.5
3	95	30	10	20	-12	1078.5
4	96	30	12	21	-11	1067.5
5	97	33	10	21.5	-10.5	1057
6	98	32	11	21.5	-10.5	1046.5
7	99	33	13	23	-9	1037.5
8	100	35	16	25.5	-6.5	1031
9	101	36	18	27	-5	1026
10	102	30	5	17.5	-14.5	1011.5
11	103	20	2	11	-21	990.5
12	104	34	12	23	-9	981.5
13	105	35	17	26	-6	975.5
14	106	50	20	35	3	978.5
15	107	46	24	35	3	981.5
16	108	46	24	35	3	984.5
17	109	49	30	39.5	7.5	992
18	110	44	28	36	4	996
19	111	45	28	36.5	4.5	1000.5
20	112	41	16	28.5	-3.5	997
21	113	47	22	34.5	2.5	999.5
22	114	49	26	37.5	5.5	1005
23	115	45	21	33	1	1006
24	116	45	23	34	2	1008
25	117	43	22	32.5	0.5	1008.5
26	118	47	23	35	3	1011.5
27	119	52	23	37.5	5.5	1017
28	120	49	25	37	5	1022
29	121	52	28	40	8	1030
30	122	47	30	38.5	6.5	1036.5
31	123	43	29	36	4	1040.5
32	124	27	5	16	-16	1024.5
33	125	20	1	10.5	-21.5	1003
34	126	28	0	14	-18	985
35	127	50	15	32.5	0.5	985.5
36	128	48	26	37	5	990.5
37	129	40	24	32	0	990.5
38	130	44	23	33.5	1.5	992
39	131	35	17	26	-6	986
40	132	35	10	22.5	-9.5	976.5
41	133	40	10	25	-7	969.5
42	134	47	17	32	0	969.5
43	135	49	23	36	4	973.5
44	136	53	26	39.5	7.5	981
45	137	57	29	43	11	992
46	138	55	32	43.5	11.5	1003.5
47	139	57	35	46	14	1017.5
48	140	53	35	44	12	1029.5
49	141	52	31	41.5	9.5	1039
50	142	53	29	41	9	1048
51	143	39	21	30	-2	1046
52	144	41	25	33	1	1047
53	145	45	25	35	3	1050
54	146	49	25	37	5	1055
55	147	49	24	36.5	4.5	1059.5
56	148	43	28	35.5	3.5	1063
57	149	45	33	39	7	1070
58	150	43	26	34.5	2.5	1072.5
59	151	48	23	35.5	3.5	1076
60	152	56	30	43	11	1087
61	153	59	34	46.5	14.5	1101.5
62	154	59	34	46.5	14.5	1116
63	155	50	31	40.5	8.5	1124.5
64	156	53	26	39.5	7.5	1132
65	157	47	32	39.5	7.5	1139.5
66	158	49	32	40.5	8.5	1148
67	159	50	29	39.5	7.5	1155.5
68	160	56	26	41	9	1164.5
69	161	58	33	45.5	13.5	1178
70	162	65	36	50.5	18.5	1196.5
71	163	66	37	51.5	19.5	1216
72	164	62	35	48.5	16.5	1232.5
73	165	67	37	52	20	1252.5
74	166	67	40	53.5	21.5	1274
75	167	68	40	54	22	1296
76	168	65	40	52.5	20.5	1316.5
77	169	61	32	46.5	14.5	1331
78	170	64	37	50.5	18.5	1349.5
79	171	60	35	47.5	15.5	1365
80	172	57	31	44	12	1377
81	173	49	28	38.5	6.5	1383.5
82	174	52	25	38.5	6.5	1390
83	175	54	32	43	11	1401
84	176	58	33	45.5	13.5	1414.5
85	177	53	38	45.5	13.5	1428
86	178	57	32	44.5	12.5	1440.5
87	179	62	35	48.5	16.5	1457
88	180	57	24	40.5	8.5	1465.5
89	181	60	38	49	17	1482.5
90	182	71	41	56	24	1506.5
91	183	78	42	60	28	1534.5
92	184	77	44	60.5	28.5	1563

93	185	61	30	45.5	13.5	1576.5
94	186	53	23	38	6	1582.5
95	187	70	33	51.5	19.5	1602
96	188	60	41	50.5	18.5	1620.5
97	189	61	38	49.5	17.5	1638
98	190	62	42	52	20	1658
99	191	58	41	49.5	17.5	1675.5
100	192	49	20	34.5	2.5	1678
101	193	59	27	43	11	1689
102	194	62	33	47.5	15.5	1704.5
103	195	68	38	53	21	1725.5
104	196	58	33	45.5	13.5	1739
105	197	65	32	48.5	16.5	1755.5
106	198	73	38	55.5	23.5	1779
107	199	78	43	60.5	28.5	1807.5
108	200	73	49	61	29	1836.5
109	201	68	39	53.5	21.5	1858
110	202	72	43	57.5	25.5	1883.5
111	203	73	47	60	28	1911.5
112	204	68	37	52.5	20.5	1932
113	205	62	45	53.5	21.5	1953.5
114	206	57	41	49	17	1970.5
115	207	59	33	46	14	1984.5
116	208	53	32	42.5	10.5	1995
117	209	57	29	43	11	2006
118	210	65	34	49.5	17.5	2023.5
119	211	70	33	51.5	19.5	2043
120	212	50	27	38.5	6.5	2049.5
121	213	53	28	40.5	8.5	2058
122	214	61	32	46.5	14.5	2072.5
123	215	68	35	51.5	19.5	2092
124	216	74	37	55.5	23.5	2115.5
125	217	75	37	56	24	2139.5
126	218	82	45	63.5	31.5	2171
127	219	82	49	65.5	33.5	2204.5
128	220	79	47	63	31	2235.5
129	221	62	37	49.5	17.5	2253
130	222	60	35	47.5	15.5	2268.5
131	223	62	37	49.5	17.5	2286
132	224	69	38	53.5	21.5	2307.5
133	225	77	42	59.5	27.5	2335
134	226	79	50	64.5	32.5	2367.5
135	227	79	49	64	32	2399.5
136	228	75	44	59.5	27.5	2427
137	229	68	43	55.5	23.5	2450.5
138	230	58	39	48.5	16.5	2467
139	231	53	36	44.5	12.5	2479.5
140	232	65	39	52	20	2499.5
141	233	71	38	54.5	22.5	2522
142	234	77	47	62	30	2552
143	235	73	49	61	29	2581
144	236	63	46	54.5	22.5	2603.5
145	237	73	40	56.5	24.5	2628
146	238	81	48	64.5	32.5	2660.5
147	239	82	49	65.5	33.5	2694
148	240	85	53	69	37	2731
149	241	79	55	67	35	2766
150	242	66	40	53	21	2787
151	243	77	42	59.5	27.5	2814.5
152	244	85	57	71	39	2853.5
153	245	79	51	65	33	2886.5
154	246	79	44	61.5	29.5	2916
155	247	87	48	67.5	35.5	2951.5
156	248	89	55	72	40	2991.5
157	249	87	56	71.5	39.5	3031
158	250	79	48	63.5	31.5	3062.5
159	251	84	49	66.5	34.5	3097
160	252	82	50	66	34	3131
161	253	84	52	68	36	3167
162	254	85	55	70	38	3205
163	255	87	51	69	37	3242
164	256	85	56	70.5	38.5	3280.5
165	257	86	56	71	39	3319.5
166	258	90	57	73.5	41.5	3361
167	259	89	59	74	42	3403
168	260	75	52	63.5	31.5	3434.5
169	261	85	57	71	39	3473.5
170	262	81	51	66	34	3507.5
171	263	78	47	62.5	30.5	3538
172	264	85	54	69.5	37.5	3575.5
173	265	92	57	74.5	42.5	3618
174	266	95	60	77.5	45.5	3663.5
175	267	94	61	77.5	45.5	3709
176	268	93	55	74	42	3751
177	269	93	57	75	43	3794
178	270	95	61	78	46	3840
179	271	96	64	80	48	3888
180	272	98	67	82.5	50.5	3938.5
181	273	85	61	73	41	3979.5
182	274	90	57	73.5	41.5	4021
183	275	98	68	83	51	4072
184	276	96	68	82	50	4122
185	277	96	64	80	48	4170
186	278	93	68	80.5	48.5	4218.5
187	279	89	66	77.5	45.5	4264
188	280	93	67	80	48	4312
189	281	92	63	77.5	45.5	4357.5
190	282	90	61	75.5	43.5	4401
191	283	85	61	73	41	4442
192	284	89	61	75	43	4485
193	285	82	57	69.5	37.5	4522.5
194	286	87	59	73	41	4563.5
195	287	86	54	70	38	4601.5
196	288	89	58	73.5	41.5	4643
197	289	89	64	76.5	44.5	4687.5
198	290	95	70	82.5	50.5	4738
199	291	93	62	77.5	45.5	4783.5
200	292	86	61	73.5	41.5	4825
201	293	92	64	78	46	4871

202	294	93	62	77.5	45.5	4916.5
203	295	93	62	77.5	45.5	4962
204	296	96	60	78	46	5008
205	297	100	66	83	51	5059
206	298	94	62	78	46	5105
207	299	76	61	68.5	36.5	5141.5
208	300	83	59	71	39	5180.5
209	301	89	59	74	42	5222.5
210	302	91	64	77.5	45.5	5268
211	303	92	65	78.5	46.5	5314.5
212	304	88	65	76.5	44.5	5359
213	305	89	62	75.5	43.5	5359
214	306	89	63	76	44	5403
215	307	91	62	76.5	44.5	5447.5
216	308	89	58	73.5	41.5	5489
217	309	93	62	77.5	45.5	5534.5
218	310	93	62	77.5	45.5	5580
219	311	94	64	79	47	5627
220	312	92	60	76	44	5671
221	313	96	59	77.5	45.5	5716.5
222	314	95	60	77.5	45.5	5762
223	315	92	65	78.5	46.5	5808.5
224	316	95	62	78.5	46.5	5855
225	317	96	64	80	48	5903
226	318	85	66	75.5	43.5	5946.5
227	319	92	59	75.5	43.5	5990
228	320	96	64	80	48	6038
229	321	96	63	79.5	47.5	6085.5
230	322	94	64	79	47	6132.5
231	323	89	64	76.5	44.5	6177
232	324	90	64	77	45	6222
233	325	89	59	74	42	6264
234	326	90	62	76	44	6308
235	327	93	63	78	46	6354
236	328	98	67	82.5	50.5	6404.5
237	329	91	65	78	46	6450.5
238	330	91	63	77	45	6495.5
239	331	94	57	75.5	43.5	6539
240	332	93	66	79.5	47.5	6586.5
241	333	90	60	75	43	6629.5
242	334	90	59	74.5	42.5	6672
243	335	84	65	74.5	42.5	6714.5
244	336	90	60	75	43	6757.5
245	337	89	59	74	42	6799.5
246	338	90	60	75	43	6842.5
247	339	87	63	75	43	6885.5
248	340	86	59	72.5	40.5	6926
249	341	78	58	68	36	6962
250	342	80	53	66.5	34.5	6996.5
251	343	82	53	67.5	35.5	7032
252	344	73	54	63.5	31.5	7063.5
253	345	72	53	62.5	30.5	7094
254	346	78	53	65.5	33.5	7127.5
255	347	78	52	65	33	7160.5
256	348	79	51	65	33	7193.5
257	349	68	47	57.5	25.5	7219
258	350	68	47	57.5	25.5	7244.5
259	351	69	59	64	32	7276.5
260	352	69	48	58.5	26.5	7303
261	353	77	48	62.5	30.5	7333.5
262	354	80	53	66.5	34.5	7368
263	355	84	54	69	37	7405
264	356	82	52	67	35	7440
265	357	84	53	68.5	36.5	7476.5
266	358	87	55	71	39	7515.5
267	359	82	52	67	35	7550.5
268	360	84	55	69.5	37.5	7588
269	361	84	52	68	36	7624
270	362	86	57	71.5	39.5	7663.5
271	363	87	55	71	39	7702.5
272	364	85	61	73	41	7743.5
273	365	80	55	67.5	35.5	7779



90	1163.5	length of freeze (day)	45
135	973.5	frost depth (^{o}F-day)	190
		average temperature	53.4

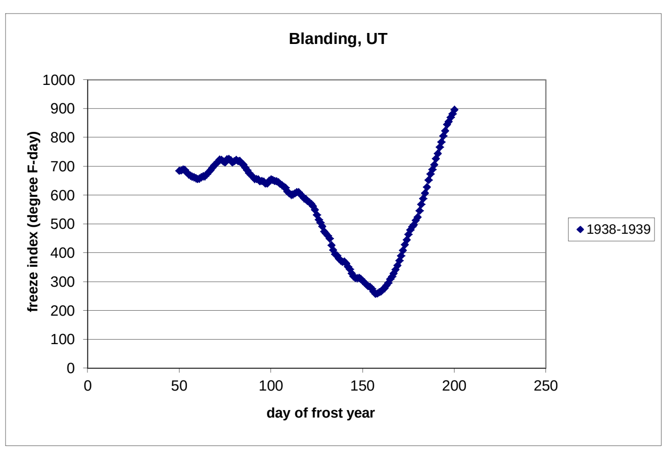
1938-1939

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	78	51	64.5	32.5	32.5
275	2	74	50	62	30	62.5
276	3	76	47	61.5	29.5	92
277	4	77	49	63	31	123
278	5	73	44	58.5	26.5	149.5
279	6	70	45	57.5	25.5	175
280	7	65	47	56	24	199
281	8	56	33	44.5	12.5	211.5
282	9	57	37	47	15	226.5
283	10	63	33	48	16	242.5
284	11	64	37	50.5	18.5	261
285	12	69	37	53	21	282
286	13	71	45	58	26	308
287	14	69	47	58	26	334
288	15	70	50	60	28	362
289	16	68	45	56.5	24.5	386.5
290	17	53	24	38.5	6.5	393
291	18	61	25	43	11	404
292	19	57	39	48	16	420
293	20	62	36	49	17	437
294	21	63	32	47.5	15.5	452.5
295	22	64	30	47	15	467.5
296	23	67	31	49	17	484.5
297	24	67	31	49	17	501.5
298	25	67	32	49.5	17.5	519
299	26	69	34	51.5	19.5	538.5
300	27	67	37	52	20	558.5
301	28	67	33	50	18	576.5
302	29	68	35	51.5	19.5	596
303	30	64	33	48.5	16.5	612.5
304	31	64	40	52	20	632.5
305	32	65	31	48	16	648.5

306	33	52	32	42	10	658.5
307	34	51	25	38	6	664.5
308	35	43	26	34.5	2.5	667
309	36	42	28	35	3	670
310	37	35	20	27.5	-4.5	665.5
311	38	43	8	25.5	-6.5	659
312	39	46	14	30	-2	657
313	40	55	21	38	6	663
314	41	51	36	43.5	11.5	674.5
315	42	48	26	37	5	679.5
316	43	35	11	23	-9	670.5
317	44	35	9	22	-10	660.5
318	45	55	15	35	3	663.5
319	46	49	18	33.5	1.5	665
320	47	52	21	36.5	4.5	669.5
321	48	54	23	38.5	6.5	676
322	49	56	21	38.5	6.5	682.5
323	50	55	14	34.5	2.5	685
324	51	48	18	33	1	686
325	52	50	21	35.5	3.5	689.5
326	53	44	16	30	-2	687.5
327	54	33	15	24	-8	679.5
328	55	33	16	24.5	-7.5	672
329	56	46	10	28	-4	668
330	57	49	9	29	-3	665
331	58	48	11	29.5	-2.5	662.5
332	59	47	11	29	-3	659.5
333	60	46	11	28.5	-3.5	656
334	61	50	19	34.5	2.5	658.5
335	62	49	23	36	4	662.5
336	63	47	24	35.5	3.5	666
337	64	44	19	31.5	-0.5	665.5
338	65	56	22	39	7	672.5
339	66	54	25	39.5	7.5	680
340	67	56	22	39	7	687
341	68	55	24	39.5	7.5	694.5
342	69	57	25	41	9	703.5
343	70	53	22	37.5	5.5	709
344	71	52	25	38.5	6.5	715.5
345	72	50	30	40	8	723.5
346	73	43	18	30.5	-1.5	722
347	74	44	10	27	-5	717
348	75	44	14	29	-3	714
349	76	53	33	43	11	725
350	77	36	30	33	1	726
351	78	40	14	27	-5	721
352	79	34	14	24	-8	713
353	80	44	29	36.5	4.5	717.5
354	81	44	30	37	5	722.5
355	82	34	22	28	-4	718.5
356	83	42	24	33	1	719.5
357	84	40	6	23	-9	710.5
358	85	44	10	27	-5	705.5
359	86	34	10	22	-10	695.5
360	87	32	14	23	-9	686.5
361	88	32	12	22	-10	676.5
362	89	40	12	26	-6	670.5
363	90	42	10	26	-6	664.5
364	91	40	10	25	-7	657.5
365	92	48	12	30	-2	655.5
1	93	48	14	31	-1	654.5
2	94	40	12	26	-6	648.5
3	95	40	26	33	1	649.5
4	96	38	20	29	-3	646.5
5	97	40	12	26	-6	640.5
6	98	42	22	32	0	640.5
7	99	52	32	42	10	650.5
8	100	40	32	36	4	654.5
9	101	42	18	30	-2	652.5
10	102	42	16	29	-3	649.5
11	103	42	20	31	-1	648.5
12	104	44	12	28	-4	644.5
13	105	38	16	27	-5	639.5
14	106	42	12	27	-5	634.5
15	107	42	12	27	-5	629.5
16	108	32	24	28	-4	625.5
17	109	32	6	19	-13	612.5
18	110	40	10	25	-7	605.5
19	111	42	14	28	-4	601.5
20	112	44	22	33	1	602.5
21	113	38	32	35	3	605.5
22	114	42	32	37	5	610.5
23	115	44	20	32	0	610.5
24	116	40	10	25	-7	603.5
25	117	42	10	26	-6	597.5
26	118	40	8	24	-8	589.5
27	119	48	12	30	-2	587.5
28	120	42	6	24	-8	579.5
29	121	46	10	28	-4	575.5
30	122	38	14	26	-6	569.5
31	123	36	12	24	-8	561.5
32	124	36	4	20	-12	549.5
33	125	26	2	14	-18	531.5
34	126	28	4	16	-16	515.5
35	127	28	16	22	-10	505.5
36	128	30	6	18	-14	491.5
37	129	28	2	15	-17	474.5
38	130	32	18	25	-7	467.5
39	131	34	14	24	-8	459.5
40	132	32	12	22	-10	449.5
41	133	22	-4	9	-23	426.5
42	134	32	-2	15	-17	409.5
43	135	34	2	18	-14	395.5
44	136	42	12	27	-5	390.5
45	137	38	6	22	-10	380.5
46	138	42	10	26	-6	374.5
47	139	40	12	26	-6	368.5
48	140	46	20	33	1	369.5
49	141	40	12	26	-6	363.5

50	142	34	8	21	-11	352.5
51	143	36	10	23	-9	343.5
52	144	34	0	17	-15	328.5
53	145	42	4	23	-9	319.5
54	146	42	10	26	-6	313.5
55	147	48	14	31	-1	312.5
56	148	50	16	33	1	313.5
57	149	46	12	29	-3	310.5
58	150	40	10	25	-7	303.5
59	151	42	8	25	-7	296.5
60	152	38	14	26	-6	290.5
61	153	40	12	26	-6	284.5
62	154	46	14	30	-2	282.5
63	155	42	8	25	-7	275.5
64	156	40	4	22	-10	265.5
65	157	44	6	25	-7	258.5
66	158	48	18	33	1	259.5
67	159	52	20	36	4	263.5
68	160	50	18	34	2	265.5
69	161	52	28	40	8	273.5
70	162	58	14	36	4	277.5
71	163	62	22	42	10	287.5
72	164	58	22	40	8	295.5
73	165	62	30	46	14	309.5
74	166	58	22	40	8	317.5
75	167	62	26	44	12	329.5
76	168	62	28	45	13	342.5
77	169	62	30	46	14	356.5
78	170	64	34	49	17	373.5
79	171	66	30	48	16	389.5
80	172	70	32	51	19	408.5
81	173	64	40	52	20	428.5
82	174	62	36	49	17	445.5
83	175	64	38	51	19	464.5
84	176	60	34	47	15	479.5
85	177	42	44	43	11	490.5
86	178	46	32	39	7	497.5
87	179	60	34	47	15	512.5
88	180	54	32	43	11	523.5
89	181	66	44	55	23	546.5
90	182	64	44	54	22	568.5
91	183	68	36	52	20	588.5
92	184	66	36	51	19	607.5
93	185	68	38	53	21	628.5
94	186	68	44	56	24	652.5
95	187	66	40	53	21	673.5
96	188	70	25	47.5	15.5	689
97	189	70	28	49	17	706
98	190	72	34	53	21	727
99	191	70	30	50	18	745
100	192	72	36	54	22	767
101	193	62	36	49	17	784
102	194	70	38	54	22	806
103	195	68	30	49	17	823
104	196	67	42	54.5	22.5	845.5
105	197	56	28	42	10	855.5
106	198	60	33	46.5	14.5	870
107	199	55	33	44	12	882
108	200	68	25	46.5	14.5	896.5
109	201	71	31	51	19	915.5
110	202	72	38	55	23	938.5
111	203	73	38	55.5	23.5	962
112	204	76	41	58.5	26.5	988.5
113	205	68	50	59	27	1015.5
114	206	62	32	47	15	1030.5
115	207	67	36	51.5	19.5	1050
116	208	71	41	56	24	1074
117	209	74	41	57.5	25.5	1099.5
118	210	76	41	58.5	26.5	1126
119	211	66	45	55.5	23.5	1149.5
120	212	68	44	56	24	1173.5
121	213	74	40	57	25	1198.5
122	214	76	50	63	31	1229.5
123	215	75	43	59	27	1256.5
124	216	78	43	60.5	28.5	1285
125	217	76	45	60.5	28.5	1313.5
126	218	65	39	52	20	1333.5
127	219	68	34	51	19	1352.5
128	220	75	41	58	26	1378.5
129	221	77	40	58.5	26.5	1405
130	222	75	44	59.5	27.5	1432.5
131	223	71	40	55.5	23.5	1456
132	224	69	38	53.5	21.5	1477.5
133	225	74	51	62.5	30.5	1508
134	226	75	43	59	27	1535
135	227	68	41	54.5	22.5	1557.5
136	228	69	42	55.5	23.5	1581
137	229	76	42	59	27	1608
138	230	80	46	63	31	1639
139	231	78	44	61	29	1668
140	232	76	39	57.5	25.5	1693.5
141	233	78	44	61	29	1722.5
142	234	77	45	61	29	1751.5
143	235	71	38	54.5	22.5	1774
144	236	62	30	46	14	1788
145	237	79	39	59	27	1815
146	238	74	43	58.5	26.5	1841.5
147	239	67	40	53.5	21.5	1863
148	240	82	41	61.5	29.5	1892.5
149	241	85	52	68.5	36.5	1929
150	242	81	52	66.5	34.5	1963.5
151	243	80	51	65.5	33.5	1997
152	244	80	50	65	33	2030
153	245	79	43	61	29	2059
154	246	85	43	64	32	2091
155	247	87	53	70	38	2129
156	248	85	59	72	40	2169
157	249	79	42	60.5	28.5	2197.5
158	250	74	40	57	25	2222.5

159	251	80	43	61.5	29.5	2252
160	252	84	46	65	33	2285
161	253	84	47	65.5	33.5	2318.5
162	254	90	50	70	38	2356.5
163	255	90	54	72	40	2396.5
164	256	93	54	73.5	41.5	2438
165	257	91	51	71	39	2477
166	258	86	52	69	37	2514
167	259	83	44	63.5	31.5	2545.5
168	260	82	57	69.5	37.5	2583
169	261	66	30	48	16	2599
170	262	73	42	57.5	25.5	2624.5
171	263	80	51	65.5	33.5	2658
172	264	84	50	67	35	2693
173	265	89	50	69.5	37.5	2730.5
174	266	89	56	72.5	40.5	2771
175	267	86	50	68	36	2807
176	268	85	55	70	38	2845
177	269	86	52	69	37	2882
178	270	88	54	71	39	2921
179	271	91	56	73.5	41.5	2962.5
180	272	90	58	74	42	3004.5
181	273	92	58	75	43	3047.5
182	274	91	61	76	44	3091.5
183	275	88	53	70.5	38.5	3130
184	276	81	49	65	33	3163
185	277	83	50	66.5	34.5	3197.5
186	278	85	51	68	36	3233.5
187	279	85	52	68.5	36.5	3270
188	280	90	60	75	43	3313
189	281	95	60	77.5	45.5	3358.5
190	282	93	62	77.5	45.5	3404
191	283	94	63	78.5	46.5	3450.5
192	284	93	60	76.5	44.5	3495
193	285	98	57	77.5	45.5	3540.5
194	286	96	62	79	47	3587.5
195	287	94	64	79	47	3634.5
196	288	96	62	79	47	3681.5
197	289	94	58	76	44	3725.5
198	290	93	57	75	43	3768.5
199	291	93	60	76.5	44.5	3813
200	292	94	56	75	43	3856
201	293	96	59	77.5	45.5	3901.5
202	294	97	70	83.5	51.5	3953
203	295	93	59	76	44	3997
204	296	93	55	74	42	4039
205	297	91	56	73.5	41.5	4080.5
206	298	84	61	72.5	40.5	4121
207	299	87	57	72	40	4161
208	300	85	61	73	41	4202
209	301	79	59	69	37	4239
210	302	83	58	70.5	38.5	4277.5
211	303	86	62	74	42	4319.5
212	304	88	59	73.5	41.5	4361
213	305	92	58	75	43	4404
214	306	94	61	77.5	45.5	4449.5
215	307	92	58	75	43	4492.5
216	308	91	62	76.5	44.5	4537
217	309	89	65	77	45	4582
218	310	82	59	70.5	38.5	4620.5
219	311	81	50	65.5	33.5	4654
220	312	85	46	65.5	33.5	4687.5
221	313	88	50	69	37	4724.5
222	314	88	52	70	38	4762.5
223	315	90	52	71	39	4801.5
224	316	91	53	72	40	4841.5
225	317	92	58	75	43	4884.5
226	318	93	57	75	43	4927.5
227	319	93	56	74.5	42.5	4970
228	320	94	56	75	43	5013
229	321	92	55	73.5	41.5	5054.5
230	322	94	54	74	42	5096.5
231	323	92	59	75.5	43.5	5140
232	324	89	64	76.5	44.5	5184.5
233	325	85	57	71	39	5223.5
234	326	89	53	71	39	5262.5
235	327	88	56	72	40	5302.5
236	328	87	52	69.5	37.5	5340
237	329	92	57	74.5	42.5	5382.5
238	330	90	56	73	41	5423.5
239	331	81	58	69.5	37.5	5461
240	332	85	56	70.5	38.5	5499.5
241	333	83	52	67.5	35.5	5535
242	334	85	56	70.5	38.5	5573.5
243	335	89	57	73	41	5614.5
244	336	88	57	72.5	40.5	5655
245	337	88	55	71.5	39.5	5694.5
246	338	86	52	69	37	5731.5
247	339	88	54	71	39	5770.5
248	340	64	57	60.5	28.5	5799
249	341	74	56	65	33	5832
250	342	76	55	65.5	33.5	5865.5
251	343	76	57	66.5	34.5	5900
252	344	82	54	68	36	5936
253	345	73	54	63.5	31.5	5967.5
254	346	75	54	64.5	32.5	6000
255	347	73	54	63.5	31.5	6031.5
256	348	73	56	64.5	32.5	6064
257	349	75	53	64	32	6096
258	350	73	43	58	26	6122
259	351	76	48	62	30	6152
260	352	78	49	63.5	31.5	6183.5
261	353	82	46	64	32	6215.5
262	354	83	50	66.5	34.5	6250
263	355	79	56	67.5	35.5	6285.5
264	356	80	54	67	35	6320.5
265	357	81	54	67.5	35.5	6356
266	358	82	48	65	33	6389
267	359	71	48	59.5	27.5	6416.5



268	360	74	46	60	28	6444.5				
269	361	58	51	54.5	22.5	6467	77	726	length of freeze (day)	80
270	362	66	44	55	23	6490	157	258.5	frost depth (^oF-day)	467.5
271	363	68	43	55.5	23.5	6513.5			average temperature	50.0
272	364	69	42	55.5	23.5	6537				
273	365	70	43	56.5	24.5	6561.5				

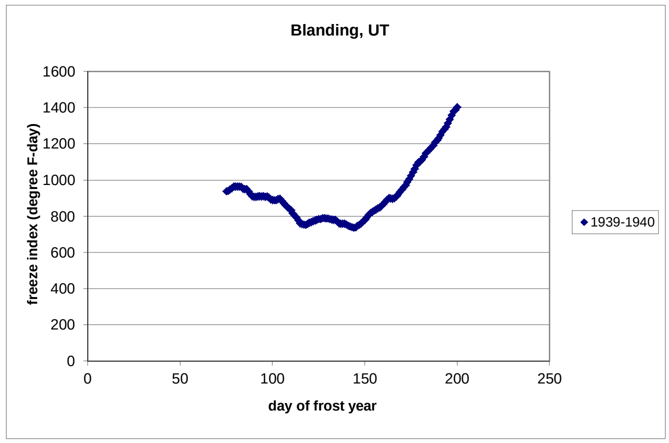
1939-1940

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	73	43	58	26	26
275	2	66	39	52.5	20.5	46.5
276	3	66	38	52	20	66.5
277	4	60	35	47.5	15.5	82
278	5	64	31	47.5	15.5	97.5
279	6	69	31	50	18	115.5
280	7	66	36	51	19	134.5
281	8	53	39	46	14	148.5
282	9	55	31	43	11	159.5
283	10	68	30	49	17	176.5
284	11	68	32	50	18	194.5
285	12	67	34	50.5	18.5	213
286	13	69	37	53	21	234
287	14	67	38	52.5	20.5	254.5
288	15	67	32	49.5	17.5	272
289	16	69	36	52.5	20.5	292.5
290	17	68	34	51	19	311.5
291	18	68	32	50	18	329.5
292	19	69	39	54	22	351.5
293	20	72	40	56	24	375.5
294	21	69	32	50.5	18.5	394
295	22	67	34	50.5	18.5	412.5
296	23	68	32	50	18	430.5
297	24	62	36	49	17	447.5
298	25	58	36	47	15	462.5
299	26	48	30	39	7	469.5
300	27	51	27	39	7	476.5
301	28	56	28	42	10	486.5
302	29	62	31	46.5	14.5	501
303	30	67	34	50.5	18.5	519.5
304	31	64	30	47	15	534.5
305	32	64	32	48	16	550.5
306	33	62	33	47.5	15.5	566
307	34	57	35	46	14	580
308	35	61	30	45.5	13.5	593.5
309	36	59	37	48	16	609.5
310	37	63	37	50	18	627.5
311	38	61	31	46	14	641.5
312	39	58	28	43	11	652.5
313	40	48	34	41	9	661.5
314	41	54	29	41.5	9.5	671
315	42	53	26	39.5	7.5	678.5
316	43	56	28	42	10	688.5
317	44	54	28	41	9	697.5
318	45	56	30	43	11	708.5
319	46	55	24	39.5	7.5	716
320	47	58	25	41.5	9.5	725.5
321	48	52	23	37.5	5.5	731
322	49	52	21	36.5	4.5	735.5
323	50	52	22	37	5	740.5
324	51	51	21	36	4	744.5
325	52	53	23	38	6	750.5
326	53	55	22	38.5	6.5	757
327	54	52	23	37.5	5.5	762.5
328	55	59	29	44	12	774.5
329	56	53	32	42.5	10.5	785
330	57	46	28	37	5	790
331	58	44	34	39	7	797
332	59	49	32	40.5	8.5	805.5
333	60	53	32	42.5	10.5	816
334	61	51	24	37.5	5.5	821.5
335	62	55	24	39.5	7.5	829
336	63	52	24	38	6	835
337	64	55	24	39.5	7.5	842.5
338	65	60	25	42.5	10.5	853
339	66	58	25	41.5	9.5	862.5
340	67	58	26	42	10	872.5
341	68	56	26	41	9	881.5
342	69	55	27	41	9	890.5
343	70	55	30	42.5	10.5	901
344	71	57	27	42	10	911
345	72	55	33	44	12	923
346	73	52	25	38.5	6.5	929.5
347	74	49	23	36	4	933.5
348	75	51	21	36	4	937.5
349	76	50	20	35	3	940.5
350	77	55	26	40.5	8.5	949
351	78	56	23	39.5	7.5	956.5
352	79	55	24	39.5	7.5	964
353	80	47	18	32.5	0.5	964.5
354	81	47	18	32.5	0.5	965
355	82	46	17	31.5	-0.5	964.5
356	83	40	21	30.5	-1.5	963
357	84	34	10	22	-10	953
358	85	40	20	30	-2	951
359	86	42	20	31	-1	950
360	87	31	8	19.5	-12.5	937.5
361	88	28	6	17	-15	922.5
362	89	36	7	21.5	-10.5	912
363	90	40	16	28	-4	908
364	91	45	20	32.5	0.5	908.5
365	92	48	19	33.5	1.5	910
1	93	44	24	34	2	912
2	94	36	22	29	-3	909
3	95	46	22	34	2	911
4	96	37	21	29	-3	908
5	97	45	22	33.5	1.5	909.5
6	98	40	14	27	-5	904.5

7	99	36	6	21	-11	893.5
8	100	33	24	28.5	-3.5	890
9	101	35	28	31.5	-0.5	889.5
10	102	40	24	32	0	889.5
11	103	51	26	38.5	6.5	896
12	104	37	30	33.5	1.5	897.5
13	105	31	10	20.5	-11.5	886
14	106	34	3	18.5	-13.5	872.5
15	107	35	7	21	-11	861.5
16	108	38	6	22	-10	851.5
17	109	38	7	22.5	-9.5	842
18	110	41	7	24	-8	834
19	111	30	-2	14	-18	816
20	112	31	10	20.5	-11.5	804.5
21	113	37	6	21.5	-10.5	794
22	114	31	-2	14.5	-17.5	776.5
23	115	28	5	16.5	-15.5	761
24	116	40	17	28.5	-3.5	757.5
25	117	40	17	28.5	-3.5	754
26	118	37	25	31	-1	753
27	119	54	23	38.5	6.5	759.5
28	120	54	22	38	6	765.5
29	121	47	23	35	3	768.5
30	122	53	22	37.5	5.5	774
31	123	45	26	35.5	3.5	777.5
32	124	38	33	35.5	3.5	781
33	125	41	29	35	3	784
34	126	38	28	33	1	785
35	127	46	26	36	4	789
36	128	43	24	33.5	1.5	790.5
37	129	40	18	29	-3	787.5
38	130	40	25	32.5	0.5	788
39	131	38	20	29	-3	785
40	132	44	16	30	-2	783
41	133	42	19	30.5	-1.5	781.5
42	134	41	21	31	-1	780.5
43	135	34	14	24	-8	772.5
44	136	33	10	21.5	-10.5	762
45	137	40	18	29	-3	759
46	138	40	26	33	1	760
47	139	42	20	31	-1	759
48	140	37	17	27	-5	754
49	141	34	16	25	-7	747
50	142	39	20	29.5	-2.5	744.5
51	143	41	16	28.5	-3.5	741
52	144	40	15	27.5	-4.5	736.5
53	145	39	30	34.5	2.5	739
54	146	47	32	39.5	7.5	746.5
55	147	50	27	38.5	6.5	753
56	148	51	31	41	9	762
57	149	49	34	41.5	9.5	771.5
58	150	54	30	42	10	781.5
59	151	56	33	44.5	12.5	794
60	152	58	32	45	13	807
61	153	51	35	43	11	818
62	154	49	30	39.5	7.5	825.5
63	155	40	32	36	4	829.5
64	156	51	28	39.5	7.5	837
65	157	53	26	39.5	7.5	844.5
66	158	47	28	37.5	5.5	850
67	159	53	25	39	7	857
68	160	58	27	42.5	10.5	867.5
69	161	59	30	44.5	12.5	880
70	162	58	32	45	13	893
71	163	44	35	39.5	7.5	900.5
72	164	38	22	30	-2	898.5
73	165	45	17	31	-1	897.5
74	166	52	18	35	3	900.5
75	167	58	24	41	9	909.5
76	168	61	24	42.5	10.5	920
77	169	58	34	46	14	934
78	170	59	30	44.5	12.5	946.5
79	171	62	30	46	14	960.5
80	172	63	24	43.5	11.5	972
81	173	65	34	49.5	17.5	989.5
82	174	67	30	48.5	16.5	1006
83	175	70	30	50	18	1024
84	176	70	35	52.5	20.5	1044.5
85	177	69	30	49.5	17.5	1062
86	178	66	41	53.5	21.5	1083.5
87	179	54	40	47	15	1098.5
88	180	51	26	38.5	6.5	1105
89	181	55	26	40.5	8.5	1113.5
90	182	63	33	48	16	1129.5
91	183	65	37	51	19	1148.5
92	184	49	36	42.5	10.5	1159
93	185	55	32	43.5	11.5	1170.5
94	186	55	27	41	9	1179.5
95	187	59	29	44	12	1191.5
96	188	57	40	48.5	16.5	1208
97	189	55	33	44	12	1220
98	190	57	30	43.5	11.5	1231.5
99	191	64	34	49	17	1248.5
100	192	67	38	52.5	20.5	1269
101	193	57	32	44.5	12.5	1281.5
102	194	63	26	44.5	12.5	1294
103	195	67	38	52.5	20.5	1314.5
104	196	72	36	54	22	1336.5
105	197	75	35	55	23	1359.5
106	198	64	41	52.5	20.5	1380
107	199	47	32	39.5	7.5	1387.5
108	200	59	35	47	15	1402.5
109	201	70	33	51.5	19.5	1422
110	202	72	36	54	22	1444
111	203	74	40	57	25	1469
112	204	75	41	58	26	1495
113	205	67	35	51	19	1514
114	206	68	36	52	20	1534
115	207	62	44	53	21	1555

116	208	68	41	54.5	22.5	1577.5
117	209	67	40	53.5	21.5	1599
118	210	49	34	41.5	9.5	1608.5
119	211	58	35	46.5	14.5	1623
120	212	63	40	51.5	19.5	1642.5
121	213	63	38	50.5	18.5	1661
122	214	73	35	54	22	1683
123	215	76	40	58	26	1709
124	216	79	41	60	28	1737
125	217	78	42	60	28	1765
126	218	74	43	58.5	26.5	1791.5
127	219	73	39	56	24	1815.5
128	220	75	42	58.5	26.5	1842
129	221	76	45	60.5	28.5	1870.5
130	222	77	42	59.5	27.5	1898
131	223	78	44	61	29	1927
132	224	80	46	63	31	1958
133	225	80	46	63	31	1989
134	226	81	43	62	30	2019
135	227	83	42	62.5	30.5	2049.5
136	228	85	47	66	34	2083.5
137	229	79	49	64	32	2115.5
138	230	61	47	54	22	2137.5
139	231	65	45	55	23	2160.5
140	232	70	39	54.5	22.5	2183
141	233	74	40	57	25	2208
142	234	73	49	61	29	2237
143	235	73	46	59.5	27.5	2264.5
144	236	73	41	57	25	2289.5
145	237	79	43	61	29	2318.5
146	238	81	45	63	31	2349.5
147	239	81	50	65.5	33.5	2383
148	240	79	46	62.5	30.5	2413.5
149	241	78	45	61.5	29.5	2443
150	242	77	44	60.5	28.5	2471.5
151	243	79	44	61.5	29.5	2501
152	244	84	45	64.5	32.5	2533.5
153	245	83	46	64.5	32.5	2566
154	246	81	48	64.5	32.5	2598.5
155	247	82	49	65.5	33.5	2632
156	248	82	46	64	32	2664
157	249	79	46	62.5	30.5	2694.5
158	250	77	43	60	28	2722.5
159	251	82	43	62.5	30.5	2753
160	252	77	48	62.5	30.5	2783.5
161	253	72	43	57.5	25.5	2809
162	254	80	46	63	31	2840
163	255	86	50	68	36	2876
164	256	91	55	73	41	2917
165	257	93	53	73	41	2958
166	258	94	52	73	41	2999
167	259	92	57	74.5	42.5	3041.5
168	260	93	58	75.5	43.5	3085
169	261	92	55	73.5	41.5	3126.5
170	262	96	59	77.5	45.5	3172
171	263	94	61	77.5	45.5	3217.5
172	264	92	60	76	44	3261.5
173	265	90	60	75	43	3304.5
174	266	91	62	76.5	44.5	3349
175	267	91	54	72.5	40.5	3389.5
176	268	88	56	72	40	3429.5
177	269	92	55	73.5	41.5	3471
178	270	88	59	73.5	41.5	3512.5
179	271	92	51	71.5	39.5	3552
180	272	94	57	75.5	43.5	3595.5
181	273	78	57	67.5	35.5	3631
182	274	73	54	63.5	31.5	3662.5
183	275	85	51	68	36	3698.5
184	276	88	56	72	40	3738.5
185	277	89	58	73.5	41.5	3780
186	278	90	55	72.5	40.5	3820.5
187	279	94	62	78	46	3866.5
188	280	93	56	74.5	42.5	3909
189	281	97	58	77.5	45.5	3954.5
190	282	96	61	78.5	46.5	4001
191	283	97	61	79	47	4048
192	284	96	60	78	46	4094
193	285	96	59	77.5	45.5	4139.5
194	286	95	63	79	47	4186.5
195	287	95	64	79.5	47.5	4234
196	288	95	58	76.5	44.5	4278.5
197	289	93	63	78	46	4324.5
198	290	86	61	73.5	41.5	4366
199	291	79	55	67	35	4401
200	292	81	56	68.5	36.5	4437.5
201	293	85	51	68	36	4473.5
202	294	89	58	73.5	41.5	4515
203	295	94	57	75.5	43.5	4558.5
204	296	97	67	82	50	4608.5
205	297	94	59	76.5	44.5	4653
206	298	94	61	77.5	45.5	4698.5
207	299	97	61	79	47	4745.5
208	300	93	60	76.5	44.5	4790
209	301	85	60	72.5	40.5	4830.5
210	302	84	54	69	37	4867.5
211	303	89	55	72	40	4907.5
212	304	90	56	73	41	4948.5
213	305	92	56	74	42	4990.5
214	306	93	59	76	44	5034.5
215	307	94	56	75	43	5077.5
216	308	94	56	75	43	5120.5
217	309	96	56	76	44	5164.5
218	310	90	58	74	42	5206.5
219	311	84	63	73.5	41.5	5248
220	312	87	57	72	40	5288
221	313	92	58	75	43	5331
222	314	94	62	78	46	5377
223	315	96	66	81	49	5426
224	316	95	55	75	43	5469

225	317	93	56	74.5	42.5	5511.5
226	318	92	57	74.5	42.5	5554
227	319	93	55	74	42	5596
228	320	94	64	79	47	5643
229	321	90	54	72	40	5683
230	322	94	60	77	45	5728
231	323	87	63	75	43	5771
232	324	86	59	72.5	40.5	5811.5
233	325	87	56	71.5	39.5	5851
234	326	89	57	73	41	5892
235	327	85	55	70	38	5930
236	328	82	57	69.5	37.5	5967.5
237	329	66	56	61	29	5996.5
238	330	72	51	61.5	29.5	6026
239	331	78	45	61.5	29.5	6055.5
240	332	82	45	63.5	31.5	6087
241	333	85	50	67.5	35.5	6122.5
242	334	87	49	68	36	6158.5
243	335	87	55	71	39	6197.5
244	336	88	53	70.5	38.5	6236
245	337	91	52	71.5	39.5	6275.5
246	338	80	55	67.5	35.5	6311
247	339	75	49	62	30	6341
248	340	78	48	63	31	6372
249	341	81	51	66	34	6406
250	342	80	56	68	36	6442
251	343	86	57	71.5	39.5	6481.5
252	344	88	59	73.5	41.5	6523
253	345	85	56	70.5	38.5	6561.5
254	346	85	54	69.5	37.5	6599
255	347	84	52	68	36	6635
256	348	72	55	63.5	31.5	6666.5
257	349	75	52	63.5	31.5	6698
258	350	78	51	64.5	32.5	6730.5
259	351	77	50	63.5	31.5	6762
260	352	76	48	62	30	6792
261	353	56	50	53	21	6813
262	354	62	49	55.5	23.5	6836.5
263	355	70	51	60.5	28.5	6865
264	356	71	51	61	29	6894
265	357	72	51	61.5	29.5	6923.5
266	358	72	47	59.5	27.5	6951
267	359	66	50	58	26	6977
268	360	74	44	59	27	7004
269	361	73	47	60	28	7032
270	362	77	49	63	31	7063
271	363	75	47	61	29	7092
272	364	68	51	59.5	27.5	7119.5
273	365	66	49	57.5	25.5	7145
274	366	64	48	56	24	7169



82	964.5	length of freeze (day)	62
144	736.5	frost index (^oF-day)	228
		average temperature	51.6

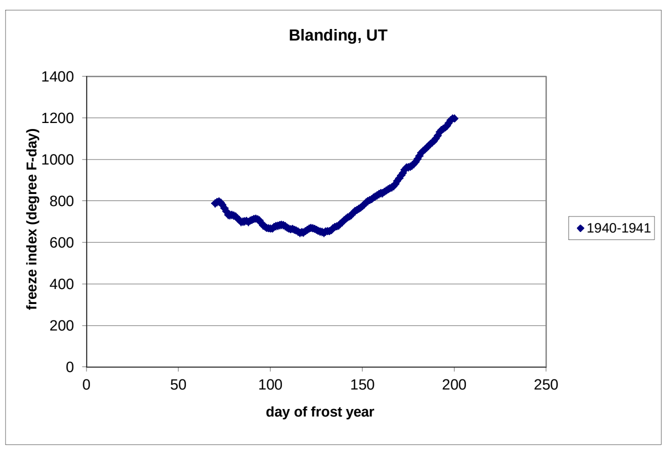
1940-1941

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	64	38	51	19	19
275	2	70	42	56	24	43
276	3	66	43	54.5	22.5	65.5
277	4	65	38	51.5	19.5	85
278	5	59	47	53	21	106
279	6	63	38	50.5	18.5	124.5
280	7	67	41	54	22	146.5
281	8	67	45	56	24	170.5
282	9	65	40	52.5	20.5	191
283	10	67	44	55.5	23.5	214.5
284	11	67	38	52.5	20.5	235
285	12	69	39	54	22	257
286	13	69	39	54	22	279
287	14	72	42	57	25	304
288	15	68	38	53	21	325
289	16	70	37	53.5	21.5	346.5
290	17	71	36	53.5	21.5	368
291	18	72	38	55	23	391
292	19	73	39	56	24	415
293	20	73	37	55	23	438
294	21	70	36	53	21	459
295	22	70	39	54.5	22.5	481.5
296	23	70	43	56.5	24.5	506
297	24	68	38	53	21	527
298	25	67	41	54	22	549
299	26	54	35	44.5	12.5	561.5
300	27	46	34	40	8	569.5
301	28	49	31	40	8	577.5
302	29	51	28	39.5	7.5	585
303	30	52	35	43.5	11.5	596.5
304	31	54	28	41	9	605.5
305	32	56	27	41.5	9.5	615
306	33	60	32	46	14	629
307	34	51	37	44	12	641
308	35	48	27	37.5	5.5	646.5
309	36	47	24	35.5	3.5	650
310	37	57	26	41.5	9.5	659.5
311	38	60	29	44.5	12.5	672
312	39	55	35	45	13	685
313	40	49	28	38.5	6.5	691.5
314	41	41	22	31.5	-0.5	691
315	42	40	15	27.5	-4.5	686.5
316	43	41	18	29.5	-2.5	684
317	44	45	15	30	-2	682
318	45	46	17	31.5	-0.5	681.5
319	46	49	18	33.5	1.5	683
320	47	51	20	35.5	3.5	686.5
321	48	52	24	38	6	692.5
322	49	39	30	34.5	2.5	695
323	50	41	32	36.5	4.5	699.5
324	51	34	30	32	0	699.5
325	52	36	31	33.5	1.5	701
326	53	37	25	31	-1	700
327	54	47	26	36.5	4.5	704.5

328	55	44	23	33.5	1.5	706
329	56	49	24	36.5	4.5	710.5
330	57	42	21	31.5	-0.5	710
331	58	44	21	32.5	0.5	710.5
332	59	48	23	35.5	3.5	714
333	60	48	25	36.5	4.5	718.5
334	61	52	26	39	7	725.5
335	62	53	27	40	8	733.5
336	63	54	27	40.5	8.5	742
337	64	54	24	39	7	749
338	65	52	24	38	6	755
339	66	52	25	38.5	6.5	761.5
340	67	54	25	39.5	7.5	769
341	68	54	26	40	8	777
342	69	53	23	38	6	783
343	70	51	26	38.5	6.5	789.5
344	71	44	32	38	6	795.5
345	72	38	31	34.5	2.5	798
346	73	32	21	26.5	-5.5	792.5
347	74	33	8	20.5	-11.5	781
348	75	37	-4	16.5	-15.5	765.5
349	76	35	-2	16.5	-15.5	750
350	77	33	-2	15.5	-16.5	733.5
351	78	37	24	30.5	-1.5	732
352	79	40	26	33	1	733
353	80	35	24	29.5	-2.5	730.5
354	81	33	21	27	-5	725.5
355	82	33	17	25	-7	718.5
356	83	32	14	23	-9	709.5
357	84	33	12	22.5	-9.5	700
358	85	41	24	32.5	0.5	700.5
359	86	49	20	34.5	2.5	703
360	87	53	14	33.5	1.5	704.5
361	88	41	14	27.5	-4.5	700
362	89	50	24	37	5	705
363	90	42	31	36.5	4.5	709.5
364	91	41	31	36	4	713.5
365	92	40	26	33	1	714.5
1	93	43	15	29	-3	711.5
2	94	42	13	27.5	-4.5	707
3	95	32	8	20	-12	695
4	96	25	13	19	-13	682
5	97	34	20	27	-5	677
6	98	34	15	24.5	-7.5	669.5
7	99	42	19	30.5	-1.5	668
8	100	45	16	30.5	-1.5	666.5
9	101	52	14	33	1	667.5
10	102	56	23	39.5	7.5	675
11	103	44	29	36.5	4.5	679.5
12	104	37	30	33.5	1.5	681
13	105	44	26	35	3	684
14	106	45	23	34	2	686
15	107	38	22	30	-2	684
16	108	37	19	28	-4	680
17	109	38	11	24.5	-7.5	672.5
18	110	38	14	26	-6	666.5
19	111	43	16	29.5	-2.5	664
20	112	40	26	33	1	665
21	113	39	18	28.5	-3.5	661.5
22	114	34	23	28.5	-3.5	658
23	115	41	15	28	-4	654
24	116	31	20	25.5	-6.5	647.5
25	117	50	20	35	3	650.5
26	118	42	17	29.5	-2.5	648
27	119	54	23	38.5	6.5	654.5
28	120	53	25	39	7	661.5
29	121	46	29	37.5	5.5	667
30	122	45	24	34.5	2.5	669.5
31	123	41	22	31.5	-0.5	669
32	124	41	16	28.5	-3.5	665.5
33	125	39	15	27	-5	660.5
34	126	43	13	28	-4	656.5
35	127	44	12	28	-4	652.5
36	128	46	15	30.5	-1.5	651
37	129	41	16	28.5	-3.5	647.5
38	130	45	31	38	6	653.5
39	131	39	29	34	2	655.5
40	132	40	22	31	-1	654.5
41	133	48	27	37.5	5.5	660
42	134	50	31	40.5	8.5	668.5
43	135	45	32	38.5	6.5	675
44	136	44	25	34.5	2.5	677.5
45	137	49	26	37.5	5.5	683
46	138	48	30	39	7	690
47	139	52	27	39.5	7.5	697.5
48	140	50	32	41	9	706.5
49	141	46	34	40	8	714.5
50	142	46	32	39	7	721.5
51	143	42	31	36.5	4.5	726
52	144	48	32	40	8	734
53	145	49	32	40.5	8.5	742.5
54	146	50	32	41	9	751.5
55	147	41	32	36.5	4.5	756
56	148	47	31	39	7	763
57	149	48	26	37	5	768
58	150	50	27	38.5	6.5	774.5
59	151	56	28	42	10	784.5
60	152	47	34	40.5	8.5	793
61	153	46	31	38.5	6.5	799.5
62	154	47	27	37	5	804.5
63	155	46	28	37	5	809.5
64	156	47	30	38.5	6.5	816
65	157	48	28	38	6	822
66	158	47	27	37	5	827
67	159	54	22	38	6	833
68	160	50	25	37.5	5.5	838.5
69	161	46	18	32	0	838.5
70	162	54	21	37.5	5.5	844
71	163	53	23	38	6	850

72	164	46	32	39	7	857
73	165	42	32	37	5	862
74	166	42	29	35.5	3.5	865.5
75	167	52	26	39	7	872.5
76	168	56	30	43	11	883.5
77	169	61	30	45.5	13.5	897
78	170	59	30	44.5	12.5	909.5
79	171	56	34	45	13	922.5
80	172	56	34	45	13	935.5
81	173	57	36	46.5	14.5	950
82	174	55	31	43	11	961
83	175	43	25	34	2	963
84	176	47	24	35.5	3.5	966.5
85	177	47	26	36.5	4.5	971
86	178	52	26	39	7	978
87	179	56	29	42.5	10.5	988.5
88	180	56	36	46	14	1002.5
89	181	58	34	46	14	1016.5
90	182	65	32	48.5	16.5	1033
91	183	50	31	40.5	8.5	1041.5
92	184	51	28	39.5	7.5	1049
93	185	51	30	40.5	8.5	1057.5
94	186	56	26	41	9	1066.5
95	187	54	28	41	9	1075.5
96	188	50	30	40	8	1083.5
97	189	54	23	38.5	6.5	1090
98	190	58	31	44.5	12.5	1102.5
99	191	62	28	45	13	1115.5
100	192	57	42	49.5	17.5	1133
101	193	44	38	41	9	1142
102	194	43	33	38	6	1148
103	195	47	30	38.5	6.5	1154.5
104	196	51	32	41.5	9.5	1164
105	197	57	29	43	11	1175
106	198	58	35	46.5	14.5	1189.5
107	199	51	29	40	8	1197.5
108	200	38	26	32	0	1197.5
109	201	42	26	34	2	1199.5
110	202	51	24	37.5	5.5	1205
111	203	50	32	41	9	1214
112	204	51	36	43.5	11.5	1225.5
113	205	53	31	42	10	1235.5
114	206	60	33	46.5	14.5	1250
115	207	53	38	45.5	13.5	1263.5
116	208	56	42	49	17	1280.5
117	209	53	40	46.5	14.5	1295
118	210	52	37	44.5	12.5	1307.5
119	211	59	37	48	16	1323.5
120	212	65	42	53.5	21.5	1345
121	213	63	43	53	21	1366
122	214	53	41	47	15	1381
123	215	65	40	52.5	20.5	1401.5
124	216	66	44	55	23	1424.5
125	217	71	37	54	22	1446.5
126	218	70	43	56.5	24.5	1471
127	219	74	38	56	24	1495
128	220	76	43	59.5	27.5	1522.5
129	221	78	48	63	31	1553.5
130	222	82	46	64	32	1585.5
131	223	80	52	66	34	1619.5
132	224	81	40	60.5	28.5	1648
133	225	79	46	62.5	30.5	1678.5
134	226	73	41	57	25	1703.5
135	227	69	37	53	21	1724.5
136	228	79	43	61	29	1753.5
137	229	77	44	60.5	28.5	1782
138	230	73	42	57.5	25.5	1807.5
139	231	52	32	42	10	1817.5
140	232	62	36	49	17	1834.5
141	233	62	44	53	21	1855.5
142	234	61	42	51.5	19.5	1875
143	235	58	42	50	18	1893
144	236	65	46	55.5	23.5	1916.5
145	237	71	43	57	25	1941.5
146	238	73	43	58	26	1967.5
147	239	71	44	57.5	25.5	1993
148	240	71	47	59	27	2020
149	241	72	41	56.5	24.5	2044.5
150	242	67	40	53.5	21.5	2066
151	243	70	41	55.5	23.5	2089.5
152	244	76	48	62	30	2119.5
153	245	78	45	61.5	29.5	2149
154	246	71	47	59	27	2176
155	247	74	44	59	27	2203
156	248	70	43	56.5	24.5	2227.5
157	249	72	43	57.5	25.5	2253
158	250	68	49	58.5	26.5	2279.5
159	251	55	43	49	17	2296.5
160	252	54	40	47	15	2311.5
161	253	64	38	51	19	2330.5
162	254	68	42	55	23	2353.5
163	255	75	46	60.5	28.5	2382
164	256	80	46	63	31	2413
165	257	83	52	67.5	35.5	2448.5
166	258	79	50	64.5	32.5	2481
167	259	83	52	67.5	35.5	2516.5
168	260	86	52	69	37	2553.5
169	261	86	52	69	37	2590.5
170	262	86	42	64	32	2622.5
171	263	84	50	67	35	2657.5
172	264	86	51	68.5	36.5	2694
173	265	89	54	71.5	39.5	2733.5
174	266	86	60	73	41	2774.5
175	267	83	58	70.5	38.5	2813
176	268	81	51	66	34	2847
177	269	83	48	65.5	33.5	2880.5
178	270	80	48	64	32	2912.5
179	271	75	42	58.5	26.5	2939
180	272	78	43	60.5	28.5	2967.5

181	273	80	47	63.5	31.5	2999
182	274	82	51	66.5	34.5	3033.5
183	275	85	48	66.5	34.5	3068
184	276	87	54	70.5	38.5	3106.5
185	277	87	53	70	38	3144.5
186	278	83	56	69.5	37.5	3182
187	279	85	50	67.5	35.5	3217.5
188	280	88	55	71.5	39.5	3257
189	281	88	57	72.5	40.5	3297.5
190	282	89	57	73	41	3338.5
191	283	89	52	70.5	38.5	3377
192	284	83	56	69.5	37.5	3414.5
193	285	83	52	67.5	35.5	3450
194	286	87	54	70.5	38.5	3488.5
195	287	90	58	74	42	3530.5
196	288	86	60	73	41	3571.5
197	289	88	52	70	38	3609.5
198	290	91	60	75.5	43.5	3653
199	291	89	56	72.5	40.5	3693.5
200	292	81	62	71.5	39.5	3733
201	293	86	53	69.5	37.5	3770.5
202	294	89	58	73.5	41.5	3812
203	295	93	56	74.5	42.5	3854.5
204	296	97	57	77	45	3899.5
205	297	82	58	70	38	3937.5
206	298	81	53	67	35	3972.5
207	299	83	52	67.5	35.5	4008
208	300	84	55	69.5	37.5	4045.5
209	301	85	51	68	36	4081.5
210	302	87	56	71.5	39.5	4121
211	303	90	56	73	41	4162
212	304	90	55	72.5	40.5	4202.5
213	305	88	53	70.5	38.5	4241
214	306	90	52	71	39	4280
215	307	93	55	74	42	4322
216	308	90	59	74.5	42.5	4364.5
217	309	89	57	73	41	4405.5
218	310	89	58	73.5	41.5	4447
219	311	87	60	73.5	41.5	4488.5
220	312	82	57	69.5	37.5	4526
221	313	80	58	69	37	4563
222	314	74	57	65.5	33.5	4596.5
223	315	81	54	67.5	35.5	4632
224	316	85	56	70.5	38.5	4670.5
225	317	88	49	68.5	36.5	4707
226	318	85	60	72.5	40.5	4747.5
227	319	83	59	71	39	4786.5
228	320	78	58	68	36	4822.5
229	321	78	60	69	37	4859.5
230	322	83	56	69.5	37.5	4897
231	323	87	58	72.5	40.5	4937.5
232	324	89	55	72	40	4977.5
233	325	85	57	71	39	5016.5
234	326	85	53	69	37	5053.5
235	327	84	49	66.5	34.5	5088
236	328	84	49	66.5	34.5	5122.5
237	329	83	50	66.5	34.5	5157
238	330	82	50	66	34	5191
239	331	83	49	66	34	5225
240	332	83	51	67	35	5260
241	333	67	55	61	29	5289
242	334	77	48	62.5	30.5	5319.5
243	335	80	48	64	32	5351.5
244	336	82	53	67.5	35.5	5387
245	337	83	49	66	34	5421
246	338	77	44	60.5	28.5	5449.5
247	339	78	39	58.5	26.5	5476
248	340	82	46	64	32	5508
249	341	86	48	67	35	5543
250	342	82	48	65	33	5576
251	343	65	41	53	21	5597
252	344	72	38	55	23	5620
253	345	80	42	61	29	5649
254	346	81	49	65	33	5682
255	347	78	50	64	32	5714
256	348	57	50	53.5	21.5	5735.5
257	349	62	46	54	22	5757.5
258	350	68	46	57	25	5782.5
259	351	73	42	57.5	25.5	5808
260	352	73	50	61.5	29.5	5837.5
261	353	74	54	64	32	5869.5
262	354	77	53	65	33	5902.5
263	355	77	48	62.5	30.5	5933
264	356	71	41	56	24	5957
265	357	52	38	45	13	5970
266	358	57	37	47	15	5985
267	359	66	39	52.5	20.5	6005.5
268	360	68	38	53	21	6026.5
269	361	72	40	56	24	6050.5
270	362	72	44	58	26	6076.5
271	363	64	48	56	24	6100.5
272	364	60	45	52.5	20.5	6121
273	365	68	39	53.5	21.5	6142.5



72	798
129	647.5

length of freeze (day)	57
frost index (^oF-day)	150.5
average temperature	48.8

1946-1947

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	65	48	56.5	24.5	24.5
275	2	62	52	57	25	49.5
276	3	63	40	51.5	19.5	69
277	4	63	41	52	20	89
278	5	54	38	46	14	103
279	6	61	36	48.5	16.5	119.5
280	7	55	29	42	10	129.5
281	8	60	32	46	14	143.5
282	9	64	32	48	16	159.5
283	10	49	38	43.5	11.5	171
284	11	49	21	35	3	174

285	12	52	25	38.5	6.5	180.5
286	13	64	34	49	17	197.5
287	14	67	30	48.5	16.5	214
288	15	66	42	54	22	236
289	16	63	35	49	17	253
290	17	56	29	42.5	10.5	263.5
291	18	54	30	42	10	273.5
292	19	57	24	40.5	8.5	282
293	20	64	29	46.5	14.5	296.5
294	21	67	31	49	17	313.5
295	22	69	38	53.5	21.5	335
296	23	66	35	50.5	18.5	353.5
297	24	60	34	47	15	368.5
298	25	64	31	47.5	15.5	384
299	26	62	31	46.5	14.5	398.5
300	27	51	38	44.5	12.5	411
301	28	56	43	49.5	17.5	428.5
302	29	49	40	44.5	12.5	441
303	30	48	30	39	7	448
304	31	50	26	38	6	454
305	32	46	20	33	1	455
306	33	42	25	33.5	1.5	456.5
307	34	43	31	37	5	461.5
308	35	43	21	32	0	461.5
309	36	46	22	34	2	463.5
310	37	50	22	36	4	467.5
311	38	47	23	35	3	470.5
312	39	44	25	34.5	2.5	473
313	40	42	14	28	-4	469
314	41	36	9	22.5	-9.5	459.5
315	42	41	22	31.5	-0.5	459
316	43	49	29	39	7	466
317	44	49	34	41.5	9.5	475.5
318	45	42	32	37	5	480.5
319	46	45	27	36	4	484.5
320	47	43	22	32.5	0.5	485
321	48	47	24	35.5	3.5	488.5
322	49	49	25	37	5	493.5
323	50	47	25	36	4	497.5
324	51	51	32	41.5	9.5	507
325	52	51	32	41.5	9.5	516.5
326	53	54	29	41.5	9.5	526
327	54	50	34	42	10	536
328	55	40	28	34	2	538
329	56	43	25	34	2	540
330	57	47	22	34.5	2.5	542.5
331	58	50	25	37.5	5.5	548
332	59	56	30	43	11	559
333	60	55	29	42	10	569
334	61	65	26	45.5	13.5	582.5
335	62	52	30	41	9	591.5
336	63	55	28	41.5	9.5	601
337	64	58	30	44	12	613
338	65	54	28	41	9	622
339	66	56	33	44.5	12.5	634.5
340	67	50	36	43	11	645.5
341	68	46	30	38	6	651.5
342	69	41	18	29.5	-2.5	649
343	70	45	21	33	1	650
344	71	45	15	30	-2	648
345	72	54	21	37.5	5.5	653.5
346	73	52	25	38.5	6.5	660
347	74	51	25	38	6	666
348	75	53	26	39.5	7.5	673.5
349	76	50	24	37	5	678.5
350	77	51	25	38	6	684.5
351	78	47	18	32.5	0.5	685
352	79	43	17	30	-2	683
353	80	44	16	30	-2	681
354	81	49	13	31	-1	680
355	82	44	19	31.5	-0.5	679.5
356	83	47	15	31	-1	678.5
357	84	45	28	36.5	4.5	683
358	85	46	31	38.5	6.5	689.5
359	86	53	33	43	11	700.5
360	87	45	30	37.5	5.5	706
361	88	40	30	35	3	709
362	89	29	14	21.5	-10.5	698.5
363	90	30	8	19	-13	685.5
364	91	34	11	22.5	-9.5	676
365	92	32	9	20.5	-11.5	664.5
1	93	32	9	20.5	-11.5	653
2	94	27	10	18.5	-13.5	639.5
3	95	31	17	24	-8	631.5
4	96	31	8	19.5	-12.5	619
5	97	44	10	27	-5	614
6	98	38	13	25.5	-6.5	607.5
7	99	33	17	25	-7	600.5
8	100	38	19	28.5	-3.5	597
9	101	35	15	25	-7	590
10	102	36	14	25	-7	583
11	103	29	8	18.5	-13.5	569.5
12	104	27	14	20.5	-11.5	558
13	105	37	11	24	-8	550
14	106	33	19	26	-6	544
15	107	28	15	21.5	-10.5	533.5
16	108	24	6	15	-17	516.5
17	109	22	-5	8.5	-23.5	493
18	110	17	-3	7	-25	468
19	111	36	5	20.5	-11.5	456.5
20	112	35	7	21	-11	445.5
21	113	45	18	31.5	-0.5	445
22	114	42	15	28.5	-3.5	441.5
23	115	41	13	27	-5	436.5
24	116	41	15	28	-4	432.5
25	117	45	21	33	1	433.5
26	118	51	24	37.5	5.5	439
27	119	49	24	36.5	4.5	443.5
28	120	44	24	34	2	445.5

29	121	45	29	37	5	450.5
30	122	30	15	22.5	-9.5	441
31	123	33	8	20.5	-11.5	429.5
32	124	45	14	29.5	-2.5	427
33	125	41	19	30	-2	425
34	126	53	15	34	2	427
35	127	55	26	40.5	8.5	435.5
36	128	54	25	39.5	7.5	443
37	129	57	28	42.5	10.5	453.5
38	130	54	25	39.5	7.5	461
39	131	51	25	38	6	467
40	132	44	26	35	3	470
41	133	42	31	36.5	4.5	474.5
42	134	49	25	37	5	479.5
43	135	46	25	35.5	3.5	483
44	136	56	32	44	12	495
45	137	57	34	45.5	13.5	508.5
46	138	56	27	41.5	9.5	518
47	139	54	29	41.5	9.5	527.5
48	140	55	34	44.5	12.5	540
49	141	46	22	34	2	542
50	142	49	22	35.5	3.5	545.5
51	143	48	22	35	3	548.5
52	144	49	18	33.5	1.5	550
53	145	51	23	37	5	555
54	146	52	29	40.5	8.5	563.5
55	147	54	29	41.5	9.5	573
56	148	49	19	34	2	575
57	149	53	26	39.5	7.5	582.5
58	150	51	36	43.5	11.5	594
59	151	39	29	34	2	596
60	152	45	15	30	-2	594
61	153	42	25	33.5	1.5	595.5
62	154	46	15	30.5	-1.5	594
63	155	47	28	37.5	5.5	599.5
64	156	41	22	31.5	-0.5	599
65	157	45	23	34	2	601
66	158	48	24	36	4	605
67	159	46	25	35.5	3.5	608.5
68	160	49	27	38	6	614.5
69	161	58	22	40	8	622.5
70	162	49	25	37	5	627.5
71	163	47	29	38	6	633.5
72	164	54	20	37	5	638.5
73	165	54	27	40.5	8.5	647
74	166	55	27	41	9	656
75	167	60	29	44.5	12.5	668.5
76	168	63	35	49	17	685.5
77	169	62	28	45	13	698.5
78	170	62	36	49	17	715.5
79	171	63	29	46	14	729.5
80	172	65	32	48.5	16.5	746
81	173	64	38	51	19	765
82	174	56	37	46.5	14.5	779.5
83	175	50	28	39	7	786.5
84	176	56	26	41	9	795.5
85	177	66	28	47	15	810.5
86	178	66	28	47	15	825.5
87	179	64	36	50	18	843.5
88	180	62	32	47	15	858.5
89	181	63	31	47	15	873.5
90	182	64	32	48	16	889.5
91	183	62	32	47	15	904.5
92	184	31	31	31	-1	903.5
93	185	58	37	47.5	15.5	919
94	186	48	30	39	7	926
95	187	50	28	39	7	933
96	188	57	25	41	9	942
97	189	58	35	46.5	14.5	956.5
98	190	59	31	45	13	969.5
99	191	54	44	49	17	986.5
100	192	55	35	45	13	999.5
101	193	52	28	40	8	1007.5
102	194	51	32	41.5	9.5	1017
103	195	63	28	45.5	13.5	1030.5
104	196	70	41	55.5	23.5	1054
105	197	71	44	57.5	25.5	1079.5
106	198	60	32	46	14	1093.5
107	199	71	30	50.5	18.5	1112
108	200	68	41	54.5	22.5	1134.5
109	201	66	32	49	17	1151.5
110	202	73	33	53	21	1172.5
111	203	72	38	55	23	1195.5
112	204	63	37	50	18	1213.5
113	205	60	28	44	12	1225.5
114	206	56	40	48	16	1241.5
115	207	61	26	43.5	11.5	1253
116	208	65	36	50.5	18.5	1271.5
117	209	60	36	48	16	1287.5
118	210	59	38	48.5	16.5	1304
119	211	66	35	50.5	18.5	1322.5
120	212	74	37	55.5	23.5	1346
121	213	80	38	59	27	1373
122	214	87	53	70	38	1411
123	215	88	48	68	36	1447
124	216	91	50	70.5	38.5	1485.5
125	217	90	52	71	39	1524.5
126	218	84	50	67	35	1559.5
127	219	85	50	67.5	35.5	1595
128	220	83	45	64	32	1627
129	221	69	40	54.5	22.5	1649.5
130	222	51	38	44.5	12.5	1662
131	223	49	35	42	10	1672
132	224	62	41	51.5	19.5	1691.5
133	225	69	41	55	23	1714.5
134	226	75	44	59.5	27.5	1742
135	227	61	43	52	20	1762
136	228	70	39	54.5	22.5	1784.5
137	229	75	41	58	26	1810.5

138	230	78	42	60	28	1838.5
139	231	78	44	61	29	1867.5
140	232	76	40	58	26	1893.5
141	233	81	40	60.5	28.5	1922
142	234	80	45	62.5	30.5	1952.5
143	235	65	50	57.5	25.5	1978
144	236	75	40	57.5	25.5	2003.5
145	237	81	42	61.5	29.5	2033
146	238	82	50	66	34	2067
147	239	76	51	63.5	31.5	2098.5
148	240	67	46	56.5	24.5	2123
149	241	74	39	56.5	24.5	2147.5
150	242	78	47	62.5	30.5	2178
151	243	72	50	61	29	2207
152	244	77	45	61	29	2236
153	245	78	47	62.5	30.5	2266.5
154	246	68	53	60.5	28.5	2295
155	247	72	43	57.5	25.5	2320.5
156	248	77	48	62.5	30.5	2351
157	249	79	45	62	30	2381
158	250	86	49	67.5	35.5	2416.5
159	251	84	51	67.5	35.5	2452
160	252	80	52	66	34	2486
161	253	75	40	57.5	25.5	2511.5
162	254	64	48	56	24	2535.5
163	255	67	34	50.5	18.5	2554
164	256	75	28	51.5	19.5	2573.5
165	257	83	43	63	31	2604.5
166	258	89	51	70	38	2642.5
167	259	90	53	71.5	39.5	2682
168	260	82	50	66	34	2716
169	261	70	48	59	27	2743
170	262	83	47	65	33	2776
171	263	85	41	63	31	2807
172	264	58	46	52	20	2827
173	265	61	44	52.5	20.5	2847.5
174	266	74	38	56	24	2871.5
175	267	81	49	65	33	2904.5
176	268	85	55	70	38	2942.5
177	269	83	50	66.5	34.5	2977
178	270	84	48	66	34	3011
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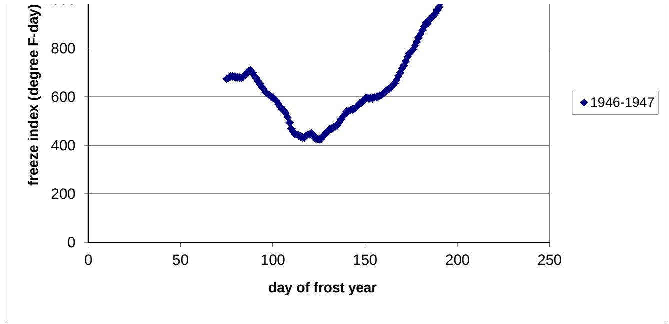
180	272	86	54	70	38	3083
181	273	85	59	72	40	3123
182	274	89	55	72	40	3163
183	275	92	53	72.5	40.5	3203.5
184	276	88	63	75.5	43.5	3247
185	277	92	51	71.5	39.5	3286.5
186	278	90	55	72.5	40.5	3327
187	279	87	59	73	41	3368
188	280	84	58	71	39	3407
189	281	87	59	73	41	3448
190	282	89	51	70	38	3486
191	283	91	59	75	43	3529
192	284	92	52	72	40	3569
193	285	92	46	69	37	3606
194	286	94	61	77.5	45.5	3651.5
195	287	92	63	77.5	45.5	3697
196	288	85	60	72.5	40.5	3737.5
197	289	84	52	68	36	3773.5
198	290	87	55	71	39	3812.5
199	291	92	56	74	42	3854.5
200	292	90	54	72	40	3894.5
201	293	94	57	75.5	43.5	3938
202	294	90	63	76.5	44.5	3982.5
203	295	85	58	71.5	39.5	4022
204	296	90	52	71	39	4061
205	297	91	54	72.5	40.5	4101.5
206	298	92	55	73.5	41.5	4143
207	299	94	58	76	44	4187
208	300	96	67	81.5	49.5	4236.5
209	301	96	65	80.5	48.5	4285
210	302	96	61	78.5	46.5	4331.5
211	303	96	62	79	47	4378.5
212	304	95	64	79.5	47.5	4426
213	305	94	62	78	46	4472
214	306	94	61	77.5	45.5	4517.5
215	307	93	63	78	46	4563.5
216	308	78	52	65	33	4596.5
217	309	81	55	68	36	4632.5
218	310	91	54	72.5	40.5	4673
219	311	91	63	77	45	4718
220	312	90	60	75	43	4761
221	313	82	58	70	38	4799
222	314	82	59	70.5	38.5	4837.5
223	315	83	56	69.5	37.5	4875
224	316	87	55	71	39	4914
225	317	85	55	70	38	4952
226	318	81	55	68	36	4988
227	319	85	57	71	39	5027
228	320	68	58	63	31	5058
229	321	74	55	64.5	32.5	5090.5
230	322	81	50	65.5	33.5	5124
231	323	85	52	68.5	36.5	5160.5
232	324	83	52	67.5	35.5	5196
233	325	72	55	63.5	31.5	5227.5
234	326	70	55	62.5	30.5	5258
235	327	77	54	65.5	33.5	5291.5
236	328	77	50	63.5	31.5	5323
237	329	81	53	67	35	5358
238	330	84	54	69	37	5395
239	331	82	54	68	36	5431
240	332	78	56	67	35	5466
241	333	81	56	68.5	36.5	5502.5
242	334	84	53	68.5	36.5	5539
243	335	89	58	73.5	41.5	5580.5
244	336	90	56	73	41	5621.5
245	337	91	57	74	42	5663.5
246	338	91	57	74	42	5705.5

247	339	90	57	73.5	41.5	5747
248	340	87	53	70	38	5785
249	341	88	57	72.5	40.5	5825.5
250	342	84	54	69	37	5862.5
251	343	78	53	65.5	33.5	5896
252	344	69	49	59	27	5923
253	345	76	47	61.5	29.5	5952.5
254	346	70	40	55	23	5975.5
255	347	74	40	57	25	6000.5
256	348	80	40	60	28	6028.5
257	349	79	42	60.5	28.5	6057
258	350	80	39	59.5	27.5	6084.5
259	351	82	45	63.5	31.5	6116
260	352	81	49	65	33	6149
261	353	78	56	67	35	6184
262	354	78	51	64.5	32.5	6216.5
263	355	79	50	64.5	32.5	6249
264	356	83	42	62.5	30.5	6279.5
265	357	83	45	64	32	6311.5
266	358	86	50	68	36	6347.5
267	359	85	52	68.5	36.5	6384
268	360	84	55	69.5	37.5	6421.5
269	361	83	52	67.5	35.5	6457
270	362	84	52	68	36	6493
271	363	84	50	67	35	6528
272	364	79	51	65	33	6561
273	365	77	50	63.5	31.5	6592.5



88	709	length of freeze (day)	38
126	427	frost index (°F-day)	282
		average temperature	50.1

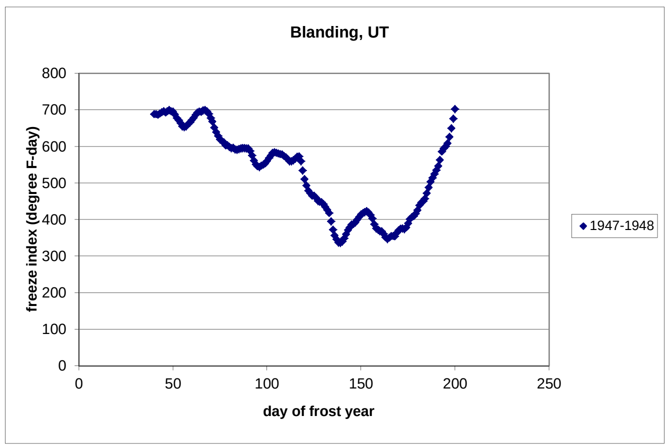
1947-1948

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (°F)	cumulative degree day (°F)
274	1	77	41	59	27	27
275	2	79	43	61	29	56
276	3	79	42	60.5	28.5	84.5
277	4	81	47	64	32	116.5
278	5	81	44	62.5	30.5	147
279	6	76	45	60.5	28.5	175.5
280	7	74	48	61	29	204.5
281	8	73	42	57.5	25.5	230
282	9	75	43	59	27	257
283	10	68	40	54	22	279
284	11	58	43	50.5	18.5	297.5
285	12	62	42	52	20	317.5
286	13	63	45	54	22	339.5
287	14	50	43	46.5	14.5	354
288	15	61	40	50.5	18.5	372.5
289	16	61	36	48.5	16.5	389
290	17	65	38	51.5	19.5	408.5
291	18	68	40	54	22	430.5
292	19	72	44	58	26	456.5
293	20	71	42	56.5	24.5	481
294	21	68	40	54	22	503
295	22	58	32	45	13	516
296	23	56	30	43	11	527
297	24	55	32	43.5	11.5	538.5
298	25	58	27	42.5	10.5	549
299	26	60	28	44	12	561
300	27	63	29	46	14	575
301	28	64	31	47.5	15.5	590.5
302	29	63	39	51	19	609.5
303	30	62	31	46.5	14.5	624
304	31	66	30	48	16	640
305	32	64	28	46	14	654
306	33	59	32	45.5	13.5	667.5
307	34	50	29	39.5	7.5	675
308	35	48	22	35	3	678
309	36	51	24	37.5	5.5	683.5
310	37	36	22	29	-3	680.5
311	38	47	20	33.5	1.5	682
312	39	48	20	34	2	684
313	40	48	24	36	4	688
314	41	42	23	32.5	0.5	688.5
315	42	44	16	30	-2	686.5
316	43	46	25	35.5	3.5	690
317	44	48	24	36	4	694
318	45	44	24	34	2	696
319	46	41	16	28.5	-3.5	692.5
320	47	45	26	35.5	3.5	696
321	48	49	22	35.5	3.5	699.5
322	49	38	20	29	-3	696.5
323	50	34	27	30.5	-1.5	695
324	51	32	17	24.5	-7.5	687.5
325	52	33	12	22.5	-9.5	678
326	53	38	13	25.5	-6.5	671.5
327	54	36	12	24	-8	663.5
328	55	37	10	23.5	-8.5	655
329	56	45	15	30	-2	653
330	57	46	23	34.5	2.5	655.5
331	58	50	26	38	6	661.5
332	59	47	26	36.5	4.5	666
333	60	49	28	38.5	6.5	672.5
334	61	42	34	38	6	678.5
335	62	45	35	40	8	686.5
336	63	45	32	38.5	6.5	693
337	64	40	28	34	2	695
338	65	35	28	31.5	-0.5	694.5
339	66	42	30	36	4	698.5
340	67	39	28	33.5	1.5	700
341	68	34	22	28	-4	696
342	69	32	18	25	-7	689
343	70	31	11	21	-11	678
344	71	40	5	22.5	-9.5	668.5
345	72	30	0	15	-17	651.5
346	73	30	9	19.5	-12.5	639
347	74	36	8	22	-10	629
348	75	36	8	22	-10	619
349	76	42	14	28	-4	615
350	77	43	14	28.5	-3.5	611.5

351	78	40	7	23.5	-8.5	603
352	79	50	15	32.5	0.5	603.5
353	80	43	13	28	-4	599.5
354	81	40	17	28.5	-3.5	596
355	82	41	24	32.5	0.5	596.5
356	83	40	16	28	-4	592.5
357	84	42	20	31	-1	591.5
358	85	48	19	33.5	1.5	593
359	86	46	22	34	2	595
360	87	44	21	32.5	0.5	595.5
361	88	45	20	32.5	0.5	596
362	89	41	20	30.5	-1.5	594.5
363	90	40	24	32	0	594.5
364	91	37	14	25.5	-6.5	588
365	92	32	8	20	-12	576
1	93	32	4	18	-14	562
2	94	34	8	21	-11	551
3	95	42	12	27	-5	546
4	96	43	18	30.5	-1.5	544.5
5	97	47	23	35	3	547.5
6	98	45	24	34.5	2.5	550
7	99	47	25	36	4	554
8	100	49	28	38.5	6.5	560.5
9	101	51	30	40.5	8.5	569
10	102	50	28	39	7	576
11	103	49	28	38.5	6.5	582.5
12	104	44	23	33.5	1.5	584
13	105	44	18	31	-1	583
14	106	41	18	29.5	-2.5	580.5
15	107	43	18	30.5	-1.5	579
16	108	43	20	31.5	-0.5	578.5
17	109	37	18	27.5	-4.5	574
18	110	38	19	28.5	-3.5	570.5
19	111	37	18	27.5	-4.5	566
20	112	38	13	25.5	-6.5	559.5
21	113	45	19	32	0	559.5
22	114	48	22	35	3	562.5
23	115	47	25	36	4	566.5
24	116	47	29	38	6	572.5
25	117	45	20	32.5	0.5	573
26	118	32	5	18.5	-13.5	559.5
27	119	19	-5	7	-25	534.5
28	120	24	-8	8	-24	510.5
29	121	29	1	15	-17	493.5
30	122	34	2	18	-14	479.5
31	123	37	12	24.5	-7.5	472
32	124	40	11	25.5	-6.5	465.5
33	125	44	20	32	0	465.5
34	126	37	17	27	-5	460.5
35	127	34	12	23	-9	451.5
36	128	39	22	30.5	-1.5	450
37	129	34	25	29.5	-2.5	447.5
38	130	36	18	27	-5	442.5
39	131	38	10	24	-8	434.5
40	132	35	14	24.5	-7.5	427
41	133	31	15	23	-9	418
42	134	18	0	9	-23	395
43	135	20	-1	9.5	-22.5	372.5
44	136	34	-2	16	-16	356.5
45	137	35	8	21.5	-10.5	346
46	138	38	10	24	-8	338
47	139	44	17	30.5	-1.5	336.5
48	140	47	25	36	4	340.5
49	141	52	29	40.5	8.5	349
50	142	53	34	43.5	11.5	360.5
51	143	53	33	43	11	371.5
52	144	51	27	39	7	378.5
53	145	51	30	40.5	8.5	387
54	146	38	28	33	1	388
55	147	45	28	36.5	4.5	392.5
56	148	49	32	40.5	8.5	401
57	149	46	32	39	7	408
58	150	50	27	38.5	6.5	414.5
59	151	41	31	36	4	418.5
60	152	39	29	34	2	420.5
61	153	41	28	34.5	2.5	423
62	154	38	20	29	-3	420
63	155	32	18	25	-7	413
64	156	29	16	22.5	-9.5	403.5
65	157	30	2	16	-16	387.5
66	158	37	5	21	-11	376.5
67	159	41	15	28	-4	372.5
68	160	41	17	29	-3	369.5
69	161	33	29	31	-1	368.5
70	162	36	14	25	-7	361.5
71	163	38	6	22	-10	351.5
72	164	41	15	28	-4	347.5
73	165	47	24	35.5	3.5	351
74	166	46	27	36.5	4.5	355.5
75	167	38	26	32	0	355.5
76	168	40	21	30.5	-1.5	354
77	169	52	31	41.5	9.5	363.5
78	170	46	32	39	7	370.5
79	171	47	26	36.5	4.5	375
80	172	38	29	33.5	1.5	376.5
81	173	39	21	30	-2	374.5
82	174	52	21	36.5	4.5	379
83	175	59	28	43.5	11.5	390.5
84	176	60	26	43	11	401.5
85	177	42	33	37.5	5.5	407
86	178	48	21	34.5	2.5	409.5
87	179	53	25	39	7	416.5
88	180	59	24	41.5	9.5	426
89	181	59	32	45.5	13.5	439.5
90	182	51	28	39.5	7.5	447
91	183	45	26	35.5	3.5	450.5
92	184	56	22	39	7	457.5
93	185	64	30	47	15	472.5
94	186	60	36	48	16	488.5

95	187	59	35	47	15	503.5
96	188	59	27	43	11	514.5
97	189	58	27	42.5	10.5	525
98	190	56	28	42	10	535
99	191	60	28	44	12	547
100	192	65	31	48	16	563
101	193	66	45	55.5	23.5	586.5
102	194	50	31	40.5	8.5	595
103	195	50	25	37.5	5.5	600.5
104	196	55	26	40.5	8.5	609
105	197	65	34	49.5	17.5	626.5
106	198	71	40	55.5	23.5	650
107	199	75	41	58	26	676
108	200	77	39	58	26	702
109	201	75	39	57	25	727
110	202	64	29	46.5	14.5	741.5
111	203	70	34	52	20	761.5
112	204	72	45	58.5	26.5	788
113	205	67	41	54	22	810
114	206	56	33	44.5	12.5	822.5
115	207	50	34	42	10	832.5
116	208	62	27	44.5	12.5	845
117	209	64	37	50.5	18.5	863.5
118	210	70	36	53	21	884.5
119	211	76	36	56	24	908.5
120	212	69	45	57	25	933.5
121	213	64	32	48	16	949.5
122	214	61	40	50.5	18.5	968
123	215	62	36	49	17	985
124	216	66	37	51.5	19.5	1004.5
125	217	70	39	54.5	22.5	1027
126	218	66	39	52.5	20.5	1047.5
127	219	75	40	57.5	25.5	1073
128	220	74	42	58	26	1099
129	221	60	40	50	18	1117
130	222	58	34	46	14	1131
131	223	62	34	48	16	1147
132	224	66	33	49.5	17.5	1164.5
133	225	69	33	51	19	1183.5
134	226	77	40	58.5	26.5	1210
135	227	80	41	60.5	28.5	1238.5
136	228	84	46	65	33	1271.5
137	229	85	49	67	35	1306.5
138	230	82	48	65	33	1339.5
139	231	72	58	65	33	1372.5
140	232	77	54	65.5	33.5	1406
141	233	80	42	61	29	1435
142	234	81	40	60.5	28.5	1463.5
143	235	78	40	59	27	1490.5
144	236	80	47	63.5	31.5	1522
145	237	76	48	62	30	1552
146	238	69	50	59.5	27.5	1579.5
147	239	71	44	57.5	25.5	1605
148	240	73	48	60.5	28.5	1633.5
149	241	78	44	61	29	1662.5
150	242	75	42	58.5	26.5	1689
151	243	78	40	59	27	1716
152	244	83	45	64	32	1748
153	245	76	50	63	31	1779
154	246	71	45	58	26	1805
155	247	71	32	51.5	19.5	1824.5
156	248	75	46	60.5	28.5	1853
157	249	79	43	61	29	1882
158	250	81	45	63	31	1913
159	251	76	56	66	34	1947
160	252	84	46	65	33	1980
161	253	88	50	69	37	2017
162	254	88	53	70.5	38.5	2055.5
163	255	82	56	69	37	2092.5
164	256	84	52	68	36	2128.5
165	257	86	48	67	35	2163.5
166	258	85	50	67.5	35.5	2199
167	259	84	48	66	34	2233
168	260	85	46	65.5	33.5	2266.5
169	261	87	47	67	35	2301.5
170	262	86	48	67	35	2336.5
171	263	81	50	65.5	33.5	2370
172	264	76	42	59	27	2397
173	265	59	43	51	19	2416
174	266	64	39	51.5	19.5	2435.5
175	267	72	31	51.5	19.5	2455
176	268	79	47	63	31	2486
177	269	83	50	66.5	34.5	2520.5
178	270	79	55	67	35	2555.5
179	271	69	48	58.5	26.5	2582
180	272	83	45	64	32	2614
181	273	86	62	74	42	2656
182	274	86	51	68.5	36.5	2692.5
183	275	87	55	71	39	2731.5
184	276	86	56	71	39	2770.5
185	277	86	48	67	35	2805.5
186	278	88	51	69.5	37.5	2843
187	279	87	55	71	39	2882
188	280	90	60	75	43	2925
189	281	88	52	70	38	2963
190	282	89	49	69	37	3000
191	283	91	46	68.5	36.5	3036.5
192	284	92	50	71	39	3075.5
193	285	91	55	73	41	3116.5
194	286	92	48	70	38	3154.5
195	287	91	51	71	39	3193.5
196	288	89	60	74.5	42.5	3236
197	289	91	57	74	42	3278
198	290	93	55	74	42	3320
199	291	93	61	77	45	3365
200	292	90	57	73.5	41.5	3406.5
201	293	81	55	68	36	3442.5
202	294	83	52	67.5	35.5	3478
203	295	84	54	69	37	3515

204	296	91	56	73.5	41.5	3556.5
205	297	88	60	74	42	3598.5
206	298	84	55	69.5	37.5	3636
207	299	85	58	71.5	39.5	3675.5
208	300	88	60	74	42	3717.5
209	301	91	56	73.5	41.5	3759
210	302	86	58	72	40	3799
211	303	86	54	70	38	3837
212	304	90	54	72	40	3877
213	305	94	56	75	43	3920
214	306	91	57	74	42	3962
215	307	93	56	74.5	42.5	4004.5
216	308	82	56	69	37	4041.5
217	309	71	58	64.5	32.5	4074
218	310	76	59	67.5	35.5	4109.5
219	311	80	54	67	35	4144.5
220	312	80	51	65.5	33.5	4178
221	313	80	55	67.5	35.5	4213.5
222	314	82	52	67	35	4248.5
223	315	85	54	69.5	37.5	4286
224	316	87	55	71	39	4325
225	317	86	57	71.5	39.5	4364.5
226	318	87	55	71	39	4403.5
227	319	86	52	69	37	4440.5
228	320	89	52	70.5	38.5	4479
229	321	90	54	72	40	4519
230	322	90	55	72.5	40.5	4559.5
231	323	91	60	75.5	43.5	4603
232	324	89	61	75	43	4646
233	325	89	54	71.5	39.5	4685.5
234	326	90	57	73.5	41.5	4727
235	327	85	54	69.5	37.5	4764.5
236	328	76	45	60.5	28.5	4793
237	329	82	55	68.5	36.5	4829.5
238	330	80	47	63.5	31.5	4861
239	331	84	45	64.5	32.5	4893.5
240	332	89	49	69	37	4930.5
241	333	92	53	72.5	40.5	4971
242	334	95	53	74	42	5013
243	335	92	56	74	42	5055
244	336	95	53	74	42	5097
245	337	95	55	75	43	5140
246	338	95	57	76	44	5184
247	339	93	53	73	41	5225
248	340	91	53	72	40	5265
249	341	90	51	70.5	38.5	5303.5
250	342	89	48	68.5	36.5	5340
251	343	86	47	66.5	34.5	5374.5
252	344	84	49	66.5	34.5	5409
253	345	84	49	66.5	34.5	5443.5
254	346	85	48	66.5	34.5	5478
255	347	86	45	65.5	33.5	5511.5
256	348	88	47	67.5	35.5	5547
257	349	88	55	71.5	39.5	5586.5
258	350	88	52	70	38	5624.5
259	351	82	40	61	29	5653.5
260	352	70	33	51.5	19.5	5673
261	353	74	52	63	31	5704
262	354	81	52	66.5	34.5	5738.5
263	355	76	52	64	32	5770.5
264	356	77	41	59	27	5797.5
265	357	80	41	60.5	28.5	5826
266	358	77	45	61	29	5855
267	359	76	40	58	26	5881
268	360	77	42	59.5	27.5	5908.5
269	361	81	46	63.5	31.5	5940
270	362	77	56	66.5	34.5	5974.5
271	363	66	50	58	26	6000.5
272	364	65	49	57	25	6025.5
273	365	79	46	62.5	30.5	6056
274	366	68	41	54.5	22.5	6078.5



67	700	length of freeze (day)	72
139	336.5	frost index (^{o}F-day)	363.5
		average temperature	48.6

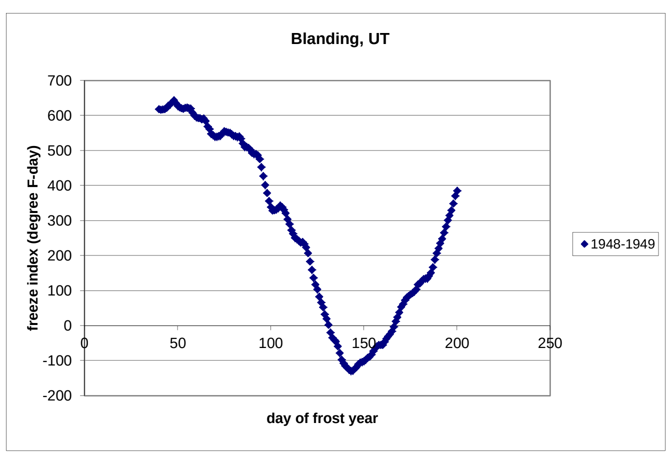
1948-1949

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	73	40	56.5	24.5	24.5
275	2	73	39	56	24	48.5
276	3	74	41	57.5	25.5	74
277	4	67	46	56.5	24.5	98.5
278	5	65	39	52	20	118.5
279	6	53	36	44.5	12.5	131
280	7	66	30	48	16	147
281	8	69	36	52.5	20.5	167.5
282	9	73	34	53.5	21.5	189
283	10	75	39	57	25	214
284	11	73	36	54.5	22.5	236.5
285	12	74	38	56	24	260.5
286	13	75	42	58.5	26.5	287
287	14	75	46	60.5	28.5	315.5
288	15	67	38	52.5	20.5	336
289	16	68	40	54	22	358
290	17	63	28	45.5	13.5	371.5
291	18	65	32	48.5	16.5	388
292	19	56	40	48	16	404
293	20	65	35	50	18	422
294	21	66	37	51.5	19.5	441.5
295	22	68	34	51	19	460.5
296	23	67	36	51.5	19.5	480
297	24	67	30	48.5	16.5	496.5
298	25	67	28	47.5	15.5	512
299	26	63	32	47.5	15.5	527.5
300	27	56	34	45	13	540.5
301	28	43	32	37.5	5.5	546
302	29	43	30	36.5	4.5	550.5
303	30	43	38	40.5	8.5	559
304	31	56	37	46.5	14.5	573.5
305	32	59	31	45	13	586.5
306	33	56	33	44.5	12.5	599

307	34	58	35	46.5	14.5	613.5
308	35	45	28	36.5	4.5	618
309	36	46	21	33.5	1.5	619.5
310	37	47	19	33	1	620.5
311	38	52	22	37	5	625.5
312	39	42	19	30.5	-1.5	624
313	40	41	12	26.5	-5.5	618.5
314	41	41	18	29.5	-2.5	616
315	42	44	22	33	1	617
316	43	47	19	33	1	618
317	44	51	20	35.5	3.5	621.5
318	45	55	22	38.5	6.5	628
319	46	50	22	36	4	632
320	47	50	25	37.5	5.5	637.5
321	48	52	25	38.5	6.5	644
322	49	34	14	24	-8	636
323	50	37	10	23.5	-8.5	627.5
324	51	36	23	29.5	-2.5	625
325	52	39	17	28	-4	621
326	53	44	16	30	-2	619
327	54	47	23	35	3	622
328	55	44	22	33	1	623
329	56	42	18	30	-2	621
330	57	44	18	31	-1	620
331	58	30	11	20.5	-11.5	608.5
332	59	37	9	23	-9	599.5
333	60	44	12	28	-4	595.5
334	61	45	13	29	-3	592.5
335	62	44	20	32	0	592.5
336	63	43	14	28.5	-3.5	589
337	64	50	20	35	3	592
338	65	34	14	24	-8	584
339	66	30	4	17	-15	569
340	67	36	13	24.5	-7.5	561.5
341	68	29	8	18.5	-13.5	548
342	69	41	15	28	-4	544
343	70	40	15	27.5	-4.5	539.5
344	71	44	20	32	0	539.5
345	72	49	18	33.5	1.5	541
346	73	45	22	33.5	1.5	542.5
347	74	51	25	38	6	548.5
348	75	48	29	38.5	6.5	555
349	76	41	20	30.5	-1.5	553.5
350	77	38	22	30	-2	551.5
351	78	42	20	31	-1	550.5
352	79	41	15	28	-4	546.5
353	80	42	13	27.5	-4.5	542
354	81	44	18	31	-1	541
355	82	44	16	30	-2	539
356	83	42	25	33.5	1.5	540.5
357	84	37	15	26	-6	534.5
358	85	31	4	17.5	-14.5	520
359	86	36	8	22	-10	510
360	87	37	27	32	0	510
361	88	35	25	30	-2	508
362	89	34	18	26	-6	502
363	90	36	10	23	-9	493
364	91	43	15	29	-3	490
365	92	-	-	-	-	490
1	93	31	27	29	-3	487
2	94	30	12	21	-11	476
3	95	20	-2	9	-23	453
4	96	20	-8	6	-26	427
5	97	22	-9	6.5	-25.5	401.5
6	98	24	-5	9.5	-22.5	379
7	99	25	-8	8.5	-23.5	355.5
8	100	33	-2	15.5	-16.5	339
9	101	33	10	21.5	-10.5	328.5
10	102	35	30	32.5	0.5	329
11	103	40	31	35.5	3.5	332.5
12	104	45	26	35.5	3.5	336
13	105	43	36	39.5	7.5	343.5
14	106	38	16	27	-5	338.5
15	107	35	14	24.5	-7.5	331
16	108	32	12	22	-10	321
17	109	29	1	15	-17	304
18	110	31	5	18	-14	290
19	111	30	0	15	-17	273
20	112	32	12	22	-10	263
21	113	32	8	20	-12	251
22	114	36	20	28	-4	247
23	115	36	20	28	-4	243
24	116	33	20	26.5	-5.5	237.5
25	117	47	20	33.5	1.5	239
26	118	32	21	26.5	-5.5	233.5
27	119	29	15	22	-10	223.5
28	120	29	2	15.5	-16.5	207
29	121	24	-8	8	-24	183
30	122	22	-5	8.5	-23.5	159.5
31	123	22	-3	9.5	-22.5	137
32	124	29	-4	12.5	-19.5	117.5
33	125	30	6	18	-14	103.5
34	126	24	-1	11.5	-20.5	83
35	127	30	0	15	-17	66
36	128	31	6	18.5	-13.5	52.5
37	129	25	-2	11.5	-20.5	32
38	130	29	10	19.5	-12.5	19.5
39	131	31	-1	15	-17	2.5
40	132	26	-7	9.5	-22.5	-20
41	133	36	0	18	-14	-34
42	134	47	4	25.5	-6.5	-40.5
43	135	35	20	27.5	-4.5	-45
44	136	31	5	18	-14	-59
45	137	26	0	13	-19	-78
46	138	28	-3	12.5	-19.5	-97.5
47	139	39	5	22	-10	-107.5
48	140	40	9	24.5	-7.5	-115
49	141	44	10	27	-5	-120
50	142	41	12	26.5	-5.5	-125.5

51	143	44	12	28	-4	-129.5
52	144	45	21	33	1	-128.5
53	145	52	23	37.5	5.5	-123
54	146	49	25	37	5	-118
55	147	52	27	39.5	7.5	-110.5
56	148	46	27	36.5	4.5	-106
57	149	44	24	34	2	-104
58	150	43	27	35	3	-101
59	151	42	29	35.5	3.5	-97.5
60	152	50	25	37.5	5.5	-92
61	153	46	24	35	3	-89
62	154	50	26	38	6	-83
63	155	55	29	42	10	-73
64	156	51	30	40.5	8.5	-64.5
65	157	51	24	37.5	5.5	-59
66	158	44	28	36	4	-55
67	159	41	22	31.5	-0.5	-55.5
68	160	44	20	32	0	-55.5
69	161	52	30	41	9	-46.5
70	162	54	29	41.5	9.5	-37
71	163	50	26	38	6	-31
72	164	50	28	39	7	-24
73	165	55	25	40	8	-16
74	166	59	30	44.5	12.5	-3.5
75	167	62	33	47.5	15.5	12
76	168	59	30	44.5	12.5	24.5
77	169	60	31	45.5	13.5	38
78	170	65	29	47	15	53
79	171	48	34	41	9	62
80	172	54	32	43	11	73
81	173	49	31	40	8	81
82	174	44	27	35.5	3.5	84.5
83	175	45	28	36.5	4.5	89
84	176	45	26	35.5	3.5	92.5
85	177	47	26	36.5	4.5	97
86	178	53	24	38.5	6.5	103.5
87	179	56	35	45.5	13.5	117
88	180	41	30	35.5	3.5	120.5
89	181	47	30	38.5	6.5	127
90	182	46	30	38	6	133
91	183	40	27	33.5	1.5	134.5
92	184	45	20	32.5	0.5	135
93	185	48	30	39	7	142
94	186	55	28	41.5	9.5	151.5
95	187	65	30	47.5	15.5	167
96	188	67	40	53.5	21.5	188.5
97	189	65	36	50.5	18.5	207
98	190	52	40	46	14	221
99	191	57	36	46.5	14.5	235.5
100	192	53	37	45	13	248.5
101	193	66	31	48.5	16.5	265
102	194	68	31	49.5	17.5	282.5
103	195	63	38	50.5	18.5	301
104	196	61	30	45.5	13.5	314.5
105	197	61	32	46.5	14.5	329
106	198	69	35	52	20	349
107	199	70	37	53.5	21.5	370.5
108	200	56	37	46.5	14.5	385
109	201	65	34	49.5	17.5	402.5
110	202	62	36	49	17	419.5
111	203	69	35	52	20	439.5
112	204	74	37	55.5	23.5	463
113	205	77	47	62	30	493
114	206	79	43	61	29	522
115	207	77	45	61	29	551
116	208	76	47	61.5	29.5	580.5
117	209	68	46	57	25	605.5
118	210	75	39	57	25	630.5
119	211	75	41	58	26	656.5
120	212	-	-	-	-	656.5
121	213	70	33	51.5	19.5	676
122	214	75	40	57.5	25.5	701.5
123	215	74	36	55	23	724.5
124	216	69	40	54.5	22.5	747
125	217	54	35	44.5	12.5	759.5
126	218	49	36	42.5	10.5	770
127	219	56	35	45.5	13.5	783.5
128	220	65	33	49	17	800.5
129	221	72	35	53.5	21.5	822
130	222	72	40	56	24	846
131	223	68	39	53.5	21.5	867.5
132	224	64	40	52	20	887.5
133	225	71	38	54.5	22.5	910
134	226	75	45	60	28	938
135	227	65	41	53	21	959
136	228	53	40	46.5	14.5	973.5
137	229	65	43	54	22	995.5
138	230	65	40	52.5	20.5	1016
139	231	68	36	52	20	1036
140	232	59	38	48.5	16.5	1052.5
141	233	67	38	52.5	20.5	1073
142	234	72	44	58	26	1099
143	235	77	42	59.5	27.5	1126.5
144	236	80	43	61.5	29.5	1156
145	237	82	49	65.5	33.5	1189.5
146	238	85	49	67	35	1224.5
147	239	73	51	62	30	1254.5
148	240	74	50	62	30	1284.5
149	241	75	43	59	27	1311.5
150	242	70	39	54.5	22.5	1334
151	243	69	39	54	22	1356
152	244	66	43	54.5	22.5	1378.5
153	245	70	35	52.5	20.5	1399
154	246	71	53	62	30	1429
155	247	66	43	54.5	22.5	1451.5
156	248	71	38	54.5	22.5	1474
157	249	65	43	54	22	1496
158	250	69	31	50	18	1514
159	251	73	45	59	27	1541

160	252	78	47	62.5	30.5	1571.5
161	253	83	49	66	34	1605.5
162	254	78	47	62.5	30.5	1636
163	255	83	51	67	35	1671
164	256	81	47	64	32	1703
165	257	81	51	66	34	1737
166	258	87	47	67	35	1772
167	259	89	54	71.5	39.5	1811.5
168	260	81	58	69.5	37.5	1849
169	261	67	55	61	29	1878
170	262	78	50	64	32	1910
171	263	80	51	65.5	33.5	1943.5
172	264	84	46	65	33	1976.5
173	265	86	55	70.5	38.5	2015
174	266	82	54	68	36	2051
175	267	77	49	63	31	2082
176	268	84	45	64.5	32.5	2114.5
177	269	83	52	67.5	35.5	2150
178	270	81	49	65	33	2183
179	271	82	48	65	33	2216
180	272	84	44	64	32	2248
181	273	87	52	69.5	37.5	2285.5
182	274	90	55	72.5	40.5	2326
183	275	87	58	72.5	40.5	2366.5
184	276	85	60	72.5	40.5	2407
185	277	83	55	69	37	2444
186	278	85	53	69	37	2481
187	279	81	60	70.5	38.5	2519.5
188	280	83	50	66.5	34.5	2554
189	281	89	53	71	39	2593
190	282	88	57	72.5	40.5	2633.5
191	283	76	55	65.5	33.5	2667
192	284	84	54	69	37	2704
193	285	86	52	69	37	2741
194	286	87	54	70.5	38.5	2779.5
195	287	90	56	73	41	2820.5
196	288	91	60	75.5	43.5	2864
197	289	95	55	75	43	2907
198	290	95	60	77.5	45.5	2952.5
199	291	94	58	76	44	2996.5
200	292	89	51	70	38	3034.5
201	293	87	55	71	39	3073.5
202	294	86	55	70.5	38.5	3112
203	295	88	59	73.5	41.5	3153.5
204	296	84	54	69	37	3190.5
205	297	83	57	70	38	3228.5
206	298	85	58	71.5	39.5	3268
207	299	89	50	69.5	37.5	3305.5
208	300	88	51	69.5	37.5	3343
209	301	89	51	70	38	3381
210	302	92	55	73.5	41.5	3422.5
211	303	94	53	73.5	41.5	3464
212	304	96	57	76.5	44.5	3508.5
213	305	96	55	75.5	43.5	3552
214	306	90	59	74.5	42.5	3594.5
215	307	85	59	72	40	3634.5
216	308	91	52	71.5	39.5	3674
217	309	93	58	75.5	43.5	3717.5
218	310	94	59	76.5	44.5	3762
219	311	90	51	70.5	38.5	3800.5
220	312	80	58	69	37	3837.5
221	313	80	52	66	34	3871.5
222	314	83	49	66	34	3905.5
223	315	84	52	68	36	3941.5
224	316	85	48	66.5	34.5	3976
225	317	86	49	67.5	35.5	4011.5
226	318	84	47	65.5	33.5	4045
227	319	84	47	65.5	33.5	4078.5
228	320	83	50	66.5	34.5	4113
229	321	86	54	70	38	4151
230	322	89	43	66	34	4185
231	323	89	45	67	35	4220
232	324	93	46	69.5	37.5	4257.5
233	325	91	50	70.5	38.5	4296
234	326	91	54	72.5	40.5	4336.5
235	327	79	50	64.5	32.5	4369
236	328	84	48	66	34	4403
237	329	84	53	68.5	36.5	4439.5
238	330	86	49	67.5	35.5	4475
239	331	88	50	69	37	4512
240	332	89	56	72.5	40.5	4552.5
241	333	91	52	71.5	39.5	4592
242	334	93	55	74	42	4634
243	335	93	52	72.5	40.5	4674.5
244	336	86	56	71	39	4713.5
245	337	87	52	69.5	37.5	4751
246	338	87	54	70.5	38.5	4789.5
247	339	86	48	67	35	4824.5
248	340	85	50	67.5	35.5	4860
249	341	87	48	67.5	35.5	4895.5
250	342	88	51	69.5	37.5	4933
251	343	87	57	72	40	4973
252	344	78	52	65	33	5006
253	345	71	52	61.5	29.5	5035.5
254	346	76	49	62.5	30.5	5066
255	347	78	46	62	30	5096
256	348	72	48	60	28	5124
257	349	75	41	58	26	5150
258	350	80	43	61.5	29.5	5179.5
259	351	81	41	61	29	5208.5
260	352	85	47	66	34	5242.5
261	353	84	41	62.5	30.5	5273
262	354	84	36	60	28	5301
263	355	85	45	65	33	5334
264	356	86	55	70.5	38.5	5372.5
265	357	94	46	70	38	5410.5
266	358	83	46	64.5	32.5	5443
267	359	82	44	63	31	5474
268	360	82	45	63.5	31.5	5505.5



48 644 length of freeze (day) 96

269	361	83	51	67	35	5540.5	144	-128.5	frost index (^oF-day)	772.5
270	362	82	50	66	34	5574.5			average temperature	47.6
271	363	75	50	62.5	30.5	5605				
272	364	76	48	62	30	5635				
273	365	72	38	55	23	5658				

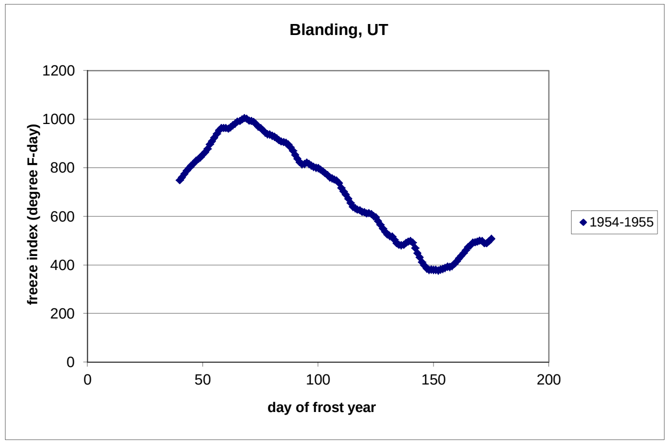
1954-1955

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	81	42	61.5	29.5	29.5
275	2	72	51	61.5	29.5	59
276	3	64	52	58	26	85
277	4	72	51	61.5	29.5	114.5
278	5	74	46	60	28	142.5
279	6	77	50	63.5	31.5	174
280	7	75	49	62	30	204
281	8	74	51	62.5	30.5	234.5
282	9	70	49	59.5	27.5	262
283	10	70	43	56.5	24.5	286.5
284	11	68	40	54	22	308.5
285	12	73	41	57	25	333.5
286	13	71	40	55.5	23.5	357
287	14	63	32	47.5	15.5	372.5
288	15	70	38	54	22	394.5
289	16	68	34	51	19	413.5
290	17	71	31	51	19	432.5
291	18	74	36	55	23	455.5
292	19	80	35	57.5	25.5	481
293	20	72	37	54.5	22.5	503.5
294	21	76	42	59	27	530.5
295	22	74	41	57.5	25.5	556
296	23	71	39	55	23	579
297	24	58	28	43	11	590
298	25	48	28	38	6	596
299	26	47	27	37	5	601
300	27	55	22	38.5	6.5	607.5
301	28	57	23	40	8	615.5
302	29	62	27	44.5	12.5	628
303	30	63	26	44.5	12.5	640.5
304	31	62	28	45	13	653.5
305	32	62	30	46	14	667.5
306	33	54	30	42	10	677.5
307	34	59	25	42	10	687.5
308	35	60	29	44.5	12.5	700
309	36	60	25	42.5	10.5	710.5
310	37	60	24	42	10	720.5
311	38	60	23	41.5	9.5	730
312	39	58	24	41	9	739
313	40	60	25	42.5	10.5	749.5
314	41	62	26	44	12	761.5
315	42	61	32	46.5	14.5	776
316	43	52	37	44.5	12.5	788.5
317	44	53	32	42.5	10.5	799
318	45	53	31	42	10	809
319	46	55	29	42	10	819
320	47	53	32	42.5	10.5	829.5
321	48	49	27	38	6	835.5
322	49	55	25	40	8	843.5
323	50	58	28	43	11	854.5
324	51	59	27	43	11	865.5
325	52	60	30	45	13	878.5
326	53	65	35	50	18	896.5
327	54	61	30	45.5	13.5	910
328	55	63	30	46.5	14.5	924.5
329	56	63	33	48	16	940.5
330	57	58	33	45.5	13.5	954
331	58	58	25	41.5	9.5	963.5
332	59	40	24	32	0	963.5
333	60	40	25	32.5	0.5	964
334	61	38	21	29.5	-2.5	961.5
335	62	47	30	38.5	6.5	968
336	63	50	29	39.5	7.5	975.5
337	64	49	28	38.5	6.5	982
338	65	48	32	40	8	990
339	66	46	24	35	3	993
340	67	50	27	38.5	6.5	999.5
341	68	50	24	37	5	1004.5
342	69	41	17	29	-3	1001.5
343	70	37	12	24.5	-7.5	994
344	71	35	26	30.5	-1.5	992.5
345	72	39	17	28	-4	988.5
346	73	34	14	24	-8	980.5
347	74	31	13	22	-10	970.5
348	75	38	11	24.5	-7.5	963
349	76	33	13	23	-9	954
350	77	36	10	23	-9	945
351	78	44	6	25	-7	938
352	79	48	14	31	-1	937
353	80	40	15	27.5	-4.5	932.5
354	81	43	13	28	-4	928.5
355	82	37	12	24.5	-7.5	921
356	83	35	14	24.5	-7.5	913.5
357	84	40	14	27	-5	908.5
358	85	42	16	29	-3	905.5
359	86	41	17	29	-3	902.5
360	87	35	16	25.5	-6.5	896
361	88	27	15	21	-11	885
362	89	30	5	17.5	-14.5	870.5
363	90	26	2	14	-18	852.5
364	91	30	3	16.5	-15.5	837
365	92	29	7	18	-14	823
1	93	33	14	23.5	-8.5	814.5
2	94	39	29	34	2	816.5
3	95	42	31	36.5	4.5	821
4	96	37	18	27.5	-4.5	816.5
5	97	34	15	24.5	-7.5	809
6	98	37	18	27.5	-4.5	804.5
7	99	36	21	28.5	-3.5	801

8	100	41	19	30	-2	799
9	101	32	18	25	-7	792
10	102	29	23	26	-6	786
11	103	33	15	24	-8	778
12	104	38	11	24.5	-7.5	770.5
13	105	33	12	22.5	-9.5	761
14	106	42	15	28.5	-3.5	757.5
15	107	39	13	26	-6	751.5
16	108	32	25	28.5	-3.5	748
17	109	38	5	21.5	-10.5	737.5
18	110	25	-1	12	-20	717.5
19	111	28	8	18	-14	703.5
20	112	33	3	18	-14	689.5
21	113	28	3	15.5	-16.5	673
22	114	30	0	15	-17	656
23	115	32	0	16	-16	640
24	116	42	12	27	-5	635
25	117	39	12	25.5	-6.5	628.5
26	118	44	14	29	-3	625.5
27	119	40	10	25	-7	618.5
28	120	49	14	31.5	-0.5	618
29	121	41	12	26.5	-5.5	612.5
30	122	45	21	33	1	613.5
31	123	37	20	28.5	-3.5	610
32	124	35	11	23	-9	601
33	125	35	20	27.5	-4.5	596.5
34	126	26	7	16.5	-15.5	581
35	127	34	0	17	-15	566
36	128	31	1	16	-16	550
37	129	31	7	19	-13	537
38	130	37	3	20	-12	525
39	131	41	12	26.5	-5.5	519.5
40	132	46	14	30	-2	517.5
41	133	30	6	18	-14	503.5
42	134	33	4	18.5	-13.5	490
43	135	40	10	25	-7	483
44	136	46	16	31	-1	482
45	137	48	18	33	1	483
46	138	50	29	39.5	7.5	490.5
47	139	50	26	38	6	496.5
48	140	39	31	35	3	499.5
49	141	37	12	24.5	-7.5	492
50	142	21	-1	10	-22	470
51	143	22	-1	10.5	-21.5	448.5
52	144	30	0	15	-17	431.5
53	145	22	2	12	-20	411.5
54	146	31	8	19.5	-12.5	399
55	147	33	5	19	-13	386
56	148	32	21	26.5	-5.5	380.5
57	149	39	27	33	1	381.5
58	150	41	22	31.5	-0.5	381
59	151	43	19	31	-1	380
60	152	45	14	29.5	-2.5	377.5
61	153	49	23	36	4	381.5
62	154	48	21	34.5	2.5	384
63	155	49	23	36	4	388
64	156	49	25	37	5	393
65	157	45	17	31	-1	392
66	158	49	23	36	4	396
67	159	55	24	39.5	7.5	403.5
68	160	57	30	43.5	11.5	415
69	161	55	34	44.5	12.5	427.5
70	162	54	32	43	11	438.5
71	163	55	29	42	10	448.5
72	164	58	30	44	12	460.5
73	165	60	31	45.5	13.5	474
74	166	52	28	40	8	482
75	167	53	32	42.5	10.5	492.5
76	168	43	24	33.5	1.5	494
77	169	48	21	34.5	2.5	496.5
78	170	50	22	36	4	500.5
79	171	42	20	31	-1	499.5
80	172	32	13	22.5	-9.5	490
81	173	48	15	31.5	-0.5	489.5
82	174	55	24	39.5	7.5	497
83	175	59	26	42.5	10.5	507.5
84	176	52	35	43.5	11.5	519
85	177	42	23	32.5	0.5	519.5
86	178	46	19	32.5	0.5	520
87	179	48	14	31	-1	519
88	180	61	26	43.5	11.5	530.5
89	181	59	30	44.5	12.5	543
90	182	48	28	38	6	549
91	183	57	23	40	8	557
92	184	59	27	43	11	568
93	185	39	17	28	-4	564
94	186	44	13	28.5	-3.5	560.5
95	187	50	28	39	7	567.5
96	188	48	28	38	6	573.5
97	189	48	20	34	2	575.5
98	190	53	27	40	8	583.5
99	191	62	28	45	13	596.5
100	192	65	28	46.5	14.5	611
101	193	45	31	38	6	617
102	194	51	28	39.5	7.5	624.5
103	195	64	25	44.5	12.5	637
104	196	67	34	50.5	18.5	655.5
105	197	70	34	52	20	675.5
106	198	69	34	51.5	19.5	695
107	199	58	38	48	16	711
108	200	66	34	50	18	729
109	201	49	25	37	5	734
110	202	59	25	42	10	744
111	203	66	31	48.5	16.5	760.5
112	204	55	36	45.5	13.5	774
113	205	59	33	46	14	788
114	206	67	34	50.5	18.5	806.5
115	207	70	36	53	21	827.5
116	208	69	37	53	21	848.5

117	209	53	31	42	10	858.5
118	210	63	30	46.5	14.5	873
119	211	71	38	54.5	22.5	895.5
120	212	70	47	58.5	26.5	922
121	213	71	46	58.5	26.5	948.5
122	214	47	33	40	8	956.5
123	215	59	28	43.5	11.5	968
124	216	68	35	51.5	19.5	987.5
125	217	76	49	62.5	30.5	1018
126	218	76	42	59	27	1045
127	219	75	45	60	28	1073
128	220	63	46	54.5	22.5	1095.5
129	221	65	35	50	18	1113.5
130	222	61	40	50.5	18.5	1132
131	223	72	36	54	22	1154
132	224	78	41	59.5	27.5	1181.5
133	225	78	44	61	29	1210.5
134	226	75	45	60	28	1238.5
135	227	58	36	47	15	1253.5
136	228	62	28	45	13	1266.5
137	229	59	39	49	17	1283.5
138	230	67	44	55.5	23.5	1307
139	231	74	47	60.5	28.5	1335.5
140	232	77	47	62	30	1365.5
141	233	82	46	64	32	1397.5
142	234	70	42	56	24	1421.5
143	235	73	38	55.5	23.5	1445
144	236	75	43	59	27	1472
145	237	70	42	56	24	1496
146	238	76	40	58	26	1522
147	239	69	39	54	22	1544
148	240	70	33	51.5	19.5	1563.5
149	241	77	43	60	28	1591.5
150	242	82	49	65.5	33.5	1625
151	243	75	45	60	28	1653
152	244	63	42	52.5	20.5	1673.5
153	245	67	32	49.5	17.5	1691
154	246	72	43	57.5	25.5	1716.5
155	247	68	42	55	23	1739.5
156	248	78	40	59	27	1766.5
157	249	84	57	70.5	38.5	1805
158	250	91	50	70.5	38.5	1843.5
159	251	90	58	74	42	1885.5
160	252	78	50	64	32	1917.5
161	253	79	49	64	32	1949.5
162	254	85	50	67.5	35.5	1985
163	255	81	48	64.5	32.5	2017.5
164	256	65	49	57	25	2042.5
165	257	67	48	57.5	25.5	2068
166	258	79	42	60.5	28.5	2096.5
167	259	77	46	61.5	29.5	2126
168	260	78	42	60	28	2154
169	261	82	47	64.5	32.5	2186.5
170	262	89	53	71	39	2225.5
171	263	90	54	72	40	2265.5
172	264	93	53	73	41	2306.5
173	265	95	52	73.5	41.5	2348
174	266	93	57	75	43	2391
175	267	87	50	68.5	36.5	2427.5
176	268	85	52	68.5	36.5	2464
177	269	84	49	66.5	34.5	2498.5
178	270	85	50	67.5	35.5	2534
179	271	85	49	67	35	2569
180	272	82	48	65	33	2602
181	273	84	45	64.5	32.5	2634.5
182	274	85	48	66.5	34.5	2669
183	275	86	48	67	35	2704
184	276	91	50	70.5	38.5	2742.5
185	277	90	51	70.5	38.5	2781
186	278	89	54	71.5	39.5	2820.5
187	279	91	53	72	40	2860.5
188	280	88	49	68.5	36.5	2897
189	281	90	47	68.5	36.5	2933.5
190	282	93	51	72	40	2973.5
191	283	94	52	73	41	3014.5
192	284	85	57	71	39	3053.5
193	285	93	55	74	42	3095.5
194	286	95	55	75	43	3138.5
195	287	98	59	78.5	46.5	3185
196	288	92	55	73.5	41.5	3226.5
197	289	95	60	77.5	45.5	3272
198	290	89	59	74	42	3314
199	291	90	55	72.5	40.5	3354.5
200	292	88	57	72.5	40.5	3395
201	293	83	61	72	40	3435
202	294	91	56	73.5	41.5	3476.5
203	295	96	57	76.5	44.5	3521
204	296	90	60	75	43	3564
205	297	87	61	74	42	3606
206	298	74	59	66.5	34.5	3640.5
207	299	82	55	68.5	36.5	3677
208	300	86	55	70.5	38.5	3715.5
209	301	88	55	71.5	39.5	3755
210	302	92	57	74.5	42.5	3797.5
211	303	91	57	74	42	3839.5
212	304	92	62	77	45	3884.5
213	305	92	63	77.5	45.5	3930
214	306	92	63	77.5	45.5	3975.5
215	307	90	64	77	45	4020.5
216	308	88	61	74.5	42.5	4063
217	309	89	62	75.5	43.5	4106.5
218	310	89	60	74.5	42.5	4149
219	311	86	51	68.5	36.5	4185.5
220	312	86	57	71.5	39.5	4225
221	313	93	58	75.5	43.5	4268.5
222	314	90	61	75.5	43.5	4312
223	315	90	55	72.5	40.5	4352.5
224	316	89	58	73.5	41.5	4394
225	317	78	60	69	37	4431

226	318	82	60	71	39	4470
227	319	89	56	72.5	40.5	4510.5
228	320	87	61	74	42	4552.5
229	321	83	59	71	39	4591.5
230	322	85	57	71	39	4630.5
231	323	85	58	71.5	39.5	4670
232	324	91	56	73.5	41.5	4711.5
233	325	89	57	73	41	4752.5
234	326	88	56	72	40	4792.5
235	327	91	59	75	43	4835.5
236	328	84	59	71.5	39.5	4875
237	329	84	58	71	39	4914
238	330	85	55	70	38	4952
239	331	89	58	73.5	41.5	4993.5
240	332	89	53	71	39	5032.5
241	333	88	53	70.5	38.5	5071
242	334	88	60	74	42	5113
243	335	86	53	69.5	37.5	5150.5
244	336	91	52	71.5	39.5	5190
245	337	93	52	72.5	40.5	5230.5
246	338	92	60	76	44	5274.5
247	339	91	52	71.5	39.5	5314
248	340	90	58	74	42	5356
249	341	93	56	74.5	42.5	5398.5
250	342	88	56	72	40	5438.5
251	343	88	52	70	38	5476.5
252	344	88	51	69.5	37.5	5514
253	345	90	55	72.5	40.5	5554.5
254	346	87	48	67.5	35.5	5590
255	347	86	50	68	36	5626
256	348	88	53	70.5	38.5	5664.5
257	349	86	50	68	36	5700.5
258	350	-	-	-	-	5700.5
259	351	82	49	65.5	33.5	5734
260	352	79	52	65.5	33.5	5767.5
261	353	78	47	62.5	30.5	5798
262	354	76	50	63	31	5829
263	355	71	36	53.5	21.5	5850.5
264	356	76	39	57.5	25.5	5876
265	357	77	38	57.5	25.5	5901.5
266	358	76	41	58.5	26.5	5928
267	359	73	42	57.5	25.5	5953.5
268	360	70	38	54	22	5975.5
269	361	72	45	58.5	26.5	6002
270	362	74	44	59	27	6029
271	363	76	40	58	26	6055
272	364	76	39	57.5	25.5	6080.5
273	365	78	38	58	26	6106.5



69	1001.5
152	377

length of freeze (day)	83
frost index (^oF-day)	624.5
average temperature	48.8

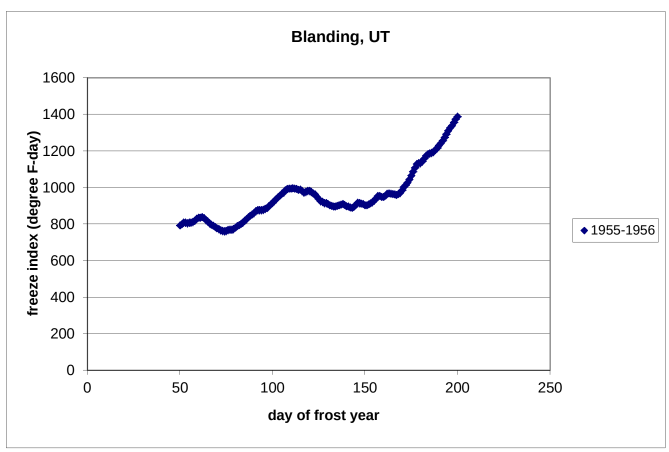
1955-1956

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	79	40	59.5	27.5	27.5
275	2	79	48	63.5	31.5	59
276	3	78	42	60	28	87
277	4	74	46	60	28	115
278	5	73	45	59	27	142
279	6	61	32	46.5	14.5	156.5
280	7	67	28	47.5	15.5	172
281	8	72	30	51	19	191
282	9	75	38	56.5	24.5	215.5
283	10	76	41	58.5	26.5	242
284	11	76	42	59	27	269
285	12	76	40	58	26	295
286	13	79	48	63.5	31.5	326.5
287	14	75	39	57	25	351.5
288	15	77	40	58.5	26.5	378
289	16	77	45	61	29	407
290	17	77	39	58	26	433
291	18	76	38	57	25	458
292	19	75	41	58	26	484
293	20	73	44	58.5	26.5	510.5
294	21	70	42	56	24	534.5
295	22	67	41	54	22	556.5
296	23	62	38	50	18	574.5
297	24	64	34	49	17	591.5
298	25	67	29	48	16	607.5
299	26	65	37	51	19	626.5
300	27	51	28	39.5	7.5	634
301	28	57	23	40	8	642
302	29	54	32	43	11	653
303	30	60	28	44	12	665
304	31	65	32	48.5	16.5	681.5
305	32	62	28	45	13	694.5
306	33	50	16	33	1	695.5
307	34	56	21	38.5	6.5	702
308	35	59	24	41.5	9.5	711.5
309	36	64	27	45.5	13.5	725
310	37	59	32	45.5	13.5	738.5
311	38	48	31	39.5	7.5	746
312	39	55	23	39	7	753
313	40	60	29	44.5	12.5	765.5
314	41	62	28	45	13	778.5
315	42	61	30	45.5	13.5	792
316	43	56	32	44	12	804
317	44	50	37	43.5	11.5	815.5
318	45	45	31	38	6	821.5
319	46	33	11	22	-10	811.5
320	47	29	6	17.5	-14.5	797
321	48	35	24	29.5	-2.5	794.5
322	49	39	21	30	-2	792.5
323	50	47	17	32	0	792.5
324	51	55	24	39.5	7.5	800
325	52	49	33	41	9	809
326	53	39	22	30.5	-1.5	807.5
327	54	40	19	29.5	-2.5	805
328	55	46	25	35.5	3.5	808.5
329	56	45	20	32.5	0.5	809

330	57	47	21	34	2	811
331	58	52	29	40.5	8.5	819.5
332	59	54	28	41	9	828.5
333	60	48	27	37.5	5.5	834
334	61	38	28	33	1	835
335	62	41	30	35.5	3.5	838.5
336	63	34	19	26.5	-5.5	833
337	64	32	12	22	-10	823
338	65	35	14	24.5	-7.5	815.5
339	66	31	10	20.5	-11.5	804
340	67	30	18	24	-8	796
341	68	38	15	26.5	-5.5	790.5
342	69	40	9	24.5	-7.5	783
343	70	35	18	26.5	-5.5	777.5
344	71	42	14	28	-4	773.5
345	72	38	13	25.5	-6.5	767
346	73	39	16	27.5	-4.5	762.5
347	74	43	18	30.5	-1.5	761
348	75	45	24	34.5	2.5	763.5
349	76	48	26	37	5	768.5
350	77	40	26	33	1	769.5
351	78	43	21	32	0	769.5
352	79	45	25	35	3	772.5
353	80	47	32	39.5	7.5	780
354	81	51	30	40.5	8.5	788.5
355	82	49	27	38	6	794.5
356	83	48	28	38	6	800.5
357	84	46	33	39.5	7.5	808
358	85	52	33	42.5	10.5	818.5
359	86	51	32	41.5	9.5	828
360	87	53	32	42.5	10.5	838.5
361	88	45	33	39	7	845.5
362	89	48	30	39	7	852.5
363	90	48	31	39.5	7.5	860
364	91	51	36	43.5	11.5	871.5
365	92	49	25	37	5	876.5
1	93	42	22	32	0	876.5
2	94	45	20	32.5	0.5	877
3	95	45	22	33.5	1.5	878.5
4	96	52	22	37	5	883.5
5	97	48	24	36	4	887.5
6	98	54	31	42.5	10.5	898
7	99	52	30	41	9	907
8	100	55	28	41.5	9.5	916.5
9	101	56	29	42.5	10.5	927
10	102	57	26	41.5	9.5	936.5
11	103	57	27	42	10	946.5
12	104	55	26	40.5	8.5	955
13	105	55	29	42	10	965
14	106	51	28	39.5	7.5	972.5
15	107	60	28	44	12	984.5
16	108	45	33	39	7	991.5
17	109	44	24	34	2	993.5
18	110	43	21	32	0	993.5
19	111	45	22	33.5	1.5	995
20	112	38	25	31.5	-0.5	994.5
21	113	37	21	29	-3	991.5
22	114	35	21	28	-4	987.5
23	115	36	30	33	1	988.5
24	116	38	12	25	-7	981.5
25	117	33	14	23.5	-8.5	973
26	118	42	29	35.5	3.5	976.5
27	119	44	30	37	5	981.5
28	120	38	27	32.5	0.5	982
29	121	34	17	25.5	-6.5	975.5
30	122	33	15	24	-8	967.5
31	123	30	25	27.5	-4.5	963
32	124	25	10	17.5	-14.5	948.5
33	125	34	7	20.5	-11.5	937
34	126	36	6	21	-11	926
35	127	41	14	27.5	-4.5	921.5
36	128	37	15	26	-6	915.5
37	129	41	23	32	0	915.5
38	130	32	20	26	-6	909.5
39	131	34	17	25.5	-6.5	903
40	132	40	15	27.5	-4.5	898.5
41	133	42	17	29.5	-2.5	896
42	134	44	21	32.5	0.5	896.5
43	135	42	26	34	2	898.5
44	136	48	24	36	4	902.5
45	137	48	25	36.5	4.5	907
46	138	45	23	34	2	909
47	139	36	20	28	-4	905
48	140	33	16	24.5	-7.5	897.5
49	141	35	24	29.5	-2.5	895
50	142	35	19	27	-5	890
51	143	43	20	31.5	-0.5	889.5
52	144	50	24	37	5	894.5
53	145	55	30	42.5	10.5	905
54	146	48	39	43.5	11.5	916.5
55	147	42	19	30.5	-1.5	915
56	148	42	16	29	-3	912
57	149	42	18	30	-2	910
58	150	39	10	24.5	-7.5	902.5
59	151	47	19	33	1	903.5
60	152	51	22	36.5	4.5	908
61	153	52	23	37.5	5.5	913.5
62	154	52	25	38.5	6.5	920
63	155	56	26	41	9	929
64	156	59	28	43.5	11.5	940.5
65	157	62	27	44.5	12.5	953
66	158	42	22	32	0	953
67	159	40	14	27	-5	948
68	160	49	17	33	1	949
69	161	56	20	38	6	955
70	162	60	25	42.5	10.5	965.5
71	163	45	24	34.5	2.5	968
72	164	41	20	30.5	-1.5	966.5
73	165	40	20	30	-2	964.5

74	166	34	24	29	-3	961.5
75	167	41	19	30	-2	959.5
76	168	54	18	36	4	963.5
77	169	55	23	39	7	970.5
78	170	65	28	46.5	14.5	985
79	171	65	33	49	17	1002
80	172	57	30	43.5	11.5	1013.5
81	173	61	31	46	14	1027.5
82	174	65	33	49	17	1044.5
83	175	70	35	52.5	20.5	1065
84	176	71	35	53	21	1086
85	177	69	38	53.5	21.5	1107.5
86	178	70	35	52.5	20.5	1128
87	179	54	20	37	5	1133
88	180	51	15	33	1	1134
89	181	60	21	40.5	8.5	1142.5
90	182	66	30	48	16	1158.5
91	183	65	30	47.5	15.5	1174
92	184	51	32	41.5	9.5	1183.5
93	185	42	27	34.5	2.5	1186
94	186	48	22	35	3	1189
95	187	56	21	38.5	6.5	1195.5
96	188	62	24	43	11	1206.5
97	189	57	24	40.5	8.5	1215
98	190	66	27	46.5	14.5	1229.5
99	191	52	36	44	12	1241.5
100	192	63	29	46	14	1255.5
101	193	68	32	50	18	1273.5
102	194	62	36	49	17	1290.5
103	195	66	38	52	20	1310.5
104	196	62	34	48	16	1326.5
105	197	53	36	44.5	12.5	1339
106	198	64	34	49	17	1356
107	199	66	32	49	17	1373
108	200	54	40	47	15	1388
109	201	57	35	46	14	1402
110	202	60	34	47	15	1417
111	203	63	35	49	17	1434
112	204	68	34	51	19	1453
113	205	74	40	57	25	1478
114	206	74	40	57	25	1503
115	207	68	43	55.5	23.5	1526.5
116	208	72	38	55	23	1549.5
117	209	68	40	54	22	1571.5
118	210	59	41	50	18	1589.5
119	211	62	32	47	15	1604.5
120	212	67	33	50	18	1622.5
121	213	70	42	56	24	1646.5
122	214	69	40	54.5	22.5	1669
123	215	75	40	57.5	25.5	1694.5
124	216	79	44	61.5	29.5	1724
125	217	80	47	63.5	31.5	1755.5
126	218	76	41	58.5	26.5	1782
127	219	72	40	56	24	1806
128	220	76	42	59	27	1833
129	221	74	39	56.5	24.5	1857.5
130	222	70	49	59.5	27.5	1885
131	223	63	38	50.5	18.5	1903.5
132	224	72	35	53.5	21.5	1925
133	225	69	43	56	24	1949
134	226	61	33	47	15	1964
135	227	56	37	46.5	14.5	1978.5
136	228	73	35	54	22	2000.5
137	229	78	46	62	30	2030.5
138	230	81	43	62	30	2060.5
139	231	83	44	63.5	31.5	2092
140	232	83	52	67.5	35.5	2127.5
141	233	80	48	64	32	2159.5
142	234	76	50	63	31	2190.5
143	235	75	48	61.5	29.5	2220
144	236	77	46	61.5	29.5	2249.5
145	237	79	50	64.5	32.5	2282
146	238	83	51	67	35	2317
147	239	76	43	59.5	27.5	2344.5
148	240	77	40	58.5	26.5	2371
149	241	75	47	61	29	2400
150	242	78	45	61.5	29.5	2429.5
151	243	85	48	66.5	34.5	2464
152	244	90	49	69.5	37.5	2501.5
153	245	86	59	72.5	40.5	2542
154	246	88	52	70	38	2580
155	247	90	53	71.5	39.5	2619.5
156	248	83	58	70.5	38.5	2658
157	249	75	45	60	28	2686
158	250	80	43	61.5	29.5	2715.5
159	251	86	49	67.5	35.5	2751
160	252	88	54	71	39	2790
161	253	90	57	73.5	41.5	2831.5
162	254	92	55	73.5	41.5	2873
163	255	90	53	71.5	39.5	2912.5
164	256	93	50	71.5	39.5	2952
165	257	93	53	73	41	2993
166	258	90	50	70	38	3031
167	259	77	52	64.5	32.5	3063.5
168	260	79	47	63	31	3094.5
169	261	85	49	67	35	3129.5
170	262	88	52	70	38	3167.5
171	263	88	56	72	40	3207.5
172	264	87	51	69	37	3244.5
173	265	85	50	67.5	35.5	3280
174	266	90	52	71	39	3319
175	267	90	52	71	39	3358
176	268	89	53	71	39	3397
177	269	89	54	71.5	39.5	3436.5
178	270	93	54	73.5	41.5	3478
179	271	97	56	76.5	44.5	3522.5
180	272	94	55	74.5	42.5	3565
181	273	93	58	75.5	43.5	3608.5
182	274	80	60	70	38	3646.5

183	275	79	55	67	35	3681.5
184	276	81	52	66.5	34.5	3716
185	277	83	48	65.5	33.5	3749.5
186	278	85	47	66	34	3783.5
187	279	89	49	69	37	3820.5
188	280	90	51	70.5	38.5	3859
189	281	93	51	72	40	3899
190	282	95	55	75	43	3942
191	283	97	58	77.5	45.5	3987.5
192	284	93	59	76	44	4031.5
193	285	90	60	75	43	4074.5
194	286	84	55	69.5	37.5	4112
195	287	88	57	72.5	40.5	4152.5
196	288	86	57	71.5	39.5	4192
197	289	91	53	72	40	4232
198	290	95	59	77	45	4277
199	291	93	58	75.5	43.5	4320.5
200	292	90	58	74	42	4362.5
201	293	91	58	74.5	42.5	4405
202	294	88	57	72.5	40.5	4445.5
203	295	93	55	74	42	4487.5
204	296	88	59	73.5	41.5	4529
205	297	91	56	73.5	41.5	4570.5
206	298	89	56	72.5	40.5	4611
207	299	92	60	76	44	4655
208	300	91	58	74.5	42.5	4697.5
209	301	89	57	73	41	4738.5
210	302	89	60	74.5	42.5	4781
211	303	86	56	71	39	4820
212	304	86	54	70	38	4858
213	305	80	56	68	36	4894
214	306	79	54	66.5	34.5	4928.5
215	307	83	53	68	36	4964.5
216	308	82	49	65.5	33.5	4998
217	309	83	49	66	34	5032
218	310	88	49	68.5	36.5	5068.5
219	311	90	51	70.5	38.5	5107
220	312	89	51	70	38	5145
221	313	90	51	70.5	38.5	5183.5
222	314	90	48	69	37	5220.5
223	315	93	52	72.5	40.5	5261
224	316	87	52	69.5	37.5	5298.5
225	317	85	50	67.5	35.5	5334
226	318	89	56	72.5	40.5	5374.5
227	319	89	60	74.5	42.5	5417
228	320	82	54	68	36	5453
229	321	66	53	59.5	27.5	5480.5
230	322	82	50	66	34	5514.5
231	323	83	51	67	35	5549.5
232	324	81	46	63.5	31.5	5581
233	325	85	53	69	37	5618
234	326	87	50	68.5	36.5	5654.5
235	327	88	52	70	38	5692.5
236	328	92	50	71	39	5731.5
237	329	90	53	71.5	39.5	5771
238	330	88	54	71	39	5810
239	331	84	53	68.5	36.5	5846.5
240	332	82	44	63	31	5877.5
241	333	82	51	66.5	34.5	5912
242	334	82	44	63	31	5943
243	335	93	50	71.5	39.5	5982.5
244	336	-	53	-	-	5982.5
245	337	86	42	64	32	6014.5
246	338	89	46	67.5	35.5	6050
247	339	90	50	70	38	6088
248	340	87	48	67.5	35.5	6123.5
249	341	89	50	69.5	37.5	6161
250	342	86	51	68.5	36.5	6197.5
251	343	84	50	67	35	6232.5
252	344	82	50	66	34	6266.5
253	345	85	48	66.5	34.5	6301
254	346	87	49	68	36	6337
255	347	88	50	69	37	6374
256	348	85	50	67.5	35.5	6409.5
257	349	86	50	68	36	6445.5
258	350	90	50	70	38	6483.5
259	351	90	50	70	38	6521.5
260	352	89	48	68.5	36.5	6558
261	353	91	51	71	39	6597
262	354	88	46	67	35	6632
263	355	89	47	68	36	6668
264	356	86	50	68	36	6704
265	357	76	45	60.5	28.5	6732.5
266	358	77	40	58.5	26.5	6759
267	359	80	42	61	29	6788
268	360	82	41	61.5	29.5	6817.5
269	361	84	42	63	31	6848.5
270	362	85	43	64	32	6880.5
271	363	82	43	62.5	30.5	6911
272	364	81	47	64	32	6943
273	365	80	41	60.5	28.5	6971.5
274	366	80	45	62.5	30.5	7002



112	994.5		length of freeze (day)	31
143	889.5		frost index (^oF-day)	105
			average temperature	51.2

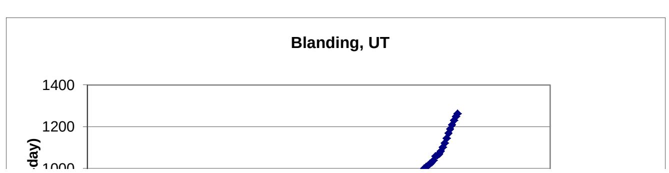
1956-1957

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	75	40	57.5	25.5	25.5
275	2	76	39	57.5	25.5	51
276	3	76	46	61	29	80
277	4	78	44	61	29	109
278	5	79	47	63	31	140
279	6	82	51	66.5	34.5	174.5
280	7	83	50	66.5	34.5	209
281	8	74	42	58	26	235
282	9	74	38	56	24	259
283	10	73	36	54.5	22.5	281.5
284	11	77	40	58.5	26.5	308
285	12	71	43	57	25	333

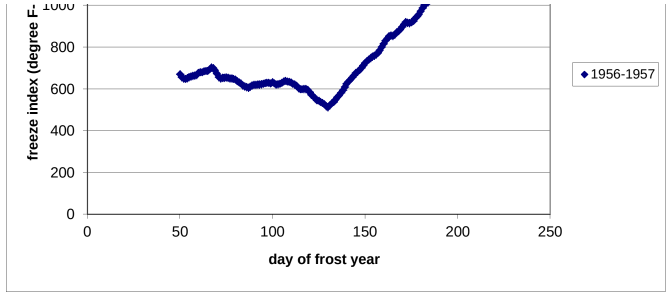
286	13	64	35	49.5	17.5	350.5
287	14	68	31	49.5	17.5	368
288	15	72	35	53.5	21.5	389.5
289	16	73	34	53.5	21.5	411
290	17	70	42	56	24	435
291	18	69	36	52.5	20.5	455.5
292	19	65	35	50	18	473.5
293	20	68	31	49.5	17.5	491
294	21	68	32	50	18	509
295	22	71	35	53	21	530
296	23	69	41	55	23	553
297	24	55	26	40.5	8.5	561.5
298	25	51	19	35	3	564.5
299	26	66	32	49	17	581.5
300	27	59	24	41.5	9.5	591
301	28	62	30	46	14	605
302	29	43	26	34.5	2.5	607.5
303	30	45	22	33.5	1.5	609
304	31	47	28	37.5	5.5	614.5
305	32	35	25	30	-2	612.5
306	33	36	20	28	-4	608.5
307	34	35	22	28.5	-3.5	605
308	35	38	18	28	-4	601
309	36	49	20	34.5	2.5	603.5
310	37	56	30	43	11	614.5
311	38	57	29	43	11	625.5
312	39	58	28	43	11	636.5
313	40	63	28	45.5	13.5	650
314	41	61	28	44.5	12.5	662.5
315	42	59	26	42.5	10.5	673
316	43	59	31	45	13	686
317	44	56	24	40	8	694
318	45	39	17	28	-4	690
319	46	38	15	26.5	-5.5	684.5
320	47	43	12	27.5	-4.5	680
321	48	46	18	32	0	680
322	49	45	24	34.5	2.5	682.5
323	50	29	12	20.5	-11.5	671
324	51	31	5	18	-14	657
325	52	42	9	25.5	-6.5	650.5
326	53	44	15	29.5	-2.5	648
327	54	52	20	36	4	652
328	55	51	22	36.5	4.5	656.5
329	56	48	22	35	3	659.5
330	57	50	20	35	3	662.5
331	58	49	18	33.5	1.5	664
332	59	48	23	35.5	3.5	667.5
333	60	55	28	41.5	9.5	677
334	61	49	20	34.5	2.5	679.5
335	62	48	17	32.5	0.5	680
336	63	53	20	36.5	4.5	684.5
337	64	48	19	33.5	1.5	686
338	65	46	18	32	0	686
339	66	52	27	39.5	7.5	693.5
340	67	48	35	41.5	9.5	703
341	68	36	20	28	-4	699
342	69	32	13	22.5	-9.5	689.5
343	70	28	3	15.5	-16.5	673
344	71	27	5	16	-16	657
345	72	33	17	25	-7	650
346	73	49	21	35	3	653
347	74	43	22	32.5	0.5	653.5
348	75	42	24	33	1	654.5
349	76	42	19	30.5	-1.5	653
350	77	39	19	29	-3	650
351	78	46	19	32.5	0.5	650.5
352	79	42	16	29	-3	647.5
353	80	41	18	29.5	-2.5	645
354	81	37	12	24.5	-7.5	637.5
355	82	38	13	25.5	-6.5	631
356	83	38	16	27	-5	626
357	84	36	10	23	-9	617
358	85	45	9	27	-5	612
359	86	42	16	29	-3	609
360	87	45	14	29.5	-2.5	606.5
361	88	51	20	35.5	3.5	610
362	89	56	23	39.5	7.5	617.5
363	90	48	20	34	2	619.5
364	91	45	19	32	0	619.5
365	92	46	22	34	2	621.5
1	93	44	20	32	0	621.5
2	94	42	25	33.5	1.5	623
3	95	41	25	33	1	624
4	96	42	29	35.5	3.5	627.5
5	97	41	25	33	1	628.5
6	98	41	23	32	0	628.5
7	99	38	21	29.5	-2.5	626
8	100	44	32	38	6	632
9	101	34	18	26	-6	626
10	102	35	21	28	-4	622
11	103	36	30	33	1	623
12	104	36	32	34	2	625
13	105	39	33	36	4	629
14	106	48	27	37.5	5.5	634.5
15	107	46	27	36.5	4.5	639
16	108	38	20	29	-3	636
17	109	41	17	29	-3	633
18	110	42	17	29.5	-2.5	630.5
19	111	37	16	26.5	-5.5	625
20	112	36	20	28	-4	621
21	113	36	17	26.5	-5.5	615.5
22	114	30	12	21	-11	604.5
23	115	37	15	26	-6	598.5
24	116	37	26	31.5	-0.5	598
25	117	41	26	33.5	1.5	599.5
26	118	37	29	33	1	600.5
27	119	34	20	27	-5	595.5
28	120	33	8	20.5	-11.5	584
29	121	35	7	21	-11	573

30	122	33	16	24.5	-7.5	565.5
31	123	30	14	22	-10	555.5
32	124	38	6	22	-10	545.5
33	125	46	13	29.5	-2.5	543
34	126	40	13	26.5	-5.5	537.5
35	127	44	9	26.5	-5.5	532
36	128	44	9	26.5	-5.5	526.5
37	129	37	10	23.5	-8.5	518
38	130	41	14	27.5	-4.5	513.5
39	131	47	33	40	8	521.5
40	132	52	31	41.5	9.5	531
41	133	46	30	38	6	537
42	134	55	34	44.5	12.5	549.5
43	135	54	31	42.5	10.5	560
44	136	52	31	41.5	9.5	569.5
45	137	53	34	43.5	11.5	581
46	138	58	33	45.5	13.5	594.5
47	139	58	35	46.5	14.5	609
48	140	58	37	47.5	15.5	624.5
49	141	53	34	43.5	11.5	636
50	142	46	36	41	9	645
51	143	47	36	41.5	9.5	654.5
52	144	47	37	42	10	664.5
53	145	51	37	44	12	676.5
54	146	41	35	38	6	682.5
55	147	50	30	40	8	690.5
56	148	53	31	42	10	700.5
57	149	54	33	43.5	11.5	712
58	150	54	34	44	12	724
59	151	53	29	41	9	733
60	152	48	33	40.5	8.5	741.5
61	153	47	32	39.5	7.5	749
62	154	45	30	37.5	5.5	754.5
63	155	48	26	37	5	759.5
64	156	48	29	38.5	6.5	766
65	157	49	28	38.5	6.5	772.5
66	158	58	32	45	13	785.5
67	159	61	34	47.5	15.5	801
68	160	60	35	47.5	15.5	816.5
69	161	56	37	46.5	14.5	831
70	162	55	31	43	11	842
71	163	57	29	43	11	853
72	164	42	27	34.5	2.5	855.5
73	165	44	17	30.5	-1.5	854
74	166	55	23	39	7	861
75	167	53	32	42.5	10.5	871.5
76	168	46	26	36	4	875.5
77	169	53	29	41	9	884.5
78	170	60	28	44	12	896.5
79	171	53	36	44.5	12.5	909
80	172	57	30	43.5	11.5	920.5
81	173	35	23	29	-3	917.5
82	174	36	23	29.5	-2.5	915
83	175	47	24	35.5	3.5	918.5
84	176	56	21	38.5	6.5	925
85	177	55	33	44	12	937
86	178	58	23	40.5	8.5	945.5
87	179	60	26	43	11	956.5
88	180	62	33	47.5	15.5	972
89	181	58	37	47.5	15.5	987.5
90	182	60	30	45	13	1000.5
91	183	49	32	40.5	8.5	1009
92	184	46	31	38.5	6.5	1015.5
93	185	50	31	40.5	8.5	1024
94	186	46	27	36.5	4.5	1028.5
95	187	60	25	42.5	10.5	1039
96	188	66	39	52.5	20.5	1059.5
97	189	45	28	36.5	4.5	1064
98	190	51	26	38.5	6.5	1070.5
99	191	63	27	45	13	1083.5
100	192	67	33	50	18	1101.5
101	193	68	36	52	20	1121.5
102	194	68	44	56	24	1145.5
103	195	70	41	55.5	23.5	1169
104	196	65	41	53	21	1190
105	197	66	36	51	19	1209
106	198	65	42	53.5	21.5	1230.5
107	199	65	37	51	19	1249.5
108	200	55	35	45	13	1262.5
109	201	56	30	43	11	1273.5
110	202	61	33	47	15	1288.5
111	203	66	38	52	20	1308.5
112	204	50	30	40	8	1316.5
113	205	48	30	39	7	1323.5
114	206	53	29	41	9	1332.5
115	207	56	29	42.5	10.5	1343
116	208	55	26	40.5	8.5	1351.5
117	209	54	32	43	11	1362.5
118	210	53	34	43.5	11.5	1374
119	211	53	36	44.5	12.5	1386.5
120	212	64	38	51	19	1405.5
121	213	71	43	57	25	1430.5
122	214	71	41	56	24	1454.5
123	215	73	40	56.5	24.5	1479
124	216	74	40	57	25	1504
125	217	74	46	60	28	1532
126	218	71	45	58	26	1558
127	219	60	47	53.5	21.5	1579.5
128	220	60	42	51	19	1598.5
129	221	68	37	52.5	20.5	1619
130	222	63	42	52.5	20.5	1639.5
131	223	52	35	43.5	11.5	1651
132	224	54	35	44.5	12.5	1663.5
133	225	59	34	46.5	14.5	1678
134	226	62	41	51.5	19.5	1697.5
135	227	53	34	43.5	11.5	1709
136	228	55	31	43	11	1720
137	229	63	35	49	17	1737
138	230	67	37	52	20	1757

139	231	60	40	50	18	1775
140	232	54	36	45	13	1788
141	233	53	32	42.5	10.5	1798.5
142	234	61	32	46.5	14.5	1813
143	235	57	38	47.5	15.5	1828.5
144	236	50	37	43.5	11.5	1840
145	237	63	36	49.5	17.5	1857.5
146	238	73	39	56	24	1881.5
147	239	74	42	58	26	1907.5
148	240	79	45	62	30	1937.5
149	241	78	54	66	34	1971.5
150	242	78	45	61.5	29.5	2001
151	243	77	47	62	30	2031
152	244	76	46	61	29	2060
153	245	79	48	63.5	31.5	2091.5
154	246	86	47	66.5	34.5	2126
155	247	88	50	69	37	2163
156	248	89	57	73	41	2204
157	249	90	54	72	40	2244
158	250	86	52	69	37	2281
159	251	85	48	66.5	34.5	2315.5
160	252	80	48	64	32	2347.5
161	253	55	45	50	18	2365.5
162	254	62	44	53	21	2386.5
163	255	73	42	57.5	25.5	2412
164	256	77	47	62	30	2442
165	257	77	45	61	29	2471
166	258	69	47	58	26	2497
167	259	63	40	51.5	19.5	2516.5
168	260	71	35	53	21	2537.5
169	261	79	48	63.5	31.5	2569
170	262	87	49	68	36	2605
171	263	86	50	68	36	2641
172	264	78	46	62	30	2671
173	265	83	49	66	34	2705
174	266	82	49	65.5	33.5	2738.5
175	267	88	51	69.5	37.5	2776
176	268	92	51	71.5	39.5	2815.5
177	269	90	53	71.5	39.5	2855
178	270	90	54	72	40	2895
179	271	95	57	76	44	2939
180	272	90	59	74.5	42.5	2981.5
181	273	90	57	73.5	41.5	3023
182	274	90	52	71	39	3062
183	275	93	55	74	42	3104
184	276	92	58	75	43	3147
185	277	91	65	78	46	3193
186	278	92	54	73	41	3234
187	279	91	59	75	43	3277
188	280	87	58	72.5	40.5	3317.5
189	281	86	60	73	41	3358.5
190	282	85	57	71	39	3397.5
191	283	88	60	74	42	3439.5
192	284	88	59	73.5	41.5	3481
193	285	85	52	68.5	36.5	3517.5
194	286	89	54	71.5	39.5	3557
195	287	89	54	71.5	39.5	3596.5
196	288	93	55	74	42	3638.5
197	289	91	58	74.5	42.5	3681
198	290	86	56	71	39	3720
199	291	80	54	67	35	3755
200	292	82	51	66.5	34.5	3789.5
201	293	81	60	70.5	38.5	3828
202	294	88	52	70	38	3866
203	295	88	54	71	39	3905
204	296	69	53	61	29	3934
205	297	83	47	65	33	3967
206	298	74	56	65	33	4000
207	299	83	55	69	37	4037
208	300	84	58	71	39	4076
209	301	89	55	72	40	4116
210	302	87	62	74.5	42.5	4158.5
211	303	90	56	73	41	4199.5
212	304	94	58	76	44	4243.5
213	305	97	62	79.5	47.5	4291
214	306	96	57	76.5	44.5	4335.5
215	307	93	58	75.5	43.5	4379
216	308	83	60	71.5	39.5	4418.5
217	309	80	61	70.5	38.5	4457
218	310	71	59	65	33	4490
219	311	85	58	71.5	39.5	4529.5
220	312	87	50	68.5	36.5	4566
221	313	90	47	68.5	36.5	4602.5
222	314	88	57	72.5	40.5	4643
223	315	88	56	72	40	4683
224	316	88	54	71	39	4722
225	317	88	55	71.5	39.5	4761.5
226	318	91	55	73	41	4802.5
227	319	88	60	74	42	4844.5
228	320	88	55	71.5	39.5	4884
229	321	89	58	73.5	41.5	4925.5
230	322	88	56	72	40	4965.5
231	323	85	60	72.5	40.5	5006
232	324	82	58	70	38	5044
233	325	81	56	68.5	36.5	5080.5
234	326	83	54	68.5	36.5	5117
235	327	85	52	68.5	36.5	5153.5
236	328	88	55	71.5	39.5	5193
237	329	85	52	68.5	36.5	5229.5
238	330	79	51	65	33	5262.5
239	331	79	49	64	32	5294.5
240	332	80	52	66	34	5328.5
241	333	77	53	65	33	5361.5
242	334	66	50	58	26	5387.5
243	335	73	46	59.5	27.5	5415
244	336	75	47	61	29	5444
245	337	80	45	62.5	30.5	5474.5
246	338	82	45	63.5	31.5	5506
247	339	84	47	65.5	33.5	5539.5



248	340	82	46	64	32	5571.5
249	341	84	52	68	36	5607.5
250	342	82	53	67.5	35.5	5643
251	343	89	45	67	35	5678
252	344	83	53	68	36	5714
253	345	79	42	60.5	28.5	5742.5
254	346	77	40	58.5	26.5	5769
255	347	78	40	59	27	5796
256	348	81	40	60.5	28.5	5824.5
257	349	76	43	59.5	27.5	5852
258	350	79	41	60	28	5880
259	351	80	44	62	30	5910
260	352	82	49	65.5	33.5	5943.5
261	353	70	38	54	22	5965.5
262	354	73	38	55.5	23.5	5989
263	355	72	41	56.5	24.5	6013.5
264	356	70	34	52	20	6033.5
265	357	71	43	57	25	6058.5
266	358	78	38	58	26	6084.5
267	359	80	40	60	28	6112.5
268	360	80	41	60.5	28.5	6141
269	361	80	41	60.5	28.5	6169.5
270	362	81	44	62.5	30.5	6200
271	363	83	44	63.5	31.5	6231.5
272	364	83	46	64.5	32.5	6264
273	365	84	48	66	34	6298



67	703
131	521.5

length of freeze (day)	64
frost index (°F-day)	181.5
average temperature	49.3

1962-1963

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (°F)	cumulative degree day (°F)
274	1	69	40	54.5	22.5	22.5
275	2	69	39	54	22	44.5
276	3	73	42	57.5	25.5	70
277	4	76	46	61	29	99
278	5	60	48	54	22	121
279	6	64	36	50	18	139
280	7	67	37	52	20	159
281	8	70	38	54	22	181
282	9	73	40	56.5	24.5	205.5
283	10	72	40	56	24	229.5
284	11	69	38	53.5	21.5	251
285	12	67	40	53.5	21.5	272.5
286	13	70	39	54.5	22.5	295
287	14	72	39	55.5	23.5	318.5
288	15	64	42	53	21	339.5
289	16	57	45	51	19	358.5
290	17	54	42	48	16	374.5
291	18	59	44	51.5	19.5	394
292	19	56	39	47.5	15.5	409.5
293	20	64	35	49.5	17.5	427
294	21	64	36	50	18	445
295	22	67	37	52	20	465
296	23	65	37	51	19	484
297	24	68	37	52.5	20.5	504.5
298	25	64	38	51	19	523.5
299	26	63	38	50.5	18.5	542
300	27	68	34	51	19	561
301	28	67	35	51	19	580
302	29	65	37	51	19	599
303	30	66	37	51.5	19.5	618.5
304	31	65	37	51	19	637.5
305	32	69	38	53.5	21.5	659
306	33	67	38	52.5	20.5	679.5
307	34	64	35	49.5	17.5	697
308	35	59	35	47	15	712
309	36	62	34	48	16	728
310	37	63	43	53	21	749
311	38	61	30	45.5	13.5	762.5
312	39	58	26	42	10	772.5
313	40	56	28	42	10	782.5
314	41	60	29	44.5	12.5	795
315	42	60	29	44.5	12.5	807.5
316	43	61	28	44.5	12.5	820
317	44	61	36	48.5	16.5	836.5
318	45	53	42	47.5	15.5	852
319	46	53	40	46.5	14.5	866.5
320	47	47	31	39	7	873.5
321	48	44	28	36	4	877.5
322	49	34	22	28	-4	873.5
323	50	39	13	26	-6	867.5
324	51	50	22	36	4	871.5
325	52	55	30	42.5	10.5	882
326	53	52	29	40.5	8.5	890.5
327	54	53	31	42	10	900.5
328	55	52	35	43.5	11.5	912
329	56	51	34	42.5	10.5	922.5
330	57	50	28	39	7	929.5
331	58	44	28	36	4	933.5
332	59	54	28	41	9	942.5
333	60	50	32	41	9	951.5
334	61	52	34	43	11	962.5
335	62	44	33	38.5	6.5	969
336	63	50	29	39.5	7.5	976.5
337	64	48	29	38.5	6.5	983
338	65	51	30	40.5	8.5	991.5
339	66	52	25	38.5	6.5	998
340	67	52	24	38	6	1004
341	68	57	28	42.5	10.5	1014.5
342	69	58	28	43	11	1025.5
343	70	58	29	43.5	11.5	1037
344	71	50	24	37	5	1042
345	72	50	22	36	4	1046
346	73	48	21	34.5	2.5	1048.5
347	74	50	22	36	4	1052.5
348	75	49	20	34.5	2.5	1055
349	76	50	22	36	4	1059
350	77	50	25	37.5	5.5	1064.5
351	78	56	24	40	8	1072.5

352	79	46	34	40	8	1080.5
353	80	42	30	36	4	1084.5
354	81	46	26	36	4	1088.5
355	82	45	23	34	2	1090.5
356	83	47	22	34.5	2.5	1093
357	84	44	19	31.5	-0.5	1092.5
358	85	33	14	23.5	-8.5	1084
359	86	27	2	14.5	-17.5	1066.5
360	87	27	-2	12.5	-19.5	1047
361	88	29	-1	14	-18	1029
362	89	32	4	18	-14	1015
363	90	37	11	24	-8	1007
364	91	39	11	25	-7	1000
365	92	38	11	24.5	-7.5	992.5
1	93	40	17	28.5	-3.5	989
2	94	36	14	25	-7	982
3	95	35	25	30	-2	980
4	96	49	15	32	0	980
5	97	37	15	26	-6	974
6	98	37	17	27	-5	969
7	99	27	10	18.5	-13.5	955.5
8	100	23	14	18.5	-13.5	942
9	101	22	13	17.5	-14.5	927.5
10	102	31	11	21	-11	916.5
11	103	17	-7	5	-27	889.5
12	104	10	-20	-5	-37	852.5
13	105	11	-19	-4	-36	816.5
14	106	15	-10	2.5	-29.5	787
15	107	18	-4	7	-25	762
16	108	27	-2	12.5	-19.5	742.5
17	109	27	-1	13	-19	723.5
18	110	32	9	20.5	-11.5	712
19	111	22	0	11	-21	691
20	112	25	0	12.5	-19.5	671.5
21	113	28	3	15.5	-16.5	655
22	114	33	6	19.5	-12.5	642.5
23	115	39	10	24.5	-7.5	635
24	116	37	10	23.5	-8.5	626.5
25	117	38	13	25.5	-6.5	620
26	118	36	10	23	-9	611
27	119	33	5	19	-13	598
28	120	40	10	25	-7	591
29	121	40	21	30.5	-1.5	589.5
30	122	37	32	34.5	2.5	592
31	123	42	34	38	6	598
32	124	46	37	41.5	9.5	607.5
33	125	52	32	42	10	617.5
34	126	52	29	40.5	8.5	626
35	127	55	31	43	11	637
36	128	60	35	47.5	15.5	652.5
37	129	61	33	47	15	667.5
38	130	60	30	45	13	680.5
39	131	58	33	45.5	13.5	694
40	132	52	33	42.5	10.5	704.5
41	133	45	28	36.5	4.5	709
42	134	34	17	25.5	-6.5	702.5
43	135	25	0	12.5	-19.5	683
44	136	33	4	18.5	-13.5	669.5
45	137	32	10	21	-11	658.5
46	138	42	23	32.5	0.5	659
47	139	41	20	30.5	-1.5	657.5
48	140	41	19	30	-2	655.5
49	141	47	24	35.5	3.5	659
50	142	50	32	41	9	668
51	143	51	31	41	9	677
52	144	52	33	42.5	10.5	687.5
53	145	50	29	39.5	7.5	695
54	146	52	27	39.5	7.5	702.5
55	147	53	29	41	9	711.5
56	148	54	31	42.5	10.5	722
57	149	52	25	38.5	6.5	728.5
58	150	43	30	36.5	4.5	733
59	151	47	23	35	3	736
60	152	48	19	33.5	1.5	737.5
61	153	44	22	33	1	738.5
62	154	42	27	34.5	2.5	741
63	155	36	23	29.5	-2.5	738.5
64	156	41	15	28	-4	734.5
65	157	45	21	33	1	735.5
66	158	48	18	33	1	736.5
67	159	53	24	38.5	6.5	743
68	160	54	24	39	7	750
69	161	53	33	43	11	761
70	162	44	22	33	1	762
71	163	40	19	29.5	-2.5	759.5
72	164	45	12	28.5	-3.5	756
73	165	48	22	35	3	759
74	166	47	26	36.5	4.5	763.5
75	167	37	16	26.5	-5.5	758
76	168	40	28	34	2	760
77	169	39	21	30	-2	758
78	170	48	20	34	2	760
79	171	58	25	41.5	9.5	769.5
80	172	61	35	48	16	785.5
81	173	60	33	46.5	14.5	800
82	174	61	33	47	15	815
83	175	58	28	43	11	826
84	176	60	31	45.5	13.5	839.5
85	177	64	31	47.5	15.5	855
86	178	64	30	47	15	870
87	179	65	40	52.5	20.5	890.5
88	180	61	32	46.5	14.5	905
89	181	64	35	49.5	17.5	922.5
90	182	66	35	50.5	18.5	941
91	183	62	36	49	17	958
92	184	44	22	33	1	959
93	185	51	18	34.5	2.5	961.5
94	186	59	28	43.5	11.5	973
95	187	64	30	47	15	988

96	188	67	31	49	17	1005
97	189	69	43	56	24	1029
98	190	66	40	53	21	1050
99	191	65	42	53.5	21.5	1071.5
100	192	53	30	41.5	9.5	1081
101	193	60	25	42.5	10.5	1091.5
102	194	67	30	48.5	16.5	1108
103	195	74	34	54	22	1130
104	196	76	44	60	28	1158
105	197	62	39	50.5	18.5	1176.5
106	198	60	28	44	12	1188.5
107	199	55	29	42	10	1198.5
108	200	45	25	35	3	1201.5
109	201	52	22	37	5	1206.5
110	202	59	30	44.5	12.5	1219
111	203	56	32	44	12	1231
112	204	52	21	36.5	4.5	1235.5
113	205	60	27	43.5	11.5	1247
114	206	62	27	44.5	12.5	1259.5
115	207	63	32	47.5	15.5	1275
116	208	56	33	44.5	12.5	1287.5
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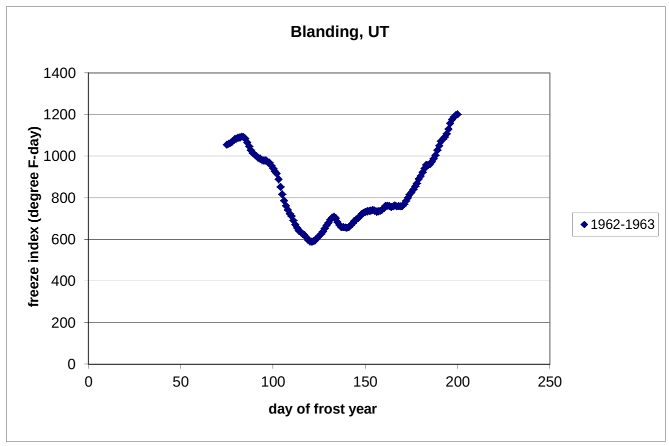
118	210	59	28	43.5	11.5	1303
119	211	66	35	50.5	18.5	1321.5
120	212	70	40	55	23	1344.5
121	213	73	40	56.5	24.5	1369
122	214	74	36	55	23	1392
123	215	75	40	57.5	25.5	1417.5
124	216	75	41	58	26	1443.5
125	217	80	40	60	28	1471.5
126	218	82	45	63.5	31.5	1503
127	219	83	49	66	34	1537
128	220	82	50	66	34	1571
129	221	76	53	64.5	32.5	1603.5
130	222	77	42	59.5	27.5	1631
131	223	74	44	59	27	1658
132	224	65	30	47.5	15.5	1673.5
133	225	78	38	58	26	1699.5
134	226	71	44	57.5	25.5	1725
135	227	76	40	58	26	1751
136	228	79	42	60.5	28.5	1779.5
137	229	81	46	63.5	31.5	1811
138	230	84	44	64	32	1843
139	231	84	52	68	36	1879
140	232	80	47	63.5	31.5	1910.5
141	233	83	52	67.5	35.5	1946
142	234	83	49	66	34	1980
143	235	71	48	59.5	27.5	2007.5
144	236	74	43	58.5	26.5	2034
145	237	76	45	60.5	28.5	2062.5
146	238	79	45	62	30	2092.5
147	239	81	48	64.5	32.5	2125
148	240	82	49	65.5	33.5	2158.5
149	241	81	48	64.5	32.5	2191
150	242	79	44	61.5	29.5	2220.5
151	243	79	43	61	29	2249.5
152	244	83	50	66.5	34.5	2284
153	245	76	45	60.5	28.5	2312.5
154	246	79	48	63.5	31.5	2344
155	247	78	48	63	31	2375
156	248	73	41	57	25	2400
157	249	75	44	59.5	27.5	2427.5
158	250	76	43	59.5	27.5	2455
159	251	75	45	60	28	2483
160	252	72	39	55.5	23.5	2506.5
161	253	77	45	61	29	2535.5
162	254	76	43	59.5	27.5	2563
163	255	83	49	66	34	2597
164	256	82	55	68.5	36.5	2633.5
165	257	82	53	67.5	35.5	2669
166	258	79	46	62.5	30.5	2699.5
167	259	81	53	67	35	2734.5
168	260	85	51	68	36	2770.5
169	261	85	56	70.5	38.5	2809
170	262	82	53	67.5	35.5	2844.5
171	263	90	54	72	40	2884.5
172	264	87	49	68	36	2920.5
173	265	85	47	66	34	2954.5
174	266	87	48	67.5	35.5	2990
175	267	84	51	67.5	35.5	3025.5
176	268	85	49	67	35	3060.5
177	269	89	50	69.5	37.5	3098
178	270	91	50	70.5	38.5	3136.5
179	271	92	53	72.5	40.5	3177
180	272	88	47	67.5	35.5	3212.5
181	273	90	50	70	38	3250.5
182	274	96	63	79.5	47.5	3298
183	275	93	73	83	51	3349
184	276	90	66	78	46	3395
185	277	91	63	77	45	3440
186	278	91	58	74.5	42.5	3482.5
187	279	93	59	76	44	3526.5
188	280	94	63	78.5	46.5	3573
189	281	89	64	76.5	44.5	3617.5
190	282	86	62	74	42	3659.5
191	283	85	58	71.5	39.5	3699
192	284	87	55	71	39	3738
193	285	86	57	71.5	39.5	3777.5
194	286	84	55	69.5	37.5	3815
195	287	90	56	73	41	3856
196	288	93	57	75	43	3899
197	289	91	60	75.5	43.5	3942.5
198	290	92	58	75	43	3985.5
199	291	94	60	77	45	4030.5
200	292	96	60	78	46	4076.5
201	293	93	61	77	45	4121.5
202	294	92	62	77	45	4166.5
203	295	90	62	76	44	4210.5
204	296	86	60	73	41	4251.5

205	297	94	60	77	45	4296.5
206	298	95	62	78.5	46.5	4343
207	299	93	61	77	45	4388
208	300	93	57	75	43	4431
209	301	93	56	74.5	42.5	4473.5
210	302	93	56	74.5	42.5	4516
211	303	93	57	75	43	4559
212	304	94	56	75	43	4602
213	305	90	63	76.5	44.5	4646.5
214	306	81	60	70.5	38.5	4685
215	307	76	59	67.5	35.5	4720.5
216	308	79	60	69.5	37.5	4758
217	309	84	60	72	40	4798
218	310	87	60	73.5	41.5	4839.5
219	311	86	62	74	42	4881.5
220	312	88	58	73	41	4922.5
221	313	88	59	73.5	41.5	4964
222	314	80	58	69	37	5001
223	315	83	56	69.5	37.5	5038.5
224	316	89	55	72	40	5078.5
225	317	88	60	74	42	5120.5
226	318	90	57	73.5	41.5	5162
227	319	90	61	75.5	43.5	5205.5
228	320	90	63	76.5	44.5	5250
229	321	80	59	69.5	37.5	5287.5
230	322	89	55	72	40	5327.5
231	323	88	58	73	41	5368.5
232	324	85	63	74	42	5410.5
233	325	86	58	72	40	5450.5
234	326	82	62	72	40	5490.5
235	327	80	54	67	35	5525.5
236	328	86	55	70.5	38.5	5564
237	329	87	58	72.5	40.5	5604.5
238	330	77	60	68.5	36.5	5641
239	331	78	57	67.5	35.5	5676.5
240	332	85	52	68.5	36.5	5713
241	333	87	53	70	38	5751
242	334	68	55	61.5	29.5	5780.5
243	335	70	51	60.5	28.5	5809
244	336	74	46	60	28	5837
245	337	81	50	65.5	33.5	5870.5
246	338	84	52	68	36	5906.5
247	339	85	55	70	38	5944.5
248	340	78	57	67.5	35.5	5980
249	341	78	58	68	36	6016
250	342	82	53	67.5	35.5	6051.5
251	343	83	54	68.5	36.5	6088
252	344	85	55	70	38	6126
253	345	83	55	69	37	6163
254	346	84	53	68.5	36.5	6199.5
255	347	86	53	69.5	37.5	6237
256	348	79	52	65.5	33.5	6270.5
257	349	75	50	62.5	30.5	6301
258	350	77	46	61.5	29.5	6330.5
259	351	79	52	65.5	33.5	6364
260	352	79	47	63	31	6395
261	353	80	56	68	36	6431
262	354	80	50	65	33	6464
263	355	79	54	66.5	34.5	6498.5
264	356	75	47	61	29	6527.5
265	357	80	50	65	33	6560.5
266	358	85	53	69	37	6597.5
267	359	85	53	69	37	6634.5
268	360	85	45	65	33	6667.5
269	361	85	48	66.5	34.5	6702
270	362	86	45	65.5	33.5	6735.5
271	363	86	48	67	35	6770.5
272	364	83	49	66	34	6804.5
273	365	85	46	65.5	33.5	6838



84	1092.5	length of freeze (day)	37
121	589.5	frost index (^oF-day)	503
		average temperature	50.7

1963-1964

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	85	56	70.5	38.5	38.5
275	2	82	55	68.5	36.5	75
276	3	82	49	65.5	33.5	108.5
277	4	80	48	64	32	140.5
278	5	75	46	60.5	28.5	169
279	6	77	46	61.5	29.5	198.5
280	7	79	45	62	30	228.5
281	8	80	46	63	31	259.5
282	9	78	51	64.5	32.5	292
283	10	78	46	62	30	322
284	11	76	46	61	29	351
285	12	73	44	58.5	26.5	377.5
286	13	67	36	51.5	19.5	397
287	14	71	37	54	22	419
288	15	73	38	55.5	23.5	442.5
289	16	76	39	57.5	25.5	468
290	17	71	46	58.5	26.5	494.5
291	18	72	45	58.5	26.5	521
292	19	59	48	53.5	21.5	542.5
293	20	54	44	49	17	559.5
294	21	63	40	51.5	19.5	579
295	22	64	38	51	19	598
296	23	63	41	52	20	618
297	24	65	39	52	20	638
298	25	64	36	50	18	656
299	26	67	39	53	21	677
300	27	71	40	55.5	23.5	700.5
301	28	67	37	52	20	720.5
302	29	68	43	55.5	23.5	744
303	30	65	39	52	20	764
304	31	54	34	44	12	776
305	32	53	29	41	9	785
306	33	55	30	42.5	10.5	795.5
307	34	56	38	47	15	810.5
308	35	55	32	43.5	11.5	822

309	36	58	32	45	13	835
310	37	58	33	45.5	13.5	848.5
311	38	60	37	48.5	16.5	865
312	39	60	32	46	14	879
313	40	65	35	50	18	897
314	41	65	38	51.5	19.5	916.5
315	42	65	35	50	18	934.5
316	43	60	30	45	13	947.5
317	44	59	33	46	14	961.5
318	45	62	35	48.5	16.5	978
319	46	60	35	47.5	15.5	993.5
320	47	47	29	38	6	999.5
321	48	43	19	31	-1	998.5
322	49	46	25	35.5	3.5	1002
323	50	48	25	36.5	4.5	1006.5
324	51	50	28	39	7	1013.5
325	52	42	31	36.5	4.5	1018
326	53	46	25	35.5	3.5	1021.5
327	54	45	22	33.5	1.5	1023
328	55	45	29	37	5	1028
329	56	49	30	39.5	7.5	1035.5
330	57	48	24	36	4	1039.5
331	58	50	23	36.5	4.5	1044
332	59	55	28	41.5	9.5	1053.5
333	60	51	25	38	6	1059.5
334	61	50	22	36	4	1063.5
335	62	51	24	37.5	5.5	1069
336	63	47	19	33	1	1070
337	64	48	19	33.5	1.5	1071.5
338	65	51	18	34.5	2.5	1074
339	66	50	20	35	3	1077
340	67	44	19	31.5	-0.5	1076.5
341	68	41	15	28	-4	1072.5
342	69	40	12	26	-6	1066.5
343	70	42	21	31.5	-0.5	1066
344	71	35	22	28.5	-3.5	1062.5
345	72	29	10	19.5	-12.5	1050
346	73	31	8	19.5	-12.5	1037.5
347	74	34	10	22	-10	1027.5
348	75	28	10	19	-13	1014.5
349	76	36	13	24.5	-7.5	1007
350	77	39	13	26	-6	1001
351	78	41	15	28	-4	997
352	79	43	18	30.5	-1.5	995.5
353	80	40	20	30	-2	993.5
354	81	37	18	27.5	-4.5	989
355	82	37	22	29.5	-2.5	986.5
356	83	43	18	30.5	-1.5	985
357	84	49	17	33	1	986
358	85	46	17	31.5	-0.5	985.5
359	86	46	18	32	0	985.5
360	87	47	18	32.5	0.5	986
361	88	48	19	33.5	1.5	987.5
362	89	48	20	34	2	989.5
363	90	43	22	32.5	0.5	990
364	91	45	16	30.5	-1.5	988.5
365	92	48	21	34.5	2.5	991
1	93	50	25	37.5	5.5	996.5
2	94	51	22	36.5	4.5	1001
3	95	43	18	30.5	-1.5	999.5
4	96	35	15	25	-7	992.5
5	97	33	13	23	-9	983.5
6	98	33	11	22	-10	973.5
7	99	39	18	28.5	-3.5	970
8	100	31	11	21	-11	959
9	101	30	5	17.5	-14.5	944.5
10	102	37	12	24.5	-7.5	937
11	103	32	12	22	-10	927
12	104	30	8	19	-13	914
13	105	32	4	18	-14	900
14	106	30	3	16.5	-15.5	884.5
15	107	36	4	20	-12	872.5
16	108	35	10	22.5	-9.5	863
17	109	44	12	28	-4	859
18	110	40	22	31	-1	858
19	111	38	14	26	-6	852
20	112	42	20	31	-1	851
21	113	47	20	33.5	1.5	852.5
22	114	39	24	31.5	-0.5	852
23	115	32	10	21	-11	841
24	116	33	12	22.5	-9.5	831.5
25	117	38	12	25	-7	824.5
26	118	44	16	30	-2	822.5
27	119	45	18	31.5	-0.5	822
28	120	49	19	34	2	824
29	121	45	20	32.5	0.5	824.5
30	122	49	17	33	1	825.5
31	123	48	19	33.5	1.5	827
32	124	48	18	33	1	828
33	125	36	25	30.5	-1.5	826.5
34	126	34	16	25	-7	819.5
35	127	50	19	34.5	2.5	822
36	128	46	15	30.5	-1.5	820.5
37	129	32	13	22.5	-9.5	811
38	130	38	10	24	-8	803
39	131	48	12	30	-2	801
40	132	52	18	35	3	804
41	133	54	21	37.5	5.5	809.5
42	134	46	27	36.5	4.5	814
43	135	39	19	29	-3	811
44	136	39	14	26.5	-5.5	805.5
45	137	32	17	24.5	-7.5	798
46	138	35	6	20.5	-11.5	786.5
47	139	42	17	29.5	-2.5	784
48	140	40	15	27.5	-4.5	779.5
49	141	42	21	31.5	-0.5	779
50	142	45	16	30.5	-1.5	777.5
51	143	38	21	29.5	-2.5	775
52	144	40	17	28.5	-3.5	771.5

53	145	42	14	28	-4	767.5
54	146	38	18	28	-4	763.5
55	147	44	11	27.5	-4.5	759
56	148	37	21	29	-3	756
57	149	40	11	25.5	-6.5	749.5
58	150	38	14	26	-6	743.5
59	151	43	14	28.5	-3.5	740
60	152	48	19	33.5	1.5	741.5
61	153	49	19	34	2	743.5
62	154	40	29	34.5	2.5	746
63	155	37	25	31	-1	745
64	156	39	15	27	-5	740
65	157	48	20	34	2	742
66	158	36	17	26.5	-5.5	736.5
67	159	36	22	29	-3	733.5
68	160	35	19	27	-5	728.5
69	161	42	13	27.5	-4.5	724
70	162	40	22	31	-1	723
71	163	45	16	30.5	-1.5	721.5
72	164	47	27	37	5	726.5
73	165	41	24	32.5	0.5	727
74	166	43	14	28.5	-3.5	723.5
75	167	47	22	34.5	2.5	726
76	168	52	31	41.5	9.5	735.5
77	169	56	26	41	9	744.5
78	170	59	25	42	10	754.5
79	171	43	24	33.5	1.5	756
80	172	48	25	36.5	4.5	760.5
81	173	55	24	39.5	7.5	768
82	174	51	30	40.5	8.5	776.5
83	175	39	23	31	-1	775.5
84	176	36	25	30.5	-1.5	774
85	177	45	16	30.5	-1.5	772.5
86	178	48	21	34.5	2.5	775
87	179	51	24	37.5	5.5	780.5
88	180	57	26	41.5	9.5	790
89	181	64	30	47	15	805
90	182	67	30	48.5	16.5	821.5
91	183	68	40	54	22	843.5
92	184	59	35	47	15	858.5
93	185	47	32	39.5	7.5	866
94	186	49	32	40.5	8.5	874.5
95	187	51	28	39.5	7.5	882
96	188	43	31	37	5	887
97	189	41	30	35.5	3.5	890.5
98	190	44	29	36.5	4.5	895
99	191	50	29	39.5	7.5	902.5
100	192	57	29	43	11	913.5
101	193	59	33	46	14	927.5
102	194	61	28	44.5	12.5	940
103	195	53	32	42.5	10.5	950.5
104	196	60	30	45	13	963.5
105	197	67	32	49.5	17.5	981
106	198	72	35	53.5	21.5	1002.5
107	199	74	39	56.5	24.5	1027
108	200	68	40	54	22	1049
109	201	55	44	49.5	17.5	1066.5
110	202	61	39	50	18	1084.5
111	203	56	33	44.5	12.5	1097
112	204	62	30	46	14	1111
113	205	63	32	47.5	15.5	1126.5
114	206	68	38	53	21	1147.5
115	207	50	26	38	6	1153.5
116	208	46	24	35	3	1156.5
117	209	57	26	41.5	9.5	1166
118	210	63	40	51.5	19.5	1185.5
119	211	70	35	52.5	20.5	1206
120	212	57	40	48.5	16.5	1222.5
121	213	63	38	50.5	18.5	1241
122	214	66	39	52.5	20.5	1261.5
123	215	54	40	47	15	1276.5
124	216	64	29	46.5	14.5	1291
125	217	61	33	47	15	1306
126	218	52	30	41	9	1315
127	219	56	32	44	12	1327
128	220	52	32	42	10	1337
129	221	59	30	44.5	12.5	1349.5
130	222	66	37	51.5	19.5	1369
131	223	70	41	55.5	23.5	1392.5
132	224	71	38	54.5	22.5	1415
133	225	75	35	55	23	1438
134	226	76	45	60.5	28.5	1466.5
135	227	79	45	62	30	1496.5
136	228	85	43	64	32	1528.5
137	229	83	45	64	32	1560.5
138	230	79	44	61.5	29.5	1590
139	231	83	45	64	32	1622
140	232	85	52	68.5	36.5	1658.5
141	233	85	51	68	36	1694.5
142	234	86	51	68.5	36.5	1731
143	235	82	49	65.5	33.5	1764.5
144	236	82	46	64	32	1796.5
145	237	84	50	67	35	1831.5
146	238	86	56	71	39	1870.5
147	239	67	51	59	27	1897.5
148	240	77	47	62	30	1927.5
149	241	71	36	53.5	21.5	1949
150	242	70	42	56	24	1973
151	243	69	45	57	25	1998
152	244	66	45	55.5	23.5	2021.5
153	245	75	42	58.5	26.5	2048
154	246	80	52	66	34	2082
155	247	79	52	65.5	33.5	2115.5
156	248	83	49	66	34	2149.5
157	249	85	53	69	37	2186.5
158	250	84	56	70	38	2224.5
159	251	79	54	66.5	34.5	2259
160	252	69	40	54.5	22.5	2281.5
161	253	81	42	61.5	29.5	2311

162	254	79	46	62.5	30.5	2341.5
163	255	74	43	58.5	26.5	2368
164	256	81	49	65	33	2401
165	257	81	47	64	32	2433
166	258	82	45	63.5	31.5	2464.5
167	259	89	50	69.5	37.5	2502
168	260	87	53	70	38	2540
169	261	74	51	62.5	30.5	2570.5
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171	263	80	48	64	32	2627
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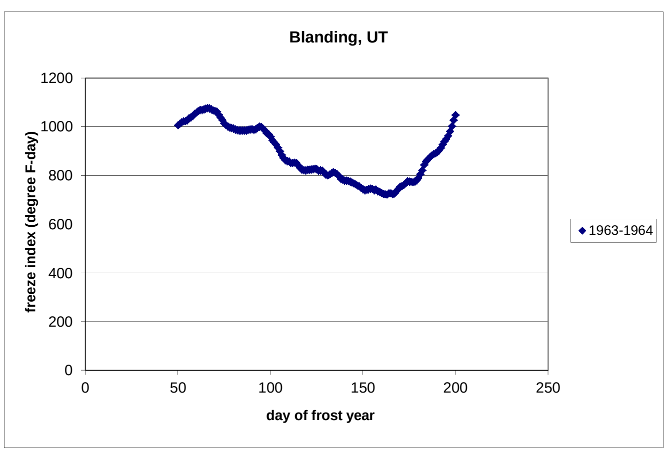
173	265	82	49	65.5	33.5	2693
174	266	75	47	61	29	2722
175	267	82	54	68	36	2758
176	268	87	52	69.5	37.5	2795.5
177	269	90	54	72	40	2835.5
178	270	90	58	74	42	2877.5
179	271	86	53	69.5	37.5	2915
180	272	84	51	67.5	35.5	2950.5
181	273	88	55	71.5	39.5	2990
182	274	88	59	73.5	41.5	3031.5
183	275	91	53	72	40	3071.5
184	276	92	55	73.5	41.5	3113
185	277	92	58	75	43	3156
186	278	91	59	75	43	3199
187	279	92	59	75.5	43.5	3242.5
188	280	94	58	76	44	3286.5
189	281	97	61	79	47	3333.5
190	282	96	63	79.5	47.5	3381
191	283	89	60	74.5	42.5	3423.5
192	284	86	57	71.5	39.5	3463
193	285	93	63	78	46	3509
194	286	87	58	72.5	40.5	3549.5
195	287	89	60	74.5	42.5	3592
196	288	89	57	73	41	3633
197	289	85	56	70.5	38.5	3671.5
198	290	86	60	73	41	3712.5
199	291	90	59	74.5	42.5	3755
200	292	93	60	76.5	44.5	3799.5
201	293	95	62	78.5	46.5	3846
202	294	96	65	80.5	48.5	3894.5
203	295	93	66	79.5	47.5	3942
204	296	91	60	75.5	43.5	3985.5
205	297	95	66	80.5	48.5	4034
206	298	87	64	75.5	43.5	4077.5
207	299	88	58	73	41	4118.5
208	300	90	57	73.5	41.5	4160
209	301	89	62	75.5	43.5	4203.5
210	302	91	64	77.5	45.5	4249
211	303	93	63	78	46	4295
212	304	88	63	75.5	43.5	4338.5
213	305	76	60	68	36	4374.5
214	306	71	59	65	33	4407.5
215	307	79	58	68.5	36.5	4444
216	308	81	60	70.5	38.5	4482.5
217	309	86	60	73	41	4523.5
218	310	87	60	73.5	41.5	4565
219	311	89	60	74.5	42.5	4607.5
220	312	89	62	75.5	43.5	4651
221	313	90	63	76.5	44.5	4695.5
222	314	90	61	75.5	43.5	4739
223	315	92	62	77	45	4784
224	316	89	61	75	43	4827
225	317	75	61	68	36	4863
226	318	79	59	69	37	4900
227	319	84	55	69.5	37.5	4937.5
228	320	88	54	71	39	4976.5
229	321	87	57	72	40	5016.5
230	322	89	58	73.5	41.5	5058
231	323	89	55	72	40	5098
232	324	85	57	71	39	5137
233	325	79	55	67	35	5172
234	326	77	44	60.5	28.5	5200.5
235	327	83	50	66.5	34.5	5235
236	328	86	48	67	35	5270
237	329	90	50	70	38	5308
238	330	84	55	69.5	37.5	5345.5
239	331	81	50	65.5	33.5	5379
240	332	76	50	63	31	5410
241	333	81	44	62.5	30.5	5440.5
242	334	79	52	65.5	33.5	5474
243	335	81	55	68	36	5510
244	336	84	50	67	35	5545
245	337	83	52	67.5	35.5	5580.5
246	338	79	48	63.5	31.5	5612
247	339	81	48	64.5	32.5	5644.5
248	340	86	46	66	34	5678.5
249	341	82	54	68	36	5714.5
250	342	78	53	65.5	33.5	5748
251	343	79	49	64	32	5780
252	344	83	54	68.5	36.5	5816.5
253	345	78	55	66.5	34.5	5851
254	346	82	48	65	33	5884
255	347	83	49	66	34	5918
256	348	84	47	65.5	33.5	5951.5
257	349	83	53	68	36	5987.5
258	350	74	48	61	29	6016.5
259	351	64	50	57	25	6041.5
260	352	76	42	59	27	6068.5
261	353	77	42	59.5	27.5	6096
262	354	77	49	63	31	6127
263	355	69	45	57	25	6152
264	356	69	40	54.5	22.5	6174.5
265	357	63	39	51	19	6193.5
266	358	69	40	54.5	22.5	6216
267	359	77	45	61	29	6245
268	360	78	50	64	32	6277
269	361	76	46	61	29	6306
270	362	73	45	59	27	6333



271	363	73	42	57.5	25.5	6358.5				
272	364	75	46	60.5	28.5	6387	66	1077	length of freeze (day)	97
273	365	75	47	61	29	6416	163	721.5	frost index (^oF-day)	355.5
274	366	76	44	60	28	6444			average temperature	49.6

1964-1965

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	79	45	62	30	30
275	2	78	44	61	29	59
276	3	81	43	62	30	89
277	4	79	46	62.5	30.5	119.5
278	5	76	44	60	28	147.5
279	6	77	50	63.5	31.5	179
280	7	76	44	60	28	207
281	8	78	42	60	28	235
282	9	79	46	62.5	30.5	265.5
283	10	76	48	62	30	295.5
284	11	71	48	59.5	27.5	323
285	12	73	40	56.5	24.5	347.5
286	13	71	37	54	22	369.5
287	14	73	38	55.5	23.5	393
288	15	75	41	58	26	419
289	16	70	41	55.5	23.5	442.5
290	17	72	42	57	25	467.5
291	18	70	40	55	23	490.5
292	19	70	34	52	20	510.5
293	20	67	38	52.5	20.5	531
294	21	68	35	51.5	19.5	550.5
295	22	67	35	51	19	569.5
296	23	61	30	45.5	13.5	583
297	24	68	28	48	16	599
298	25	65	30	47.5	15.5	614.5
299	26	63	34	48.5	16.5	631
300	27	64	35	49.5	17.5	648.5
301	28	69	39	54	22	670.5
302	29	73	43	58	26	696.5
303	30	63	40	51.5	19.5	716
304	31	64	32	48	16	732
305	32	61	30	45.5	13.5	745.5
306	33	55	35	45	13	758.5
307	34	56	32	44	12	770.5
308	35	59	29	44	12	782.5
309	36	57	28	42.5	10.5	793
310	37	65	29	47	15	808
311	38	64	28	46	14	822
312	39	63	33	48	16	838
313	40	58	32	45	13	851
314	41	54	35	44.5	12.5	863.5
315	42	43	22	32.5	0.5	864
316	43	40	23	31.5	-0.5	863.5
317	44	47	27	37	5	868.5
318	45	34	19	26.5	-5.5	863
319	46	36	22	29	-3	860
320	47	38	20	29	-3	857
321	48	39	10	24.5	-7.5	849.5
322	49	35	21	28	-4	845.5
323	50	39	12	25.5	-6.5	839
324	51	41	10	25.5	-6.5	832.5
325	52	41	18	29.5	-2.5	830
326	53	44	21	32.5	0.5	830.5
327	54	47	21	34	2	832.5
328	55	45	23	34	2	834.5
329	56	49	23	36	4	838.5
330	57	41	29	35	3	841.5
331	58	45	26	35.5	3.5	845
332	59	46	22	34	2	847
333	60	53	27	40	8	855
334	61	51	26	38.5	6.5	861.5
335	62	44	28	36	4	865.5
336	63	38	26	32	0	865.5
337	64	43	20	31.5	-0.5	865
338	65	40	21	30.5	-1.5	863.5
339	66	34	18	26	-6	857.5
340	67	38	17	27.5	-4.5	853
341	68	36	12	24	-8	845
342	69	34	10	22	-10	835
343	70	34	18	26	-6	829
344	71	36	13	24.5	-7.5	821.5
345	72	37	18	27.5	-4.5	817
346	73	32	16	24	-8	809
347	74	31	5	18	-14	795
348	75	28	6	17	-15	780
349	76	35	10	22.5	-9.5	770.5
350	77	40	14	27	-5	765.5
351	78	40	15	27.5	-4.5	761
352	79	37	18	27.5	-4.5	756.5
353	80	40	23	31.5	-0.5	756
354	81	39	28	33.5	1.5	757.5
355	82	42	23	32.5	0.5	758
356	83	46	23	34.5	2.5	760.5
357	84	47	26	36.5	4.5	765
358	85	49	30	39.5	7.5	772.5
359	86	48	28	38	6	778.5
360	87	44	28	36	4	782.5
361	88	49	34	41.5	9.5	792
362	89	40	25	32.5	0.5	792.5
363	90	34	19	26.5	-5.5	787
364	91	31	16	23.5	-8.5	778.5
365	92	32	27	29.5	-2.5	776
1	93	35	6	20.5	-11.5	764.5
2	94	28	-1	13.5	-18.5	746
3	95	33	7	20	-12	734
4	96	41	21	31	-1	733
5	97	41	26	33.5	1.5	734.5
6	98	39	31	35	3	737.5
7	99	41	33	37	5	742.5
8	100	35	23	29	-3	739.5

9	101	37	21	29	-3	736.5
10	102	36	21	28.5	-3.5	733
11	103	39	23	31	-1	732
12	104	42	27	34.5	2.5	734.5
13	105	40	20	30	-2	732.5
14	106	43	21	32	0	732.5
15	107	44	24	34	2	734.5
16	108	45	26	35.5	3.5	738
17	109	45	26	35.5	3.5	741.5
18	110	34	20	27	-5	736.5
19	111	35	24	29.5	-2.5	734
20	112	39	24	31.5	-0.5	733.5
21	113	37	29	33	1	734.5
22	114	36	23	29.5	-2.5	732
23	115	43	20	31.5	-0.5	731.5
24	116	38	27	32.5	0.5	732
25	117	33	20	26.5	-5.5	726.5
26	118	31	17	24	-8	718.5
27	119	38	15	26.5	-5.5	713
28	120	43	18	30.5	-1.5	711.5
29	121	48	24	36	4	715.5
30	122	56	30	43	11	726.5
31	123	57	30	43.5	11.5	738
32	124	49	28	38.5	6.5	744.5
33	125	50	24	37	5	749.5
34	126	53	26	39.5	7.5	757
35	127	54	27	40.5	8.5	765.5
36	128	51	27	39	7	772.5
37	129	43	32	37.5	5.5	778
38	130	37	22	29.5	-2.5	775.5
39	131	40	16	28	-4	771.5
40	132	36	25	30.5	-1.5	770
41	133	28	14	21	-11	759
42	134	27	3	15	-17	742
43	135	31	-2	14.5	-17.5	724.5
44	136	30	-2	14	-18	706.5
45	137	30	7	18.5	-13.5	693
46	138	37	6	21.5	-10.5	682.5
47	139	36	8	22	-10	672.5
48	140	43	10	26.5	-5.5	667
49	141	44	18	31	-1	666
50	142	47	21	34	2	668
51	143	49	24	36.5	4.5	672.5
52	144	50	26	38	6	678.5
53	145	54	30	42	10	688.5
54	146	34	22	28	-4	684.5
55	147	41	17	29	-3	681.5
56	148	50	24	37	5	686.5
57	149	53	25	39	7	693.5
58	150	51	28	39.5	7.5	701
59	151	44	28	36	4	705
60	152	32	18	25	-7	698
61	153	31	15	23	-9	689
62	154	30	13	21.5	-10.5	678.5
63	155	42	12	27	-5	673.5
64	156	48	17	32.5	0.5	674
65	157	50	20	35	3	677
66	158	49	30	39.5	7.5	684.5
67	159	54	26	40	8	692.5
68	160	52	23	37.5	5.5	698
69	161	52	24	38	6	704
70	162	46	31	38.5	6.5	710.5
71	163	41	30	35.5	3.5	714
72	164	42	29	35.5	3.5	717.5
73	165	46	23	34.5	2.5	720
74	166	51	25	38	6	726
75	167	50	30	40	8	734
76	168	51	28	39.5	7.5	741.5
77	169	44	22	33	1	742.5
78	170	38	19	28.5	-3.5	739
79	171	46	10	28	-4	735
80	172	56	22	39	7	742
81	173	56	33	44.5	12.5	754.5
82	174	55	33	44	12	766.5
83	175	49	32	40.5	8.5	775
84	176	40	17	28.5	-3.5	771.5
85	177	48	27	37.5	5.5	777
86	178	53	30	41.5	9.5	786.5
87	179	56	33	44.5	12.5	799
88	180	55	34	44.5	12.5	811.5
89	181	62	33	47.5	15.5	827
90	182	67	34	50.5	18.5	845.5
91	183	66	34	50	18	863.5
92	184	53	30	41.5	9.5	873
93	185	50	30	40	8	881
94	186	45	30	37.5	5.5	886.5
95	187	45	29	37	5	891.5
96	188	55	27	41	9	900.5
97	189	45	32	38.5	6.5	907
98	190	49	33	41	9	916
99	191	44	30	37	5	921
100	192	38	19	28.5	-3.5	917.5
101	193	41	18	29.5	-2.5	915
102	194	52	30	41	9	924
103	195	49	24	36.5	4.5	928.5
104	196	54	25	39.5	7.5	936
105	197	60	28	44	12	948
106	198	66	30	48	16	964
107	199	69	36	52.5	20.5	984.5
108	200	64	43	53.5	21.5	1006
109	201	72	37	54.5	22.5	1028.5
110	202	75	42	58.5	26.5	1055
111	203	77	44	60.5	28.5	1083.5
112	204	75	42	58.5	26.5	1110
113	205	69	40	54.5	22.5	1132.5
114	206	67	37	52	20	1152.5
115	207	62	45	53.5	21.5	1174
116	208	56	40	48	16	1190
117	209	50	33	41.5	9.5	1199.5

118	210	62	33	47.5	15.5	1215
119	211	67	34	50.5	18.5	1233.5
120	212	75	40	57.5	25.5	1259
121	213	77	43	60	28	1287
122	214	75	41	58	26	1313
123	215	71	37	54	22	1335
124	216	66	41	53.5	21.5	1356.5
125	217	64	30	47	15	1371.5
126	218	63	31	47	15	1386.5
127	219	58	33	45.5	13.5	1400
128	220	53	32	42.5	10.5	1410.5
129	221	62	30	46	14	1424.5
130	222	60	39	49.5	17.5	1442
131	223	67	35	51	19	1461
132	224	66	43	54.5	22.5	1483.5
133	225	51	41	46	14	1497.5
134	226	62	37	49.5	17.5	1515
135	227	65	42	53.5	21.5	1536.5
136	228	69	39	54	22	1558.5
137	229	77	43	60	28	1586.5
138	230	80	45	62.5	30.5	1617
139	231	77	48	62.5	30.5	1647.5
140	232	78	48	63	31	1678.5
141	233	79	48	63.5	31.5	1710
142	234	76	49	62.5	30.5	1740.5
143	235	64	44	54	22	1762.5
144	236	57	37	47	15	1777.5
145	237	50	36	43	11	1788.5
146	238	57	34	45.5	13.5	1802
147	239	60	34	47	15	1817
148	240	69	38	53.5	21.5	1838.5
149	241	74	42	58	26	1864.5
150	242	75	45	60	28	1892.5
151	243	75	46	60.5	28.5	1921
152	244	72	45	58.5	26.5	1947.5
153	245	73	44	58.5	26.5	1974
154	246	74	43	58.5	26.5	2000.5
155	247	73	53	63	31	2031.5
156	248	72	47	59.5	27.5	2059
157	249	80	43	61.5	29.5	2088.5
158	250	82	48	65	33	2121.5
159	251	78	49	63.5	31.5	2153
160	252	69	50	59.5	27.5	2180.5
161	253	62	44	53	21	2201.5
162	254	64	44	54	22	2223.5
163	255	82	46	64	32	2255.5
164	256	83	50	66.5	34.5	2290
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169	261	81	43	62	30	2432
170	262	81	49	65	33	2465
171	263	83	46	64.5	32.5	2497.5
172	264	86	47	66.5	34.5	2532
173	265	84	49	66.5	34.5	2566.5
174	266	83	52	67.5	35.5	2602
175	267	73	51	62	30	2632
176	268	76	48	62	30	2662
177	269	69	42	55.5	23.5	2685.5
178	270	74	41	57.5	25.5	2711
179	271	84	45	64.5	32.5	2743.5
180	272	85	47	66	34	2777.5
181	273	83	57	70	38	2815.5
182	274	87	54	70.5	38.5	2854
183	275	88	54	71	39	2893
184	276	90	52	71	39	2932
185	277	91	56	73.5	41.5	2973.5
186	278	92	57	74.5	42.5	3016
187	279	91	64	77.5	45.5	3061.5
188	280	90	58	74	42	3103.5
189	281	85	61	73	41	3144.5
190	282	91	57	74	42	3186.5
191	283	89	55	72	40	3226.5
192	284	84	58	71	39	3265.5
193	285	77	54	65.5	33.5	3299
194	286	85	50	67.5	35.5	3334.5
195	287	88	54	71	39	3373.5
196	288	90	55	72.5	40.5	3414
197	289	88	58	73	41	3455
198	290	87	58	72.5	40.5	3495.5
199	291	83	60	71.5	39.5	3535
200	292	86	55	70.5	38.5	3573.5
201	293	88	59	73.5	41.5	3615
202	294	90	59	74.5	42.5	3657.5
203	295	86	58	72	40	3697.5
204	296	86	55	70.5	38.5	3736
205	297	86	58	72	40	3776
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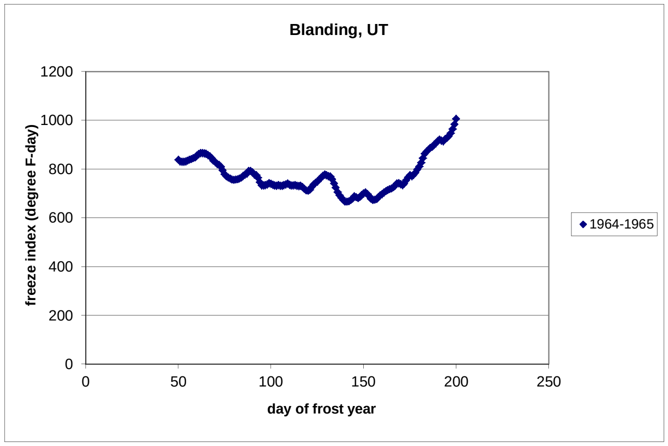
208	300	87	56	71.5	39.5	3890.5
209	301	89	58	73.5	41.5	3932
210	302	86	62	74	42	3974
211	303	88	59	73.5	41.5	4015.5
212	304	80	60	70	38	4053.5
213	305	82	55	68.5	36.5	4090
214	306	85	59	72	40	4130
215	307	85	54	69.5	37.5	4167.5
216	308	90	55	72.5	40.5	4208
217	309	91	55	73	41	4249
218	310	89	60	74.5	42.5	4291.5
219	311	92	55	73.5	41.5	4333
220	312	92	59	75.5	43.5	4376.5
221	313	93	56	74.5	42.5	4419
222	314	92	64	78	46	4465
223	315	90	57	73.5	41.5	4506.5
224	316	93	59	76	44	4550.5
225	317	91	58	74.5	42.5	4593
226	318	91	56	73.5	41.5	4634.5

227	319	84	54	69	37	4671.5
228	320	85	58	71.5	39.5	4711
229	321	79	54	66.5	34.5	4745.5
230	322	78	56	67	35	4780.5
231	323	81	50	65.5	33.5	4814
232	324	82	46	64	32	4846
233	325	81	53	67	35	4881
234	326	82	49	65.5	33.5	4914.5
235	327	83	50	66.5	34.5	4949
236	328	86	48	67	35	4984
237	329	87	46	66.5	34.5	5018.5
238	330	88	50	69	37	5055.5
239	331	89	50	69.5	37.5	5093
240	332	89	55	72	40	5133
241	333	75	53	64	32	5165
242	334	76	49	62.5	30.5	5195.5
243	335	78	46	62	30	5225.5
244	336	79	47	63	31	5256.5
245	337	79	50	64.5	32.5	5289
246	338	79	49	64	32	5321
247	339	79	45	62	30	5351
248	340	77	53	65	33	5384
249	341	78	53	65.5	33.5	5417.5
250	342	80	49	64.5	32.5	5450
251	343	78	52	65	33	5483
252	344	77	51	64	32	5515
253	345	80	48	64	32	5547
254	346	76	51	63.5	31.5	5578.5
255	347	77	49	63	31	5609.5
256	348	80	49	64.5	32.5	5642
257	349	81	45	63	31	5673
258	350	79	43	61	29	5702
259	351	83	44	63.5	31.5	5733.5
260	352	65	42	53.5	21.5	5755
261	353	51	40	45.5	13.5	5768.5
262	354	53	40	46.5	14.5	5783
263	355	53	34	43.5	11.5	5794.5
264	356	60	28	44	12	5806.5
265	357	67	36	51.5	19.5	5826
266	358	73	39	56	24	5850
267	359	76	41	58.5	26.5	5876.5
268	360	77	43	60	28	5904.5
269	361	76	44	60	28	5932.5
270	362	79	44	61.5	29.5	5962
271	363	73	43	58	26	5988
272	364	57	38	47.5	15.5	6003.5
273	365	62	34	48	16	6019.5



64	865	length of freeze (day)	78
142	668	frost index (^{o}F-day)	197
		average temperature	48.5

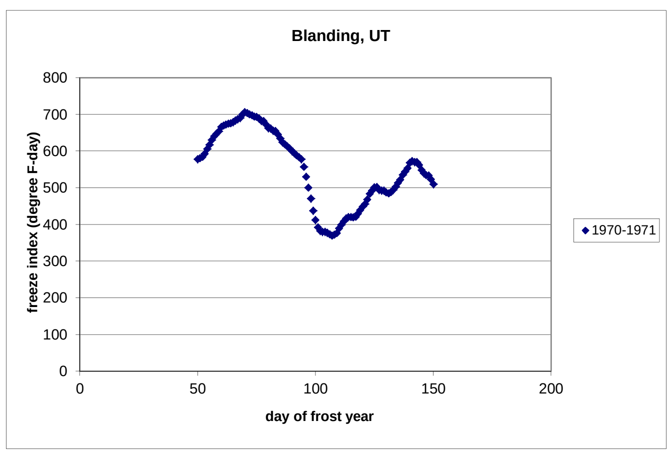
1970-1971

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^{o}F)	cumulative degree day (^{o}F)
274	1	79	46	62.5	30.5	30.5
275	2	77	43	60	28	58.5
276	3	70	42	56	24	82.5
277	4	71	44	57.5	25.5	108
278	5	72	45	58.5	26.5	134.5
279	6	70	40	55	23	157.5
280	7	52	31	41.5	9.5	167
281	8	52	28	40	8	175
282	9	58	27	42.5	10.5	185.5
283	10	61	35	48	16	201.5
284	11	63	27	45	13	214.5
285	12	67	32	49.5	17.5	232
286	13	70	37	53.5	21.5	253.5
287	14	68	38	53	21	274.5
288	15	58	35	46.5	14.5	289
289	16	49	35	42	10	299
290	17	59	31	45	13	312
291	18	61	29	45	13	325
292	19	59	36	47.5	15.5	340.5
293	20	63	36	49.5	17.5	358
294	21	64	38	51	19	377
295	22	48	34	41	9	386
296	23	53	28	40.5	8.5	394.5
297	24	57	24	40.5	8.5	403
298	25	50	30	40	8	411
299	26	42	25	33.5	1.5	412.5
300	27	45	22	33.5	1.5	414
301	28	51	18	34.5	2.5	416.5
302	29	56	22	39	7	423.5
303	30	60	28	44	12	435.5
304	31	60	34	47	15	450.5
305	32	58	33	45.5	13.5	464
306	33	53	25	39	7	471
307	34	51	22	36.5	4.5	475.5
308	35	51	26	38.5	6.5	482
309	36	56	37	46.5	14.5	496.5
310	37	59	31	45	13	509.5
311	38	44	33	38.5	6.5	516
312	39	50	30	40	8	524
313	40	52	25	38.5	6.5	530.5
314	41	53	32	42.5	10.5	541
315	42	54	25	39.5	7.5	548.5
316	43	48	30	39	7	555.5
317	44	48	34	41	9	564.5
318	45	46	25	35.5	3.5	568
319	46	45	19	32	0	568
320	47	47	20	33.5	1.5	569.5
321	48	53	21	37	5	574.5
322	49	49	21	35	3	577.5
323	50	47	19	33	1	578.5
324	51	49	20	34.5	2.5	581
325	52	48	23	35.5	3.5	584.5
326	53	53	27	40	8	592.5
327	54	59	32	45.5	13.5	606
328	55	58	29	43.5	11.5	617.5
329	56	59	30	44.5	12.5	630
330	57	50	35	42.5	10.5	640.5

331	58	45	33	39	7	647.5
332	59	46	31	38.5	6.5	654
333	60	49	39	44	12	666
334	61	46	26	36	4	670
335	62	43	26	34.5	2.5	672.5
336	63	41	27	34	2	674.5
337	64	45	22	33.5	1.5	676
338	65	45	25	35	3	679
339	66	49	24	36.5	4.5	683.5
340	67	49	23	36	4	687.5
341	68	48	23	35.5	3.5	691
342	69	54	29	41.5	9.5	700.5
343	70	44	32	38	6	706.5
344	71	38	21	29.5	-2.5	704
345	72	39	17	28	-4	700
346	73	43	16	29.5	-2.5	697.5
347	74	41	16	28.5	-3.5	694
348	75	41	22	31.5	-0.5	693.5
349	76	37	18	27.5	-4.5	689
350	77	36	15	25.5	-6.5	682.5
351	78	44	19	31.5	-0.5	682
352	79	34	11	22.5	-9.5	672.5
353	80	35	10	22.5	-9.5	663
354	81	37	24	30.5	-1.5	661.5
355	82	30	23	26.5	-5.5	656
356	83	40	22	31	-1	655
357	84	37	8	22.5	-9.5	645.5
358	85	34	8	21	-11	634.5
359	86	34	10	22	-10	624.5
360	87	44	7	25.5	-6.5	618
361	88	40	14	27	-5	613
362	89	41	13	27	-5	608
363	90	36	11	23.5	-8.5	599.5
364	91	41	13	27	-5	594.5
365	92	38	14	26	-6	588.5
1	93	40	14	27	-5	583.5
2	94	34	19	26.5	-5.5	578
3	95	22	1	11.5	-20.5	557.5
4	96	17	-8	4.5	-27.5	530
5	97	19	-14	2.5	-29.5	500.5
6	98	19	-14	2.5	-29.5	471
7	99	10	-13	-1.5	-33.5	437.5
8	100	19	-5	7	-25	412.5
9	101	20	3	11.5	-20.5	392
10	102	36	10	23	-9	383
11	103	42	17	29.5	-2.5	380.5
12	104	44	20	32	0	380.5
13	105	40	18	29	-3	377.5
14	106	39	16	27.5	-4.5	373
15	107	43	15	29	-3	370
16	108	45	23	34	2	372
17	109	52	22	37	5	377
18	110	58	31	44.5	12.5	389.5
19	111	56	27	41.5	9.5	399
20	112	51	32	41.5	9.5	408.5
21	113	52	29	40.5	8.5	417
22	114	45	26	35.5	3.5	420.5
23	115	43	21	32	0	420.5
24	116	40	21	30.5	-1.5	419
25	117	48	21	34.5	2.5	421.5
26	118	53	27	40	8	429.5
27	119	56	28	42	10	439.5
28	120	54	29	41.5	9.5	449
29	121	53	25	39	7	456
30	122	60	29	44.5	12.5	468.5
31	123	61	33	47	15	483.5
32	124	52	31	41.5	9.5	493
33	125	52	29	40.5	8.5	501.5
34	126	42	24	33	1	502.5
35	127	36	12	24	-8	494.5
36	128	44	17	30.5	-1.5	493
37	129	40	23	31.5	-0.5	492.5
38	130	35	19	27	-5	487.5
39	131	45	14	29.5	-2.5	485
40	132	52	18	35	3	488
41	133	55	22	38.5	6.5	494.5
42	134	54	28	41	9	503.5
43	135	58	26	42	10	513.5
44	136	56	26	41	9	522.5
45	137	60	29	44.5	12.5	535
46	138	54	29	41.5	9.5	544.5
47	139	57	26	41.5	9.5	554
48	140	58	35	46.5	14.5	568.5
49	141	46	26	36	4	572.5
50	142	40	19	29.5	-2.5	570
51	143	38	26	32	0	570
52	144	37	11	24	-8	562
53	145	33	4	18.5	-13.5	548.5
54	146	36	11	23.5	-8.5	540
55	147	41	12	26.5	-5.5	534.5
56	148	45	18	31.5	-0.5	534
57	149	29	14	21.5	-10.5	523.5
58	150	31	6	18.5	-13.5	510
59	151	28	9	18.5	-13.5	496.5
60	152	26	13	19.5	-12.5	484
61	153	34	13	23.5	-8.5	475.5
62	154	40	11	25.5	-6.5	469
63	155	50	27	38.5	6.5	475.5
64	156	38	20	29	-3	472.5
65	157	38	12	25	-7	465.5
66	158	46	15	30.5	-1.5	464
67	159	48	21	34.5	2.5	466.5
68	160	52	21	36.5	4.5	471
69	161	56	25	40.5	8.5	479.5
70	162	54	28	41	9	488.5
71	163	59	26	42.5	10.5	499
72	164	54	30	42	10	509
73	165	45	24	34.5	2.5	511.5
74	166	52	22	37	5	516.5

75	167	54	20	37	5	521.5
76	168	58	25	41.5	9.5	531
77	169	38	20	29	-3	528
78	170	52	15	33.5	1.5	529.5
79	171	57	23	40	8	537.5
80	172	64	27	45.5	13.5	551
81	173	65	34	49.5	17.5	568.5
82	174	70	35	52.5	20.5	589
83	175	62	44	53	21	610
84	176	66	33	49.5	17.5	627.5
85	177	74	40	57	25	652.5
86	178	68	39	53.5	21.5	674
87	179	64	32	48	16	690
88	180	68	27	47.5	15.5	705.5
89	181	72	33	52.5	20.5	726
90	182	58	29	43.5	11.5	737.5
91	183	52	17	34.5	2.5	740
92	184	60	24	42	10	750
93	185	60	34	47	15	765
94	186	56	32	44	12	777
95	187	62	27	44.5	12.5	789.5
96	188	65	28	46.5	14.5	804
97	189	70	40	55	23	827
98	190	65	37	51	19	846
99	191	69	33	51	19	865
100	192	72	38	55	23	888
101	193	74	36	55	23	911
102	194	74	38	56	24	935
103	195	75	38	56.5	24.5	959.5
104	196	66	47	56.5	24.5	984
105	197	72	44	58	26	1010
106	198	72	37	54.5	22.5	1032.5
107	199	63	38	50.5	18.5	1051
108	200	50	30	40	8	1059
109	201	50	29	39.5	7.5	1066.5
110	202	63	33	48	16	1082.5
111	203	56	33	44.5	12.5	1095
112	204	59	34	46.5	14.5	1109.5
113	205	55	32	43.5	11.5	1121
114	206	63	36	49.5	17.5	1138.5
115	207	67	36	51.5	19.5	1158
116	208	49	27	38	6	1164
117	209	59	23	41	9	1173
118	210	65	33	49	17	1190
119	211	65	35	50	18	1208
120	212	71	34	52.5	20.5	1228.5
121	213	75	40	57.5	25.5	1254
122	214	78	39	58.5	26.5	1280.5
123	215	77	38	57.5	25.5	1306
124	216	62	41	51.5	19.5	1325.5
125	217	56	37	46.5	14.5	1340
126	218	62	39	50.5	18.5	1358.5
127	219	56	36	46	14	1372.5
128	220	57	38	47.5	15.5	1388
129	221	64	34	49	17	1405
130	222	67	37	52	20	1425
131	223	74	37	55.5	23.5	1448.5
132	224	72	41	56.5	24.5	1473
133	225	74	41	57.5	25.5	1498.5
134	226	76	45	60.5	28.5	1527
135	227	80	47	63.5	31.5	1558.5
136	228	79	45	62	30	1588.5
137	229	57	38	47.5	15.5	1604
138	230	59	35	47	15	1619
139	231	65	30	47.5	15.5	1634.5
140	232	75	35	55	23	1657.5
141	233	77	39	58	26	1683.5
142	234	63	39	51	19	1702.5
143	235	62	32	47	15	1717.5
144	236	78	39	58.5	26.5	1744
145	237	79	40	59.5	27.5	1771.5
146	238	81	42	61.5	29.5	1801
147	239	81	45	63	31	1832
148	240	74	47	60.5	28.5	1860.5
149	241	51	38	44.5	12.5	1873
150	242	67	37	52	20	1893
151	243	72	36	54	22	1915
152	244	75	38	56.5	24.5	1939.5
153	245	76	41	58.5	26.5	1966
154	246	73	36	54.5	22.5	1988.5
155	247	73	37	55	23	2011.5
156	248	77	44	60.5	28.5	2040
157	249	80	43	61.5	29.5	2069.5
158	250	84	49	66.5	34.5	2104
159	251	79	53	66	34	2138
160	252	83	45	64	32	2170
161	253	81	46	63.5	31.5	2201.5
162	254	81	50	65.5	33.5	2235
163	255	73	48	60.5	28.5	2263.5
164	256	82	47	64.5	32.5	2296
165	257	89	55	72	40	2336
166	258	91	56	73.5	41.5	2377.5
167	259	93	55	74	42	2419.5
168	260	91	56	73.5	41.5	2461
169	261	92	58	75	43	2504
170	262	89	52	70.5	38.5	2542.5
171	263	92	50	71	39	2581.5
172	264	93	57	75	43	2624.5
173	265	97	61	79	47	2671.5
174	266	97	58	77.5	45.5	2717
175	267	96	59	77.5	45.5	2762.5
176	268	95	56	75.5	43.5	2806
177	269	93	58	75.5	43.5	2849.5
178	270	88	55	71.5	39.5	2889
179	271	86	50	68	36	2925
180	272	85	55	70	38	2963
181	273	89	53	71	39	3002
182	274	90	58	74	42	3044
183	275	87	59	73	41	3085

184	276	87	53	70	38	3123
185	277	88	53	70.5	38.5	3161.5
186	278	91	51	71	39	3200.5
187	279	82	55	68.5	36.5	3237
188	280	81	55	68	36	3273
189	281	89	52	70.5	38.5	3311.5
190	282	91	51	71	39	3350.5
191	283	93	57	75	43	3393.5
192	284	94	54	74	42	3435.5
193	285	98	58	78	46	3481.5
194	286	101	58	79.5	47.5	3529
195	287	99	70	84.5	52.5	3581.5
196	288	97	65	81	49	3630.5
197	289	98	64	81	49	3679.5
198	290	98	63	80.5	48.5	3728
199	291	97	65	81	49	3777
200	292	91	62	76.5	44.5	3821.5
201	293	89	62	75.5	43.5	3865
202	294	83	60	71.5	39.5	3904.5
203	295	86	61	73.5	41.5	3946
204	296	90	53	71.5	39.5	3985.5
205	297	90	54	72	40	4025.5
206	298	92	56	74	42	4067.5
207	299	91	58	74.5	42.5	4110
208	300	92	62	77	45	4155
209	301	92	59	75.5	43.5	4198.5
210	302	95	63	79	47	4245.5
211	303	92	63	77.5	45.5	4291
212	304	90	60	75	43	4334
213	305	88	57	72.5	40.5	4374.5
214	306	92	54	73	41	4415.5
215	307	92	58	75	43	4458.5
216	308	91	57	74	42	4500.5
217	309	87	57	72	40	4540.5
218	310	86	53	69.5	37.5	4578
219	311	87	52	69.5	37.5	4615.5
220	312	91	52	71.5	39.5	4655
221	313	90	59	74.5	42.5	4697.5
222	314	92	60	76	44	4741.5
223	315	90	58	74	42	4783.5
224	316	92	56	74	42	4825.5
225	317	93	56	74.5	42.5	4868
226	318	92	56	74	42	4910
227	319	89	56	72.5	40.5	4950.5
228	320	90	60	75	43	4993.5
229	321	92	56	74	42	5035.5
230	322	87	59	73	41	5076.5
231	323	89	59	74	42	5118.5
232	324	79	57	68	36	5154.5
233	325	84	56	70	38	5192.5
234	326	81	54	67.5	35.5	5228
235	327	84	57	70.5	38.5	5266.5
236	328	86	55	70.5	38.5	5305
237	329	84	57	70.5	38.5	5343.5
238	330	83	57	70	38	5381.5
239	331	87	61	74	42	5423.5
240	332	82	55	68.5	36.5	5460
241	333	84	54	69	37	5497
242	334	86	52	69	37	5534
243	335	81	50	65.5	33.5	5567.5
244	336	85	54	69.5	37.5	5605
245	337	83	55	69	37	5642
246	338	79	50	64.5	32.5	5674.5
247	339	71	38	54.5	22.5	5697
248	340	79	39	59	27	5724
249	341	86	48	67	35	5759
250	342	85	57	71	39	5798
251	343	81	45	63	31	5829
252	344	84	46	65	33	5862
253	345	88	55	71.5	39.5	5901.5
254	346	89	49	69	37	5938.5
255	347	93	50	71.5	39.5	5978
256	348	89	57	73	41	6019
257	349	87	50	68.5	36.5	6055.5
258	350	79	47	63	31	6086.5
259	351	81	45	63	31	6117.5
260	352	67	33	50	18	6135.5
261	353	59	23	41	9	6144.5
262	354	65	34	49.5	17.5	6162
263	355	69	32	50.5	18.5	6180.5
264	356	70	41	55.5	23.5	6204
265	357	67	37	52	20	6224
266	358	70	39	54.5	22.5	6246.5
267	359	71	38	54.5	22.5	6269
268	360	76	41	58.5	26.5	6295.5
269	361	75	41	58	26	6321.5
270	362	74	40	57	25	6346.5
271	363	72	38	55	23	6369.5
272	364	62	42	52	20	6389.5
273	365	66	42	54	22	6411.5



70	706.5	length of freeze (day)	38
108	372	frost index (°F-day)	334.5
		average temperature	49.6

1971-1972

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (°F)	cumulative degree day (°F)
274	1	52	31	41.5	9.5	9.5
275	2	55	30	42.5	10.5	20
276	3	61	30	45.5	13.5	33.5
277	4	68	34	51	19	52.5
278	5	72	38	55	23	75.5
279	6	73	40	56.5	24.5	100
280	7	74	40	57	25	125
281	8	75	43	59	27	152
282	9	75	50	62.5	30.5	182.5
283	10	77	43	60	28	210.5
284	11	76	41	58.5	26.5	237
285	12	77	44	60.5	28.5	265.5
286	13	73	40	56.5	24.5	290
287	14	73	38	55.5	23.5	313.5
288	15	72	42	57	25	338.5

289	16	57	40	48.5	16.5	355
290	17	43	34	38.5	6.5	361.5
291	18	42	28	35	3	364.5
292	19	54	26	40	8	372.5
293	20	56	27	41.5	9.5	382
294	21	60	35	47.5	15.5	397.5
295	22	64	32	48	16	413.5
296	23	62	35	48.5	16.5	430
297	24	57	43	50	18	448
298	25	54	39	46.5	14.5	462.5
299	26	46	34	40	8	470.5
300	27	53	31	42	10	480.5
301	28	54	37	45.5	13.5	494
302	29	42	20	31	-1	493
303	30	34	10	22	-10	483
304	31	44	23	33.5	1.5	484.5
305	32	44	22	33	1	485.5
306	33	51	21	36	4	489.5
307	34	53	22	37.5	5.5	495
308	35	55	25	40	8	503
309	36	58	26	42	10	513
310	37	57	24	40.5	8.5	521.5
311	38	55	26	40.5	8.5	530
312	39	57	25	41	9	539
313	40	55	28	41.5	9.5	548.5
314	41	62	29	45.5	13.5	562
315	42	64	30	47	15	577
316	43	58	35	46.5	14.5	591.5
317	44	49	30	39.5	7.5	599
318	45	52	24	38	6	605
319	46	44	30	37	5	610
320	47	42	27	34.5	2.5	612.5
321	48	39	25	32	0	612.5
322	49	36	17	26.5	-5.5	607
323	50	39	13	26	-6	601
324	51	42	20	31	-1	600
325	52	37	24	30.5	-1.5	598.5
326	53	41	23	32	0	598.5
327	54	48	22	35	3	601.5
328	55	46	22	34	2	603.5
329	56	47	24	35.5	3.5	607
330	57	49	26	37.5	5.5	612.5
331	58	41	27	34	2	614.5
332	59	37	21	29	-3	611.5
333	60	44	20	32	0	611.5
334	61	37	24	30.5	-1.5	610
335	62	42	23	32.5	0.5	610.5
336	63	32	27	29.5	-2.5	608
337	64	38	14	26	-6	602
338	65	35	12	23.5	-8.5	593.5
339	66	34	9	21.5	-10.5	583
340	67	35	15	25	-7	576
341	68	31	22	26.5	-5.5	570.5
342	69	37	7	22	-10	560.5
343	70	29	2	15.5	-16.5	544
344	71	34	5	19.5	-12.5	531.5
345	72	35	7	21	-11	520.5
346	73	31	2	16.5	-15.5	505
347	74	30	17	23.5	-8.5	496.5
348	75	32	5	18.5	-13.5	483
349	76	25	5	15	-17	466
350	77	30	0	15	-17	449
351	78	28	1	14.5	-17.5	431.5
352	79	30	3	16.5	-15.5	416
353	80	34	9	21.5	-10.5	405.5
354	81	34	3	18.5	-13.5	392
355	82	40	7	23.5	-8.5	383.5
356	83	40	22	31	-1	382.5
357	84	50	32	41	9	391.5
358	85	49	34	41.5	9.5	401
359	86	47	35	41	9	410
360	87	46	33	39.5	7.5	417.5
361	88	40	21	30.5	-1.5	416
362	89	41	25	33	1	417
363	90	38	25	31.5	-0.5	416.5
364	91	36	19	27.5	-4.5	412
365	92	38	15	26.5	-5.5	406.5
1	93	39	16	27.5	-4.5	402
2	94	39	18	28.5	-3.5	398.5
3	95	26	10	18	-14	384.5
4	96	24	2	13	-19	365.5
5	97	31	7	19	-13	352.5
6	98	37	13	25	-7	345.5
7	99	38	15	26.5	-5.5	340
8	100	41	19	30	-2	338
9	101	40	15	27.5	-4.5	333.5
10	102	40	15	27.5	-4.5	329
11	103	40	19	29.5	-2.5	326.5
12	104	44	22	33	1	327.5
13	105	44	22	33	1	328.5
14	106	40	17	28.5	-3.5	325
15	107	43	15	29	-3	322
16	108	45	18	31.5	-0.5	321.5
17	109	44	17	30.5	-1.5	320
18	110	47	20	33.5	1.5	321.5
19	111	49	24	36.5	4.5	326
20	112	50	25	37.5	5.5	331.5
21	113	47	24	35.5	3.5	335
22	114	45	23	34	2	337
23	115	52	28	40	8	345
24	116	40	22	31	-1	344
25	117	43	20	31.5	-0.5	343.5
26	118	52	25	38.5	6.5	350
27	119	37	23	30	-2	348
28	120	42	15	28.5	-3.5	344.5
29	121	34	18	26	-6	338.5
30	122	37	10	23.5	-8.5	330
31	123	37	10	23.5	-8.5	321.5
32	124	40	11	25.5	-6.5	315

33	125	28	9	18.5	-13.5	301.5
34	126	39	5	22	-10	291.5
35	127	44	12	28	-4	287.5
36	128	43	21	32	0	287.5
37	129	45	20	32.5	0.5	288
38	130	47	19	33	1	289
39	131	50	20	35	3	292
40	132	50	24	37	5	297
41	133	41	15	28	-4	293
42	134	46	11	28.5	-3.5	289.5
43	135	51	16	33.5	1.5	291
44	136	50	19	34.5	2.5	293.5
45	137	51	23	37	5	298.5
46	138	47	25	36	4	302.5
47	139	55	27	41	9	311.5
48	140	57	29	43	11	322.5
49	141	57	26	41.5	9.5	332
50	142	63	29	46	14	346
51	143	62	30	46	14	360
52	144	58	28	43	11	371
53	145	60	33	46.5	14.5	385.5
54	146	59	29	44	12	397.5
55	147	57	25	41	9	406.5
56	148	57	25	41	9	415.5
57	149	57	27	42	10	425.5
58	150	60	28	44	12	437.5
59	151	63	27	45	13	450.5
60	152	62	34	48	16	466.5
61	153	47	26	36.5	4.5	471
62	154	55	20	37.5	5.5	476.5
63	155	64	30	47	15	491.5
64	156	66	31	48.5	16.5	508
65	157	68	34	51	19	527
66	158	70	31	50.5	18.5	545.5
67	159	70	35	52.5	20.5	566
68	160	70	33	51.5	19.5	585.5
69	161	71	33	52	20	605.5
70	162	72	35	53.5	21.5	627
71	163	70	35	52.5	20.5	647.5
72	164	71	36	53.5	21.5	669
73	165	71	33	52	20	689
74	166	65	36	50.5	18.5	707.5
75	167	60	28	44	12	719.5
76	168	68	30	49	17	736.5
77	169	71	35	53	21	757.5
78	170	71	36	53.5	21.5	779
79	171	59	35	47	15	794
80	172	62	29	45.5	13.5	807.5
81	173	66	30	48	16	823.5
82	174	69	32	50.5	18.5	842
83	175	59	41	50	18	860
84	176	62	30	46	14	874
85	177	69	31	50	18	892
86	178	62	35	48.5	16.5	908.5
87	179	47	30	38.5	6.5	915
88	180	44	23	33.5	1.5	916.5
89	181	47	17	32	0	916.5
90	182	46	21	33.5	1.5	918
91	183	55	25	40	8	926
92	184	65	29	47	15	941
93	185	67	40	53.5	21.5	962.5
94	186	66	30	48	16	978.5
95	187	69	35	52	20	998.5
96	188	70	41	55.5	23.5	1022
97	189	71	40	55.5	23.5	1045.5
98	190	71	33	52	20	1065.5
99	191	72	34	53	21	1086.5
100	192	72	38	55	23	1109.5
101	193	73	37	55	23	1132.5
102	194	73	40	56.5	24.5	1157
103	195	64	40	52	20	1177
104	196	55	31	43	11	1188
105	197	42	25	33.5	1.5	1189.5
106	198	60	24	42	10	1199.5
107	199	67	30	48.5	16.5	1216
108	200	67	32	49.5	17.5	1233.5
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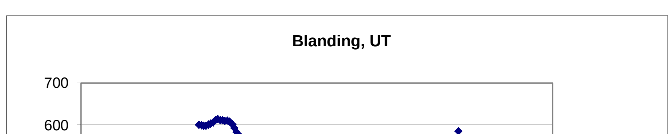
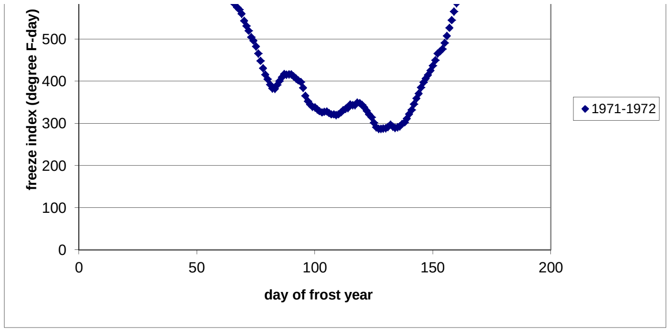
110	202	55	31	43	11	1265
111	203	55	24	39.5	7.5	1272.5
112	204	65	24	44.5	12.5	1285
113	205	71	30	50.5	18.5	1303.5
114	206	74	32	53	21	1324.5
115	207	78	36	57	25	1349.5
116	208	65	35	50	18	1367.5
117	209	56	30	43	11	1378.5
118	210	63	32	47.5	15.5	1394
119	211	70	30	50	18	1412
120	212	73	36	54.5	22.5	1434.5
121	213	65	36	50.5	18.5	1453
122	214	67	28	47.5	15.5	1468.5
123	215	70	32	51	19	1487.5
124	216	76	33	54.5	22.5	1510
125	217	79	39	59	27	1537
126	218	77	46	61.5	29.5	1566.5
127	219	74	44	59	27	1593.5
128	220	70	40	55	23	1616.5
129	221	74	35	54.5	22.5	1639
130	222	73	39	56	24	1663
131	223	67	38	52.5	20.5	1683.5
132	224	65	29	47	15	1698.5
133	225	67	33	50	18	1716.5
134	226	66	36	51	19	1735.5
135	227	75	45	60	28	1763.5
136	228	81	40	60.5	28.5	1792
137	229	83	42	62.5	30.5	1822.5
138	230	78	52	65	33	1855.5
139	231	80	45	62.5	30.5	1886
140	232	78	49	63.5	31.5	1917.5
141	233	78	37	57.5	25.5	1943

142	234	70	35	52.5	20.5	1963.5
143	235	71	33	52	20	1983.5
144	236	78	36	57	25	2008.5
145	237	80	40	60	28	2036.5
146	238	80	40	60	28	2064.5
147	239	81	42	61.5	29.5	2094
148	240	82	45	63.5	31.5	2125.5
149	241	83	46	64.5	32.5	2158
150	242	85	56	70.5	38.5	2196.5
151	243	78	52	65	33	2229.5
152	244	82	45	63.5	31.5	2261
153	245	87	50	68.5	36.5	2297.5
154	246	88	50	69	37	2334.5
155	247	83	49	66	34	2368.5
156	248	82	51	66.5	34.5	2403
157	249	80	45	62.5	30.5	2433.5
158	250	79	50	64.5	32.5	2466
159	251	78	50	64	32	2498
160	252	76	47	61.5	29.5	2527.5
161	253	81	46	63.5	31.5	2559
162	254	82	47	64.5	32.5	2591.5
163	255	86	48	67	35	2626.5
164	256	87	56	71.5	39.5	2666
165	257	85	48	66.5	34.5	2700.5
166	258	85	50	67.5	35.5	2736
167	259	87	48	67.5	35.5	2771.5
168	260	86	48	67	35	2806.5
169	261	89	52	70.5	38.5	2845
170	262	87	50	68.5	36.5	2881.5
171	263	89	48	68.5	36.5	2918
172	264	89	48	68.5	36.5	2954.5
173	265	87	57	72	40	2994.5
174	266	68	50	59	27	3021.5
175	267	78	52	65	33	3054.5
176	268	80	44	62	30	3084.5
177	269	82	46	64	32	3116.5
178	270	82	48	65	33	3149.5
179	271	88	47	67.5	35.5	3185
180	272	89	55	72	40	3225
181	273	92	64	78	46	3271
182	274	92	55	73.5	41.5	3312.5
183	275	96	58	77	45	3357.5
184	276	95	64	79.5	47.5	3405
185	277	93	55	74	42	3447
186	278	89	56	72.5	40.5	3487.5
187	279	90	58	74	42	3529.5
188	280	90	54	72	40	3569.5
189	281	90	52	71	39	3608.5
190	282	90	53	71.5	39.5	3648
191	283	88	58	73	41	3689
192	284	90	55	72.5	40.5	3729.5
193	285	90	53	71.5	39.5	3769
194	286	94	64	79	47	3816
195	287	93	61	77	45	3861
196	288	95	62	78.5	46.5	3907.5
197	289	97	61	79	47	3954.5
198	290	94	58	76	44	3998.5
199	291	92	51	71.5	39.5	4038
200	292	87	51	69	37	4075
201	293	84	49	66.5	34.5	4109.5
202	294	83	55	69	37	4146.5
203	295	82	53	67.5	35.5	4182
204	296	85	54	69.5	37.5	4219.5
205	297	92	50	71	39	4258.5
206	298	84	60	72	40	4298.5
207	299	82	58	70	38	4336.5
208	300	88	57	72.5	40.5	4377
209	301	91	64	77.5	45.5	4422.5
210	302	92	60	76	44	4466.5
211	303	94	60	77	45	4511.5
212	304	97	59	78	46	4557.5
213	305	95	64	79.5	47.5	4605
214	306	91	61	76	44	4649
215	307	92	63	77.5	45.5	4694.5
216	308	92	65	78.5	46.5	4741
217	309	90	64	77	45	4786
218	310	86	59	72.5	40.5	4826.5
219	311	93	57	75	43	4869.5
220	312	93	59	76	44	4913.5
221	313	91	56	73.5	41.5	4955
222	314	90	55	72.5	40.5	4995.5
223	315	90	56	73	41	5036.5
224	316	95	60	77.5	45.5	5082
225	317	92	60	76	44	5126
226	318	90	60	75	43	5169
227	319	85	60	72.5	40.5	5209.5
228	320	85	58	71.5	39.5	5249
229	321	87	55	71	39	5288
230	322	86	55	70.5	38.5	5326.5
231	323	75	58	66.5	34.5	5361
232	324	80	52	66	34	5395
233	325	83	48	65.5	33.5	5428.5
234	326	91	53	72	40	5468.5
235	327	87	57	72	40	5508.5
236	328	88	51	69.5	37.5	5546
237	329	81	45	63	31	5577
238	330	74	56	65	33	5610
239	331	72	48	60	28	5638
240	332	72	51	61.5	29.5	5667.5
241	333	78	59	68.5	36.5	5704
242	334	73	57	65	33	5737
243	335	80	50	65	33	5770
244	336	84	53	68.5	36.5	5806.5
245	337	84	50	67	35	5841.5
246	338	84	52	68	36	5877.5
247	339	82	51	66.5	34.5	5912
248	340	84	50	67	35	5947
249	341	85	52	68.5	36.5	5983.5
250	342	70	50	60	28	6011.5



251	343	72	49	60.5	28.5	6040				
252	344	82	46	64	32	6072				
253	345	79	57	68	36	6108				
254	346	79	55	67	35	6143				
255	347	80	53	66.5	34.5	6177.5				
256	348	78	48	63	31	6208.5				
257	349	76	49	62.5	30.5	6239				
258	350	81	49	65	33	6272				
259	351	83	48	65.5	33.5	6305.5				
260	352	83	50	66.5	34.5	6340				
261	353	83	48	65.5	33.5	6373.5				
262	354	80	50	65	33	6406.5				
263	355	73	43	58	26	6432.5				
264	356	71	39	55	23	6455.5				
265	357	74	42	58	26	6481.5				
266	358	74	45	59.5	27.5	6509				
267	359	76	45	60.5	28.5	6537.5				
268	360	68	43	55.5	23.5	6561				
269	361	71	44	57.5	25.5	6586.5				
270	362	74	43	58.5	26.5	6613				
271	363	75	40	57.5	25.5	6638.5				
272	364	75	44	59.5	27.5	6666	58	614.5	length of freeze (day)	70
273	365	70	45	57.5	25.5	6691.5	128	287.5	frost index (^oF-day)	327
274	366	76	40	58	26	6717.5			average temperature	50.4



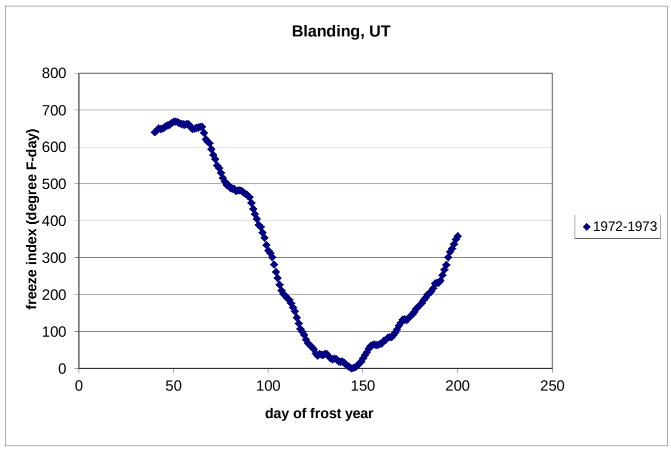
1972-1973

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (^oF)	cumulative degree day (^oF)
274	1	79	40	59.5	27.5	27.5
275	2	76	45	60.5	28.5	56
276	3	81	46	63.5	31.5	87.5
277	4	56	48	52	20	107.5
278	5	63	47	55	23	130.5
279	6	61	47	54	22	152.5
280	7	57	48	52.5	20.5	173
281	8	65	47	56	24	197
282	9	65	44	54.5	22.5	219.5
283	10	66	47	56.5	24.5	244
284	11	67	43	55	23	267
285	12	70	48	59	27	294
286	13	70	50	60	28	322
287	14	70	48	59	27	349
288	15	65	47	56	24	373
289	16	62	45	53.5	21.5	394.5
290	17	55	45	50	18	412.5
291	18	53	45	49	17	429.5
292	19	52	46	49	17	446.5
293	20	54	38	46	14	460.5
294	21	54	33	43.5	11.5	472
295	22	59	33	46	14	486
296	23	58	35	46.5	14.5	500.5
297	24	56	35	45.5	13.5	514
298	25	55	37	46	14	528
299	26	50	37	43.5	11.5	539.5
300	27	45	40	42.5	10.5	550
301	28	50	38	44	12	562
302	29	48	30	39	7	569
303	30	34	24	29	-3	566
304	31	36	22	29	-3	563
305	32	42	33	37.5	5.5	568.5
306	33	51	28	39.5	7.5	576
307	34	52	27	39.5	7.5	583.5
308	35	52	30	41	9	592.5
309	36	49	35	42	10	602.5
310	37	52	27	39.5	7.5	610
311	38	51	30	40.5	8.5	618.5
312	39	53	37	45	13	631.5
313	40	52	30	41	9	640.5
314	41	47	25	36	4	644.5
315	42	44	32	38	6	650.5
316	43	37	24	30.5	-1.5	649
317	44	45	21	33	1	650
318	45	43	28	35.5	3.5	653.5
319	46	43	27	35	3	656.5
320	47	43	26	34.5	2.5	659
321	48	37	31	34	2	661
322	49	45	27	36	4	665
323	50	45	26	35.5	3.5	668.5
324	51	40	25	32.5	0.5	669
325	52	40	21	30.5	-1.5	667.5
326	53	37	21	29	-3	664.5
327	54	42	19	30.5	-1.5	663
328	55	43	19	31	-1	662
329	56	41	21	31	-1	661
330	57	45	22	33.5	1.5	662.5
331	58	42	21	31.5	-0.5	662
332	59	32	16	24	-8	654
333	60	38	15	26.5	-5.5	648.5
334	61	46	20	33	1	649.5
335	62	48	22	35	3	652.5
336	63	45	20	32.5	0.5	653
337	64	45	23	34	2	655
338	65	38	25	31.5	-0.5	654.5
339	66	25	6	15.5	-16.5	638
340	67	25	6	15.5	-16.5	621.5
341	68	36	15	25.5	-6.5	615
342	69	34	22	28	-4	611
343	70	27	3	15	-17	594
344	71	31	2	16.5	-15.5	578.5
345	72	29	13	21	-11	567.5
346	73	28	1	14.5	-17.5	550
347	74	37	13	25	-7	543
348	75	32	6	19	-13	530
349	76	31	6	18.5	-13.5	516.5
350	77	35	10	22.5	-9.5	507
351	78	34	11	22.5	-9.5	497.5
352	79	40	21	30.5	-1.5	496
353	80	34	17	25.5	-6.5	489.5

354	81	44	17	30.5	-1.5	488
355	82	41	20	30.5	-1.5	486.5
356	83	38	15	26.5	-5.5	481
357	84	45	22	33.5	1.5	482.5
358	85	42	22	32	0	482.5
359	86	40	20	30	-2	480.5
360	87	38	18	28	-4	476.5
361	88	40	17	28.5	-3.5	473
362	89	35	22	28.5	-3.5	469.5
363	90	32	22	27	-5	464.5
364	91	28	5	16.5	-15.5	449
365	92	29	2	15.5	-16.5	432.5
1	93	30	5	17.5	-14.5	418
2	94	33	5	19	-13	405
3	95	25	6	15.5	-16.5	388.5
4	96	34	21	27.5	-4.5	384
5	97	29	4	16.5	-15.5	368.5
6	98	34	2	18	-14	354.5
7	99	27	-4	11.5	-20.5	334
8	100	29	6	17.5	-14.5	319.5
9	101	30	20	25	-7	312.5
10	102	32	10	21	-11	301.5
11	103	21	3	12	-20	281.5
12	104	24	1	12.5	-19.5	262
13	105	25	5	15	-17	245
14	106	25	3	14	-18	227
15	107	30	2	16	-16	211
16	108	39	6	22.5	-9.5	201.5
17	109	39	17	28	-4	197.5
18	110	37	13	25	-7	190.5
19	111	34	22	28	-4	186.5
20	112	35	9	22	-10	176.5
21	113	36	5	20.5	-11.5	165
22	114	35	9	22	-10	155
23	115	28	2	15	-17	138
24	116	29	3	16	-16	122
25	117	31	4	17.5	-14.5	107.5
26	118	35	13	24	-8	99.5
27	119	34	13	23.5	-8.5	91
28	120	33	5	19	-13	78
29	121	37	8	22.5	-9.5	68.5
30	122	42	12	27	-5	63.5
31	123	36	17	26.5	-5.5	58
32	124	39	13	26	-6	52
33	125	34	8	21	-11	41
34	126	37	15	26	-6	35
35	127	42	29	35.5	3.5	38.5
36	128	43	18	30.5	-1.5	37
37	129	36	26	31	-1	36
38	130	45	26	35.5	3.5	39.5
39	131	39	24	31.5	-0.5	39
40	132	31	20	25.5	-6.5	32.5
41	133	32	20	26	-6	26.5
42	134	39	23	31	-1	25.5
43	135	41	26	33.5	1.5	27
44	136	44	17	30.5	-1.5	25.5
45	137	38	15	26.5	-5.5	20
46	138	39	22	30.5	-1.5	18.5
47	139	42	23	32.5	0.5	19
48	140	41	16	28.5	-3.5	15.5
49	141	39	16	27.5	-4.5	11
50	142	40	15	27.5	-4.5	6.5
51	143	41	16	28.5	-3.5	3
52	144	38	20	29	-3	0
53	145	38	30	34	2	2
54	146	37	30	33.5	1.5	3.5
55	147	42	30	36	4	7.5
56	148	48	28	38	6	13.5
57	149	49	25	37	5	18.5
58	150	52	30	41	9	27.5
59	151	47	34	40.5	8.5	36
60	152	48	32	40	8	44
61	153	48	35	41.5	9.5	53.5
62	154	49	29	39	7	60.5
63	155	41	28	34.5	2.5	63
64	156	43	25	34	2	65
65	157	41	20	30.5	-1.5	63.5
66	158	35	30	32.5	0.5	64
67	159	40	30	35	3	67
68	160	39	28	33.5	1.5	68.5
69	161	49	28	38.5	6.5	75
70	162	42	27	34.5	2.5	77.5
71	163	46	30	38	6	83.5
72	164	40	27	33.5	1.5	85
73	165	41	23	32	0	85
74	166	49	25	37	5	90
75	167	54	24	39	7	97
76	168	54	28	41	9	106
77	169	53	31	42	10	116
78	170	52	27	39.5	7.5	123.5
79	171	53	29	41	9	132.5
80	172	38	27	32.5	0.5	133
81	173	36	25	30.5	-1.5	131.5
82	174	48	25	36.5	4.5	136
83	175	47	29	38	6	142
84	176	51	22	36.5	4.5	146.5
85	177	52	25	38.5	6.5	153
86	178	47	33	40	8	161
87	179	44	30	37	5	166
88	180	46	29	37.5	5.5	171.5
89	181	48	27	37.5	5.5	177
90	182	52	28	40	8	185
91	183	49	28	38.5	6.5	191.5
92	184	50	31	40.5	8.5	200
93	185	47	26	36.5	4.5	204.5
94	186	46	27	36.5	4.5	209
95	187	56	24	40	8	217
96	188	62	28	45	13	230
97	189	45	24	34.5	2.5	232.5

98	190	43	20	31.5	-0.5	232
99	191	55	22	38.5	6.5	238.5
100	192	62	30	46	14	252.5
101	193	58	36	47	15	267.5
102	194	61	30	45.5	13.5	281
103	195	66	38	52	20	301
104	196	59	35	47	15	316
105	197	51	31	41	9	325
106	198	58	30	44	12	337
107	199	60	30	45	13	350
108	200	51	30	40.5	8.5	358.5
109	201	43	26	34.5	2.5	361
110	202	47	19	33	1	362
111	203	47	22	34.5	2.5	364.5
112	204	59	25	42	10	374.5
113	205	65	30	47.5	15.5	390
114	206	60	35	47.5	15.5	405.5
115	207	62	36	49	17	422.5
116	208	63	32	47.5	15.5	438
117	209	68	32	50	18	456
118	210	71	38	54.5	22.5	478.5
119	211	68	38	53	21	499.5
120	212	54	38	46	14	513.5
121	213	53	36	44.5	12.5	526
122	214	60	30	45	13	539
123	215	68	33	50.5	18.5	557.5
124	216	71	39	55	23	580.5
125	217	53	35	44	12	592.5
126	218	59	32	45.5	13.5	606
127	219	66	36	51	19	625
128	220	72	39	55.5	23.5	648.5
129	221	76	45	60.5	28.5	677
130	222	80	44	62	30	707
131	223	80	48	64	32	739
132	224	80	47	63.5	31.5	770.5
133	225	71	43	57	25	795.5
134	226	69	44	56.5	24.5	820
135	227	70	40	55	23	843
136	228	78	43	60.5	28.5	871.5
137	229	80	45	62.5	30.5	902
138	230	84	50	67	35	937
139	231	80	49	64.5	32.5	969.5
140	232	80	51	65.5	33.5	1003
141	233	70	43	56.5	24.5	1027.5
142	234	65	40	52.5	20.5	1048
143	235	72	39	55.5	23.5	1071.5
144	236	78	42	60	28	1099.5
145	237	68	45	56.5	24.5	1124
146	238	60	41	50.5	18.5	1142.5
147	239	62	35	48.5	16.5	1159
148	240	74	40	57	25	1184
149	241	78	43	60.5	28.5	1212.5
150	242	76	48	62	30	1242.5
151	243	79	48	63.5	31.5	1274
152	244	69	49	59	27	1301
153	245	67	46	56.5	24.5	1325.5
154	246	63	40	51.5	19.5	1345
155	247	65	39	52	20	1365
156	248	72	39	55.5	23.5	1388.5
157	249	80	47	63.5	31.5	1420
158	250	85	46	65.5	33.5	1453.5
159	251	87	50	68.5	36.5	1490
160	252	89	52	70.5	38.5	1528.5
161	253	89	53	71	39	1567.5
162	254	85	47	66	34	1601.5
163	255	85	50	67.5	35.5	1637
164	256	78	50	64	32	1669
165	257	63	47	55	23	1692
166	258	69	45	57	25	1717
167	259	70	37	53.5	21.5	1738.5
168	260	77	42	59.5	27.5	1766
169	261	69	46	57.5	25.5	1791.5
170	262	72	41	56.5	24.5	1816
171	263	79	45	62	30	1846
172	264	83	52	67.5	35.5	1881.5
173	265	85	48	66.5	34.5	1916
174	266	85	47	66	34	1950
175	267	87	53	70	38	1988
176	268	91	52	71.5	39.5	2027.5
177	269	93	58	75.5	43.5	2071
178	270	94	63	78.5	46.5	2117.5
179	271	95	65	80	48	2165.5
180	272	92	56	74	42	2207.5
181	273	92	63	77.5	45.5	2253
182	274	91	52	71.5	39.5	2292.5
183	275	92	52	72	40	2332.5
184	276	95	57	76	44	2376.5
185	277	94	57	75.5	43.5	2420
186	278	96	62	79	47	2467
187	279	96	56	76	44	2511
188	280	92	65	78.5	46.5	2557.5
189	281	86	62	74	42	2599.5
190	282	92	56	74	42	2641.5
191	283	91	57	74	42	2683.5
192	284	87	61	74	42	2725.5
193	285	87	60	73.5	41.5	2767
194	286	83	53	68	36	2803
195	287	84	53	68.5	36.5	2839.5
196	288	82	56	69	37	2876.5
197	289	85	60	72.5	40.5	2917
198	290	79	58	68.5	36.5	2953.5
199	291	75	55	65	33	2986.5
200	292	80	51	65.5	33.5	3020
201	293	83	51	67	35	3055
202	294	81	54	67.5	35.5	3090.5
203	295	82	51	66.5	34.5	3125
204	296	84	52	68	36	3161
205	297	88	52	70	38	3199
206	298	87	60	73.5	41.5	3240.5

207	299	87	57	72	40	3280.5
208	300	87	52	69.5	37.5	3318
209	301	87	52	69.5	37.5	3355.5
210	302	87	50	68.5	36.5	3392
211	303	86	57	71.5	39.5	3431.5
212	304	85	52	68.5	36.5	3468
213	305	88	52	70	38	3506
214	306	88	57	72.5	40.5	3546.5
215	307	89	56	72.5	40.5	3587
216	308	86	58	72	40	3627
217	309	84	54	69	37	3664
218	310	85	53	69	37	3701
219	311	80	54	67	35	3736
220	312	89	51	70	38	3774
221	313	92	60	76	44	3818
222	314	92	56	74	42	3860
223	315	92	58	75	43	3903
224	316	94	56	75	43	3946
225	317	92	56	74	42	3988
226	318	90	58	74	42	4030
227	319	88	54	71	39	4069
228	320	88	53	70.5	38.5	4107.5
229	321	86	58	72	40	4147.5
230	322	85	56	70.5	38.5	4186
231	323	90	57	73.5	41.5	4227.5
232	324	88	60	74	42	4269.5
233	325	76	56	66	34	4303.5
234	326	84	51	67.5	35.5	4339
235	327	87	53	70	38	4377
236	328	86	60	73	41	4418
237	329	87	53	70	38	4456
238	330	83	51	67	35	4491
239	331	84	53	68.5	36.5	4527.5
240	332	84	50	67	35	4562.5
241	333	82	53	67.5	35.5	4598
242	334	70	53	61.5	29.5	4627.5
243	335	78	47	62.5	30.5	4658
244	336	80	49	64.5	32.5	4690.5
245	337	73	42	57.5	25.5	4716
246	338	77	40	58.5	26.5	4742.5
247	339	84	43	63.5	31.5	4774
248	340	84	49	66.5	34.5	4808.5
249	341	83	57	70	38	4846.5
250	342	84	50	67	35	4881.5
251	343	80	48	64	32	4913.5
252	344	83	43	63	31	4944.5
253	345	64	50	57	25	4969.5
254	346	68	45	56.5	24.5	4994
255	347	76	42	59	27	5021
256	348	80	45	62.5	30.5	5051.5
257	349	80	49	64.5	32.5	5084
258	350	79	49	64	32	5116
259	351	79	45	62	30	5146
260	352	80	42	61	29	5175
261	353	80	47	63.5	31.5	5206.5
262	354	78	45	61.5	29.5	5236
263	355	79	43	61	29	5265
264	356	80	45	62.5	30.5	5295.5
265	357	80	46	63	31	5326.5
266	358	71	48	59.5	27.5	5354
267	359	68	35	51.5	19.5	5373.5
268	360	56	42	49	17	5390.5
269	361	62	42	52	20	5410.5
270	362	68	40	54	22	5432.5
271	363	74	40	57	25	5457.5
272	364	73	44	58.5	26.5	5484
273	365	77	44	60.5	28.5	5512.5



52	667.5	length of freeze (day)	92
144	0	frost index (°F-day)	667.5
		average temperature	47.1

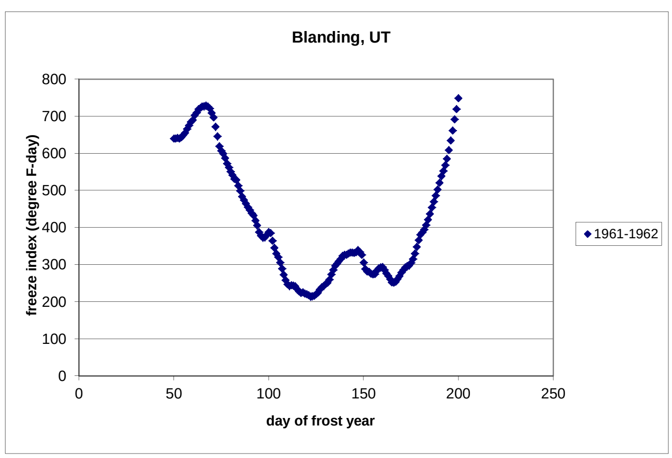
1961-1962

day of year	day of frost year (consecutive date)	max. temp.	min. temp	avg. temp	degree day (°F)	cumulative degree day (°F)
274	1	66	37	51.5	19.5	19.5
275	2	70	36	53	21	40.5
276	3	70	32	51	19	59.5
277	4	72	35	53.5	21.5	81
278	5	73	36	54.5	22.5	103.5
279	6	75	38	56.5	24.5	128
280	7	74	41	57.5	25.5	153.5
281	8	60	43	51.5	19.5	173
282	9	49	34	41.5	9.5	182.5
283	10	55	31	43	11	193.5
284	11	61	33	47	15	208.5
285	12	65	37	51	19	227.5
286	13	69	41	55	23	250.5
287	14	70	44	57	25	275.5
288	15	71	43	57	25	300.5
289	16	72	40	56	24	324.5
290	17	71	40	55.5	23.5	348
291	18	74	43	58.5	26.5	374.5
292	19	71	40	55.5	23.5	398
293	20	68	40	54	22	420
294	21	66	41	53.5	21.5	441.5
295	22	61	35	48	16	457.5
296	23	58	27	42.5	10.5	468
297	24	64	30	47	15	483
298	25	64	33	48.5	16.5	499.5
299	26	62	35	48.5	16.5	516
300	27	61	39	50	18	534
301	28	48	30	39	7	541
302	29	35	28	31.5	-0.5	540.5
303	30	46	29	37.5	5.5	546
304	31	44	34	39	7	553
305	32	40	32	36	4	557
306	33	38	28	33	1	558
307	34	45	22	33.5	1.5	559.5
308	35	54	26	40	8	567.5
309	36	44	23	33.5	1.5	569
310	37	48	20	34	2	571
311	38	57	25	41	9	580

312	39	47	34	40.5	8.5	588.5
313	40	53	35	44	12	600.5
314	41	57	30	43.5	11.5	612
315	42	53	32	42.5	10.5	622.5
316	43	44	29	36.5	4.5	627
317	44	43	27	35	3	630
318	45	47	19	33	1	631
319	46	54	21	37.5	5.5	636.5
320	47	52	28	40	8	644.5
321	48	40	22	31	-1	643.5
322	49	39	18	28.5	-3.5	640
323	50	43	21	32	0	640
324	51	41	23	32	0	640
325	52	41	26	33.5	1.5	641.5
326	53	42	19	30.5	-1.5	640
327	54	47	23	35	3	643
328	55	49	27	38	6	649
329	56	41	36	38.5	6.5	655.5
330	57	51	34	42.5	10.5	666
331	58	53	30	41.5	9.5	675.5
332	59	52	30	41	9	684.5
333	60	49	26	37.5	5.5	690
334	61	54	35	44.5	12.5	702.5
335	62	48	30	39	7	709.5
336	63	52	31	41.5	9.5	719
337	64	47	25	36	4	723
338	65	49	22	35.5	3.5	726.5
339	66	45	20	32.5	0.5	727
340	67	46	22	34	2	729
341	68	40	19	29.5	-2.5	726.5
342	69	33	20	26.5	-5.5	721
343	70	28	12	20	-12	709
344	71	27	13	20	-12	697
345	72	20	-7	6.5	-25.5	671.5
346	73	21	-8	6.5	-25.5	646
347	74	18	-7	5.5	-26.5	619.5
348	75	29	10	19.5	-12.5	607
349	76	32	16	24	-8	599
350	77	31	10	20.5	-11.5	587.5
351	78	23	11	17	-15	572.5
352	79	32	11	21.5	-10.5	562
353	80	31	10	20.5	-11.5	550.5
354	81	34	11	22.5	-9.5	541
355	82	36	8	22	-10	531
356	83	45	14	29.5	-2.5	528.5
357	84	31	2	16.5	-15.5	513
358	85	35	1	18	-14	499
359	86	29	4	16.5	-15.5	483.5
360	87	36	9	22.5	-9.5	474
361	88	36	9	22.5	-9.5	464.5
362	89	35	10	22.5	-9.5	455
363	90	38	11	24.5	-7.5	447.5
364	91	37	10	23.5	-8.5	439
365	92	39	12	25.5	-6.5	432.5
1	93	29	8	18.5	-13.5	419
2	94	31	7	19	-13	406
3	95	24	3	13.5	-18.5	387.5
4	96	36	10	23	-9	378.5
5	97	38	15	26.5	-5.5	373
6	98	47	18	32.5	0.5	373.5
7	99	47	29	38	6	379.5
8	100	51	30	40.5	8.5	388
9	101	40	18	29	-3	385
10	102	21	2	11.5	-20.5	364.5
11	103	25	1	13	-19	345.5
12	104	28	4	16	-16	329.5
13	105	27	18	22.5	-9.5	320
14	106	28	8	18	-14	306
15	107	27	4	15.5	-16.5	289.5
16	108	27	3	15	-17	272.5
17	109	30	6	18	-14	258.5
18	110	31	10	20.5	-11.5	247
19	111	37	18	27.5	-4.5	242.5
20	112	41	27	34	2	244.5
21	113	37	25	31	-1	243.5
22	114	42	18	30	-2	241.5
23	115	35	14	24.5	-7.5	234
24	116	38	13	25.5	-6.5	227.5
25	117	41	16	28.5	-3.5	224
26	118	49	17	33	1	225
27	119	41	16	28.5	-3.5	221.5
28	120	40	21	30.5	-1.5	220
29	121	40	19	29.5	-2.5	217.5
30	122	39	19	29	-3	214.5
31	123	43	22	32.5	0.5	215
32	124	43	23	33	1	216
33	125	47	25	36	4	220
34	126	48	25	36.5	4.5	224.5
35	127	54	27	40.5	8.5	233
36	128	49	27	38	6	239
37	129	45	26	35.5	3.5	242.5
38	130	46	29	37.5	5.5	248
39	131	40	31	35.5	3.5	251.5
40	132	46	35	40.5	8.5	260
41	133	57	35	46	14	274
42	134	52	36	44	12	286
43	135	50	36	43	11	297
44	136	46	30	38	6	303
45	137	46	31	38.5	6.5	309.5
46	138	46	30	38	6	315.5
47	139	50	31	40.5	8.5	324
48	140	41	27	34	2	326
49	141	42	22	32	0	326
50	142	43	28	35.5	3.5	329.5
51	143	41	28	34.5	2.5	332
52	144	41	23	32	0	332
53	145	43	20	31.5	-0.5	331.5
54	146	45	22	33.5	1.5	333
55	147	46	30	38	6	339

56	148	35	20	27.5	-4.5	334.5
57	149	32	15	23.5	-8.5	326
58	150	26	-2	12	-20	306
59	151	32	-4	14	-18	288
60	152	42	9	25.5	-6.5	281.5
61	153	44	18	31	-1	280.5
62	154	39	15	27	-5	275.5
63	155	45	15	30	-2	273.5
64	156	44	22	33	1	274.5
65	157	53	30	41.5	9.5	284
66	158	47	29	38	6	290
67	159	45	24	34.5	2.5	292.5
68	160	41	25	33	1	293.5
69	161	33	15	24	-8	285.5
70	162	34	11	22.5	-9.5	276
71	163	32	18	25	-7	269
72	164	33	15	24	-8	261
73	165	37	10	23.5	-8.5	252.5
74	166	44	17	30.5	-1.5	251
75	167	48	22	35	3	254
76	168	51	28	39.5	7.5	261.5
77	169	52	27	39.5	7.5	269
78	170	54	29	41.5	9.5	278.5
79	171	52	26	39	7	285.5
80	172	47	31	39	7	292.5
81	173	46	25	35.5	3.5	296
82	174	38	30	34	2	298
83	175	50	27	38.5	6.5	304.5
84	176	59	27	43	11	315.5
85	177	64	28	46	14	329.5
86	178	67	34	50.5	18.5	348
87	179	65	35	50	18	366
88	180	60	33	46.5	14.5	380.5
89	181	49	27	38	6	386.5
90	182	57	23	40	8	394.5
91	183	61	27	44	12	406.5
92	184	61	33	47	15	421.5
93	185	63	31	47	15	436.5
94	186	63	37	50	18	454.5
95	187	60	34	47	15	469.5
96	188	59	38	48.5	16.5	486
97	189	65	32	48.5	16.5	502.5
98	190	59	42	50.5	18.5	521
99	191	59	41	50	18	539
100	192	57	35	46	14	553
101	193	63	32	47.5	15.5	568.5
102	194	67	31	49	17	585.5
103	195	73	37	55	23	608.5
104	196	78	38	58	26	634.5
105	197	77	41	59	27	661.5
106	198	77	47	62	30	691.5
107	199	78	42	60	28	719.5
108	200	80	43	61.5	29.5	749
109	201	80	47	63.5	31.5	780.5
110	202	71	43	57	25	805.5
111	203	55	31	43	11	816.5
112	204	69	37	53	21	837.5
113	205	71	35	53	21	858.5
114	206	75	40	57.5	25.5	884
115	207	71	44	57.5	25.5	909.5
116	208	62	40	51	19	928.5
117	209	68	37	52.5	20.5	949
118	210	71	43	57	25	974
119	211	58	31	44.5	12.5	986.5
120	212	55	27	41	9	995.5
121	213	64	29	46.5	14.5	1010
122	214	72	35	53.5	21.5	1031.5
123	215	79	40	59.5	27.5	1059
124	216	81	45	63	31	1090
125	217	82	47	64.5	32.5	1122.5
126	218	83	44	63.5	31.5	1154
127	219	80	45	62.5	30.5	1184.5
128	220	81	48	64.5	32.5	1217
129	221	83	45	64	32	1249
130	222	82	46	64	32	1281
131	223	83	51	67	35	1316
132	224	77	53	65	33	1349
133	225	67	35	51	19	1368
134	226	63	39	51	19	1387
135	227	56	33	44.5	12.5	1399.5
136	228	61	35	48	16	1415.5
137	229	61	37	49	17	1432.5
138	230	67	30	48.5	16.5	1449
139	231	79	40	59.5	27.5	1476.5
140	232	72	40	56	24	1500.5
141	233	57	35	46	14	1514.5
142	234	68	35	51.5	19.5	1534
143	235	75	40	57.5	25.5	1559.5
144	236	75	40	57.5	25.5	1585
145	237	69	44	56.5	24.5	1609.5
146	238	70	38	54	22	1631.5
147	239	67	40	53.5	21.5	1653
148	240	56	38	47	15	1668
149	241	73	42	57.5	25.5	1693.5
150	242	75	43	59	27	1720.5
151	243	76	49	62.5	30.5	1751
152	244	78	49	63.5	31.5	1782.5
153	245	82	52	67	35	1817.5
154	246	79	47	63	31	1848.5
155	247	77	50	63.5	31.5	1880
156	248	76	42	59	27	1907
157	249	78	42	60	28	1935
158	250	76	47	61.5	29.5	1964.5
159	251	75	35	55	23	1987.5
160	252	81	45	63	31	2018.5
161	253	87	50	68.5	36.5	2055
162	254	84	49	66.5	34.5	2089.5
163	255	86	49	67.5	35.5	2125
164	256	84	49	66.5	34.5	2159.5

165	257	80	46	63	31	2190.5
166	258	69	47	58	26	2216.5
167	259	71	40	55.5	23.5	2240
168	260	75	43	59	27	2267
169	261	84	53	68.5	36.5	2303.5
170	262	88	53	70.5	38.5	2342
171	263	93	52	72.5	40.5	2382.5
172	264	90	58	74	42	2424.5
173	265	91	53	72	40	2464.5
174	266	92	54	73	41	2505.5
175	267	93	56	74.5	42.5	2548
176	268	92	55	73.5	41.5	2589.5
177	269	93	63	78	46	2635.5
178	270	92	63	77.5	45.5	2681
179	271	92	60	76	44	2725
180	272	84	60	72	40	2765
181	273	81	55	68	36	2801
182	274	88	53	70.5	38.5	2839.5
183	275	86	59	72.5	40.5	2880
184	276	86	54	70	38	2918
185	277	87	60	73.5	41.5	2959.5
186	278	91	56	73.5	41.5	3001
187	279	89	60	74.5	42.5	3043.5
188	280	93	61	77	45	3088.5
189	281	94	61	77.5	45.5	3134
190	282	89	58	73.5	41.5	3175.5
191	283	91	57	74	42	3217.5
192	284	96	57	76.5	44.5	3262
193	285	89	63	76	44	3306
194	286	80	57	68.5	36.5	3342.5
195	287	82	52	67	35	3377.5
196	288	88	53	70.5	38.5	3416
197	289	88	55	71.5	39.5	3455.5
198	290	88	56	72	40	3495.5
199	291	88	57	72.5	40.5	3536
200	292	92	59	75.5	43.5	3579.5
201	293	92	56	74	42	3621.5
202	294	95	65	80	48	3669.5
203	295	90	59	74.5	42.5	3712
204	296	84	63	73.5	41.5	3753.5
205	297	83	57	70	38	3791.5
206	298	89	53	71	39	3830.5
207	299	86	55	70.5	38.5	3869
208	300	89	55	72	40	3909
209	301	88	54	71	39	3948
210	302	90	59	74.5	42.5	3990.5
211	303	88	58	73	41	4031.5
212	304	86	56	71	39	4070.5
213	305	90	58	74	42	4112.5
214	306	90	57	73.5	41.5	4154
215	307	84	60	72	40	4194
216	308	87	53	70	38	4232
217	309	87	47	67	35	4267
218	310	87	50	68.5	36.5	4303.5
219	311	91	55	73	41	4344.5
220	312	92	58	75	43	4387.5
221	313	88	63	75.5	43.5	4431
222	314	91	58	74.5	42.5	4473.5
223	315	94	62	78	46	4519.5
224	316	94	59	76.5	44.5	4564
225	317	94	60	77	45	4609
226	318	95	60	77.5	45.5	4654.5
227	319	97	62	79.5	47.5	4702
228	320	94	65	79.5	47.5	4749.5
229	321	88	58	73	41	4790.5
230	322	90	62	76	44	4834.5
231	323	85	59	72	40	4874.5
232	324	88	57	72.5	40.5	4915
233	325	85	51	68	36	4951
234	326	80	54	67	35	4986
235	327	82	52	67	35	5021
236	328	82	42	62	30	5051
237	329	86	50	68	36	5087
238	330	89	48	68.5	36.5	5123.5
239	331	90	53	71.5	39.5	5163
240	332	88	55	71.5	39.5	5202.5
241	333	88	53	70.5	38.5	5241
242	334	84	47	65.5	33.5	5274.5
243	335	84	45	64.5	32.5	5307
244	336	84	43	63.5	31.5	5338.5
245	337	86	52	69	37	5375.5
246	338	86	49	67.5	35.5	5411
247	339	85	48	66.5	34.5	5445.5
248	340	87	52	69.5	37.5	5483
249	341	73	52	62.5	30.5	5513.5
250	342	78	51	64.5	32.5	5546
251	343	82	50	66	34	5580
252	344	72	36	54	22	5602
253	345	79	40	59.5	27.5	5629.5
254	346	80	48	64	32	5661.5
255	347	82	49	65.5	33.5	5695
256	348	84	52	68	36	5731
257	349	82	55	68.5	36.5	5767.5
258	350	86	58	72	40	5807.5
259	351	85	58	71.5	39.5	5847
260	352	87	55	71	39	5886
261	353	90	60	75	43	5929
262	354	87	55	71	39	5968
263	355	78	53	65.5	33.5	6001.5
264	356	73	53	63	31	6032.5
265	357	77	51	64	32	6064.5
266	358	70	50	60	28	6092.5
267	359	73	48	60.5	28.5	6121
268	360	76	50	63	31	6152
269	361	71	45	58	26	6178
270	362	64	51	57.5	25.5	6203.5
271	363	62	47	54.5	22.5	6226
272	364	67	43	55	23	6249
273	365	68	42	55	23	6272



68 726.5

123 215

length of freeze (day) 55

frost index (°F-day) 511.5

average temperature 49.2

ATTACHMENT B.2

MODIFIED BERGGEN FORMULA OUTPUT

1919-1920

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 262 F-days
Design Freezing Index (SURFACE) = 183 F-days
Mean Annual Temperature = 48.2 °F
Length of Freezing Season = 58 Days

LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	33	33
2: Fine-grained	7.2	146	179

End of Frost Penetration

TOTAL FROST PENETRATION = 13.2 inches

Do you want a hard copy of this data (Y or default N)?

1920-1921

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 191 F-days
Design Freezing Index (SURFACE) = 134 F-days
Mean Annual Temperature = 49.8 °F
Length of Freezing Season = 42 Days

LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	37	37
2: Fine-grained	5.3	106	143

End of Frost Penetration

TOTAL FROST PENETRATION = 11.3 inches

Do you want a hard copy of this data (Y or default N)?

1923-1924

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 420 F-days
Design Freezing Index (SURFACE) = 294 F-days
Mean Annual Temperature = 49.4 °F
Length of Freezing Season = 62 Days

LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	30	30
2: Fine-grained	12.0	273	303

------------------ End of Frost Penetration ------------------

TOTAL FROST PENETRATION = 18.0 inches

Do you want a hard copy of this data (Y or default N)?

1924-1925

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 696 F-days
Design Freezing Index (SURFACE) = 487 F-days
Mean Annual Temperature = 49.9 °F
Length of Freezing Season = 60 Days

LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	26	26
2: Fine-grained	12.0	238	264
3: Fine-grained	6.5	228	492

------------------ End of Frost Penetration ------------------

TOTAL FROST PENETRATION = 24.5 inches

Do you want a hard copy of this data (Y or default N)?

1927-1928

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 335 F-days
Design Freezing Index (SURFACE) = 235 F-days
Mean Annual Temperature = 49.6 °F
Length of Freezing Season = 81 Days

LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	38	38
2: Fine-grained	8.0	191	229

------------------ End of Frost Penetration ------------------

TOTAL FROST PENETRATION = 14.0 inches

Do you want a hard copy of this data (Y or default N)?

1928-1929

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 682 F-days
Design Freezing Index (SURFACE) = 477 F-days
Mean Annual Temperature = 47.3 °F
Length of Freezing Season = 96 Days

LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	27	27
2: Fine-grained	12.0	241	268
3: Fine-grained	6.0	213	481

------------------ End of Frost Penetration ------------------

TOTAL FROST PENETRATION = 24.0 inches

Do you want a hard copy of this data (Y or default N)?

1929-1930

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C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                 Summary: MODIFIED BERGGREN SOLUTION

        Design Freezing Index (AIR)      =  509 F-days
        Design Freezing Index (SURFACE)  =  356 F-days
        Mean Annual Temperature          = 48.5 °F
        Length of Freezing Season        =   53 Days

 -------------------------------------------------------------
                        LAYER     FREEZING INDEX DISTRIBUTION
       LAYER          THICKNESS
      #: Type          (inches)    Each Layer    Accumulated
 -------------------  ---------   ------------  -------------
 1: Fine-grained         6.0           26             26
 2: Fine-grained        12.0          235            261
 3: Fine-grained         3.0           97            358
 ----------------- End of Frost Penetration ------------------

 TOTAL FROST PENETRATION =  21.0 inches


 Do you want a hard copy of this data (Y or default N)?
```

1931-1932

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                 Summary: MODIFIED BERGGREN SOLUTION

        Design Freezing Index (AIR)      = 1008 F-days
        Design Freezing Index (SURFACE)  =  706 F-days
        Mean Annual Temperature          = 47.3 °F
        Length of Freezing Season        =   81 Days

 -------------------------------------------------------------
                        LAYER     FREEZING INDEX DISTRIBUTION
       LAYER          THICKNESS
      #: Type          (inches)    Each Layer    Accumulated
 -------------------  ---------   ------------  -------------
 1: Fine-grained         6.0           23             23
 2: Fine-grained        12.0          210            233
 3: Fine-grained        12.0          421            654
 4: Fine-grained         1.0           44            698
 ----------------- End of Frost Penetration ------------------

 TOTAL FROST PENETRATION =  31.0 inches


 Do you want a hard copy of this data (Y or default N)?
```

1938-1939

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 468 F-days
Design Freezing Index (SURFACE) = 328 F-days
Mean Annual Temperature = 50.0 °F
Length of Freezing Season = 80 Days

LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	33	33
2: Fine-grained	12.0	299	332

------------------ End of Frost Penetration ------------------

TOTAL FROST PENETRATION = 18.0 inches

Do you want a hard copy of this data (Y or default N)?

1939-1940

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 228 F-days
Design Freezing Index (SURFACE) = 160 F-days
Mean Annual Temperature = 51.6 °F
Length of Freezing Season = 62 Days

LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	46	46
2: Fine-grained	4.6	111	157

------------------ End of Frost Penetration ------------------

TOTAL FROST PENETRATION = 10.6 inches

Do you want a hard copy of this data (Y or default N)?

1940-1941

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 151 F-days
Design Freezing Index (SURFACE) = 106 F-days
Mean Annual Temperature = 48.8 °F
Length of Freezing Season = 57 Days

LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	45	45
2: Fine-grained	3.0	65	110

End of Frost Penetration

TOTAL FROST PENETRATION = 9.0 inches

Do you want a hard copy of this data (Y or default N)?

1946-1947

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 282 F-days
Design Freezing Index (SURFACE) = 197 F-days
Mean Annual Temperature = 50.1 °F
Length of Freezing Season = 38 Days

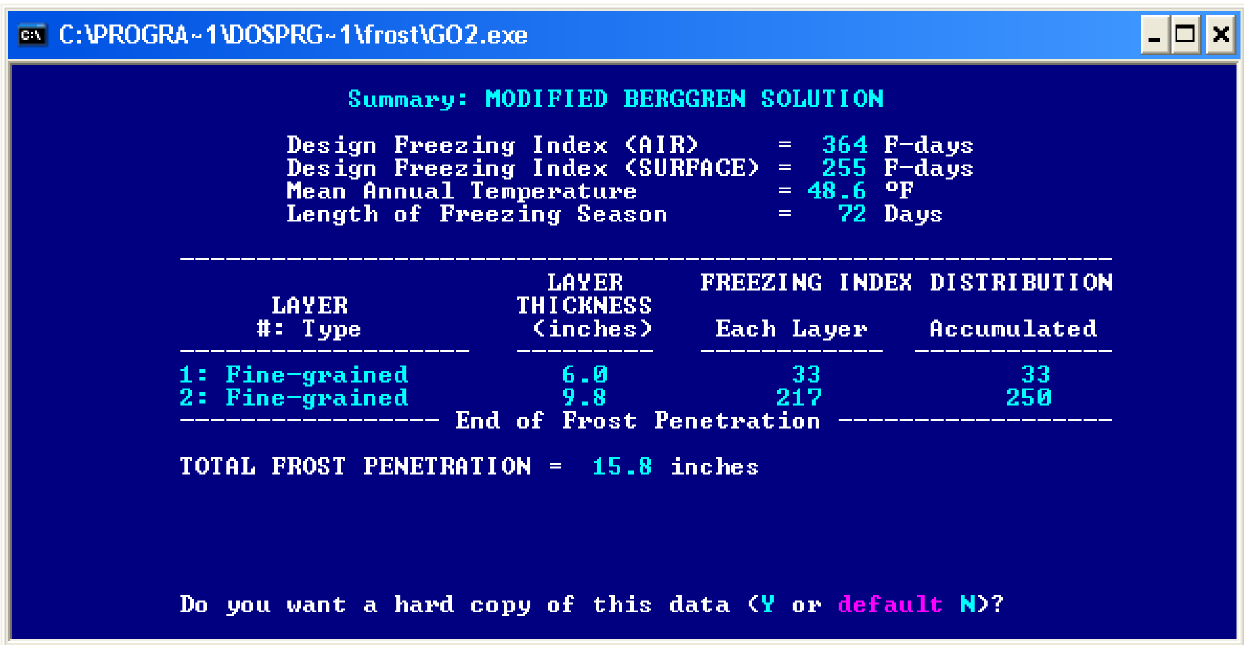
LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	30	30
2: Fine-grained	8.3	162	192

End of Frost Penetration

TOTAL FROST PENETRATION = 14.3 inches

Do you want a hard copy of this data (Y or default N)?

1947-1948


C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 364 F-days
Design Freezing Index (SURFACE) = 255 F-days
Mean Annual Temperature = 48.6 °F
Length of Freezing Season = 72 Days

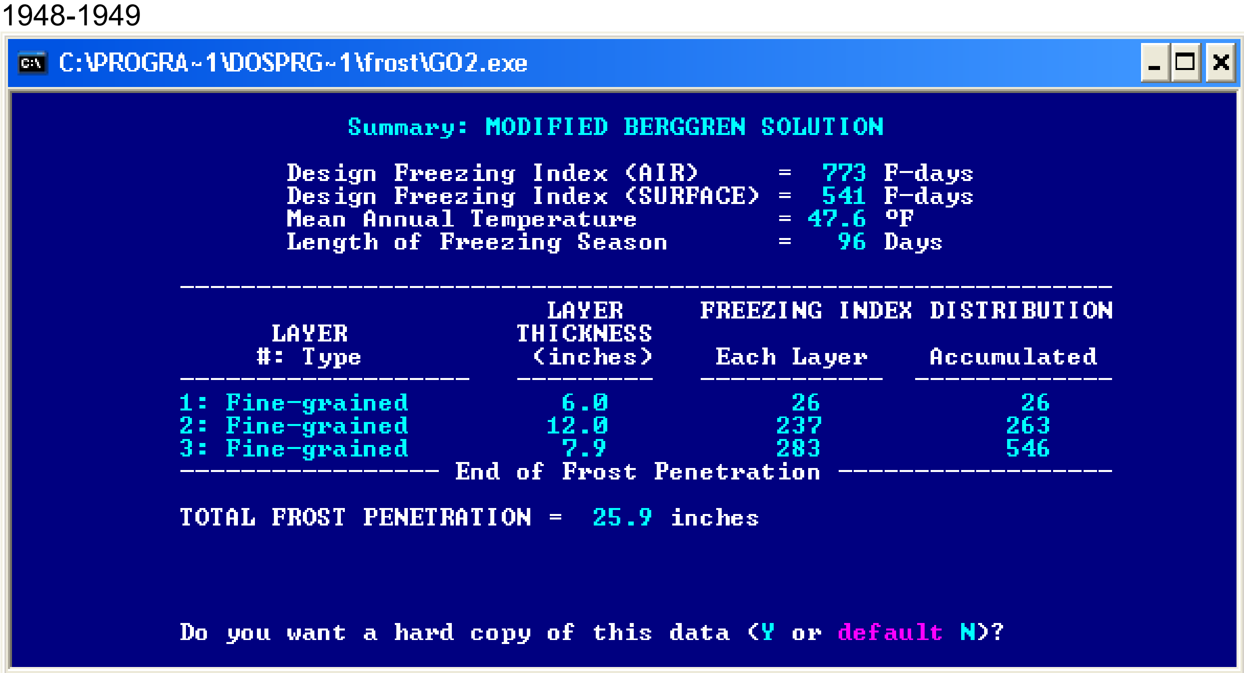
LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	33	33
2: Fine-grained	9.8	217	250

End of Frost Penetration

TOTAL FROST PENETRATION = 15.8 inches

Do you want a hard copy of this data (Y or default N)?

1948-1949


C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 773 F-days
Design Freezing Index (SURFACE) = 541 F-days
Mean Annual Temperature = 47.6 °F
Length of Freezing Season = 96 Days

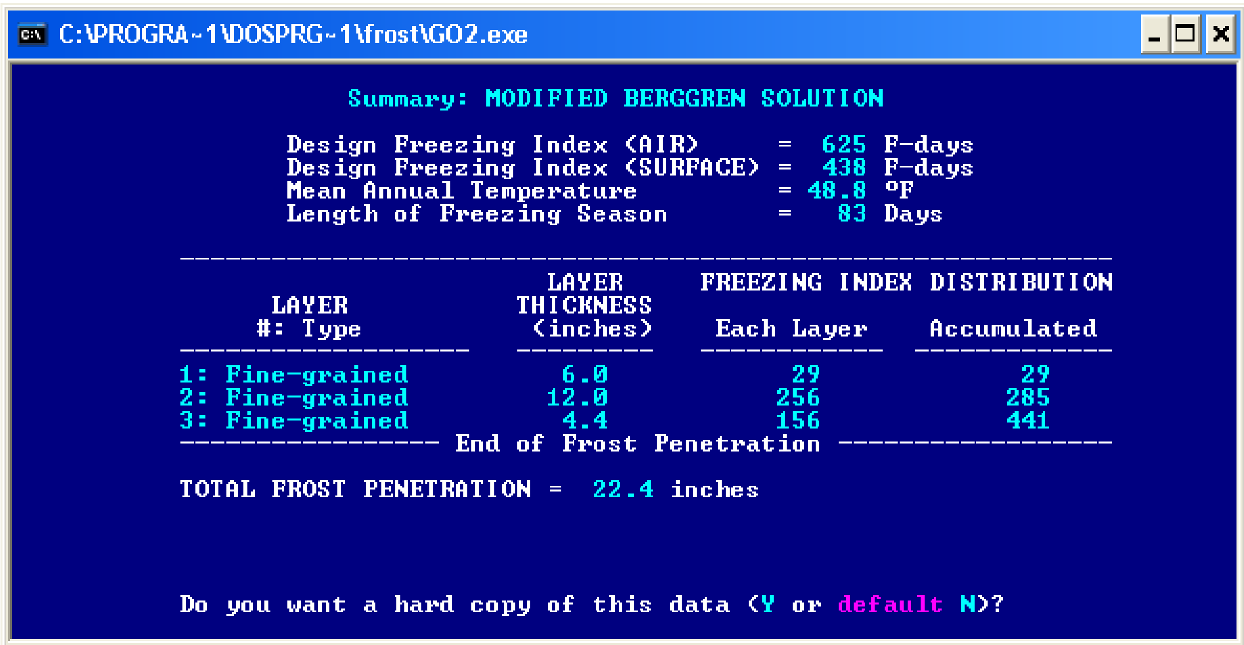
LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	26	26
2: Fine-grained	12.0	237	263
3: Fine-grained	7.9	283	546

End of Frost Penetration

TOTAL FROST PENETRATION = 25.9 inches

Do you want a hard copy of this data (Y or default N)?

1954-1955



C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 625 F-days
Design Freezing Index (SURFACE) = 438 F-days
Mean Annual Temperature = 48.8 °F
Length of Freezing Season = 83 Days

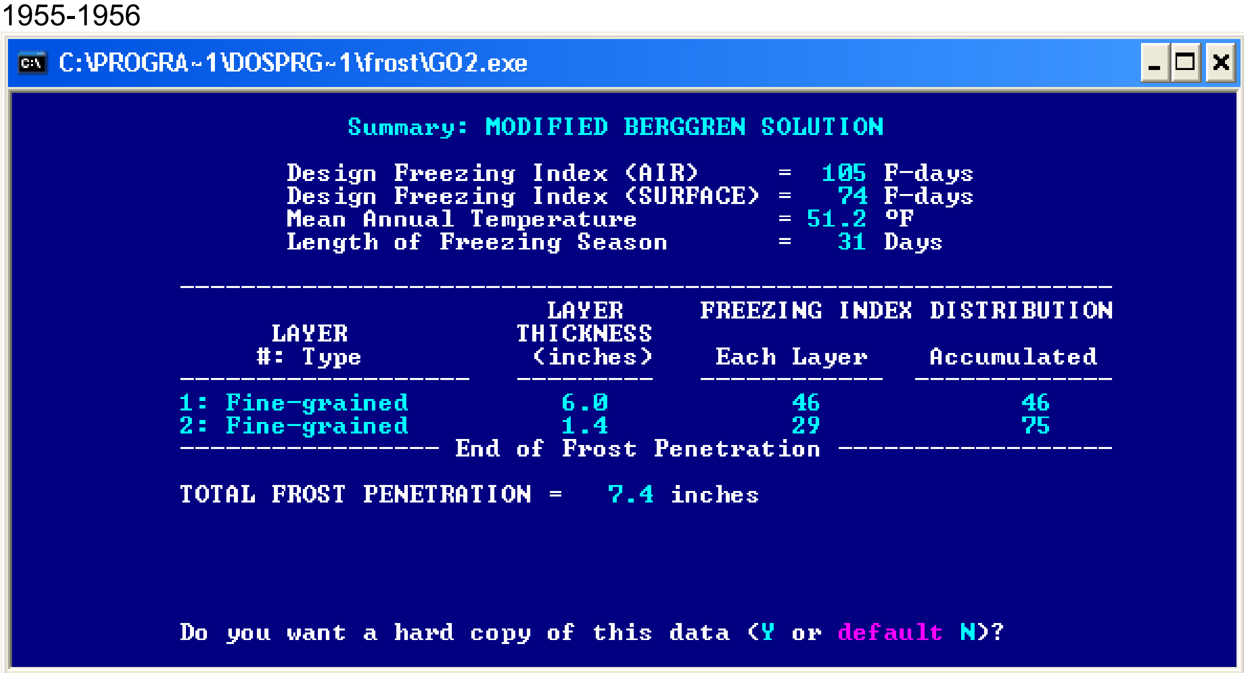
LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	29	29
2: Fine-grained	12.0	256	285
3: Fine-grained	4.4	156	441

------------------ End of Frost Penetration ------------------

TOTAL FROST PENETRATION = 22.4 inches

Do you want a hard copy of this data (Y or default N)?

1955-1956



C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 105 F-days
Design Freezing Index (SURFACE) = 74 F-days
Mean Annual Temperature = 51.2 °F
Length of Freezing Season = 31 Days

LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	46	46
2: Fine-grained	1.4	29	75

------------------ End of Frost Penetration ------------------

TOTAL FROST PENETRATION = 7.4 inches

Do you want a hard copy of this data (Y or default N)?

1956-1957

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 182 F-days
Design Freezing Index (SURFACE) = 127 F-days
Mean Annual Temperature = 49.3 ºF
Length of Freezing Season = 64 Days

LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	45	45
2: Fine-grained	3.9	90	135

End of Frost Penetration

TOTAL FROST PENETRATION = 9.9 inches

Do you want a hard copy of this data (Y or default N)?

1961-1962

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 512 F-days
Design Freezing Index (SURFACE) = 358 F-days
Mean Annual Temperature = 49.2 ºF
Length of Freezing Season = 55 Days

LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	27	27
2: Fine-grained	12.0	245	272
3: Fine-grained	2.6	86	358

End of Frost Penetration

TOTAL FROST PENETRATION = 20.6 inches

Do you want a hard copy of this data (Y or default N)?

1962-1963

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                 Summary: MODIFIED BERGGREN SOLUTION

       Design Freezing Index (AIR)      =  503 F-days
       Design Freezing Index (SURFACE)  =  352 F-days
       Mean Annual Temperature          = 50.7 ºF
       Length of Freezing Season        =   37 Days

----------------------------------------------------------------
                          LAYER     FREEZING INDEX DISTRIBUTION
     LAYER              THICKNESS
    #: Type              (inches)    Each Layer     Accumulated
--------------------   ---------  ------------  -------------
1: Fine-grained           6.0          26             26
2: Fine-grained          12.0         237            263
3: Fine-grained           2.9          91            354
----------------- End of Frost Penetration ------------------

TOTAL FROST PENETRATION =  20.9 inches



Do you want a hard copy of this data (Y or default N)?
```

1963-1964

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                 Summary: MODIFIED BERGGREN SOLUTION

       Design Freezing Index (AIR)      =  356 F-days
       Design Freezing Index (SURFACE)  =  249 F-days
       Mean Annual Temperature          = 49.6 ºF
       Length of Freezing Season        =   97 Days

----------------------------------------------------------------
                          LAYER     FREEZING INDEX DISTRIBUTION
     LAYER              THICKNESS
    #: Type              (inches)    Each Layer     Accumulated
--------------------   ---------  ------------  -------------
1: Fine-grained           6.0          40             40
2: Fine-grained           8.0         202            242
----------------- End of Frost Penetration ------------------

TOTAL FROST PENETRATION =  14.0 inches



Do you want a hard copy of this data (Y or default N)?
```

1964-1965

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                 Summary: MODIFIED BERGGREN SOLUTION

             Design Freezing Index (AIR)     =  197 F-days
             Design Freezing Index (SURFACE) =  138 F-days
             Mean Annual Temperature         = 48.5 ºF
             Length of Freezing Season       =   78 Days

      -------------------------------------------------------------
                                 LAYER     FREEZING INDEX DISTRIBUTION
              LAYER            THICKNESS
             #: Type            (inches)    Each Layer   Accumulated
      -------------------      ---------   ------------  -------------
      1: Fine-grained             6.0           45             45
      2: Fine-grained             4.3          101            146
      ----------------- End of Frost Penetration ------------------

      TOTAL FROST PENETRATION =  10.3 inches



      Do you want a hard copy of this data (Y or default N)?
```

1970-1971

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                 Summary: MODIFIED BERGGREN SOLUTION

             Design Freezing Index (AIR)     =  197 F-days
             Design Freezing Index (SURFACE) =  138 F-days
             Mean Annual Temperature         = 48.5 ºF
             Length of Freezing Season       =   78 Days

      -------------------------------------------------------------
                                 LAYER     FREEZING INDEX DISTRIBUTION
              LAYER            THICKNESS
             #: Type            (inches)    Each Layer   Accumulated
      -------------------      ---------   ------------  -------------
      1: Fine-grained             6.0           45             45
      2: Fine-grained             4.3          101            146
      ----------------- End of Frost Penetration ------------------

      TOTAL FROST PENETRATION =  10.3 inches



      Do you want a hard copy of this data (Y or default N)?
```

1971-1972

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

              Summary: MODIFIED BERGGREN SOLUTION

          Design Freezing Index (AIR)      =   327 F-days
          Design Freezing Index (SURFACE)  =   229 F-days
          Mean Annual Temperature          =  50.4 ºF
          Length of Freezing Season        =    70 Days

   -------------------------------------------------------------
                            LAYER    FREEZING INDEX DISTRIBUTION
         LAYER            THICKNESS
        #: Type           (inches)    Each Layer    Accumulated
   -------------------  ---------   ------------  -------------
   1: Fine-grained         6.0          38             38
   2: Fine-grained         7.9         185            223
   ----------------- End of Frost Penetration ------------------

   TOTAL FROST PENETRATION =  13.9 inches



   Do you want a hard copy of this data (Y or default N)?
```

1972-1973

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

              Summary: MODIFIED BERGGREN SOLUTION

          Design Freezing Index (AIR)      =   668 F-days
          Design Freezing Index (SURFACE)  =   468 F-days
          Mean Annual Temperature          =  47.1 ºF
          Length of Freezing Season        =    92 Days

   -------------------------------------------------------------
                            LAYER    FREEZING INDEX DISTRIBUTION
         LAYER            THICKNESS
        #: Type           (inches)    Each Layer    Accumulated
   -------------------  ---------   ------------  -------------
   1: Fine-grained         6.0          26             26
   2: Fine-grained        12.0         237            263
   3: Fine-grained         6.0         208            471
   ----------------- End of Frost Penetration ------------------

   TOTAL FROST PENETRATION =  24.0 inches



   Do you want a hard copy of this data (Y or default N)?
```

1980-1981

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                    Summary: MODIFIED BERGGREN SOLUTION

                Design Freezing Index (AIR)      =   28 F-days
                Design Freezing Index (SURFACE)  =   21 F-days
                Mean Annual Temperature          = 52.9 ºF
                Length of Freezing Season        =   19 Days

          ------------------------------------------------------------
                                   LAYER     FREEZING INDEX DISTRIBUTION
                LAYER            THICKNESS
               #: Type            (inches)    Each Layer    Accumulated
          ------------------   ---------    ------------  -------------
          1: Portland Cement       6.0            1               1
          2: Fine-grained         12.0           15              16
          ----------------- End of Frost Penetration ------------------

          TOTAL FROST PENETRATION =  18.0 inches



          Do you want a hard copy of this data (Y or default N)?
```

1981-1982

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                    Summary: MODIFIED BERGGREN SOLUTION

                Design Freezing Index (AIR)      =  291 F-days
                Design Freezing Index (SURFACE)  =  204 F-days
                Mean Annual Temperature          = 50.0 ºF
                Length of Freezing Season        =   57 Days

          ------------------------------------------------------------
                                   LAYER     FREEZING INDEX DISTRIBUTION
                LAYER            THICKNESS
               #: Type            (inches)    Each Layer    Accumulated
          ------------------   ---------    ------------  -------------
          1: Fine-grained          6.0           35              35
          2: Fine-grained          7.5          160             195
          ----------------- End of Frost Penetration ------------------

          TOTAL FROST PENETRATION =  13.5 inches



          Do you want a hard copy of this data (Y or default N)?
```

1982-1983

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                      Summary: MODIFIED BERGGREN SOLUTION

              Design Freezing Index (AIR)      =  105 F-days
              Design Freezing Index (SURFACE) =   74 F-days
              Mean Annual Temperature          = 49.4 °F
              Length of Freezing Season        =   13 Days

      -------------------------------------------------------------
                                LAYER     FREEZING INDEX DISTRIBUTION
            LAYER             THICKNESS
           #: Type             (inches)    Each Layer    Accumulated
      -------------------    ---------   ------------  -------------
      1: Fine-grained           6.0           29             29
      2: Fine-grained           3.5           50             79
      ----------------- End of Frost Penetration ------------------

      TOTAL FROST PENETRATION =    9.5 inches



      Do you want a hard copy of this data (Y or default N)?
```

1983-1984

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                      Summary: MODIFIED BERGGREN SOLUTION

              Design Freezing Index (AIR)      =  195 F-days
              Design Freezing Index (SURFACE) =  137 F-days
              Mean Annual Temperature          = 50.6 °F
              Length of Freezing Season        =   66 Days

      -------------------------------------------------------------
                                LAYER     FREEZING INDEX DISTRIBUTION
            LAYER             THICKNESS
           #: Type             (inches)    Each Layer    Accumulated
      -------------------    ---------   ------------  -------------
      1: Fine-grained           6.0           48             48
      2: Fine-grained           4.0           97            145
      ----------------- End of Frost Penetration ------------------

      TOTAL FROST PENETRATION =   10.0 inches



      Do you want a hard copy of this data (Y or default N)?
```

1984-1985

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                      Summary: MODIFIED BERGGREN SOLUTION

                Design Freezing Index (AIR)      =   223 F-days
                Design Freezing Index (SURFACE)  =   156 F-days
                Mean Annual Temperature          =  50.0 °F
                Length of Freezing Season        =    43 Days

         -------------------------------------------------------------
                                   LAYER    FREEZING INDEX DISTRIBUTION
               LAYER             THICKNESS
              #: Type             (inches)    Each Layer    Accumulated
         -------------------     ---------   ------------  -------------
         1: Fine-grained            6.0           35             35
         2: Fine-grained            5.9          118            153
         ----------------- End of Frost Penetration ------------------

         TOTAL FROST PENETRATION =  11.9 inches



         Do you want a hard copy of this data (Y or default N)?
```

1985-1986

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                      Summary: MODIFIED BERGGREN SOLUTION

                Design Freezing Index (AIR)      =    60 F-days
                Design Freezing Index (SURFACE)  =    42 F-days
                Mean Annual Temperature          =  51.4 °F
                Length of Freezing Season        =     7 Days

         -------------------------------------------------------------
                                   LAYER    FREEZING INDEX DISTRIBUTION
               LAYER             THICKNESS
              #: Type             (inches)    Each Layer    Accumulated
         -------------------     ---------   ------------  -------------
         1: Fine-grained            6.0           31             31
         2: Fine-grained            0.5            6             37
         ----------------- End of Frost Penetration ------------------

         TOTAL FROST PENETRATION =   6.5 inches



         Do you want a hard copy of this data (Y or default N)?
```

1986-1987

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                Summary: MODIFIED BERGGREN SOLUTION

            Design Freezing Index (AIR)      =   153 F-days
            Design Freezing Index (SURFACE)  =   107 F-days
            Mean Annual Temperature          =  50.6 °F
            Length of Freezing Season        =    34 Days

 ------------------------------------------------------------
                                LAYER    FREEZING INDEX DISTRIBUTION
        LAYER                 THICKNESS
      #: Type                 (inches)   Each Layer    Accumulated
 -------------------         ---------  ------------  -------------
 1: Fine-grained                6.0          38             38
 2: Fine-grained                3.8          75            113
 ----------------- End of Frost Penetration ------------------

 TOTAL FROST PENETRATION =    9.8 inches



 Do you want a hard copy of this data (Y or default N)?
```

1987-1988

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                Summary: MODIFIED BERGGREN SOLUTION

            Design Freezing Index (AIR)      =   397 F-days
            Design Freezing Index (SURFACE)  =   278 F-days
            Mean Annual Temperature          =  50.4 °F
            Length of Freezing Season        =    70 Days

 ------------------------------------------------------------
                                LAYER    FREEZING INDEX DISTRIBUTION
        LAYER                 THICKNESS
      #: Type                 (inches)   Each Layer    Accumulated
 -------------------         ---------  ------------  -------------
 1: Fine-grained                6.0          34             34
 2: Fine-grained                9.9         237            271
 ----------------- End of Frost Penetration ------------------

 TOTAL FROST PENETRATION =   15.9 inches



 Do you want a hard copy of this data (Y or default N)?
```

1989-1990

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

```
                  Summary: MODIFIED BERGGREN SOLUTION

              Design Freezing Index (AIR)      =  133 F-days
              Design Freezing Index (SURFACE)  =   93 F-days
              Mean Annual Temperature          = 53.1 °F
              Length of Freezing Season        =   34 Days

     ----------------------------------------------------------------
                                  LAYER      FREEZING INDEX DISTRIBUTION
             LAYER              THICKNESS
            #: Type              (inches)    Each Layer    Accumulated
     --------------------       ---------   ------------  -------------
     1: Fine-grained               6.0          48             48
     2: Fine-grained               2.2          48             96
     ----------------- End of Frost Penetration ------------------

     TOTAL FROST PENETRATION =    8.2 inches



     Do you want a hard copy of this data (Y or default N)?
```

1990-1991

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

```
                  Summary: MODIFIED BERGGREN SOLUTION

              Design Freezing Index (AIR)      =  448 F-days
              Design Freezing Index (SURFACE)  =  314 F-days
              Mean Annual Temperature          = 51.1 °F
              Length of Freezing Season        =   35 Days

     ----------------------------------------------------------------
                                  LAYER      FREEZING INDEX DISTRIBUTION
             LAYER              THICKNESS
            #: Type              (inches)    Each Layer    Accumulated
     --------------------       ---------   ------------  -------------
     1: Fine-grained               6.0          27             27
     2: Fine-grained              12.0         244            271
     3: Fine-grained               1.1          34            305
     ----------------- End of Frost Penetration ------------------

     TOTAL FROST PENETRATION =   19.1 inches



     Do you want a hard copy of this data (Y or default N)?
```

1991-1992

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                 Summary: MODIFIED BERGGREN SOLUTION

         Design Freezing Index (AIR)     =  215 F-days
         Design Freezing Index (SURFACE) =  151 F-days
         Mean Annual Temperature         = 52.8 ºF
         Length of Freezing Season       =   54 Days

 -------------------------------------------------------------
                      LAYER    FREEZING INDEX DISTRIBUTION
      LAYER         THICKNESS
     #: Type         (inches)   Each Layer    Accumulated
 -------------------  --------- ------------  -------------
 1: Fine-grained        6.0         47             47
 2: Fine-grained        4.6        114            161
 ----------------- End of Frost Penetration ------------------

 TOTAL FROST PENETRATION =  10.6 inches



 Do you want a hard copy of this data (Y or default N)?
```

1992-1993

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                 Summary: MODIFIED BERGGREN SOLUTION

         Design Freezing Index (AIR)     =  193 F-days
         Design Freezing Index (SURFACE) =  135 F-days
         Mean Annual Temperature         = 51.8 ºF
         Length of Freezing Season       =   52 Days

 -------------------------------------------------------------
                      LAYER    FREEZING INDEX DISTRIBUTION
      LAYER         THICKNESS
     #: Type         (inches)   Each Layer    Accumulated
 -------------------  --------- ------------  -------------
 1: Fine-grained        6.0         46             46
 2: Fine-grained        4.1         97            143
 ----------------- End of Frost Penetration ------------------

 TOTAL FROST PENETRATION =  10.1 inches



 Do you want a hard copy of this data (Y or default N)?
```

1993-1994

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                  Summary: MODIFIED BERGGREN SOLUTION

              Design Freezing Index (AIR)      =   51  F-days
              Design Freezing Index (SURFACE)  =   36  F-days
              Mean Annual Temperature          = 53.7  °F
              Length of Freezing Season        =   12  Days

           -------------------------------------------------------------
                                       LAYER     FREEZING INDEX DISTRIBUTION
                 LAYER               THICKNESS
                #: Type               (inches)     Each Layer    Accumulated
           -------------------      ---------    ------------  -------------
           1: Fine-grained             4.5            27              27
           ----------------- End of Frost Penetration ------------------

           TOTAL FROST PENETRATION =   4.5 inches




           Do you want a hard copy of this data (Y or default N)?
```

1994-1995

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                  Summary: MODIFIED BERGGREN SOLUTION

              Design Freezing Index (AIR)      =   33  F-days
              Design Freezing Index (SURFACE)  =   23  F-days
              Mean Annual Temperature          = 52.2  °F
              Length of Freezing Season        =    7  Days

           -------------------------------------------------------------
                                       LAYER     FREEZING INDEX DISTRIBUTION
                 LAYER               THICKNESS
                #: Type               (inches)     Each Layer    Accumulated
           -------------------      ---------    ------------  -------------
           1: Fine-grained             3.4            13              13
           ----------------- End of Frost Penetration ------------------

           TOTAL FROST PENETRATION =   3.4 inches




           Do you want a hard copy of this data (Y or default N)?
```

1995-1996

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

```
                  Summary: MODIFIED BERGGREN SOLUTION

              Design Freezing Index (AIR)      =    61  F-days
              Design Freezing Index (SURFACE)  =    43  F-days
              Mean Annual Temperature          =  55.0  °F
              Length of Freezing Season        =    18  Days

       -------------------------------------------------------------
                                    LAYER     FREEZING INDEX DISTRIBUTION
             LAYER                THICKNESS
            #: Type                (inches)    Each Layer    Accum  Berggren
       -------------------        ---------   ------------  ------Calculations
       1: Fine-grained             < 4.4           31           ←     could not
                                                                      converge
                                                                    Surface DFI
       ----------------- End of Frost Penetration ------------------

       TOTAL FROST PENETRATION =    4.4 inches


       Do you want a hard copy of this data (Y or default N)?
```

1996-1997

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

```
                  Summary: MODIFIED BERGGREN SOLUTION

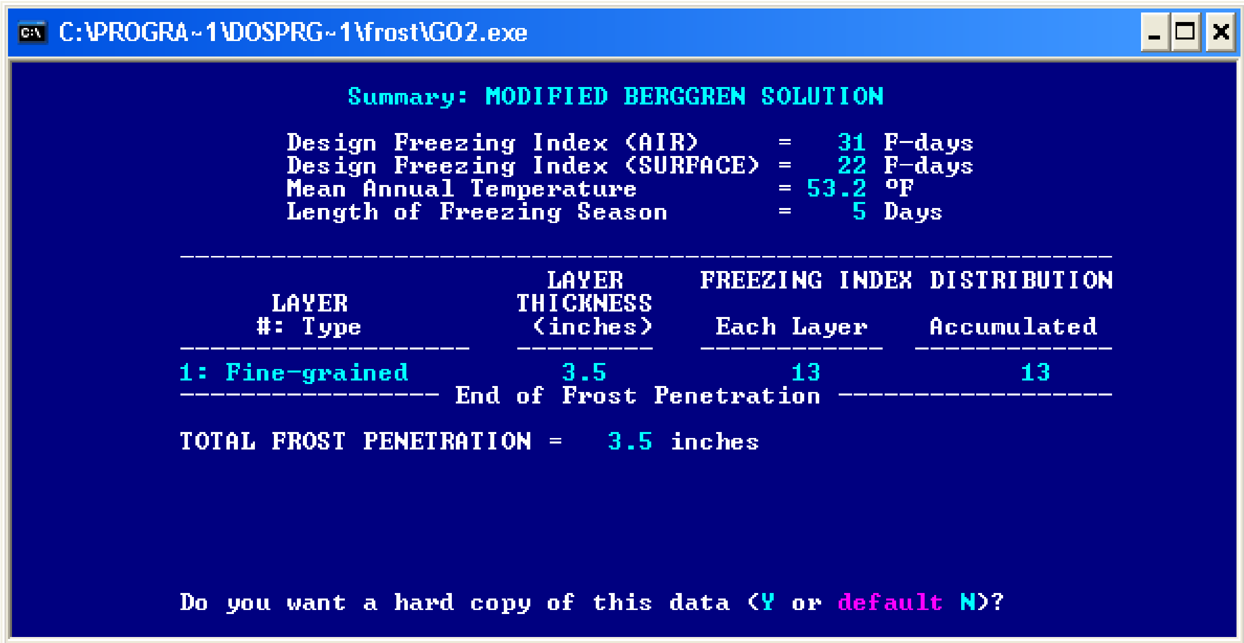
              Design Freezing Index (AIR)      =   116  F-days
              Design Freezing Index (SURFACE)  =    81  F-days
              Mean Annual Temperature          =  52.7  °F
              Length of Freezing Season        =    21  Days

       -------------------------------------------------------------
                                    LAYER     FREEZING INDEX DISTRIBUTION
             LAYER                THICKNESS
            #: Type                (inches)    Each Layer    Accumulated
       -------------------        ---------   ------------  -------------
       1: Fine-grained                6.0          40              40
       2: Fine-grained                2.4          43              83
       ----------------- End of Frost Penetration ------------------

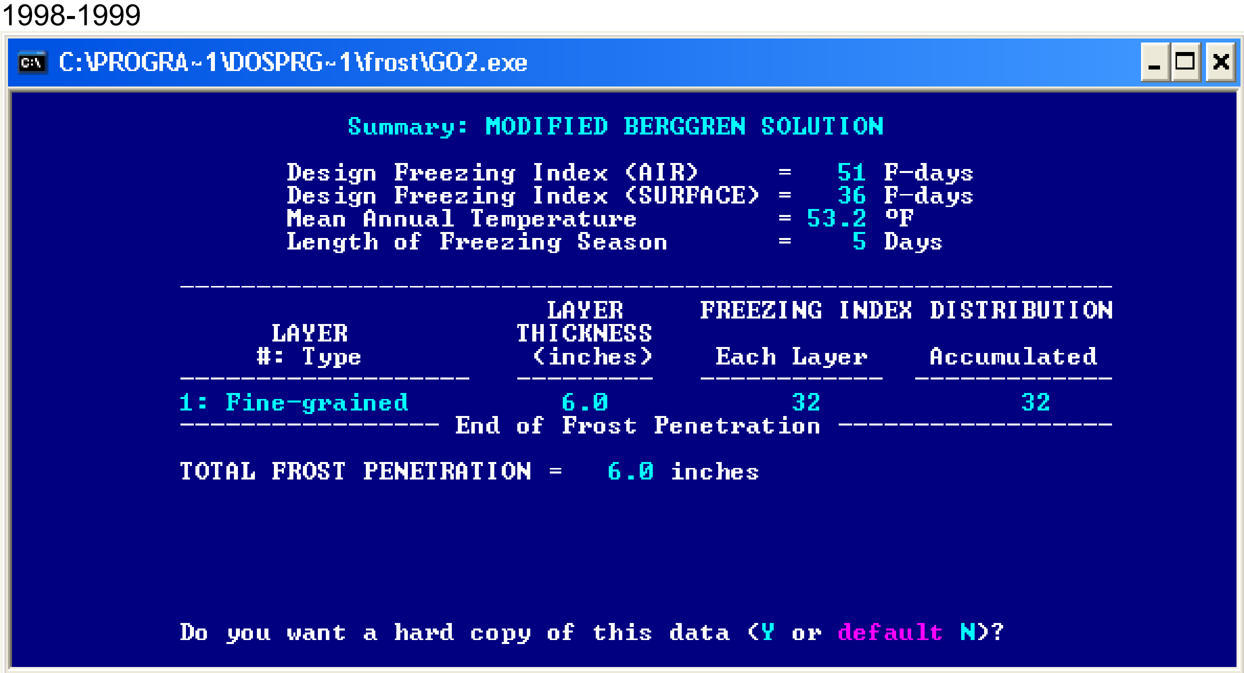
       TOTAL FROST PENETRATION =    8.4 inches


       Do you want a hard copy of this data (Y or default N)?
```

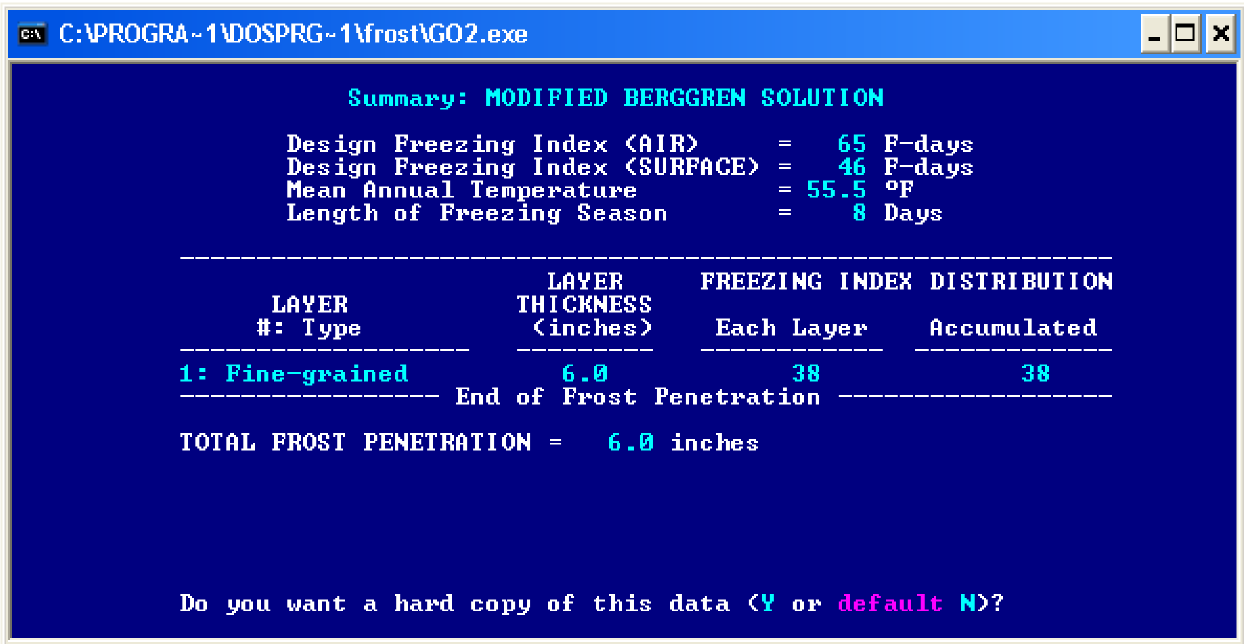
1997-1998



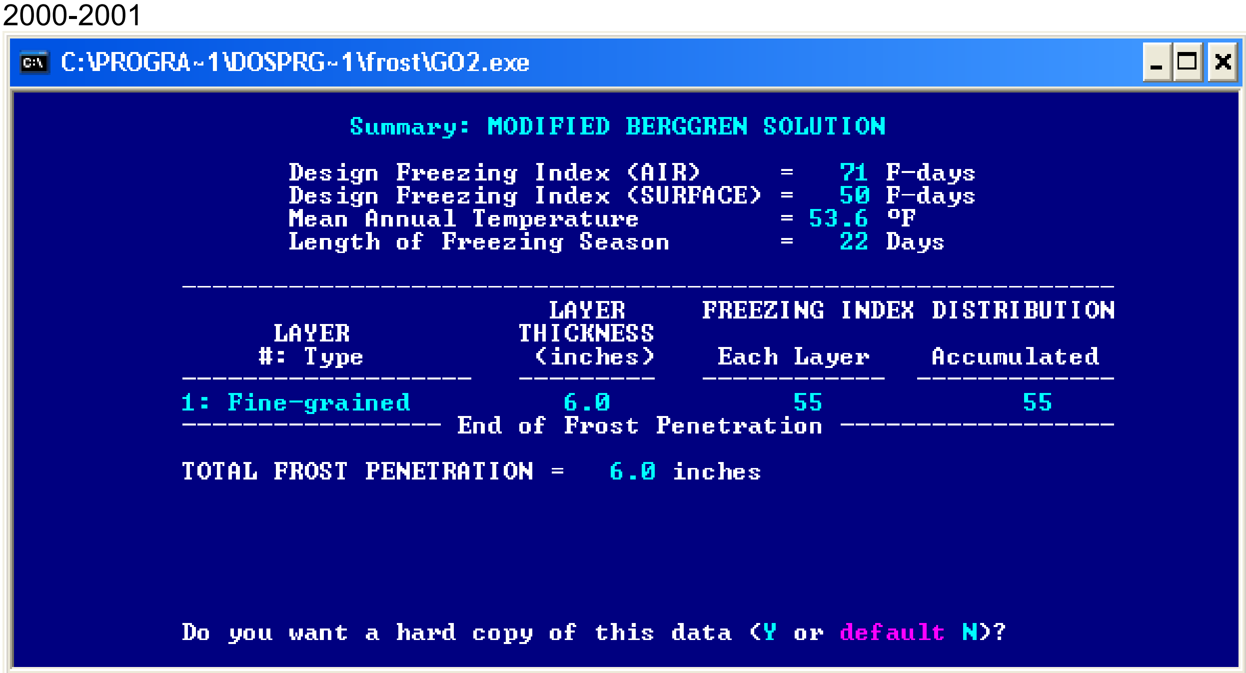
1998-1999



1999-2000



2000-2001



2001-2002

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 123 F-days
Design Freezing Index (SURFACE) = 86 F-days
Mean Annual Temperature = 54.7 °F
Length of Freezing Season = 42 Days

LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	63	63
2: Fine-grained	0.5	13	76

------------------ End of Frost Penetration ------------------

TOTAL FROST PENETRATION = 6.5 inches

Do you want a hard copy of this data (Y or default N)?

2002-2003

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 70 F-days
Design Freezing Index (SURFACE) = 49 F-days
Mean Annual Temperature = 54.5 °F
Length of Freezing Season = 14 Days

LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	45	45

------------------ End of Frost Penetration ------------------

TOTAL FROST PENETRATION = 6.0 inches

Do you want a hard copy of this data (Y or default N)?

2003-2004

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

```
                   Summary: MODIFIED BERGGREN SOLUTION

               Design Freezing Index (AIR)      =  133 F-days
               Design Freezing Index (SURFACE)  =   93 F-days
               Mean Annual Temperature          = 53.9 °F
               Length of Freezing Season        =   51 Days

        -------------------------------------------------------------
                                   LAYER     FREEZING INDEX DISTRIBUTION
              LAYER              THICKNESS
             #: Type              (inches)    Each Layer    Accumulated
        -------------------     ---------   ------------   -------------
        1: Fine-grained            6.0           65              65
        2: Fine-grained            1.0           28              93
        ----------------- End of Frost Penetration ------------------

        TOTAL FROST PENETRATION =    7.0 inches



        Do you want a hard copy of this data (Y or default N)?
```

2005-2006

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

```
                   Summary: MODIFIED BERGGREN SOLUTION

               Design Freezing Index (AIR)      =   79 F-days
               Design Freezing Index (SURFACE)  =   55 F-days
               Mean Annual Temperature          = 54.4 °F
               Length of Freezing Season        =   15 Days

        -------------------------------------------------------------
                                   LAYER     FREEZING INDEX DISTRIBUTION
              LAYER              THICKNESS
             #: Type              (inches)    Each Layer    Accumulated
        -------------------     ---------   ------------   -------------
        1: Fine-grained            6.0           44              44
        2: Fine-grained            0.3            6              50
        ----------------- End of Frost Penetration ------------------

        TOTAL FROST PENETRATION =    6.3 inches



        Do you want a hard copy of this data (Y or default N)?
```

2006-2007

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                    Summary: MODIFIED BERGGREN SOLUTION

                Design Freezing Index (AIR)      =  116 F-days
                Design Freezing Index (SURFACE) =   81 F-days
                Mean Annual Temperature          = 54.1 °F
                Length of Freezing Season        =   30 Days

     -------------------------------------------------------------
                                  LAYER     FREEZING INDEX DISTRIBUTION
           LAYER                THICKNESS
          #: Type                (inches)    Each Layer    Accumulated
     -------------------      ---------   ------------   -------------
     1: Fine-grained             6.0           52             52
     2: Fine-grained             1.3           29             81
     ----------------- End of Frost Penetration ------------------

     TOTAL FROST PENETRATION =    7.3 inches



     Do you want a hard copy of this data (Y or default N)?
```

2007-2008

```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

                    Summary: MODIFIED BERGGREN SOLUTION

                Design Freezing Index (AIR)      =  370 F-days
                Design Freezing Index (SURFACE) =  259 F-days
                Mean Annual Temperature          = 52.6 °F
                Length of Freezing Season        =   59 Days

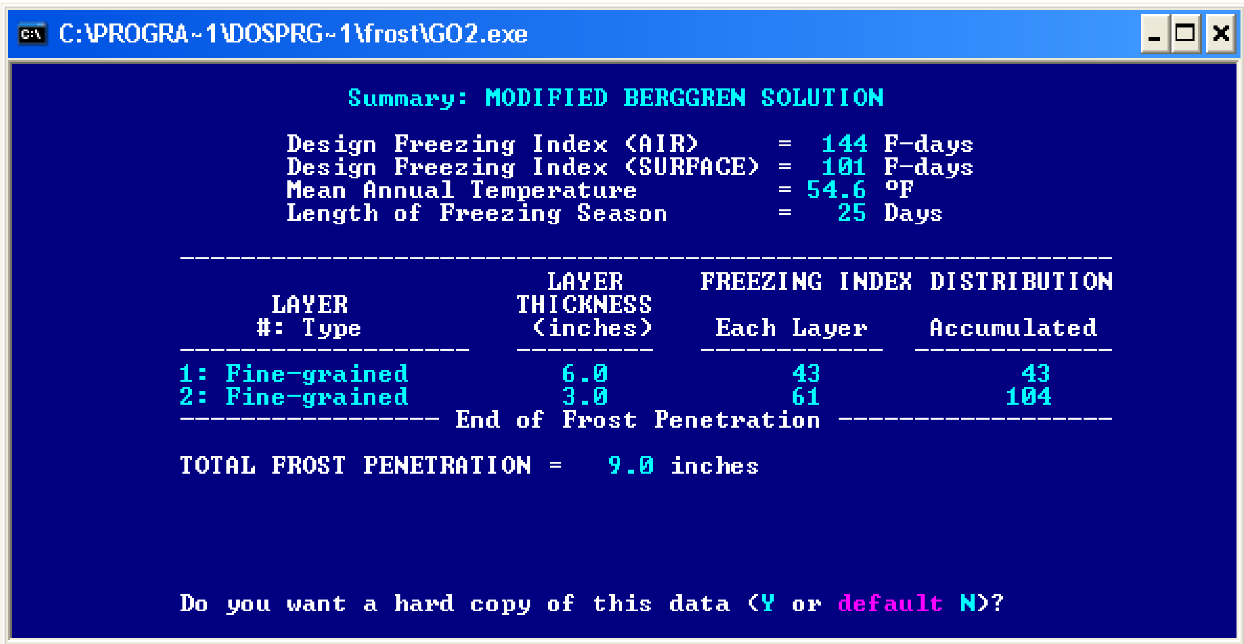
     -------------------------------------------------------------
                                  LAYER     FREEZING INDEX DISTRIBUTION
           LAYER                THICKNESS
          #: Type                (inches)    Each Layer    Accumulated
     -------------------      ---------   ------------   -------------
     1: Fine-grained             6.0           37             37
     2: Fine-grained             8.9          216            253
     ----------------- End of Frost Penetration ------------------

     TOTAL FROST PENETRATION =   14.9 inches



     Do you want a hard copy of this data (Y or default N)?
```

2008-2009



```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

             Summary: MODIFIED BERGGREN SOLUTION

        Design Freezing Index (AIR)     =  144 F-days
        Design Freezing Index (SURFACE) =  101 F-days
        Mean Annual Temperature         = 54.6 °F
        Length of Freezing Season       =   25 Days

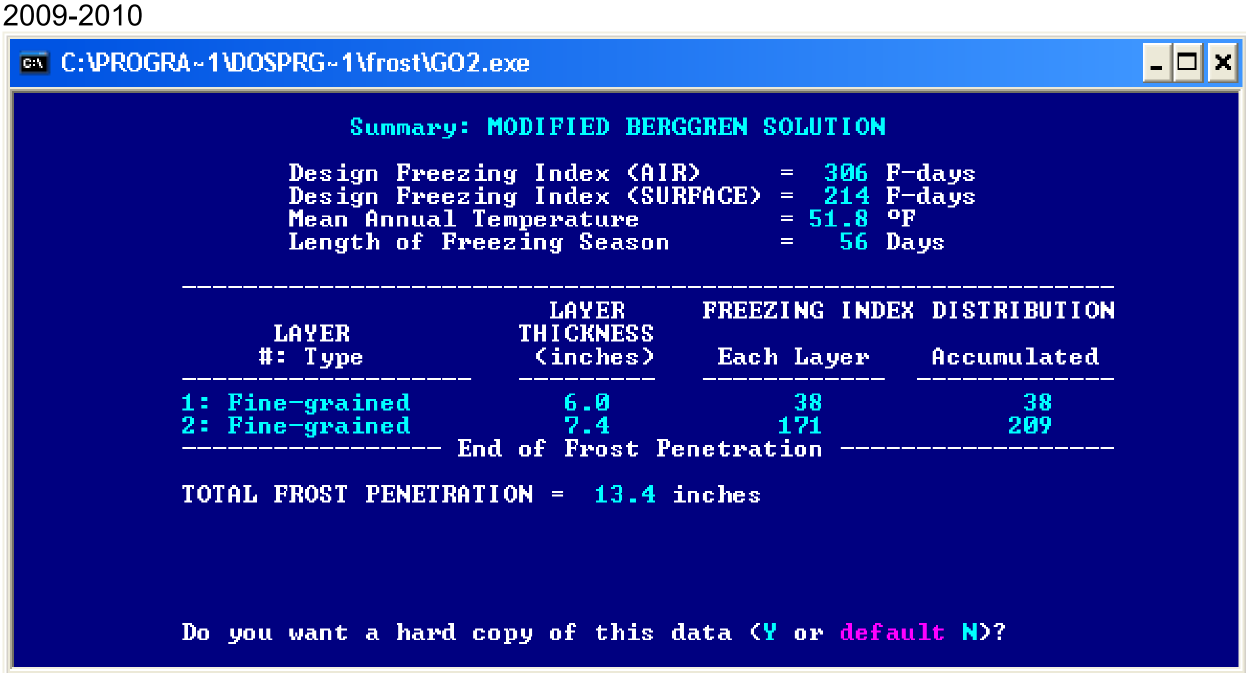
 -------------------------------------------------------------
                          LAYER     FREEZING INDEX DISTRIBUTION
      LAYER             THICKNESS
     #: Type            (inches)     Each Layer    Accumulated
 -------------------   ---------   ------------  -------------
 1: Fine-grained          6.0           43             43
 2: Fine-grained          3.0           61            104
 ----------------- End of Frost Penetration ------------------

 TOTAL FROST PENETRATION =   9.0 inches



 Do you want a hard copy of this data (Y or default N)?
```

2009-2010



```
C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

             Summary: MODIFIED BERGGREN SOLUTION

        Design Freezing Index (AIR)     =  306 F-days
        Design Freezing Index (SURFACE) =  214 F-days
        Mean Annual Temperature         = 51.8 °F
        Length of Freezing Season       =   56 Days

 -------------------------------------------------------------
                          LAYER     FREEZING INDEX DISTRIBUTION
      LAYER             THICKNESS
     #: Type            (inches)     Each Layer    Accumulated
 -------------------   ---------   ------------  -------------
 1: Fine-grained          6.0           38             38
 2: Fine-grained          7.4          171            209
 ----------------- End of Frost Penetration ------------------

 TOTAL FROST PENETRATION =  13.4 inches



 Do you want a hard copy of this data (Y or default N)?
```

2010-2011

C:\PROGRA~1\DOSPRG~1\frost\GO2.exe

Summary: MODIFIED BERGGREN SOLUTION

Design Freezing Index (AIR) = 190 F-days
Design Freezing Index (SURFACE) = 133 F-days
Mean Annual Temperature = 53.4 °F
Length of Freezing Season = 45 Days

LAYER #: Type	LAYER THICKNESS (inches)	FREEZING INDEX DISTRIBUTION Each Layer	Accumulated
1: Fine-grained	6.0	47	47
2: Fine-grained	4.0	95	142

------------------ End of Frost Penetration ------------------

TOTAL FROST PENETRATION = 10.0 inches

Do you want a hard copy of this data (Y or default N)?

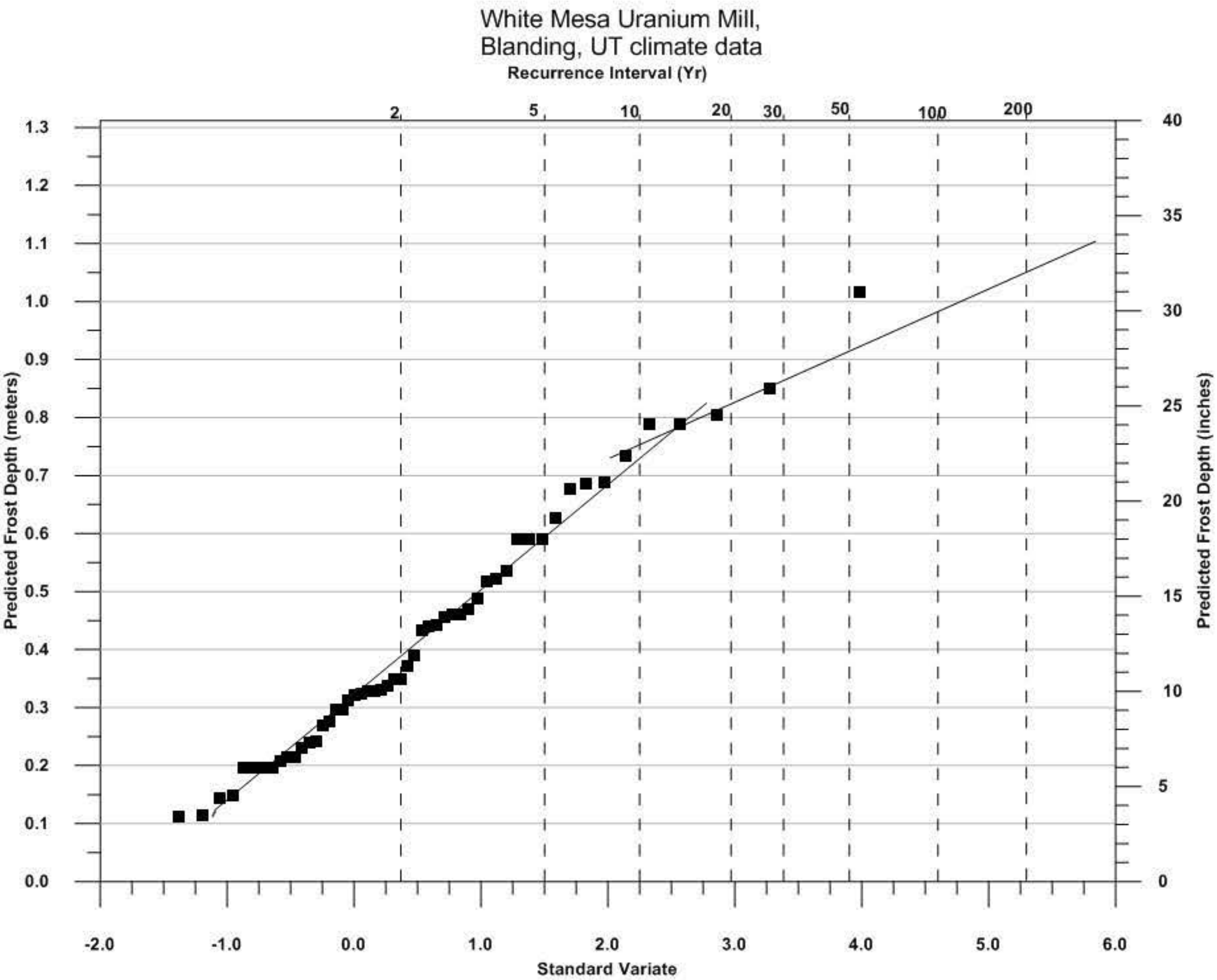
ATTACHMENT B.3

RESULTS OF EXTREME VALUE FROST PENETRATION ANALYSIS

Frost Penetration Prediction
Extreme-Value Probability
White Mesa (Blanding, UT)

year interval	rank (m)	recurrance interval (Tr) (n + 1 / m)	1/Tr	standard variate	predicted frost depth (inches)
1994-1995	1	54.000	0.02	3.9797	31.0
1997-1998	2	27.000	0.04	3.2770	25.9
1995-1996	3	18.000	0.06	2.8619	24.5
1993-1994	4	13.500	0.07	2.5645	24.0
1998-1999	5	10.800	0.09	2.3314	24.0
1999-2000	6	9.000	0.11	2.1389	22.4
2000-2001	7	7.714	0.13	1.9745	21.0
2002-2003	8	6.750	0.15	1.8304	20.9
1961-1962	9	6.000	0.17	1.7020	20.6
2005-2006	10	5.400	0.19	1.5857	19.1
1985-1986	11	4.909	0.20	1.4794	18.0
2001-2002	12	4.500	0.22	1.3811	18.0
2003-2004	13	4.154	0.24	1.2895	18.0
2006-2007	14	3.857	0.26	1.2036	16.3
1955-1956	15	3.600	0.28	1.1226	15.9
1989-1990	16	3.375	0.30	1.0458	15.8
1996-1997	17	3.176	0.31	0.9727	14.9
1940-1941	18	3.000	0.33	0.9027	14.3
2008-2009	19	2.842	0.35	0.8355	14.0
1982-1983	20	2.700	0.37	0.7708	14.0
1986-1987	21	2.571	0.39	0.7083	13.9
1956-1957	22	2.455	0.41	0.6477	13.5
1983-1984	23	2.348	0.43	0.5888	13.4
2010-2011	24	2.250	0.44	0.5314	13.2
1992-1993	25	2.160	0.46	0.4753	11.9
1964-1965	26	2.077	0.48	0.4204	11.3
1939-1940	27	2.000	0.50	0.3665	10.6
1991-1992	28	1.929	0.52	0.3135	10.6
1920-1921	29	1.862	0.54	0.2612	10.3
1984-1985	30	1.800	0.56	0.2096	10.1
1919-1920	31	1.742	0.57	0.1584	10.0
2009-2010	32	1.688	0.59	0.1077	10.0
1981-1982	33	1.636	0.61	0.0571	9.9
1971-1972	34	1.588	0.63	0.0068	9.8
1927-1928	35	1.543	0.65	-0.0436	9.5
1963-1964	36	1.500	0.67	-0.0940	9.0
1946-1947	37	1.459	0.69	-0.1448	9.0
2007-2008	38	1.421	0.70	-0.1959	8.4
1947-1948	39	1.385	0.72	-0.2476	8.2
1987-1988	40	1.350	0.74	-0.3001	7.4
1970-1971	41	1.317	0.76	-0.3535	7.3
1923-1924	42	1.286	0.78	-0.4082	7.0
1938-1939	43	1.256	0.80	-0.4644	6.5
1980-1981	44	1.227	0.81	-0.5226	6.5

1990-1991	45	1.200	0.83	-0.5832	6.3
1962-1963	46	1.174	0.85	-0.6469	6.0
1929-1930	47	1.149	0.87	-0.7145	6.0
1954-1955	48	1.125	0.89	-0.7872	6.0
1928-1929	49	1.102	0.91	-0.8669	6.0
1972-1973	50	1.080	0.93	-0.9565	4.5
1924-1925	51	1.059	0.94	-1.0614	4.4
1948-1949	52	1.038	0.96	-1.1927	3.5
1931-1932	53	1.019	0.98	-1.3835	3.4


White Mesa Uranium Mill,
Blanding, UT climate data
Recurrence Interval (Yr)
2
5
10
20
30
50
100
200
Predicted Frost Depth (meters)
Predicted Frost Depth (inches)
Standard Variate
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
40
35
30
25
20
15
10
5
0
-2.0
-1.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0

APPENDIX C

RADON EMANATION MODELING

C.1 BACKGROUND

This appendix presents the results of modeling the emanation of radon-222 from the top surface of the proposed cover over the White Mesa tailing impoundments to achieve the State of Utah's long-term radon emanation standard for uranium mill tailings (Utah Administrative Code, Rule 313-24). These results comprise an update of radon emanation modeling presented in Attachment F of the 2009 Reclamation Plan (Denison, 2009) and Appendix H of the Infiltration and Contaminant Transport Modeling Report (Denison, 2010), as well as an update to Appendix C of the 2011 Updated Tailings Cover Design report (MWH, 2011). This appendix provides a summary of additional analyses of radon attenuation through the proposed evapotranspiration (ET) cover, and incorporates the revised cover grading design, results of cover material testing conducted in 2010 and 2012 (summarized in Attachment B of EFRI, 2012), and results of tailings testing conducted in 2013 (presented in MWH, 2015).

The monolithic ET cover system evaluated in this appendix consists of the following layers from top to bottom:

- 0.5 ft (15 cm) Erosion Protection Layer (gravel-admixture or topsoil)
- 3.5 ft (107 cm) Water Storage/Biointrusion/Frost Protection/Radon Attenuation Layer (loam to sandy clay)
- 3.0 to 4.0 ft (91 to 122 cm) Radon Attenuation Layer (highly compacted loam to sandy clay)
- 2.5 ft (76 cm) Radon Attenuation and Grading Layer (loam to sandy clay)

The loam to sandy clay soil used to construct the ET cover, referred to in previous reports (Titan 1996, Knight Piesold 1999) as random/platform fill, is stockpiled at the site.

C.2 DESCRIPTION OF MODEL AND INPUT VALUES

The thickness of the reclamation cover necessary to limit radon emanation from the disposal areas was analyzed using the NRC RADON model (NRC, 1989). The model utilizes the one-dimensional radon diffusion equation, which uses the physical and radiological characteristics of the tailings and overlying materials to calculate the rate of radon emanation from the tailings through the cover. The model was used to calculate the cover thickness required to limit the radon emanation rate through the top of the cover to 20 picocuries per square meter per second (pCi/m^2-s), following the guidance presented in U.S. Nuclear Regulatory Commission (NRC) publications NUREG/CR-3533 and Regulatory Guide 3.64 (NRC 1984, 1989). The rate of emanation standard is applied to the average emanation over the entire surface of the disposal area.

The input parameters used in the model are based on engineering experience with similar projects, recent laboratory testing results for samples of random fill (summarized in Attachment B of EFRI, 2012) and tailings (MWH, 2015), in addition to available data from previous work by others, including Chen and Associates (1978, 1979, 1987), Rogers and Associates Engineering Corporation (1988), Western Colorado Testing (1999a, 1999b), IUC (2000), and Titan (1996). The available data from testing performed by others was summarized in Appendix A of the Updated Tailings Cover Design report (MWH, 2011). Appendix A will be revised for the next version of the Updated Tailings Cover Design report to include data from recent random fill and tailings testing. The input parameters and values used in the model are outlined below.

C.2.1 Thickness of Tailings

The thickness of tailings currently deposited in Cells 2 and 3 is approximately 30 ft (914 cm), while the anticipated tailings thickness deposited in Cells 4A and 4B will be approximately 42 ft (1,280 cm). As documented in NRC Regulatory Guide 3.64, a tailings thickness greater than 100 to 200 cm is effectively equivalent to an infinitely thick radon source. Therefore, a thickness of 500 cm may be used in RADON to represent an equivalent infinitely thick tailings source of radon.

C.2.2 Radium Activity Concentration

The radium-226 activity concentration values for the tailings in the impoundments are estimated based on material inventory data provided by Energy Fuels Resources (USA), Inc. (EFRI). A summary of the material inventories for Cells 2 and 3 and the projected inventory for Cells 4A and 4B is provided in Attachment C.1. The radium-226 and thorium-230 activity concentrations are listed for each material in the inventories. These values were used to calculate a weighted average for radium-226 and thorium-230 activity concentrations for the tailings using the volume of material placed in Cells 2 and 3. In addition, these values were used to project radium-226 and thorium-230 activity concentrations for the materials to be placed in Cells 4A and 4B. Calculations for radium-226 from decay of thorium-230 were also made. These calculations are also provided in Attachment C.1. The results for Cell 3 and Cells 4A and 4B indicate the highest radium-226 values are a result of original radium-226 and radium-226 from thorium-230 decay at approximately 1000 years. The results are summarized below and in Table C.1.

Table C.1. Radium Activity Concentrations

Tailings Cell	Weighted Average Radium-226 Activity Concentration (pCi/g)	Weighted Average Thorium-230 Activity Concentration (pCi/g)	Total Radium-226 Activity Concentration (original radium-226 and radium-226 from thorium-230 decay) (pCi/g)
Cell 2	923	923	923
Cell 3	606	1048	758
Cells 4A and 4B	617	695	642

Random Fill and Erosion Protection. The radium activity of the random fill and erosion protection layer is assumed to be zero, based on guidance in Regulatory Guide 3.64 (NRC, 1989) which states that radium activity in the cover soils may be neglected for cover design purposes provided the cover soils are obtained from background materials that are not associated with ore formations or other radium-enriched materials.

C.2.3 Radon Emanation Coefficient

The radon emanation coefficient used in the model for the tailings is 0.20 based on laboratory data (Rogers & Associates, 1988) and the recommendation in NUREG-1620 (NRC, 2003) to use a value of 0.20 for tailings if there is limited site-specific data.

The radon emanation coefficient used in the model for the cover layers is 0.35. This is the conservative default value used in the RADON model.

C.2.4 Specific Gravity, Density and Porosity

The densities and porosities of the tailings and cover materials used in the model are based on laboratory testing results. The values are summarized in Table C.2 and discussed in more detail below.

Table C.2. Density and Porosity Values

Material	Specific Gravity	Degree of Compaction (%)	Placed Density (pcf)	Placed Density (g/cc)	Porosity
Erosion Protection (topsoil)	2.61	85% SP	100	1.6	0.38
Erosion Protection (rock mulch)*	2.62	85% SP	106	1.7	0.35
Random fill (low compaction water storage, rooting zone)	2.63	85% SP	100	1.6	0.39
Random Fill (high compaction)	2.63	95% SP	112	1.8	0.32
Random Fill (in place, low compaction, platform fill)	2.63	80% SP	94	1.5	0.43
Tailings	2.80	---	96	1.5	0.45

SP = standard proctor compaction
* Estimated by applying a 25% rock correction to the topsoil

The specific gravity of the tailings was estimated as 2.80 based as the weighted average specific gravity from laboratory tests using estimated percentages of sand, sand-slime, and slime tailings of 10, 65, and 25 percent, respectively (MWH, 2015). The dry density of the tailings was estimated as 96 pcf, based on laboratory tests (Chen and Associates, 1987 and Western Colorado Testing, 1999b) and assuming the upper bound long-term density of the tailings should be no greater than 90 percent of the average laboratory measured maximum dry density for the tailings. The referenced reports are provided as part of Appendix A.1 of MWH (2011). The porosity of the tailings was calculated using the estimated specific gravity and dry density based on the following equation:

$$n = 1 - \left(\frac{\gamma_d}{G_s \gamma_w}\right) \qquad \text{(Eq. C.1)}$$

where

n = porosity,

γ_d = dry density of soil,

G_s = specific gravity of soil, and

γ_w = unit weight of water.

The specific gravity and dry density values used in the model for the random fill layers were estimated by laboratory tests (ATT, 2010 and UWM, 2012). The referenced reports will be provided as part of Appendix A.2 of the next version of the of the Updated Tailings Cover Design report. These reports were presented in Attachment B of EFRI (2012). The estimation for the values used in the model is provided in Attachment C.2. The porosity values for the layers were calculated using equation C.1. The proposed cover system has three layers of random fill placed at different levels of compaction. The lower layer of random fill consists of a minimum thickness of 2.5 feet of random fill that is assumed to be dumped and minimally compacted by construction equipment to approximately 80 percent standard Proctor. The middle layer (3.0 – 4.0 feet) of random fill will be compacted to 95 percent of standard Proctor. In Cell 2 and parts of Cell 3, the lower layer of random fill is already placed and is approximately

3 feet. It is assumed the upper 6 inches of this fill will be part of the middle random fill layer and can be compacted by additional passes of compactors to reach 95 percent of standard Proctor compaction. The uppermost 3.5 feet of random fill will be placed at 85 percent of standard Proctor compaction in order to optimize water storage and rooting characteristics for plant growth.

The 0.5 foot erosion protection layer is assumed to be topsoil or rock mulch consisting of topsoil material mixed with 25 percent gravel by weight. The specific gravity and density of the topsoil was estimated to be 2.61 and 100 pcf, respectively, based on laboratory testing results for topsoil (UWM, 2012) The specific gravity and density of the rock mulch was estimated to be 2.62 and 106 pcf, respectively, based on laboratory testing results for topsoil (UWM, 2012) and applying a rock correction based on 25 percent gravel by weight.

C.2.5 Long-term Moisture Content

The long-term moisture content value for the tailings is assumed to be 6 percent. This is a conservative assumption, per NRC Regulatory Guide 3.64 (NRC, 1989), which represents the lower bound for moisture in western soils and is typically used as a default value for the long-term water content of tailings. Use of 15 bar water contents to estimate a long-term water content is one of the methods recommended in NRC (2003) for radon emanation modeling.

MWH collected representative samples from the on-site random fill and topsoil stockpiles for use in estimating the long-term moisture contents for the random fill and erosion protection cover layers. The laboratory results for the 15 bar water contents for these samples were used to estimate long-term water contents for the random fill and erosion protection layers.

The long-term water content of the topsoil was estimated as 5.2 percent based on the measured 15 bar gravimetric water content for a topsoil sample (E1-A) which represents the average index properties for the topsoil stockpiles (UWM, 2012). The long-term water content of the rock mulch was estimated as 4 percent based on the addition of 25 percent gravel by weight to the topsoil.

Based on the cover material gradations, the cover soils were bracketed into three groups, finer grained soils, uniform graded soils, and broadly graded soils. A weighted average procedure that accounts for the size of soil type based on the stockpile volumes was incorporated to determine the average long-term gravimetric water content for the random fill using the measured 15 bar water contents. The estimation of the long-term water content value for the cover material is provided in Attachment C.2.

The average long-term moisture contents are summarized in Table C.3.

Table C.3. Estimated Long-Term Moisture Contents

Material	Gravimetric Water Content (%)
Erosion Protection (topsoil)	5.2
Erosion Protection (rock mulch)	4.0
Random fill	6.7
Tailings	6.0

C.2.6 Diffusion Coefficient

The radon diffusion coefficient used in the RADON model can either be calculated based on an empirical relationship dependent upon porosity and the degree of saturation or input directly in the model using values measured from laboratory testing. Although laboratory test data was available for the tailings and the cover material (Rogers & Associates 1988), tests were performed at porosities and water contents different than those estimated to represent long-term conditions. Therefore, the empirical relationship presented in Rogers and Nielson (1991) was used, resulting in the calculated values summarized in Table C.4 below.

Table C.4. Estimated Radon Diffusion Coefficients

Material	Diffusion Coefficient (cm^2/s)
Erosion Protection (rock mulch)	0.0254
Random Fill (low compaction water storage, rooting zone)	0.0225
Random Fill (high compaction)	0.0160
Random Fill (in place, low compaction, platform fill)	0.0260
Tailings	0.0288

C.3 MODEL RESULTS

The radon emanation modeling results show that the designed cover systems presented in Table C.5 will reduce the rate of radon emanation to values below the limit of 20 picocuries per square meter per second (pCi/m^2-s) averaged over the entire area of the tailings impoundments, which is the regulatory criterion (Utah Administrative Code, Rule 313-24). The RADON model output is provided in Attachment C.3.

Table C.5. Summary of Results

Cover Layer	Cover Thickness (ft)		
	Cell 2	Cell 3	Cells 4A/4B
Erosion Protection (rock mulch or topsoil)	0.5	0.5	0.5
Random Fill (low compaction water storage, rooting zone)	3.5	3.5	3.5
Random Fill (high compaction)	4.0	3.5	3.0
Random Fill (in place, low compaction, platform fill)	2.5	2.5	2.5
Total Cover Thickness	**10.5**	**10.0**	**9.5**

C.4 IMPACTS OF INCREASED THICKNESS OF RANDOM FILL

Radon modeling as discussed above assumed that the lower layer of random fill was placed at 80 percent of standard Proctor compaction, and had a thickness of 2.5 feet (assuming top 6 inches can be compacted to 95 percent of standard Proctor density prior to placement of additional fill). However, there are some areas within Cells 2 and 3 which show thicknesses of existing random fill greater than 3.0 feet. Additional modeling was performed to determine the minimum thickness of highly compacted random fill required in order to meet regulatory criterion to limit the radon emanation rate through the top of the cover to 20 pCi/m^2-s. This modeling indicates that for every extra foot of low-compaction random fill (80 percent standard Proctor compaction), the highly compacted random fill layer (95 percent standard Proctor compaction) can be reduced in thickness by approximately 0.75 feet. This trend is shown in Figure C.1. The RADON model output is provided in Attachment C.4.

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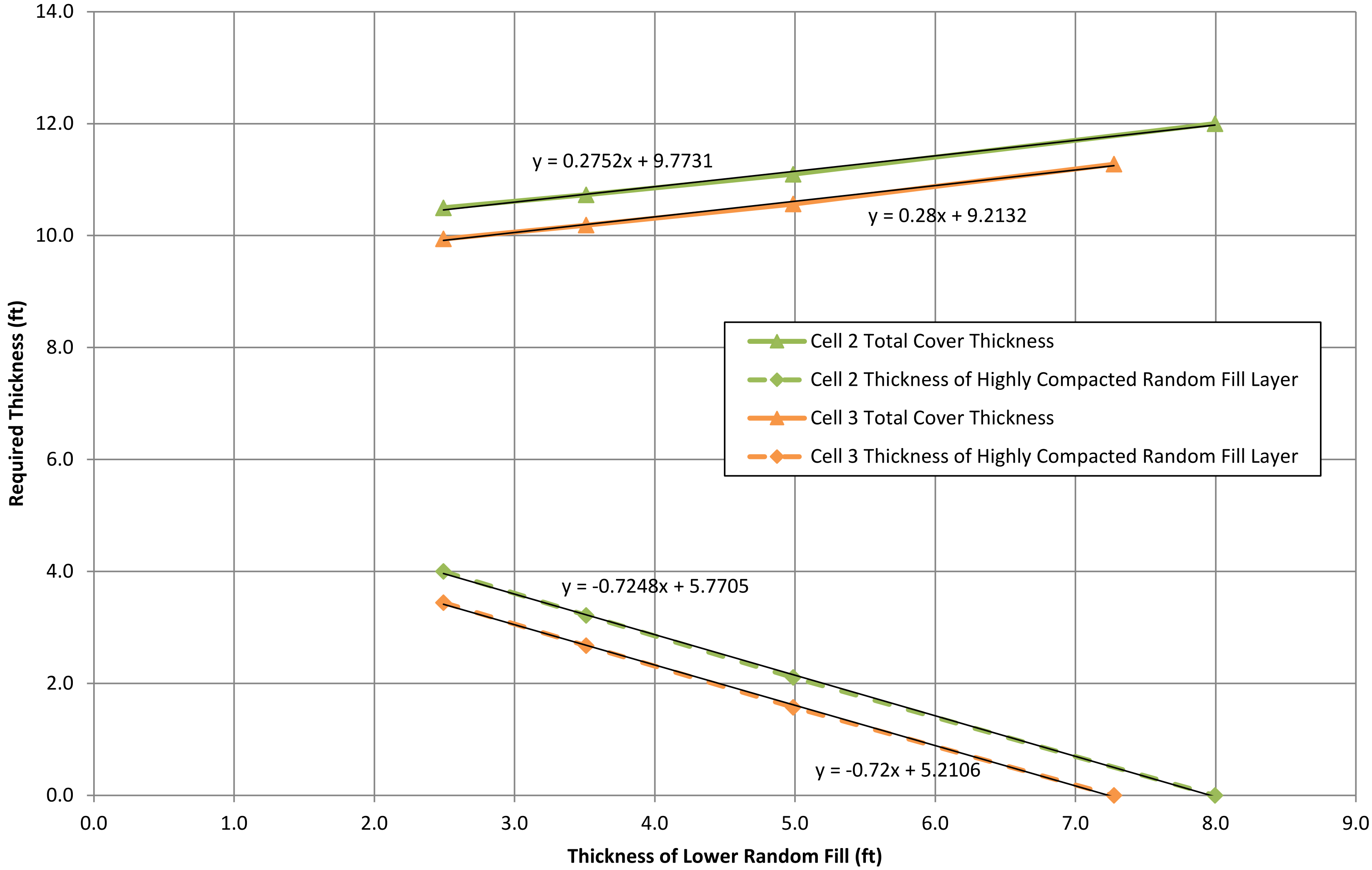

Energy Fuels Resources (USA) Inc.

PROJECT	White Mesa Mill Reclamation
TITLE	RADON EMANATION INCREASED THICKNESS OF LOWER RANDOM FILL VS TOTAL COVER THICKNESS
DATE	AUG 2015
	FIGURE C.1
FILENAME	Summary of Radon Runs_8-2015pptx

MWH

ATTACHMENT C.1

RADIUM-226 ESTIMATION TABLES

Energy Fuels Resources (USA) Inc.
White Mesa Mill Site, Summary of Processed Ores and Alternate Feeds

Material Category/Location	Origin/ Description	Dates	Total Mass Ores Processed (tons)	$\%U_3O_8$	Ra-226 Activity Conc.[a] (pCi/g)	Th-230 Activity Conc.[b] (pCi/g)	Reference/Comments
Processed Ores							
Natural Ores	Arizona Strip Ores	1980 - 2000	1,000,000	0.55	1546.6	1546.6	Total quantity for both ores from Denison (2009, 2011), ore grades and quantity breakdown from Roberts (2012b)
	Colorado Plateau Ores	1980 - 2000	2,840,536	0.25	703.0	703.0	Total quantity for both ores from Denison (2009, 2011), ore grades and quantity breakdown from Roberts (2012b)
Pandora		2008-2011	231,191	0.218	613.0	613.0	Data provided from D. Turk (2012a)
Daneros		2010-2011	71,287	0.269	756.4	756.4	Data provided from D. Turk (2012a)
Beaver		2010-2011	90,280	0.174	489.3	489.3	Data provided from D. Turk (2012a)
Arizona 1		2010-2011	41,863	0.608	1709.7	1709.7	Data provided from D. Turk (2012a)
Sunday		2008-2011	20,251	0.178	500.5	500.5	Data provided from D. Turk (2012a)
West Sunday		2008-2010	79,744	0.157	441.5	441.5	Data provided from D. Turk (2012a)
Topaz		2008-2010	16,869	0.128	359.9	359.9	Data provided from D. Turk (2012a)
St. Jude		2008-2010	29,572	0.167	469.6	469.6	Data provided from D. Turk (2012a)
Tony M		2008-2009	189,876	0.131	368.4	368.4	Data provided from D. Turk (2012a)
Dawn Mining		2009-2010	2,875	0.456	1282.3	1282.3	Data provided from D. Turk (2012a)
Carnation		2009-2010	5,584	0.166	466.8	466.8	Data provided from D. Turk (2012a)
Purchased Ore		2010-2011	18,008	0.146	410.6	410.6	Data provided from D. Turk (2012a)
Humbug Cressler		2011	118	0.044	123.7	123.7	Data provided from D. Turk (2012a)
Alternate Feeds							
Linde	Soil	1996-1999, 2002-2003, 2007	258,992		33	133	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Ashland 1	Soil	1996-1999, 2002-2003	317,831		91.3	1849	Date range est. from Denison (2011) and Roberts (2012c). Quantities and activities est. from Roberts (2012a,2012c).
Heritage	Monazite sands	1996-1999, 2002-2003, 2007	7,374		19.4	10.6	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Cabot	Tantalum residues	1996-1999	16,828		772	118	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Ashland 2	Soil	1996-1999	43,981		91.3	1849	Date range est. from Denison (2011) and Roberts (2012c). Quantities and activities est. from Roberts (2012a,2012c).
Cameco	KF product	1996-1999	1,966		0.6	5.3	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Allied Signal/Honeywell	Calcium Fluoride	1996-1997	2,343		989	23800	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Cameco	Phosph. regen. product	1996-1999	557		2.70	2.10	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Cameco	Calcined product	1996-1999	2,197		1040	9170	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Allied Signal	KOH solution recovery	1996-1999	1,526		989	0.00	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Harold (2012a) and Turk (2012b).
Rhone-Poulenc	Uranyl nitrate hexahydrate	1996-1997	17		156	2550	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Harold (2012a) and Turk (2012b).
Cameco	UF4 with filter ash	1996-1999	10		156	2550	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Nev. Test Site	Cotter Concentrate	1996-1997	420		3590	585000	Date range est. from Denison (2011) and Roberts (2012c). Quantities and activities est. from Roberts (2012a,2012c).
Molycorp		2002-2003, 2007	11,689		38.6	268.0	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Cabot	Tantalum residues	2011	8,700		772	118	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Cameco	UF4	2009-2010	462		156	2550	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Allied Signal/Honeywell	Calcium Fluoride	2011	1,969		989	23800	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
FMRI (Fansteel)		2011	1,369		236	4.9	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).

Notes:
[a]Values for ores estimated using method in NRC Reg. Guide 3.64 (1989) of multiplying the ore grade by 2812 pCi/g.
[b]Values for thorium estimated as Ra-226 values.

References:

Denison Mines USA Corporation (Denison), 2009. Reclamation Plan, White Mesa Mill, Blanding Utah, Revision 4.0, November.
Denison Mines USA Corporation (Denison), 2011. Reclamation Plan, White Mesa Mill, Blanding Utah, Revision 5.0, September.
Roberts, H., 2012a. Electronic communication including files "InvThNov00.xls and Inventory Umass in tails.xls" from Harold Roberts, Denison Mines (USA) Corp., to Melanie Davis, MWH Americas, Inc., July 20.
Roberts, H., 2012b. Personal communication from Harold Roberts, Denison Mines (USA) Corp., to Melanie Davis, MWH Americas, Inc., June 21.
Roberts, H., 2012c. Electronic communication including file "Alternate Feed Tons.pdf" and personal communication from Harold Roberts, Denison Mines (USA) Corp., to Melanie Davis, MWH Americas, Inc., July 24.
Turk, D., 2012a. Electronic communication including file "Ore Numbers.pdf" from David Turk, Denison Mines (USA) Corp., to Melanie Davis, MWH Americas, Inc., June 8.
Turk, D., 2012b. Electronic communication including file "DAC s Calculations 2012_rev6-29-12" from David Turk, Denison Mines (USA) Corp., to Melanie Davis, MWH Americas, Inc., June 29.

Energy Fuels Resources (USA) Inc.
Estimation of Cell 2 Ra-226 and Th-230 Activity Concentrations for Tailings

Material Category/Location	Origin/ Description	Dates	Total Mass Ores Processed (tons)	Total Mass Ore Processed for Cell 2[a] (tons)	$\%U_3O_8$	Ra-226 Activity Conc.[b] (pCi/g)	Th-230 Activity Conc.[c] (pCi/g)	Reference/Comments
Processed Ores								
Natural Ores	Arizona Strip Ores	1980 - 2000	1,000,000	598,875	0.55	1547	1547	Total quantity for both ores from Denison (2009, 2011), ore grades and quantity breakdown from Roberts (2012b)
	Colorado Plateau Ores	1980 - 2000	2,840,536	1,701,125	0.25	703	703	Total quantity for both ores from Denison (2009, 2011), ore grades and quantity breakdown from Roberts (2012b
			Total Tons	2,300,000	**Weighted Ave.**	**923**	**923**	

Notes:
[c]Estimated from total tons of tailings to Cell 2 from Denison (2009), Attachment E. Estimated mass is for ore processed. Material placed in Cell 2 are only those listed in the table (Roberts, 2012c).
[b]Values for ores estimated using method in NRC Reg. Guide 3.64 (1989) of multiplying the ore grade by 2812 pCi/g.
[c]Values for thorium estimated as Ra-226 values.

References:

Denison Mines USA Corporation (Denison), 2009. Reclamation Plan, White Mesa Mill, Blanding Utah, Revision 4.0, November.
Denison Mines USA Corporation (Denison), 2011. Reclamation Plan, White Mesa Mill, Blanding Utah, Revision 5.0, September.
Roberts, H., 2012b. Personal communication from Harold Roberts, Denison Mines (USA) Corp., to Melanie Davis, MWH Americas, Inc., June 21.
Roberts, H., 2012c. Electronic communication including file "Alternate Feed Tons.pdf" and personal communication from Harold Roberts, Denison Mines (USA) Corp., to Melanie Davis, MWH Americas, Inc., July 24.

Energy Fuels Resources (USA) Inc.
Estimation of Cell 3 Ra-226 and Th-230 Activity Concentrations for Tailings

Material Category/Location	Origin/ Description	Dates	Total Mass Ores Processed (tons)	Total Mass Ore Processed for Cell 3[a] (tons)	$\%U_3O_8$	Ra-226 Activity Conc.[a] (pCi/g)		Th-230 Activity Conc.[b] (pCi/g)		Reference/Comments
Processed Ores										
Natural Ores	Arizona Strip Ores	1980 - 2000	1,000,000	401,125	0.55	1546.6	253.15	1546.6	253.15	Total quantity for both ores from Denison (2009, 2011), ore grades and quantity breakdown from Roberts (2012b)
	Colorado Plateau Ores	1980 - 2000	2,840,536	1,139,411	0.25	703.0	326.85	703.0	326.85	Total quantity for both ores from Denison (2009, 2011), ore grades and quantity breakdown from Roberts (2012b)
Pandora		2008	80,046	80,046	0.218	613.0	20.02	613.02	20.02	Data provided from D. Turk (2012a)
Sunday		2008	12,066	12,066	0.178	500.5	2.46	500.54	2.46	Data provided from D. Turk (2012a)
West Sunday		2008	53,613	53,613	0.157	441.5	9.66	441.48	9.66	Data provided from D. Turk (2012a)
Topaz		2008	8,746	8,746	0.128	359.9	1.28	359.94	1.28	Data provided from D. Turk (2012a)
St. Jude		2008	15,140	15,140	0.167	469.6	2.90	469.60	2.90	Data provided from D. Turk (2012a)
Tony M		2008	74,802	74,802	0.131	368.4	11.24	368.37	11.24	Data provided from D. Turk (2012a)
Alternate Feeds										
Linde	Soil	1996-1999, 2002-2003, 2007	258,992	258,992		33	3.49	133	14.06	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Ashland 1	Soil	1996-1999, 2002-2003	317,831	317,831		91.3	11.84	1849	239.80	Date range est. from Denison (2011) and Roberts (2012c). Quantities and activities est. from Roberts (2012a,2012c).
Heritage	Monazite sands	1996-1999, 2002-2003, 2007	7,374	7,374		19.4	0.06	10.6	0.03	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Cabot	Tantalum residues	1996-1999	16,828	16,828		772	5.30	118	0.81	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Ashland 2	Soil	1996-1999	43,981	43,981		91.3	1.64	1849	33.18	Date range est. from Denison (2011) and Roberts (2012c). Quantities and activities est. from Roberts (2012a,2012c).
Cameco	KF product	1996-1999	1,966	1,966		0.6	0.00	5.3	0.00	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Allied Signal/Honeywell	Calcium Fluoride	1996-1997	2,343	2,343		989	0.95	23800	22.75	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Cameco	Phosph. regen. product	1996-1999	557	557		2.70	0.00	2.10	0.00	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Cameco	Calcined product	1996-1999	2,197	2,197		1040	0.93	9170	8.22	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Allied Signal	KOH solution recovery	1996-1999	1,526	1,526		989	0.62	0.00	0.00	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Harold (2012a) and Turk (2012b).
Rhone-Poulenc	Uranyl nitrate hexahydrate	1996-1997	17	17		156	0.00	2550	0.02	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Harold (2012a) and Turk (2012b).
Cameco	UF4 with filter ash	1996-1999	10	10		156	0.00	2550	0.01	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Nev. Test Site	Cotter Concentrate	1996-1997	420	420		3590	0.62	585000	100.26	Date range est. from Denison (2011) and Roberts (2012c). Quantities and activities est. from Roberts (2012a,2012c).
Molycorp		2002-2003, 2007	11,689	11,689		38.6	0.18	268.0	1.28	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
			Total Tons	2,450,679	**Weighted Ave.**	**606**		**1048**		

Notes:
[c]Estimated from total tons of tailings to Cell 2 and capacity of Cell 3 from Denison (2009), Attachment E. Material placed before 2009 was placed in Cells 2 and 3 (Roberts, 2012c).
[b]Values for ores estimated using method in NRC Reg. Guide 3.64 (1989) of multiplying the ore grade by 2812 pCi/g.
[c]Values for thorium estimated as Ra-226 values.

References:

Denison Mines USA Corporation (Denison), 2009. Reclamation Plan, White Mesa Mill, Blanding Utah, Revision 4.0, November.
Denison Mines USA Corporation (Denison), 2011. Reclamation Plan, White Mesa Mill, Blanding Utah, Revision 5.0, September.
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Roberts, H., 2012b. Personal communication from Harold Roberts, Denison Mines (USA) Corp., to Melanie Davis, MWH Americas, Inc., June 21.
Roberts, H., 2012c. Electronic communication including file "Alternate Feed Tons.pdf" and personal communication from Harold Roberts, Denison Mines (USA) Corp., to Melanie Davis, MWH Americas, Inc., July 24.
Turk, D., 2012a. Electronic communication including file "Ore Numbers.pdf" from David Turk, Denison Mines (USA) Corp., to Melanie Davis, MWH Americas, Inc., June 8.
Turk, D., 2012b. Electronic communication including file "DAC s Calculations 2012_rev6-29-12" from David Turk, Denison Mines (USA) Corp., to Melanie Davis, MWH Americas, Inc., June 29.

Energy Fuels Resources (USA) Inc.
Estimation of Cell 4A and 4B Ra-226 and Th-230 Activity Concentrations for Tailings

Material Category/Location	Origin/ Description	Dates	Total Mass Ore/Alt. Feed Processed[a] (tons)	$\%U_3O_8$	Ra-226 Activity Conc.[b] (pCi/g)	Th-230 Activity Conc.[c] (pCi/g)	Reference/Comments
Processed Ores							
Pandora		2009-2011	151,145	0.218	613.0	613.0	Data provided from D. Turk (2012a)
Daneros		2010-2011	71,287	0.269	756.4	756.4	Data provided from D. Turk (2012a)
Beaver		2010-2011	90,280	0.174	489.3	489.3	Data provided from D. Turk (2012a)
Arizona 1		2010-2011	41,863	0.608	1709.7	1709.7	Data provided from D. Turk (2012a)
Sunday		2009-2011	8,185	0.178	500.5	500.5	Data provided from D. Turk (2012a)
West Sunday		2009-2010	26,131	0.157	441.5	441.5	Data provided from D. Turk (2012a)
Topaz		2009-2010	8,123	0.128	359.9	359.9	Data provided from D. Turk (2012a)
St. Jude		2009-2010	14,432	0.167	469.6	469.6	Data provided from D. Turk (2012a)
Tony M		2009	115,074	0.131	368.4	368.4	Data provided from D. Turk (2012a)
Dawn Mining		2009-2010	2,875	0.456	1282.3	1282.3	Data provided from D. Turk (2012a)
Carnation		2009-2010	5,584	0.166	466.8	466.8	Data provided from D. Turk (2012a)
Purchased Ore		2010-2011	18,008	0.146	410.6	410.6	Data provided from D. Turk (2012a)
Humbug Cressler		2011	118	0.044	123.7	123.7	Data provided from D. Turk (2012a)
Alternate Feeds							
Cabot	Tantalum residues	2011	8,700		772	118	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Cameco	UF4	2009-2010	462		156	2550	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
Allied Signal/Honeywell	Calcium Fluoride	2011	1,969		989	23800	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
FMRI (Fansteel)		2011	1,369		236	4.9	Date range est. from Denison (2011) and Roberts (2012c). Quantities est. from Roberts (2012a,2012c). Activities est. from Turk (2012b).
				Weighted Ave.	**617**	**695**	

Notes:
[c]Current tailings in Cell 4A and future tailings to Cell 4A and 4B are projected to be from ores and alternative feeds similar to those processed after 2008 (Roberts, 2012c).
[b]Values for ores estimated using method in NRC Reg. Guide 3.64 (1989) of multiplying the ore grade by 2812 pCi/g.
[c]Values for thorium estimated as Ra-226 values.

References:

Denison Mines USA Corporation (Denison), 2009. Reclamation Plan, White Mesa Mill, Blanding Utah, Revision 4.0, November.
Denison Mines USA Corporation (Denison), 2011. Reclamation Plan, White Mesa Mill, Blanding Utah, Revision 5.0, September.
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Roberts, H., 2012b. Personal communication from Harold Roberts, Denison Mines (USA) Corp., to Melanie Davis, MWH Americas, Inc., June 21.
Roberts, H., 2012c. Electronic communication including file "Alternate Feed Tons.pdf" and personal communication from Harold Roberts, Denison Mines (USA) Corp., to Melanie Davis, MWH Americas, Inc., July 24.
Turk, D., 2012a. Electronic communication including file "Ore Numbers.pdf" from David Turk, Denison Mines (USA) Corp., to Melanie Davis, MWH Americas, Inc., June 8.
Turk, D., 2012b. Electronic communication including file "DAC s Calculations 2012_rev6-29-12" from David Turk, Denison Mines (USA) Corp., to Melanie Davis, MWH Americas, Inc., June 29.

Energy Fuels Resources (USA) Inc. White Mesa Mill
Tailings Cell 2
Calculation of Ra-226 Concentrations Due to Future Decay of Th-230

The RA-226 concentration at various times in the future depends on both the decay of the Ra-226 currently present and the ingrowth from Th-230. The Ra-226 decays with a half-life of 1602 years. The ingrowth is also a function of the Ra-226 half-life (1602 years) and the Th-230 half-life (77,000 years).

A (Ra-226) at a time t (years) = [A (Ra-226) at t=0][exp(-0.693t/1602 years)]

A (Ra-226 from decay of Th-230 at time t (years)) = [A (Th-230)][1-exp(-0.693t/1602 years)][exp(-0.693t/77,000 years)]

Residual Ra-226 at time t

Time (years)	exp (-0.693t/1602)	Initial Ra-226 Concentration (pCi/g) Cell 2	Ra-226 Concentration at time t (pCi/g) Cell 2
0	1.000	923	923
100	0.958	923	884
200	0.917	923	847
500	0.805	923	743
1000	0.649	923	599

Ra-226 Concentration from Ingrowth Due to Decay of Th-230

Time (years)	exp (-0.693t/1602)	Initial Th-230 Concentration (pCi/g) S.I.	Ra-226 Concentration at time t (pCi/g) S.I.	exp (-0.693t/77000)
0	1.000	923	0	1.000
100	0.958	923	39	0.999
200	0.917	923	76	0.998
500	0.805	923	179	0.996
1000	0.649	923	321	0.991

Total Ra-226 Concentration at Time t (original Ra-226 and Ra-226 from Th-230 decay)

Time (years)	Total Ra-226 Concentration (pCi/g) avg. S.I.
0	923
100	923
200	**923**
500	922
1000	920

Energy Fuels Resources (USA) Inc. White Mesa Mill
Tailings Cell 3
Calculation of Ra-226 Concentrations Due to Future Decay of Th-230

The RA-226 concentration at various times in the future depends on both the decay of the Ra-226 currently present and the ingrowth from Th-230. The Ra-226 decays with a half-life of 1602 years. The ingrowth is also a function of the Ra-226 half-life (1602 years) and the Th-230 half-life (77,000 years).

A (Ra-226) at a time t (years) = [A (Ra-226) at t=0][exp(-0.693t/1602 years)]

A (Ra-226 from decay of Th-230 at time t (years)) = [A (Th-230)][1-exp(-0.693t/1602 years)][exp(-0.693t/77,000 years)]

Residual Ra-226 at time t

Time (years)	exp (-0.693t/1602)	Initial Ra-226 Concentration (pCi/g) Cell 3	Ra-226 Concentration at time t (pCi/g) Cell 3
0	1.000	606	606
100	0.958	606	580
200	0.917	606	556
500	0.805	606	488
1000	0.649	606	393

Ra-226 Concentration from Ingrowth Due to Decay of Th-230

Time (years)	exp (-0.693t/1602)	Initial Th-230 Concentration (pCi/g) S.I.	Ra-226 Concentration at time t (pCi/g) S.I.	exp (-0.693t/77000)
0	1.000	1048	0	1.000
100	0.958	1048	44	0.999
200	0.917	1048	87	0.998
500	0.805	1048	203	0.996
1000	0.649	1048	365	0.991

Total Ra-226 Concentration at Time t (original Ra-226 and Ra-226 from Th-230 decay)

Time (years)	Total Ra-226 Concentration (pCi/g) avg. S.I.
0	606
100	625
200	642
500	691
1000	**758**

Energy Fuels Resources (USA) Inc. White Mesa Mill
Tailings Cells 4A/B
Calculation of Ra-226 Concentrations Due to Future Decay of Th-230

The RA-226 concentration at various times in the future depends on both the decay of the Ra-226 currently present and the ingrowth from Th-230. The Ra-226 decays with a half-life of 1602 years. The ingrowth is also a function of the Ra-226 half-life (1602 years) and the Th-230 half-life (77,000 years).

A (Ra-226) at a time t (years) = [A (Ra-226) at t=0][exp(-0.693t/1602 years)]

A (Ra-226 from decay of Th-230 at time t (years)) = [A (Th-230)][1-exp(-0.693t/1602 years)][exp(-0.693t/77,000 years)]

Residual Ra-226 at time t

Time (years)	exp (-0.693t/1602)	Initial Ra-226 Concentration (pCi/g) Cell 4A/B	Ra-226 Concentration at time t (pCi/g) Cell 4A/B
0	1.000	617	617
100	0.958	617	591
200	0.917	617	566
500	0.805	617	497
1000	0.649	617	400

Ra-226 Concentration from Ingrowth Due to Decay of Th-230

Time (years)	exp (-0.693t/1602)	Initial Th-230 Concentration (pCi/g) S.I.	Ra-226 Concentration at time t (pCi/g) S.I.	exp (-0.693t/77000)
0	1.000	695	0	1.000
100	0.958	695	29	0.999
200	0.917	695	57	0.998
500	0.805	695	135	0.996
1000	0.649	695	242	0.991

Total Ra-226 Concentration at Time t (original Ra-226 and Ra-226 from Th-230 decay)

Time (years)	Total Ra-226 Concentration (pCi/g) avg. S.I.
0	617
100	620
200	623
500	632
1000	**642**

ATTACHMENT C.2

COVER MATERIAL PARAMETERS ESTIMATION TABLE

ENERGY FUELS RESOURCES (USA) INC. WHITE MESA MILL

Summary of Laboratory Testing Results for Borrow Stockpiles

Borrow Stockpile ID	Estimated Stockpile Volume[1] (cy)	Field Investigation Date	Material Description	USCS	Sample ID	Sample Depth (ft)	Gravimetric Water Content (%)	Atterberg Limits[2] LL/PL/PI (%)	PI	Specific Gravity	% Gravel	%Sand	%Silt	% Clay	% Fines	Max. Density (pcf)	Opt. Moist. Cont. (%)	Ksat (cm/s)	15bar Grav. Water Content (%)	Soil Group[4]
E1	15,900	Apr-2012	Topsoil (Sandy Silty Clay)	CL-ML	E1-A	0 - 3	--	23/18/5	5	2.61	0	41	43	16	59	118	11	1.3×10^{-4}	5.2	Topsoil
E2	92,000	Oct-2010	Silty Sand/Clayey Sand	SM	A	5	4.5	NP	NP	--	0.5	77.1	13.5	8.9	22					B
				SC	B	12	5.7	23.3/11.2/12.1	12.1	2.64	13.1	50.3	22.6	14.0	37					U
E3	16,800	Apr-2012	Clay with Sand	CH	E3-A	0 - 3	--	54/24/30	30	2.53	0	23	29	48	77	105	19	9.5×10^{-5}	13.6	F
E4	66,600	Oct-2010	Sandy Clay	CL	A	5	8.6	30.3/14.4/15.9	15.9	--	0.0	41.2	39.1	19.7	59					U
E5	68,800	Oct-2010	Sandy Clay	CL	A	6	9.0	33.2/14.3/18.9	18.9	--	0.0	35.5	38.1	26.4	65					F
		Apr-2012	Clay with Sand	CH	E5-B	0 - 3	--	51/24/27	27	2.56	2	15	36	47	83					F
E6	100,700	Oct-2010	Clay	CL	A	5	14.4	40.2/15.8/24.4	24.4	2.74	0.1	17.7	49.5	32.7	82					F
E7	74,900	Oct-2010	Sandy Clay	CL	A	6	5.7	26.2/16.3/9.9	9.9	--	0.0	30.2	56.1	13.7	70					U
E8	227,300	Oct-2010	Sandy Clay	CL	A	2	7.4	23.0/12.0/11.0	11.0	--	0.0	47.0	36.9	16.1	53					U
		Apr-2012	Gravel with Clay and Sand	GW-GC	E8-B	0 - 4	--	27/16/11	11	2.63	40.0	31.0	18.0	11.0	29	125	11		6.0	B
W1	85,700	Oct-2010	Sandy Clay	CL	A	5	8.8	32.1/14.5/17.6	17.6	--	0.0	40.6	37.6	21.8	59					U
W2	584,500	Oct-2010	Sandy Clay	CL	A	surface	8.5	28.1/13.1/15.0	15.0	--	0.2	41.5	42.5	15.8	58					U
		Apr-2012	Clayey Sand with Gravel	SC	W2-A	0 - 3	--	24/14/10	10	2.62	30	45	15.0	10.0	25				6.9	B
		Apr-2012	Silty Clayey Sand with Gravel	SC-SM	W2-B	0 - 5	--	18/13/5	5	2.63	41	45	9.0	5.0	14	128	9	1.5×10^{-3}	3.5	B
W3	84,800	Oct-2010	Topsoil (Sandy Silty Clay)	CL-ML	A	surface	4.3	20.9/16.2/4.7	4.7	--	0.2	44.2	39.2	16.4	56					Topsoil
W4	90,000	Oct-2010	Topsoil (Sandy Silt)	ML	A	5	5.3	21.9/18.0/3.9	3.9	--	0.0	32.6	54.3	13.1	67					Topsoil
		Apr-2012	Topsoil (Sandy Silty Clay)	CL-ML	W4-B	0 - 4	--	26/19/7	7	2.60	0	38	44	18	62					Topsoil
W5	2,001,160	Apr-2012	Sandy Clay	CL	W5-A	0 - 4	--	27/18/9	9	2.61	1	49	32	18	50				7.0	U
			Clayey Sand with Gravel	SC	W5-B	0 - 4	--	24/15/9	9	2.63	29	44	19	8	27	122	10	1.1×10^{-3}	3.6	B
W6	93,400	Oct-2010	Topsoil (Sandy Silty Clay)	CL-ML	A	surface	3.3	23.1/16.5/6.6	6.6	--	0.0	34.3	51.8	13.9	66					Topsoil
W7	39,500	Oct-2010	Sandy Clay	CL	A	5	8.7	28.0/10.6/17.3	17.3	2.67	0.0	43.8	43.1	13.1	56					U
W8	178,411	Apr-2012	Silty Sand with Gravel	SM	W8-A	0 - 3	--	NP	NP	2.64	35	51	9	5	14	117	13	1.2×10^{-3}	5.0	B
			Silty Sand with Gravel	SM	W8-B	0 - 4	--	NP	NP	2.66	32	40	18	10	28				6.4	B
W9	60,250	Oct-2010	Sandy Clay	CL	A	surface	4.4	25.9/12.3/13.5	13.5	--	0.0	37.4	45.2	17.4	63					U
		Apr-2012	Sandy Clay	CL	W9-B	0 - 4	--	28/16/12	12	2.63	6	44	35	15	50	115	14	4.1×10^{-4}	7.7	U

Estimation of Cover Material Properties Used in Model

Soil Group[4]	Volume (cy)	Total Vol (cy)	Percent of Total Volume	Ave. Max. Dry Density (pcf)	Ave. Specific Gravity	Ave. 15bar Grav. Water Content (%)
Group B	1,728,308	3,596,621	48.1%	123	2.64	5.2
Group U	1,682,013	3,596,621	46.8%	115	2.64	7.3
Group F	186,300	3,596,621	5.2%	105	2.61	13.6
			Weighted Ave.	**118**	**2.63**	**6.7**

Notes:

1. Volumes estimated using 2009 topography and assuming a relatively flat bottom surface, except for stockpiles W5, W8 and W9. The volumes for stockpiles W8 and W9 were estimated by comparing the 2011 versus 2009 topography. The volume for stockpile W5 was estimated using a combination of both methods.
2. LL = Liquid Limt, PL = Plastic Limit, PI = Plasticity Index (PI = LL-PL)
3. Gravel = 4.75 mm to 75 mm, Sand = 0.075 mm to 4.75 mm, Fines: Silt = 0 .075 mm to 0.002 mm, Clay = less than 0.002 mm
4. Group B (broadly graded), Group U (uniformly graded), and Group F (fine textured) based on evaluation of gradations and Benson (2012). See Attachment B of EFRI (2012) for gradations and laboratory reports.

References:

Benson, C., 2012. Electronic communication from Craig Benson, University of Wisconsin-Madison, to Melanie Davis, MWH Americas, Inc., regarding evaluation of gradations performed for potential cover soils for White Mesa, May 20.

Energy Fuels Resouces (USA) Inc. (EFRI), 2012. Response to Interrogatories - Round 1 for Reclamation Plan, revision 5.0., March 2012. August 15.

ATTACHMENT C.3

RADON MODEL OUTPUT

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                    -----*****! RADON !*****-----

Version 1.2 - MAY 22, 1989 - G.F. Birchard tel.# (301)492-7000
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         RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Cell2ts

DESCRIPTION: Cell 2 Cover (topsoil on surface)


              CONSTANTS


RADON DECAY CONSTANT                      .0000021     s^-1
RADON WATER/AIR PARTITION COEFFICIENT     .26
DEFAULT SPECIFIC GRAVITY OF COVER & TAILINGS            2.65

              GENERAL INPUT PARAMETERS


LAYERS OF COVER AND TAILINGS              5
NO LIMIT ON RADON FLUX
LAYER THICKNESS NOT OPTIMIZED
DEFAULT SURFACE RADON CONCENTRATION       0            pCi l^-1
SURFACE FLUX PRECISION                    .001         pCi m^-2 s^-1

              LAYER INPUT PARAMETERS


LAYER 1       Tailings


THICKNESS                                 500          cm
POROSITY                                  .45
MEASURED MASS DENSITY                     1.5          g cm^-3
MEASURED RADIUM ACTIVITY                  923          pCi/g^-1
MEASURED EMANATION COEFFICIENT            .2
CALCULATED SOURCE TERM CONCENTRATION      1.292D-03    pCi cm^-3 s^-1
WEIGHT % MOISTURE                         6            %
MOISTURE SATURATION FRACTION              .200
MEASURED DIFFUSION COEFFICIENT            .0288        cm^2 s^-1


LAYER 2       Random Fill


THICKNESS                                 76           cm
POROSITY                                  .43
MEASURED MASS DENSITY                     1.5          g cm^-3
MEASURED RADIUM ACTIVITY                  0            pCi/g^-1
MEASURED EMANATION COEFFICIENT            .35
CALCULATED SOURCE TERM CONCENTRATION      0.000D+00    pCi cm^-3 s^-1
WEIGHT % MOISTURE                         6.7          %
MOISTURE SATURATION FRACTION              .234
MEASURED DIFFUSION COEFFICIENT            .026         cm^2 s^-1
```

LAYER 3 Compacted Random Fill

THICKNESS	122	cm
POROSITY	.32	
MEASURED MASS DENSITY	1.8	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.377	
MEASURED DIFFUSION COEFFICIENT	.016	cm^2 s^-1

LAYER 4 ET Cover

THICKNESS	107	cm
POROSITY	.39	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.275	
MEASURED DIFFUSION COEFFICIENT	.0225	cm^2 s^-1

LAYER 5 Topsoil

THICKNESS	15	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	5.2	%
MOISTURE SATURATION FRACTION	.219	
MEASURED DIFFUSION COEFFICIENT	.0254	cm^2 s^-1

DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC
5	-1.000D+00	0.000D+00	0	0.000D+00	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	2.880D-02	4.500D-01	1.292D-03	2.000D-01	1.500
2	7.600D+01	2.600D-02	4.300D-01	0.000D+00	2.337D-01	1.500
3	1.220D+02	1.600D-02	3.200D-01	0.000D+00	3.769D-01	1.800
4	1.070D+02	2.250D-02	3.900D-01	0.000D+00	2.749D-01	1.600
5	1.500D+01	2.540D-02	3.800D-01	0.000D+00	2.189D-01	1.600

BARE SOURCE FLUX FROM LAYER 1: 6.713D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	2.884D+02	3.461D+05
2	7.600D+01	1.094D+02	2.058D+05
3	1.220D+02	3.505D+01	3.071D+04
4	1.070D+02	2.018D+01	2.963D+03
5	1.500D+01	2.000D+01	0.000D+00

-----*****! RADON !*****-----

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Cell2rm

DESCRIPTION: Cell 2 Cover (rock mulch on surface)

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	5	
NO LIMIT ON RADON FLUX		
LAYER THICKNESS NOT OPTIMIZED		
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 Tailings

THICKNESS	500	cm
POROSITY	.45	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	923	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.2	
CALCULATED SOURCE TERM CONCENTRATION	1.292D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.200	
MEASURED DIFFUSION COEFFICIENT	.0288	cm^2 s^-1

LAYER 2 Random Fill

THICKNESS	76	cm
POROSITY	.43	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.234	
MEASURED DIFFUSION COEFFICIENT	.026	cm^2 s^-1

LAYER 3 Compacted Random Fill

THICKNESS	122	cm
POROSITY	.32	
MEASURED MASS DENSITY	1.8	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.377	
MEASURED DIFFUSION COEFFICIENT	.016	cm^2 s^-1

LAYER 4 ET Cover

THICKNESS	107	cm
POROSITY	.39	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.275	
MEASURED DIFFUSION COEFFICIENT	.0225	cm^2 s^-1

LAYER 5 Rock Mulch

THICKNESS	15	cm
POROSITY	.35	
MEASURED MASS DENSITY	1.7	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	4	%
MOISTURE SATURATION FRACTION	.194	
MEASURED DIFFUSION COEFFICIENT	.0256	cm^2 s^-1

DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC
5	-1.000D+00	0.000D+00	0	0.000D+00	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	2.880D-02	4.500D-01	1.292D-03	2.000D-01	1.500
2	7.600D+01	2.600D-02	4.300D-01	0.000D+00	2.337D-01	1.500
3	1.220D+02	1.600D-02	3.200D-01	0.000D+00	3.769D-01	1.800
4	1.070D+02	2.250D-02	3.900D-01	0.000D+00	2.749D-01	1.600
5	1.500D+01	2.560D-02	3.500D-01	0.000D+00	1.943D-01	1.700

BARE SOURCE FLUX FROM LAYER 1: 6.713D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	2.884D+02	3.461D+05
2	7.600D+01	1.094D+02	2.058D+05
3	1.220D+02	3.501D+01	3.077D+04
4	1.070D+02	2.007D+01	3.107D+03
5	1.500D+01	1.988D+01	0.000D+00

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         RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS
ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Cell3ts

DESCRIPTION: Cell 3 Cover (topsoil on surface)


              CONSTANTS

RADON DECAY CONSTANT                       .0000021     s^-1
RADON WATER/AIR PARTITION COEFFICIENT      .26
DEFAULT SPECIFIC GRAVITY OF COVER & TAILINGS             2.65


              GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS               5
NO LIMIT ON RADON FLUX
LAYER THICKNESS NOT OPTIMIZED
DEFAULT SURFACE RADON CONCENTRATION        0            pCi l^-1
SURFACE FLUX PRECISION                     .001         pCi m^-2 s^-1


              LAYER INPUT PARAMETERS

LAYER 1       Tailings


THICKNESS                                  500          cm
POROSITY                                   .45
MEASURED MASS DENSITY                      1.5          g cm^-3
MEASURED RADIUM ACTIVITY                   758          pCi/g^-1
MEASURED EMANATION COEFFICIENT             .2
CALCULATED SOURCE TERM CONCENTRATION       1.061D-03    pCi cm^-3 s^-1
WEIGHT % MOISTURE                          6            %
MOISTURE SATURATION FRACTION               .200
MEASURED DIFFUSION COEFFICIENT             .0288        cm^2 s^-1


LAYER 2       Random Fill


THICKNESS                                  76           cm
POROSITY                                   .43
MEASURED MASS DENSITY                      1.5          g cm^-3
MEASURED RADIUM ACTIVITY                   0            pCi/g^-1
MEASURED EMANATION COEFFICIENT             .35
CALCULATED SOURCE TERM CONCENTRATION       0.000D+00    pCi cm^-3 s^-1
WEIGHT % MOISTURE                          6.7          %
MOISTURE SATURATION FRACTION               .234
MEASURED DIFFUSION COEFFICIENT             .026         cm^2 s^-1
```

LAYER 3 Compacted Random Fill

THICKNESS	107	cm
POROSITY	.32	
MEASURED MASS DENSITY	1.8	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.377	
MEASURED DIFFUSION COEFFICIENT	.016	cm^2 s^-1

LAYER 4 ET Cover

THICKNESS	107	cm
POROSITY	.39	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.275	
MEASURED DIFFUSION COEFFICIENT	.0225	cm^2 s^-1

LAYER 5 Topsoil

THICKNESS	15	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	5.2	%
MOISTURE SATURATION FRACTION	.219	
MEASURED DIFFUSION COEFFICIENT	.0254	cm^2 s^-1

DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC
5	-1.000D+00	0.000D+00	0	0.000D+00	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	2.880D-02	4.500D-01	1.061D-03	2.000D-01	1.500
2	7.600D+01	2.600D-02	4.300D-01	0.000D+00	2.337D-01	1.500
3	1.070D+02	1.600D-02	3.200D-01	0.000D+00	3.769D-01	1.800
4	1.070D+02	2.250D-02	3.900D-01	0.000D+00	2.749D-01	1.600
5	1.500D+01	2.540D-02	3.800D-01	0.000D+00	2.189D-01	1.600

BARE SOURCE FLUX FROM LAYER 1: 5.513D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	2.374D+02	2.838D+05
2	7.600D+01	9.084D+01	1.681D+05
3	1.070D+02	3.427D+01	3.003D+04
4	1.070D+02	1.974D+01	2.898D+03
5	1.500D+01	1.956D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Cell3rm

DESCRIPTION: Cell 3 Cover (rock mulch on surface)

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	5	
NO LIMIT ON RADON FLUX		
LAYER THICKNESS NOT OPTIMIZED		
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 Tailings

THICKNESS	500	cm
POROSITY	.45	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	758	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.2	
CALCULATED SOURCE TERM CONCENTRATION	1.061D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.200	
MEASURED DIFFUSION COEFFICIENT	.0288	cm^2 s^-1

LAYER 2 Random Fill

THICKNESS	76	cm
POROSITY	.43	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.234	
MEASURED DIFFUSION COEFFICIENT	.026	cm^2 s^-1

LAYER 3 Compacted Random Fill

THICKNESS	107	cm
POROSITY	.32	
MEASURED MASS DENSITY	1.8	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.377	
MEASURED DIFFUSION COEFFICIENT	.016	cm^2 s^-1

LAYER 4 ET Cover

THICKNESS	107	cm
POROSITY	.39	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.275	
MEASURED DIFFUSION COEFFICIENT	.0225	cm^2 s^-1

LAYER 5 Rock Mulch

THICKNESS	15	cm
POROSITY	.35	
MEASURED MASS DENSITY	1.7	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	4	%
MOISTURE SATURATION FRACTION	.194	
MEASURED DIFFUSION COEFFICIENT	.0256	cm^2 s^-1

DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC
5	-1.000D+00	0.000D+00	0	0.000D+00	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	2.880D-02	4.500D-01	1.061D-03	2.000D-01	1.500
2	7.600D+01	2.600D-02	4.300D-01	0.000D+00	2.337D-01	1.500
3	1.070D+02	1.600D-02	3.200D-01	0.000D+00	3.769D-01	1.800
4	1.070D+02	2.250D-02	3.900D-01	0.000D+00	2.749D-01	1.600
5	1.500D+01	2.560D-02	3.500D-01	0.000D+00	1.943D-01	1.700

BARE SOURCE FLUX FROM LAYER 1: 5.513D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	2.374D+02	2.838D+05
2	7.600D+01	9.083D+01	1.681D+05
3	1.070D+02	3.424D+01	3.009D+04
4	1.070D+02	1.962D+01	3.038D+03
5	1.500D+01	1.945D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Cells4AB

DESCRIPTION: Cells 4A and 4B Cover

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	5	
NO LIMIT ON RADON FLUX		
LAYER THICKNESS NOT OPTIMIZED		
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 Tailings

THICKNESS	500	cm
POROSITY	.45	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	642	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.2	
CALCULATED SOURCE TERM CONCENTRATION	8.988D-04	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.200	
MEASURED DIFFUSION COEFFICIENT	.0288	cm^2 s^-1

LAYER 2 Random Fill

THICKNESS	76	cm
POROSITY	.43	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.234	
MEASURED DIFFUSION COEFFICIENT	.026	cm^2 s^-1

LAYER 3 Compacted Random Fill

THICKNESS	91	cm
POROSITY	.32	
MEASURED MASS DENSITY	1.8	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.377	
MEASURED DIFFUSION COEFFICIENT	.016	cm^2 s^-1

LAYER 4 ET Cover

THICKNESS	107	cm
POROSITY	.39	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.275	
MEASURED DIFFUSION COEFFICIENT	.0225	cm^2 s^-1

LAYER 5 Rock Mulch

THICKNESS	15	cm
POROSITY	.35	
MEASURED MASS DENSITY	1.7	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	4	%
MOISTURE SATURATION FRACTION	.194	

DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC
5	-1.000D+00	0.000D+00	0	0.000D+00	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	2.880D-02	4.500D-01	8.988D-04	2.000D-01	1.500
2	7.600D+01	2.600D-02	4.300D-01	0.000D+00	2.337D-01	1.500
3	9.100D+01	1.600D-02	3.200D-01	0.000D+00	3.769D-01	1.800
4	1.070D+02	2.250D-02	3.900D-01	0.000D+00	2.749D-01	1.600
5	1.500D+01	2.560D-02	3.500D-01	0.000D+00	1.943D-01	1.700

BARE SOURCE FLUX FROM LAYER 1: 4.669D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	2.017D+02	2.398D+05
2	7.600D+01	7.817D+01	1.412D+05
3	9.100D+01	3.498D+01	3.074D+04
4	1.070D+02	2.005D+01	3.104D+03
5	1.500D+01	1.987D+01	0.000D+00

ATTACHMENT C.4

RADON MODEL OUTPUT FOR VARIABLE THICKNESS OF RANDOM FILL

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Cell2pt1

DESCRIPTION: Cell 2 Evaluation of Impact of Increased Random Fill Thickness – Point 1

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	5	
DEFAULT RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	3	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 Tailings

THICKNESS	500	cm
POROSITY	.45	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	923	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.2	
CALCULATED SOURCE TERM CONCENTRATION	1.292D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.200	
MEASURED DIFFUSION COEFFICIENT	.0288	cm^2 s^-1

LAYER 2 Random Fill

THICKNESS	76	cm
POROSITY	.43	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	

CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.234	
MEASURED DIFFUSION COEFFICIENT	.026	cm^2 s^-1

LAYER 3 Compacted Random Fill

THICKNESS	1	cm
POROSITY	.32	
MEASURED MASS DENSITY	1.8	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.377	
MEASURED DIFFUSION COEFFICIENT	.016	cm^2 s^-1

LAYER 4 ET Cover

THICKNESS	107	cm
POROSITY	.39	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.275	
MEASURED DIFFUSION COEFFICIENT	.0225	cm^2 s^-1

LAYER 5 Topsoil

THICKNESS	15	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	5.2	%
MOISTURE SATURATION FRACTION	.219	
MEASURED DIFFUSION COEFFICIENT	.0254	cm^2 s^-1

DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC
5	-1.000D+00	0.000D+00	3	2.000D+01	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	2.880D-02	4.500D-01	1.292D-03	2.000D-01	1.500
2	7.600D+01	2.600D-02	4.300D-01	0.000D+00	2.337D-01	1.500
3	1.000D+00	1.600D-02	3.200D-01	0.000D+00	3.769D-01	1.800
4	1.070D+02	2.250D-02	3.900D-01	0.000D+00	2.749D-01	1.600
5	1.500D+01	2.540D-02	3.800D-01	0.000D+00	2.189D-01	1.600

BARE SOURCE FLUX FROM LAYER 1: 6.713D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	2.884D+02	3.461D+05
2	7.600D+01	1.094D+02	2.058D+05
3	1.219D+02	3.507D+01	3.073D+04
4	1.070D+02	2.020D+01	2.966D+03
5	1.500D+01	2.000D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Cell2pt2

DESCRIPTION: Cell 2 Evaluation of Impact of Increased Random Fill Thickness – Point 2

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	5	
DEFAULT RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	3	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 Tailings

THICKNESS	500	cm
POROSITY	.45	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	923	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.2	
CALCULATED SOURCE TERM CONCENTRATION	1.292D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.200	
MEASURED DIFFUSION COEFFICIENT	.0288	cm^2 s^-1

LAYER 2 Random Fill

THICKNESS	107	cm
POROSITY	.43	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	

CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.234	
MEASURED DIFFUSION COEFFICIENT	.026	cm^2 s^-1

LAYER 3 Compacted Random Fill

THICKNESS	1	cm
POROSITY	.32	
MEASURED MASS DENSITY	1.8	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.377	
MEASURED DIFFUSION COEFFICIENT	.016	cm^2 s^-1

LAYER 4 ET Cover

THICKNESS	107	cm
POROSITY	.39	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.275	
MEASURED DIFFUSION COEFFICIENT	.0225	cm^2 s^-1

LAYER 5 Topsoil

THICKNESS	15	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	5.2	%
MOISTURE SATURATION FRACTION	.219	
MEASURED DIFFUSION COEFFICIENT	.0254	cm^2 s^-1

DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC
5	-1.000D+00	0.000D+00	3	2.000D+01	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	2.880D-02	4.500D-01	1.292D-03	2.000D-01	1.500
2	1.070D+02	2.600D-02	4.300D-01	0.000D+00	2.337D-01	1.500
3	1.000D+00	1.600D-02	3.200D-01	0.000D+00	3.769D-01	1.800
4	1.070D+02	2.250D-02	3.900D-01	0.000D+00	2.749D-01	1.600
5	1.500D+01	2.540D-02	3.800D-01	0.000D+00	2.189D-01	1.600

BARE SOURCE FLUX FROM LAYER 1: 6.713D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	3.002D+02	3.355D+05
2	1.070D+02	8.457D+01	1.545D+05
3	9.819D+01	3.508D+01	3.075D+04
4	1.070D+02	2.021D+01	2.967D+03
5	1.500D+01	2.000D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Cell2pt3

DESCRIPTION: Cell 2 Evaluation of Impact of Increased Random Fill Thickness – Point 3

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	5	
DEFAULT RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	3	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 Tailings

THICKNESS	500	cm
POROSITY	.45	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	923	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.2	
CALCULATED SOURCE TERM CONCENTRATION	1.292D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.200	
MEASURED DIFFUSION COEFFICIENT	.0288	cm^2 s^-1

LAYER 2 Random Fill

THICKNESS	152	cm
POROSITY	.43	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	

CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.234	
MEASURED DIFFUSION COEFFICIENT	.026	cm^2 s^-1

LAYER 3 Compacted Random Fill

THICKNESS	1	cm
POROSITY	.32	
MEASURED MASS DENSITY	1.8	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.377	
MEASURED DIFFUSION COEFFICIENT	.016	cm^2 s^-1

LAYER 4 ET Cover

THICKNESS	107	cm
POROSITY	.39	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.275	
MEASURED DIFFUSION COEFFICIENT	.0225	cm^2 s^-1

LAYER 5 Topsoil

THICKNESS	15	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	5.2	%
MOISTURE SATURATION FRACTION	.219	
MEASURED DIFFUSION COEFFICIENT	.0254	cm^2 s^-1

DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC
5	-1.000D+00	0.000D+00	3	2.000D+01	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	2.880D-02	4.500D-01	1.292D-03	2.000D-01	1.500
2	1.520D+02	2.600D-02	4.300D-01	0.000D+00	2.337D-01	1.500
3	1.000D+00	1.600D-02	3.200D-01	0.000D+00	3.769D-01	1.800
4	1.070D+02	2.250D-02	3.900D-01	0.000D+00	2.749D-01	1.600
5	1.500D+01	2.540D-02	3.800D-01	0.000D+00	2.189D-01	1.600

BARE SOURCE FLUX FROM LAYER 1: 6.713D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	3.089D+02	3.276D+05
2	1.520D+02	5.950D+01	1.003D+05
3	6.418D+01	3.509D+01	3.075D+04
4	1.070D+02	2.021D+01	2.967D+03
5	1.500D+01	2.000D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Cell2pt4

DESCRIPTION: Cell 2 Evaluation of Impact of Increased Random Fill Thickness – Point 4

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	4	
RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	2	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 Tailings

THICKNESS	500	cm
POROSITY	.45	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	923	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.2	
CALCULATED SOURCE TERM CONCENTRATION	1.292D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.200	
MEASURED DIFFUSION COEFFICIENT	.0288	cm^2 s^-1

LAYER 2 Random Fill

THICKNESS	1	cm
POROSITY	.43	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	

CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.234	
MEASURED DIFFUSION COEFFICIENT	.026	cm^2 s^-1

LAYER 3 ET Cover

THICKNESS	107	cm
POROSITY	.39	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.275	
MEASURED DIFFUSION COEFFICIENT	.0225	cm^2 s^-1

LAYER 4 Topsoil

THICKNESS	15	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	5.2	%
MOISTURE SATURATION FRACTION	.219	
MEASURED DIFFUSION COEFFICIENT	.0254	cm^2 s^-1

DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC
4	-1.000D+00	0.000D+00	2	2.000D+01	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	2.880D-02	4.500D-01	1.292D-03	2.000D-01	1.500
2	1.000D+00	2.600D-02	4.300D-01	0.000D+00	2.337D-01	1.500
3	1.070D+02	2.250D-02	3.900D-01	0.000D+00	2.749D-01	1.600
4	1.500D+01	2.540D-02	3.800D-01	0.000D+00	2.189D-01	1.600

BARE SOURCE FLUX FROM LAYER 1: 6.713D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	3.145D+02	3.225D+05
2	2.437D+02	3.502D+01	3.520D+04
3	1.070D+02	2.017D+01	2.961D+03
4	1.500D+01	1.998D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Cell3pt1

DESCRIPTION: Cell 3 Evaluation of Impact of Increased Random Fill Thickness – Point 1

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	5	
RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	3	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 Tailings

THICKNESS	500	cm
POROSITY	.45	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	758	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.2	
CALCULATED SOURCE TERM CONCENTRATION	1.061D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.200	
MEASURED DIFFUSION COEFFICIENT	.0288	cm^2 s^-1

LAYER 2 Random Fill

THICKNESS	76	cm
POROSITY	.43	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	

CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.234	
MEASURED DIFFUSION COEFFICIENT	.026	cm^2 s^-1

LAYER 3 Compacted Random Fill

THICKNESS	1	cm
POROSITY	.32	
MEASURED MASS DENSITY	1.8	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.377	
MEASURED DIFFUSION COEFFICIENT	.016	cm^2 s^-1

LAYER 4 ET Cover

THICKNESS	107	cm
POROSITY	.39	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.275	
MEASURED DIFFUSION COEFFICIENT	.0225	cm^2 s^-1

LAYER 5 Topsoil

THICKNESS	15	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	5.2	%
MOISTURE SATURATION FRACTION	.219	
MEASURED DIFFUSION COEFFICIENT	.0254	cm^2 s^-1

DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC
5	-1.000D+00	0.000D+00	3	2.000D+01	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	2.880D-02	4.500D-01	1.061D-03	2.000D-01	1.500
2	7.600D+01	2.600D-02	4.300D-01	0.000D+00	2.337D-01	1.500
3	1.000D+00	1.600D-02	3.200D-01	0.000D+00	3.769D-01	1.800
4	1.070D+02	2.250D-02	3.900D-01	0.000D+00	2.749D-01	1.600
5	1.500D+01	2.540D-02	3.800D-01	0.000D+00	2.189D-01	1.600

BARE SOURCE FLUX FROM LAYER 1: 5.513D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	2.375D+02	2.837D+05
2	7.600D+01	9.099D+01	1.679D+05
3	1.050D+02	3.508D+01	3.074D+04
4	1.070D+02	2.020D+01	2.966D+03
5	1.500D+01	2.000D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Cell3pt2

DESCRIPTION: Cell 3 Evaluation of Impact of Increased Random Fill Thickness – Point 2

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	5	
RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	3	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 Tailings

THICKNESS	500	cm
POROSITY	.45	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	758	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.2	
CALCULATED SOURCE TERM CONCENTRATION	1.061D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.200	
MEASURED DIFFUSION COEFFICIENT	.0288	cm^2 s^-1

LAYER 2 Random Fill

THICKNESS	107	cm
POROSITY	.43	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	

CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.234	
MEASURED DIFFUSION COEFFICIENT	.026	cm^2 s^-1

LAYER 3 Compacted Random Fill

THICKNESS	1	cm
POROSITY	.32	
MEASURED MASS DENSITY	1.8	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.377	
MEASURED DIFFUSION COEFFICIENT	.016	cm^2 s^-1

LAYER 4 ET Cover

THICKNESS	107	cm
POROSITY	.39	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.275	
MEASURED DIFFUSION COEFFICIENT	.0225	cm^2 s^-1

LAYER 5 Topsoil

THICKNESS	15	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	5.2	%
MOISTURE SATURATION FRACTION	.219	
MEASURED DIFFUSION COEFFICIENT	.0254	cm^2 s^-1

DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC
5	-1.000D+00	0.000D+00	3	2.000D+01	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	2.880D-02	4.500D-01	1.061D-03	2.000D-01	1.500
2	1.070D+02	2.600D-02	4.300D-01	0.000D+00	2.337D-01	1.500
3	1.000D+00	1.600D-02	3.200D-01	0.000D+00	3.769D-01	1.800
4	1.070D+02	2.250D-02	3.900D-01	0.000D+00	2.749D-01	1.600
5	1.500D+01	2.540D-02	3.800D-01	0.000D+00	2.189D-01	1.600

BARE SOURCE FLUX FROM LAYER 1: 5.513D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	2.471D+02	2.750D+05
2	1.070D+02	7.089D+01	1.255D+05
3	8.150D+01	3.507D+01	3.073D+04
4	1.070D+02	2.020D+01	2.966D+03
5	1.500D+01	2.000D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Cell3pt3

DESCRIPTION: Cell 3 Evaluation of Impact of Increased Random Fill Thickness – Point 3

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	5	
RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	3	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 Tailings

THICKNESS	500	cm
POROSITY	.45	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	758	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.2	
CALCULATED SOURCE TERM CONCENTRATION	1.061D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.200	
MEASURED DIFFUSION COEFFICIENT	.0288	cm^2 s^-1

LAYER 2 Random Fill

THICKNESS	152	cm
POROSITY	.43	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	

CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.234	
MEASURED DIFFUSION COEFFICIENT	.026	cm^2 s^-1

LAYER 3 Compacted Random Fill

THICKNESS	1	cm
POROSITY	.32	
MEASURED MASS DENSITY	1.8	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.377	
MEASURED DIFFUSION COEFFICIENT	.016	cm^2 s^-1

LAYER 4 ET Cover

THICKNESS	107	cm
POROSITY	.39	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.275	
MEASURED DIFFUSION COEFFICIENT	.0225	cm^2 s^-1

LAYER 5 Topsoil

THICKNESS	15	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	5.2	%
MOISTURE SATURATION FRACTION	.219	
MEASURED DIFFUSION COEFFICIENT	.0254	cm^2 s^-1

DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC
5	-1.000D+00	0.000D+00	3	2.000D+01	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	2.880D-02	4.500D-01	1.061D-03	2.000D-01	1.500
2	1.520D+02	2.600D-02	4.300D-01	0.000D+00	2.337D-01	1.500
3	1.000D+00	1.600D-02	3.200D-01	0.000D+00	3.769D-01	1.800
4	1.070D+02	2.250D-02	3.900D-01	0.000D+00	2.749D-01	1.600
5	1.500D+01	2.540D-02	3.800D-01	0.000D+00	2.189D-01	1.600

BARE SOURCE FLUX FROM LAYER 1: 5.513D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	2.543D+02	2.685D+05
2	1.520D+02	5.094D+01	8.036D+04
3	4.798D+01	3.509D+01	3.075D+04
4	1.070D+02	2.021D+01	2.967D+03
5	1.500D+01	2.000D+01	0.000D+00

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RADON FLUX, CONCENTRATION AND TAILINGS COVER THICKNESS ARE CALCULATED FOR MULTIPLE LAYERS

OUTPUT FILE: Cell3pt4

DESCRIPTION: Cell 3 Evaluation of Impact of Increased Random Fill Thickness – Point 4

CONSTANTS

RADON DECAY CONSTANT	.0000021	s^-1
RADON WATER/AIR PARTITION COEFFICIENT	.26	
DEFAULT SPECIFIC GRAVITY OF COVER & TAILINGS	2.65	

GENERAL INPUT PARAMETERS

LAYERS OF COVER AND TAILINGS	4	
RADON FLUX LIMIT	20	pCi m^-2 s^-1
NO. OF THE LAYER TO BE OPTIMIZED	2	
DEFAULT SURFACE RADON CONCENTRATION	0	pCi l^-1
SURFACE FLUX PRECISION	.001	pCi m^-2 s^-1

LAYER INPUT PARAMETERS

LAYER 1 Tailings

THICKNESS	500	cm
POROSITY	.45	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	758	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.2	
CALCULATED SOURCE TERM CONCENTRATION	1.061D-03	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6	%
MOISTURE SATURATION FRACTION	.200	
MEASURED DIFFUSION COEFFICIENT	.0288	cm^2 s^-1

LAYER 2 Random Fill

THICKNESS	1	cm
POROSITY	.43	
MEASURED MASS DENSITY	1.5	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	

CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.234	
MEASURED DIFFUSION COEFFICIENT	.026	cm^2 s^-1

LAYER 3 ET Cover

THICKNESS	107	cm
POROSITY	.39	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	6.7	%
MOISTURE SATURATION FRACTION	.275	
MEASURED DIFFUSION COEFFICIENT	.0225	cm^2 s^-1

LAYER 4 Topsoil

THICKNESS	15	cm
POROSITY	.38	
MEASURED MASS DENSITY	1.6	g cm^-3
MEASURED RADIUM ACTIVITY	0	pCi/g^-1
MEASURED EMANATION COEFFICIENT	.35	
CALCULATED SOURCE TERM CONCENTRATION	0.000D+00	pCi cm^-3 s^-1
WEIGHT % MOISTURE	5.2	%
MOISTURE SATURATION FRACTION	.219	
MEASURED DIFFUSION COEFFICIENT	.0254	cm^2 s^-1

DATA SENT TO THE FILE `RNDATA' ON DRIVE A:

N	F01	CN1	ICOST	CRITJ	ACC
4	-1.000D+00	0.000D+00	2	2.000D+01	1.000D-03

LAYER	DX	D	P	Q	XMS	RHO
1	5.000D+02	2.880D-02	4.500D-01	1.061D-03	2.000D-01	1.500
2	1.000D+00	2.600D-02	4.300D-01	0.000D+00	2.337D-01	1.500
3	1.070D+02	2.250D-02	3.900D-01	0.000D+00	2.749D-01	1.600
4	1.500D+01	2.540D-02	3.800D-01	0.000D+00	2.189D-01	1.600

BARE SOURCE FLUX FROM LAYER 1: 5.513D+02 pCi m^-2 s^-1

RESULTS OF THE RADON DIFFUSION CALCULATIONS

LAYER	THICKNESS (cm)	EXIT FLUX (pCi m^-2 s^-1)	EXIT CONC. (pCi l^-1)
1	5.000D+02	2.583D+02	2.649D+05
2	2.217D+02	3.506D+01	3.523D+04
3	1.070D+02	2.019D+01	2.964D+03
4	1.500D+01	2.000D+01	0.000D+00

APPENDIX D

VEGETATION AND BIOTINTRUSION EVALUATION

D.1 INTRODUCTION

This appendix provides an evaluation of vegetation that would be used as an integral part of an evapotranspiration (ET) cover proposed for reclamation of tailings cells at the White Mesa Mill (Mill) site. A critical component of an ET cover is the plant community that will be established on the cover and will function over the long term to provide protection from wind and water erosion and assist in removing water through the process of transpiration. In this appendix, issues related to the short-term establishment and long-term sustainability of vegetation proposed as part of the ET cover are addressed. These issues include: plant species selection, ecological characteristics of species (i.e., longevity, sustainability, compatibility, competition, rooting depth and root distribution), characteristics of the established plant community (i.e., percent plant cover and leaf area index [LAI]), and soil requirements for sustained plant growth. Information is also presented on weed control, vegetation performance goals and criteria, and post-closure vegetation monitoring. In addition, biointrusion from both plants and animals is addressed using information from an on-site survey conducted in June 2012 and literature applicable to site conditions. Finally there is discussion on climate change projections for the performance period and possible changes that may occur with plant community composition over time.

D.2 PROPOSED SPECIES FOR ET COVER RECLAMATION

The following 15 species (11 grasses, 2 forbs, and 2 shrubs) are proposed for the ET cover system at the Mill site. These species were selected for their adaptability to site conditions, compatibility, and long-term sustainability. Species were also selected based on the assumption that institutional controls will exclude grazing by domestic livestock. The proposed species are:

- Western wheatgrass, variety Arriba (*Pascopyrum smithii*)
- Bluebunch wheatgrass, variety Goldar (*Pseudoroegneria spicata*)
- Slender wheatgrass, variety San Luis (*Elymus trachycaulus*)
- Streambank wheatgrass, variety Sodar (*Elymus lanceolatus ssp. psammophilus*)
- Pubescent wheatgrass, variety Luna (*Thinopyrum intermedium ssp. barbulatum*)
- Indian ricegrass, variety Paloma (*Achnatherum hymenoides*)
- Sandberg bluegrass, variety Canbar (*Poa secunda*)
- Sheep fescue, variety Covar (*Festuca ovina*)
- Squirreltail, variety Toe Jam Creek (*Elymus elymoides*)
- Blue grama, variety Hachita (*Bouteloua gracilis*)
- Galleta, variety Viva (*Hilaria jamesii*)
- Common yarrow, no variety (*Achillea millefolium*)
- White sage, variety Summit (*Artemisia ludoviciana*)
- Fourwing saltbush, variety Wytana (*Atriplex canescens*)
- Rubber rabbitbrush, no variety (*Ericameria nauseosus*).

These species are described in more detail later in this appendix.

D.3 PROPOSED SEEDING RATES

Given a mixture of the species listed above, Table D.1 presents broadcast seeding rates for each species. Seeding rates were developed based on the objective of establishing a permanent cover of grasses, forbs, and shrubs in a mixture that would promote compatibility among species and minimize competitive exclusion or loss of species over time. The proposed seeding rate is based on number of seeds/ft^2 and then converted to pounds of pure live seed per acre (lbs PLS/acre), with further discussion presented below.

The number of seeds placed in a unit area of soil is called the seeding rate. The total seeding rate is the sum of the individual species seeding rates. Seeding rates are normally expressed as the number of seeds per square foot or pounds per acre. Many different seeding rates for the same species can be found in the literature. The primary reason for these differences is that some rates are for monocultures and other rates are for diverse mixtures. In addition, seeding rates vary depending on the method of seeding and site conditions related to edpaphic factors, topography and climate.

Seeding rates are developed on the basis of number of seeds per unit area (e.g. number of seeds per square foot). Once this number is determined, then it can be converted to weight per unit area (e.g. pounds per acre). Since each species produces seed that weighs a different amount, the development of seeding rates based purely on weight per unit area will produce erroneous rates that will tend to over emphasize small seeded species and under-emphasize large seeded species. For example, blue grama has approximately 700,000 seeds per pound, while Indian ricegrass has approximately 175,000 seeds per pound. If seeding rates were calculated simply on the basis of weight per unit area, without recognizing the fact that a pound of blue grama seed has four times the number of seeds per pound as Indian ricegrass, it would be very easy to over plant blue grama and under plant Indian ricegrass.

Table D.1. Species and Seeding Rates Proposed for ET Cover at the Mill Site

Scientific Name	Common Name	Varietal Name	Native/ Introduced	Seeding Rate (lbs PLS/acre)†	Seeding Rate (# seeds/ft^2)
Grasses					
Pascopyrum smithii	Western wheatgrass	Arriba	Native	3.0	7.9
Pseudoroegneria spicata	Bluebunch wheatgrass	Goldar	Native	3.0	9.6
Elymus trachycaulus	Slender wheatgrass	San Luis	Native	2.0	6.2
Elymus lanceolatus	Streambank wheatgrass	Sodar	Native	2.0	7.3
Elymus elymoides	Squirreltail	Toe Jam	Native	2.0	8.8
Thinopyrum intermedium	Pubescent wheatgrass	Luna	Introduced‡	1.0	1.8
Achnatherum hymenoides	Indian ricegrass	Paloma	Native	4.0	14.7
Poa secunda	Sandberg bluegrass	Canbar	Native	0.5	11.4
Festuca ovina	Sheep fescue	Covar	Introduced‡	1.0	11.5
Bouteloua gracilis	Blue grama	Hachita	Native	1.0	16.5
Hilaria jamesii	Galleta	Viva	Native	2.0	7.3
Forbs					

Scientific Name	Common Name	Varietal Name	Native/ Introduced	Seeding Rate (lbs PLS/acre)†	Seeding Rate (# seeds/ft^2)
Achillea millefolium, variety occidentalis	Common yarrow	VNS*	Native	0.5	32
Artemisia ludoviciana	White sage	VNS	Native	0.5	45
Shrubs					
Atriplex canescens	Fourwing saltbush	Wytana	Native	3.0	3.4
Ericameria nauseosus	Rubber rabbitbrush	VNS	Native	0.5	4.6
Total				26.5	188

†Seeding rate is for broadcast seed and presented as pounds of pure live seed per acre (lbs PLS/acre).
‡Introduced refers to species that have been 'introduced' from another geographic region, typically outside of North America. Also referred to as 'exotic' species. *VNS=Variety Not Specified but seed source would be designated from sites similar to the Mill site.

Seeding rate may be calculated from an expected field emergence for each species and the desired number of plants per unit area. For purposes of calculation, field emergence for small seeded grasses and forbs is assumed to be around 50 percent if germination is greater than 80 percent. Field emergence is assumed to be around 30 percent if germination is between 60 and 80 percent. The Natural Resource Conservation Service recommends a seeding rate of 20 to 30 pure live seeds per square foot as a minimum number of seeds when drill seeding single species in areas with an annual precipitation between 6 and 18 inches. Twenty pure live seeds per square foot, with an expected field emergence of 50 percent should produce an adequate number of plants on the seeded area to control erosion and suppress annual invasion. This seeding rate is primarily for favorable growing conditions, soils that are not extreme in texture, gentle slopes, north or east facing aspect, good moisture, adequate soil nutrients and single species vs. multiple species in a mixture. When conditions are less favorable when the seed is broadcast, or when multiple species are in a mixture the seeding rates are increased.

A Quality Assurance/Quality Control Plan for application rates and procedures for confirming that specified application rates are achieved is as follows. The first step begins with a seed order. Seed would be purchased as pounds of pure live seed. Each State has a seed certifying agency and certification programs may be adopted by seed growers. Certification of a container of seed assures the customer that the seed is correctly identified and genetically pure. The State agency responsible for seed certification sets minimum standards for mechanical purity and germination for each species of seed. When certified, a container of seed must be labeled as to origin, germination percentage, date of the germination test, percentage of pure seed (by weight), other crop and weed seeds, and inert material. The certification is the consumer's best guarantee that the seed being purchased meets minimum standards and the quality specified.

Once the seed is obtained, seed labels would be checked to determine the percent PLS and the date that the seed was tested for percent purity and percent germination. If the test date is greater than 6 months old, the seed would be tested again before being accepted. Seed will be applied using a broadcasting method. This procedure would use a centrifugal type broadcaster (or similar implement)), also called an end-gate seeder. These broadcasters operate with an electric motor and are usually mounted on the back of a small tractor and generally have an effective spreading width of about 20 feet or more. Prior to seeding, a known area will be covered with a tarp and seed will be distributed using the broadcaster and simulating conditions that would exist under actual seeding conditions. Seed will then be collected and weighed to determine actual seeding rate in terms of pounds per acre. This process will be repeated until the specified seeding rate is obtained. During the seeding process, the seeding rate will be verified at least once by comparing pounds of seed applied to the size of the area seeded. In addition, seed will be applied in two separate passes. One-half of the seed will be spread in one direction and the other half of seed will be spread in a perpendicular direction. This will ensure that seed distribution across the site is highly uniform and also provide the opportunity to adjust the seeding rate if the specified rate is not being achieved.

D.4 ECOLOGICAL CHARACTERISTICS OF PROPOSED SPECIES AND ESTABLISHED PLANT COMMUNITY

D.4.1 Ecological Characteristics of Plant Species of Tailings Cover System

Important ecological characteristics for each species proposed for reclamation are provided in the paragraphs that follow. Species information was obtained from a number of references that are cited below. The proposed species are adapted to the elevation (5,600 feet), precipitation (13 inches per year on average), and soil textural ranges (loam to sandy clay) that are well within the environmental conditions of the Mill site. Table D.2 presents a summary of the ecological characteristics discussed in the following paragraphs.

Western wheatgrass, variety Arriba (*Pascopyrum smithii*) – Western wheatgrass is a native, rhizomatous, long-lived perennial cool season grass. It grows well in a 10- to 14-inch mean annual precipitation zone and is adapted to a wide range of soil textural classes at elevation ranges up to 9,000 feet. Western wheatgrass has been an important species for restoring mining related disturbances, for erosion control and for critical area stabilization in semi-arid regions because of its ease of establishment and ability to grow successfully in pure or mixed stands of both warm and cool season species. Western wheatgrass is fire tolerant and regenerates readily following burning. The variety of Arriba is known for rapidly establishing seedlings and high seed production. The combination of its ability to spread vegetatively and reproduce by seed ensures long-term sustainability of this species.

Bluebunch wheatgrass, variety Goldar (*Pseudoroegneria spicata*) – Bluebunch wheatgrass is a native, cool season perennial bunch grass. Bluebunch wheatgrass grows on soils that vary in texture, depth and parent material. It is one of the most important and productive grasses found in sagebrush communities in the intermountain west. Bluebunch wheatgrass is fire tolerant and regenerates vegetatively following burning. This species is well adapted to a 12- to 14-inch mean annual precipitation range and is considered to be highly drought resistant. Bluebunch wheatgrass performs well in mixtures with other species and grows at elevations up to 10,000 feet.

Slender wheatgrass, variety San Luis (*Elymus trachycaulus*) – Slender wheatgrass is a native, cool season, perennial bunch grass that occasional produces rhizomes. It is a short-lived species (5 to 10 years) but it reseeds and spreads well by natural seeding, exceeding most other wheatgrasses in this characteristic. Slender wheatgrass can serve as an important pioneer species; its seedlings are vigorous and capable of establishing on harsh sites. In addition, it is able to establish and compete with weedy species. Slender wheatgrass is commonly seeded in mixtures with other grasses and forbs to restore disturbances and rehabilitate native communities. It is adapted to a wide variety of sites and is moderately drought tolerant. It performs best at sites with an annual precipitation of 15 inches or more, but can grow on sites with precipitation levels as low as 13 inches.

Table D.2. Summary of Ecological Characteristics of Plant Species Proposed for the ET Cover at the Mill Site

Species	Origin	Annual or Perennial	Method of Spread	Ease of Establishment[a]	Compatibility with Other Species[a]	Longevity[a]	Annual Precipitation Range (inches)	Elevation Range (feet)	Soil Texture[b]	Rooting Depth (cm)	Soil Stabilization[a]	Drought Tolerance[a]	Fire Tolerance[a]
Western wheatgrass	Native	Perennial	Vegetative	4	3	4	10-14	≤9,000	S,C,L	109[d]	4	4	4
Bluebunch wheatgrass	Native	Perennial	Seed	4	4	4	12-14	≤10,000	S,C,L	122[e]	4	4	4
Slender wheatgrass	Native	Perennial	Seed	4	4	2	13-18	≤10,000	S,C,L	109[d]	2	2	2
Streambank wheatgrass	Native	Perennial	Vegetative	4	4	4	11-18	≤10,000	S,C,L	165[f]	4	4	3
Pubescent wheatgrass	Introduced	Perennial	Vegetative	4	2	4	12-18	≤10,000	S,C,L	185[d]	4	4	3
Indian ricegrass	Native	Perennial	Seed	3	4	4	6-16	≤10,000	S,L	84[g]	2	4	2
Sandberg bluegrass	Native	Perennial	Seed	4	4	4	12-18	≤12,000	S,C,L	45[h]	2	3	4
Sheep fescue	Introduced	Perennial	Seed	4	2	4	10-14	≤11,000	S,C, L	56[e]	3	4	2
Squirreltail	Native	Perennial	Seed	3	4	3	8-15	≤11,000	S,C,L	30[c,i]	2	4	3
Blue grama	Native	Perennial	Vegetative	2	4	4	10-16	≤10,000	S,L	119[g]	4	4	4
Galleta	Native	Perennial	Vegetative	3	4	4	6-18	≤8,000	S,C,L	30[j]	4	4	4
Common yarrow	Native	Perennial	Vegetative	4	3	4	13-18	≤11,000	S,C,L	105[h]	4	3	2
White sage	Native	Perennial	Vegetative	4	4	4	12-18	≥5,000	S,C,L	20[c,i]	3	3	2
Fourwing saltbush	Native	Perennial	Seed	4	4	4	8-14	≤8,000	S,L	600[j]	4	4	1
Rubber rabbitbrush	Native	Perennial	Seed	4	4	4	7-18	≤9,000	S,C,L	150[k]	4	4	1

[a]Key to Ratings—4 = Excellent, 3 = Good, 2 = Fair, 1 = Poor
[b]Soil Texture Codes—S = Sand, C = Clay, L = Loam
[c]Depth represents minimum depth; no information in the literature on average or maximum depth could be found.
[d]Wyatt et al., 1980.
[e]Weaver and Clements, 1938.
[f]Coupland and Johnson, 1965.
[g]Foxx and Tierney, 1987.
[h]Spence, 1937.
[i]USDA, 2012.
[j]Gibbens and Lenz 2001
[k]Monsen et al., 2004.

Streambank wheatgrass, variety Sodar (*Elymus lanceolatus* ssp. *psammophilus*) – Streambank wheatgrass is considered to be part of the thickspike wheatgrass (*Elymus lanceolatus* ssp. *lanceolatus*) taxa. Variety Sodar is a native, perennial sod grass that is highly rhizomatous and adapted to the western intermountain area. It is highly drought tolerant and performs well in mean annual precipitation ranges between 11 and 18 inches. It grows on a wide range of soil textures, from sandy to clayey. Streambank wheatgrass is commonly used in mine land reclamation and is best known for its ability to control erosion and compete with annual weeds. Its highly rhizomatous nature ensures long-term sustainability of this species.

Pubescent wheatgrass, variety Luna (*Thinopyrum intermedium* ssp. *barbulatum*) – Pubescent wheatgrass is a long-lived sod forming perennial introduced from Eurasia. It is highly drought tolerant and grows where the mean annual precipitation is 12 inches or more. It is adapted to a wide range of soil textures, from sand to clay. Pubescent wheatgrass is a highly persistent species, should be seeded at low densities to avoid competition with native species.

Indian ricegrass, variety Paloma (*Achnatherum hymenoides*) – Indian ricegrass is a native, cool season, perennial bunchgrass with a highly fibrous root system. Indian ricegrass is one of the most common grasses on semi-arid lands in the west and is one of the most drought tolerant species used in mine land reclamation. It generally occurs on sandy soils, but is found on soils ranging from sandy to heavy clays. It grows from 2,000 to 10,000 feet in areas where the mean annual precipitation is 6 to 16 inches. Indian ricegrass is slow to establish, but highly persistent once it becomes established.

Sandberg bluegrass, variety Canbar (*Poa secunda*) – Sandberg bluegrass is a native, cool season perennial bunchgrass that is adapted to all soil textures and is highly resistant to fire damage. Sandberg bluegrass is one of the more common early-season bunchgrasses in the Intermountain area. It grows at elevations from 1,000 to 12,000 feet and can be successfully established in areas with a mean annual precipitation of 12 inches or more. Established plants are not overly competitive, and therefore highly compatible with other native species.

Sheep fescue, variety Covar (*Festuca ovina*) – Sheep fescue is a short, mat-forming introduced perennial that grows well on infertile soils in areas with a mean annual precipitation of 10 to 14 inches. It is long-lived and highly drought tolerant. Sheep fescue is a cool season species that greens up early in the spring. The proposed variety, Covar, was introduced from Turkey and is commonly used in mine land reclamation for long-term stabilization and erosion control. This variety was selected because plants are persistent, winter hardy, and drought tolerant.

Squirreltail, variety Toe Jam Creek (*Elymus elymoides*) – Squirreltail is a short-lived perennial that is selected for its ability to establish quickly and to effectively compete with undesirable annual grasses. It grows along an elevation range from 2,000 to 11,000 feet and on all soil textures in mean annual precipitations zones of 8 to 15 inches. Squirreltail is fairly tolerant of fire because of its small size.

Blue grama, variety Hachita (*Bouteloua gracilis*) – Blue grama is a low-growing perennial warm season bunchgrass. Blue grama produces an efficient, widely spreading root system that is mostly concentrated near the soil surface. Blue grama is adapted to a variety of soil types, but does best on well-drained soils and once established, is highly drought tolerant. This species is commonly found with cool-season species and is highly compatible with other native perennials.

Galleta, variety Viva (*Hilaria jamesii*) – Galleta is a strongly rhizomatous perennial warm season grass with a dense, fibrous root system. Galleta grows on sits receiving 6 to 18 inches of annual precipitation with soils ranging from coarse to fine. Plants have a low requirement for soil fertility and are drought and fire tolerant.

Common yarrow (*Achillea millefolium, var. occidentalis*) – Yarrow is a common native forb species that is rhizomatous and found growing from valley bottoms to timberline. It is commonly used in mine land reclamation, establishes easily from seed and is highly persistent. It grows on a variety of soil textures and found in a mean annual precipitation range between 13 and 18 inches. If seed is not available for *Achillea millefolium* var. *occidentalis*, then the introduced *Achillea millefolium* would be used, which has the same growth characteristics as the native form.

White sage, variety Summit (*Artemisia ludoviciana*) – White sage is considered to be a pioneer rhizomatous forb species that establishes quickly on disturbed sites and is highly compatible with perennial grasses. It does best on well-drained soils, but can be found growing on a wide range of soil textures. It is adapted to sites above 5,000 feet in elevation and to sites with a mean annual precipitation above 12 inches.

Fourwing saltbush, variety Wytana (*Atriplex canescens*) – Fourwing saltbush can be deciduous or evergreen, depending on climate. Its much-branched stems are stout and mature plants range from 1 to 8 feet in height, depending on ecotype, the soil, and climate. Fourwing saltbush is one of the most widely distributed and important native shrubs on rangelands in the western United States. Fourwing saltbush is highly palatable browse and is utilized primarily in the winter at which time it is high in carotene and digestible protein. Fourwing saltbush provides excellent season long browse for deer. It is a good browse plant for antelope and elk in fall and winter. It is also a food source and excellent cover for upland birds. Fourwing saltbush has excellent drought tolerance. Fourwing saltbush is adapted to most soils but is best suited to loamy to sandy to gravely soils. It is not especially tolerant of fire, but may re-sprout to some degree if fire intensity is not too severe. Fourwing saltbush occurs most commonly in salt-desert scrub communities in the desert areas of western North America in areas that receive 8 to 14 inches of annual precipitation. It can be found from sea level in Texas to over 8,000 feet in Wyoming.

Rubber rabbitbrush (*Ericameria nauseosus*) – Rubber rabbitbrush is a native, perennial, warm-season shrub that grows to 1 to 8 feet tall. Rubber rabbitbrush is an important browse species for wildlife during the winter months. Rubber rabbitbrush occurs as a dominant to minor component in many plant communities, ranging from arid rangelands to montane openings. It thrives in poor conditions, and can tolerate coarse, alkaline soils. Dense stands are often found on degraded rangelands, along roadsides, and in abandoned agricultural fields. The species is useful in soil stabilization and restoration of disturbed sites. The root system establishes quickly and plants produce large quantities of leaf litter. Rubber rabbitbrush is adapted to cold, dry environments receiving 7 to 18 inches of annual precipitation at elevations ranging from 450 to 8,000 feet. Depending on the ecotype, rubber rabbitbrush can be found on loamy, sandy, gravelly or heavy clay soils that are slightly acidic, slight to strongly basic, or saline.

D.4.2 Longevity and Sustainability

All of the species proposed for reclamation of the tailings cells are long-lived, except for slender wheatgrass (*Elymus trachycaulus*) and squirreltail (*Elymus elymoides*). Slender wheatgrass is a perennial bunchgrass that is short-lived (5 to 10 years) but has the ability to reseed and spread vegetatively with rhizomes. Squirreltail is also a short-lived perennial but has the ability to establish quickly and is highly effective in competing with undesirable annual grasses. Both of these species are included in the proposed seed mixture because of their ability to provide quick cover for erosion protection and to effectively compete with annual and biennial species that cannot be relied upon to provide consistent and sustainable plant cover. The use of these species will facilitate the establishment of the remaining long-lived perennials that have been documented to be highly adapted to the elevation, climate, and soil conditions found at the Mill site (Monsen et al., 2004; Alderson and Sharp, 1994; Wasser, 1982; Thornburg, 1982).

The perennial grasses, forbs, and shrubs in the proposed seed mixture include species that develop individual plants that are long lived (30 years or more) and are able to reproduce either by seed or vegetative plant parts like rhizomes and tillers. The use of these species in reclamation of the tailings cells will ensure a permanent or sustainable plant cover because of the highly adapted nature of these species to site conditions, their tolerance to environmental stresses such as drought, fire, and herbivory, and their ability to effectively reproduce over time.

The use of a mixture of species for the ET cover also contributes to longevity and sustainability. The establishment of a diverse community has many advantages over a monoculture for sustained plant growth. The use of a variety of species ensures that diverse microsites that may exist over a seeded site are properly matched with species that are adapted to those specific environmental conditions. In addition, a mixture of species reverses the loss of plant diversity and enhances natural recovery processes following impacts from insects, disease organisms, and adverse or changes in climatic conditions. Finally, mixtures provide improved ground cover and surface stability, along with reducing weed invasion by fully utilizing plant resources such as water, nutrients, sunlight and space. Weeds in this context are typically annual or biennial plants considered to be undesirable, especially growing where they are not wanted.

D.4.3 Compatibility

Reclamation research and its application have been ongoing in the U.S. since the early 1900s. First with the reseeding of millions of acres following the dust bowl of the 1930s. Then, improvements of large tracts of arid and semi-arid rangelands between the 1960s and 1980s following more than a half a century of rangeland exploitation through overgrazing. In 1985 the U.S. Department of Agriculture Conservation Reserve Program was implemented which resulted in the conversion of more than 40 million acres of marginal farm land to permanent grasslands through an extensive seeding program. Finally, there have been tens of thousands of acres of mined lands reclaimed across the U.S. with the implementation of federal and state rules and regulations governing mine land reclamation. Over this time period, there have been thousands of reclamation publications in the form of books, scientific journal articles, symposium proceedings, and government publications. Many publications have reported on the performance of individual species and mixtures of species under semi-arid conditions similar to southeastern Utah (e.g., Plummer et al., 1968; Monsen et al., 2004). All of this work has led to a knowledge base about species compatibility. Species that are seeded together in mixtures must be compatible as young, developing plants or certain individuals will succeed and others will fail. The species proposed for the ET cover at the Mill site are all compatible with each other and seeding rates will be used to prevent overseeding species that may be aggressive [e.g., pubescent wheatgrass (*Thinopyrum intermedium*)] and could potentially dominate the site (Monsen et al., 2004). These species are commonly seeded together and many studies have shown excellent interspecies compatibility (e.g., DePuit et al., 1978; DePuit, 1982; Redente et al., 1984; Sydnor and Redente, 2000; Newman and Redente, 2001). Finally, to increase compatibility and to reduce competition among seeded species, sites would be broadcast seeded as opposed to drill seeded. According to Monsen et al. (2004), drill seeding causes species in a mixture to be placed in potentially competitive situations, while broadcasted seeds are not placed in as close contact with each other as with drilling and therefore are less likely to be negatively impacted from competition.

D.4.4 Competition

There are two ways to view competition. In the context of establishing an ET cover on the tailings cells, the use of seeded species to compete with weeds is a desirable attribute. However, competition among seeded species with the potential loss of any of these species is undesirable. Therefore, as stated earlier, the proposed seed mixtures is comprised of species that can coexist and also fully utilize plant resources to minimize weed species establishment and excluding seeded species. The establishment of weeds, especially invasives (i.e., non-native species whose introduction causes economic and environmental harm) is unacceptable because of the potential loss of seeded perennial species and the subsequent reduction in species diversity, plant cover, and overall sustainability. Once established, the proposed seed mixture will produce a grass-forb-shrub community of highly adapted and productive species that will effectively compete with undesirable species.

D.4.5 Plant Cover

Monitoring of an alternative cover at the Monticello, Utah, Uranium Mill Tailings Disposal Site showed that the plant cover performed well over a seven year period. Plant cover ranged from 5.5 percent during the first growing season to nearly 46 percent in the seventh growing season (Waugh et al., 2008). Using results from the 2007 vegetation monitoring report (DOE, 2008) the following contributions to relative cover were reported showing that 6 of the 16 species seeded provided 70 percent or more of the cover when cover differences between reclamation zones is averaged: big sagebrush—5 percent to 10 percent; rubber rabbitbrush—5.3 percent to 17 percent; western wheatgrass—38.6 percent; cicer milkvetch—11 percent; thickspike wheatgrass—7.2 percent; and globemallow—0.1 to 0.2 percent.

Approximately 40 percent of the species proposed for the Mill site were seeded at Monticello and of the six best-performing species, three of these species are in the White Mesa mixture (i.e. *Pascopyrum smithii, Elymus lanceolatus,* and *Ericameria nauseosus*). Highly competitive species used at Monticello that are not proposed for White Mesa include three introduced species (i.e. smooth brome, crested wheatgrass, and alfalfa) that were not considered acceptable for the Mill site. Based on these results and the similarity in environmental conditions between Monticello and White Mesa, a plant cover estimate of 40 percent was determined to be a reasonable estimate for a long-term average, while a percent plant cover of 30 percent was assigned as a reduced performance scenario. The percent vegetative cover at White Mesa is expected to be slightly less than what would be found at Monticello because the average annual precipitation at White Mesa is approximately 13 inches compared to 15 inches at Monticello and the average annual maximum/minimum air temperatures are 64/37°F for White Mesa and 59/33°F for Monticello. The slightly greater precipitation and lower temperatures at Monticello are due to its slightly higher elevation of 7,000 feet compared to 5,600 feet at White Mesa.

A map of current vegetation at the Mill site does not exist. The most recent mapping of vegetation at the Mill site was conducted by Dames and Moore in 1977 (Dames and Moore 1978) as part of the Environmental Report for the White Mesa Uranium Project. In 1977, the major mapping units for the project site were: big sagebrush (232 acres), controlled big sagebrush (567 acres), and reseeded grassland (369 acres). In June 2012 the area surrounding the Mill site was surveyed for plant community composition and cover in response to Interrogatory 11/1: Vegetation and Biointrusion Evaluation and Revegetation Plan of DRC (2012). There are two principal plant community types in the vicinity of the Mill site. These plant communities are Big Sagebrush shrubland and Juniper woodland. The Dames and Moore Environmental Report (1978) classified the Juniper woodland as a Pinyon-Juniper community type, but the primary tree species is Utah juniper (*Juniperus osteosperma*) and the presence of pinyon pine (*Pinus edulis*) is so infrequent that the community may be more appropriately classified as a Juniper woodland. In addition to these two principal plant community types, there are a number of disturbed areas that are in different stages of successional development and reflect past disturbances such as sagebrush removal (chaining and plowing) and seeding and intense grazing as evidenced by a complete lack of any understory species in some areas. The vegetation survey conducted in 2012 provides information of species that exist on the Mill site and their relative importance in terms of plant cover. All areas surveyed in 2012 show that big sagebrush (*Artemisia tridentata*) is the dominant species and subdominants are either broom snakeweed (*Gutierrezia sarothroae*) or galleta (*Hilaria jamesii*). If the area were re-mapped, most of the site would map as Big Sagebrush association. It appears that areas that were reseeded to crested wheatgrass and areas where controlled measures were applied to remove big sagebrush have returned to big sagebrush following seeding and/or control measures implemented sometime prior to 1978.

The Big Sagebrush shrubland is dominated by big sagebrush (*Artemisia tridentata*) with interspersed shrubs of broom snakeweed (*Gutierrezia sarothroae*) pale desert-thorn (*Lycium pallidum* var. *pallidum*), and rubber rabbitbrush (*Ericameria nauseosa*). The understory is mostly grasses with an infrequent occurrence of forbs. The grasses include galleta (*Hilaria jamesii*), squirreltail (*Elymus elymoides*), Indian ricegrass (*Achnatherum hymenoides*), and cheatgrass (*Bromus tectorum*). Forb species include scarlet globemallow (*Sphaeralcea coccinea*), lesser rushy milkvetch (*Astragalus convallarius*), and Russian thistle (*Salsola kali*).

The Juniper woodland occurs on shallow soils along the canyon rim to the east and west of the site. It is highly unlikely that this community type would expand its range into the deep, very fine sandy loam soil that occurs on the Mill site, which is the primary soil type supporting the Big Sagebrush shrubland. The vegetation sampling that was conducted in 2012 focused on the Big Sagebrush community and did not include the Juniper woodland because of the unlikely probability that this community type would ever establish on the Mill site or tailings cell cover system. A reconnaissance level survey was conducted in the Juniper community to observe both plant and animal species that occupy these areas.

D.4.6 2012 Plant Survey

The big sagebrush community type within the White Mesa Control Area to the north, south, and west of the restricted area of the mill and tailings facilities was surveyed using randomly placed transects and estimating cover by species using a point intercept sampling method (see Figure D.1). Along each 100 m long transect, live plant cover by species was determined by lowering a pin at 1 meter intervals and recording the plant species or ground cover (litter and bareground) that intersected the point. A total of 10 transects were sampled in each of the areas to the north, south and west of the mill and tailings cells. Table D.3 presents a summary of the vegetation survey conducted in the areas surrounding the mill and tailings cells. Tables D.4 through D.33 present plant cover data by transect for each of the three areas sampled in 2012.

Table D.3. Average Plant and Ground Cover from June 2012 Sampling in Areas Surrounding the Mill Site

Site and Plant Species	% Cover
North of Mill	
o Big sagebrush (*Artemisia tridentata*)	19.1
o Broom snakeweed (*Gutierrezia sarothroae*)	3.9
o Rubber rabbitbrush (*Ericameria nauseosa*).	0.2
o Palm desert-thorn (*Lycium pallidum* var. *pallidum*)	0.1
o Galleta (*Hilaria jaamesii*)	3.6
o Squirreltail (*Elymus elymoides*)	0.1
o Indian ricegrass (*Achnatherum hymenoides*)	0.1
o Cheatgrass (*Bromus tectorum*)	9.5
o Scarlet globemallow (*Sphaeralcea coccinea*)	0.1
o Lesser rushy milkvetch (*Astragalus convallarius*)	0.1
o Russian thistle (*Salsola kali*)	0.6
Total Live Cover	37.4
Total Litter Cover	9.7
Total Bareground	53.1
South of Mill	
o Big sagebrush (*Artemisia tridentata*)	18.3
o Broom snakeweed (*Gutierrezia sarothroae*)	3.0
o Galleta (*Hilaria jaamesii*)	8.5
o Squirreltail (*Elymus elymoides*)	0.3
o Indian ricegrass (*Achnatherum hymenoides*)	0.1
o Cheatgrass (*Bromus tectorum*)	6.7
o Scarlet globemallow (*Sphaeralcea coccinea*)	0.1
o Russian thistle (*Salsola kali*)	1.4
Total Live Cover	38.4
Total Litter Cover	13.4
Total Bareground	48.2
West of Mill	
o Big sagebrush (*Artemisia tridentata*)	20.5
o Broom snakeweed (*Gutierrezia sarothroae*)	4.4
o Pale desert-thorn (*Lycium pallidum* var. *pallidum*)	0.1
o Galleta (*Hilaria jaamesii*)	6.6
o Squirreltail (*Elymus elymoides*)	0.1
o Indian ricegrass (*Achnatherum hymenoides*)	0.1
o Cheatgrass (*Bromus tectorum*)	5.3
o Scarlet globemallow (*Sphaeralcea coccinea*)	0.1
o Russian thistle (*Salsola kali*)	0.8
Total Live Cover	37.9
Total Litter Cover	16.1
Total Bareground	46.0

Results from the 2012 sampling of the Big Sagebrush community surrounding the Mill site showed a mean live plant cover of 37.8 percent after averaging live plant cover estimated in areas north, south and west of the Mill site (Table D.3). This plant cover included an average of 23.1 percent cover for shrubs, 13.7 percent cover for grasses, and 1.0 percent cover for forbs. In addition, the average percent litter was 13.1 percent and bareground averaged 49.1 percent. These cover estimates are somewhat greater than the cover values reported in Dames and Moore Environmental Report (1978). In the Environmental Report, the average live plant cover in the Big Sagebrush community was 33.3 percent. This cover included an average of 19.4 percent for shrubs and 13.8 percent for grasses. Litter was estimated at 16.9 percent and bareground was 49.9 percent. Annual precipitation in 1977 was 23.6 cm compared to a long-term average of 29.7 cm (Dames and Moore 1978). In addition, monthly precipitation during the period May-September 1978 totaled 3.8 cm compared to a long-term average of 12.5 cm for the same period. Considering the fact that the areas sampled are currently grazed, it is highly likely that a cover of 40 percent can be achieved and maintained on the tailings cell cover system for conditions that exclude grazing by livestock. The formation of desert pavement and potential impact on plant cover has been raised as an issue for discussion. Desert pavements are armored surfaces composed of angular or rounded rock fragments, usually 2 to 3 cm thick, set on or in a matrix of finer material (Cooke and Warren, 1973). These surfaces form on arid soils through deflation of fine material by wind or water erosion due to a lack of protection by surface vegetation (Cooke and Warren, 1973). Desert pavements are not common in semi-arid regions and do not occur where either wind or water erosion are controlled by plant cover (Hendricks, 1991), as would be the case for the White Mesa cover system. In addition, there is no evidence of desert pavement formation either on the Mill site or areas surrounding the site (which was confirmed during the 2012 plant survey). Even with the use of a topsoil layer amended with gravel, there is no supporting evidence to indicate a potential for desert pavement formation or an associated decrease in plant cover over the long term.

Table D.4. Plant cover data collected in 2012 north of the Mill site on Transect #1

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	20
Broom snakeweed (*Gutierrezia sarothroae*)	7
Galleta (*Hilaria jaamesii*)	6
Cheatgrass (*Bromus tectorum*)	13
Russian thistle (*Salsola kali*)	1
Litter	8
Bareground	45
Total Live Cover	47

Table D.5. Plant cover data collected in 2012 north of the Mill Site on Transect #2

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	28
Broom snakeweed (*Gutierrezia sarothroae*)	9
Rubber rabbitbrush (*Ericameria nauseosa*).	1
Galleta (*Hilaria jaamesii*)	2
Cheatgrass (*Bromus tectorum*)	8
Scarlet globemallow (*Sphaeralcea coccinea*)	1
Russian thistle (*Salsola kali*)	1
Litter	11
Bareground	39
Total Live Cover	50

Table D.6. Plant cover data collected in 2012 north of the Mill site on Transect #3

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	13
Rubber rabbitbrush (*Ericameria nauseosa*).	1
Galleta (*Hilaria jaamesii*)	6
Cheatgrass (*Bromus tectorum*)	9
Litter	7
Bareground	63
Total Live Cover	30

Table D.7. Plant cover data collected in 2012 north of the Mill site on Transect #4

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	27
Galleta (*Hilaria jaamesii*)	3
Cheatgrass (*Bromus tectorum*)	13
Russian thistle (*Salsola kali*)	2
Litter	8
Bareground	47
Total Live Cover	45

Table D.8. Plant cover data collected in 2012 north of the Mill site on Transect #5

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	31
Broom snakeweed (*Gutierrezia sarothroae*)	8
Indian ricegrass (*Achnatherum hymenoides*)	1
Lesser rushy milkvetch (*Astragalus convallarius*)	1
Russian thistle (*Salsola kali*)	1
Litter	9
Bareground	49
Total Live Cover	42

Table D.9. Plant cover data collected in 2012 north of the Mill site on Transect #6

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	6
Broom snakeweed (*Gutierrezia sarothroae*)	6
Squirreltail (*Elymus elymoides*)	1
Cheatgrass (*Bromus tectorum*)	9
Russian thistle (*Salsola kali*)	1
Litter	6
Bareground	71
Total Live Cover	23

Table D.10. Plant cover data collected in 2012 north of the Mill site on Transect #7

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	8
Broom snakeweed (*Gutierrezia sarothroae*)	6
Galleta (*Hilaria jaamesii*)	4
Cheatgrass (*Bromus tectorum*)	7
Litter	12
Bareground	63
Total Live Cover	25

Table D.11. Plant cover data collected in 2012 north of the Mill site on Transect #8

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	29
Galleta (*Hilaria jaamesii*)	11
Cheatgrass (*Bromus tectorum*)	14
Litter	14
Bareground	32
Total Live Cover	54

Table D.12. Plant cover data collected in 2012 north of the Mill site on Transect #9

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	4
Broom snakeweed (*Gutierrezia sarothroae*)	2
Indian ricegrass (*Achnatherum hymenoides*)	1
Galleta (*Hilaria jaamesii*)	4
Cheatgrass (*Bromus tectorum*)	6
Litter	9
Bareground	74
Total Live Cover	17

Table D.13. Plant cover data collected in 2012 north of the Mill site on Transect #10

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	24
Palm desert-thorn (*Lycium pallidum* var. *pallidum*)	1
Cheatgrass (*Bromus tectorum*)	16
Litter	13
Bareground	46
Total Live Cover	41

Table D.14. Plant cover data collected in 2012 south of the Mill site on Transect #1

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	12
Broom snakeweed (*Gutierrezia sarothroae*)	4
Galleta (*Hilaria jaamesii*)	7
Cheatgrass (*Bromus tectorum*)	12
Russian thistle (*Salsola kali*)	3
Litter	14
Bareground	48
Total Live Cover	38

Table D.15. Plant cover data collected in 2012 south of the Mill site on Transect #2

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	15
Broom snakeweed (*Gutierrezia sarothroae*)	
Galleta (*Hilaria jaamesii*)	17
Cheatgrass (*Bromus tectorum*)	7
Russian thistle (*Salsola kali*)	2
Litter	19
Bareground	40
Total Live Cover	41

Table D.16. Plant cover data collected in 2012 south of the Mill site on Transect #3

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	14
Rubber rabbitbrush (*Ericameria nauseosa*).	7
Galleta (*Hilaria jaamesii*)	8
Scarlet globemallow (*Sphaeralcea coccinea*)	1
Cheatgrass (*Bromus tectorum*)	6
Russian thistle (*Salsola kali*)	2
Litter	16
Bareground	46
Total Live Cover	38

Table D.17. Plant cover data collected in 2012 south of the Mill site on Transect #4

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	28
Galleta (*Hilaria jaamesii*)	4
Indian ricegrass (*Achnatherum hymenoides*)	1
Cheatgrass (*Bromus tectorum*)	1
Russian thistle (*Salsola kali*)	1
Litter	17
Bareground	48
Total Live Cover	35

Table D.18. Plant cover data collected in 2012 south of the Mill site on Transect #5

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	6
Galleta (*Hilaria jaamesii*)	6
Squirreltail (*Elymus elymoides*)	3
Cheatgrass (*Bromus tectorum*)	11
Litter	14
Bareground	60
Total Live Cover	26

Table D.19. Plant cover data collected in 2012 south of the Mill site on Transect #6

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	26
Broom snakeweed (*Gutierrezia sarothroae*)	8
Galleta (*Hilaria jaamesii*)	8
Cheatgrass (*Bromus tectorum*)	5
Litter	8
Bareground	45
Total Live Cover	47

Table D.20. Plant cover data collected in 2012 south of the Mill site on Transect #7

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	23
Cheatgrass (*Bromus tectorum*)	6
Russian thistle (*Salsola kali*)	3
Litter	12
Bareground	56
Total Live Cover	32

Table D.21. Plant cover data collected in 2012 south of the Mill site on Transect #8

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	13
Galleta (*Hilaria jaamesii*)	13
Cheatgrass (*Bromus tectorum*)	11
Russian thistle (*Salsola kali*)	3
Litter	16
Bareground	44
Total Live Cover	40

Table D.22. Plant cover data collected in 2012 south of the Mill site on Transect #9

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	18
Broom snakeweed (*Gutierrezia sarothroae*)	8
Galleta (*Hilaria jaamesii*)	9
Cheatgrass (*Bromus tectorum*)	2
Litter	14
Bareground	49
Total Live Cover	37

Table D.23. Plant cover data collected in 2012 south of the Mill site on Transect #10

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	29
Broom snakeweed (*Gutierrezia sarothroae*)	2
Galleta (*Hilaria jaamesii*)	13
Cheatgrass (*Bromus tectorum*)	6
Litter	4
Bareground	46
Total Live Cover	50

Table D.24. Plant cover data collected in 2012 west of the Mill site on Transect #1

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	26
Broom snakeweed (*Gutierrezia sarothroae*)	6
Galleta (*Hilaria jaamesii*)	4
Cheatgrass (*Bromus tectorum*)	7
Litter	13
Bareground	44
Total Live Cover	43

Table D.25. Plant cover data collected in 2012 west of the Mill site on Transect #2

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	26
Galleta (*Hilaria jaamesii*)	9
Cheatgrass (*Bromus tectorum*)	1
Litter	18
Bareground	46
Total Live Cover	36

Table D.26. Plant cover data collected in 2012 west of the Mill site on Transect #3

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	9
Cheatgrass (*Bromus tectorum*)	11
Litter	23
Bareground	57
Total Live Cover	20

Table D.27 Plant cover data collected in 2012 west of the Mill site on Transect #4

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	33
Broom snakeweed (*Gutierrezia sarothroae*)	13
Galleta (*Hilaria jaamesii*)	7
Scarlet globemallow (*Sphaeralcea coccinea*)	1
Cheatgrass (*Bromus tectorum*)	4
Russian thistle (*Salsola kali*)	4
Litter	9
Bareground	39
Total Live Cover	62

Table D.28. Plant cover data collected in 2012 west of the Mill site on Transect #5

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	29
Galleta (*Hilaria jaamesii*)	6
Squirreltail (*Elymus elymoides*)	1
Cheatgrass (*Bromus tectorum*)	5
Russian thistle (*Salsola kali*)	2
Litter	14
Bareground	43
Total Live Cover	43

Table D.29. Plant cover data collected in 2012 west of the Mill site on Transect #6

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	12
Broom snakeweed (*Gutierrezia sarothroae*)	9
Indian ricegrass (*Achnatherum hymenoides*)	1
Cheatgrass (*Bromus tectorum*)	7
Russian thistle (*Salsola kali*)	2
Litter	17
Bareground	52
Total Live Cover	31

Table D.30. Plant cover data collected in 2012 west of the Mill site on Transect #7

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	14
Broom snakeweed (*Gutierrezia sarothroae*)	4
Galleta (*Hilaria jaamesii*)	14
Palm desert-thorn (*Lycium pallidum* var. *pallidum*)	1
Cheatgrass (*Bromus tectorum*)	6
Litter	14
Bareground	37
Total Live Cover	39

Table D.31. Plant cover data collected in 2012 west of the Mill site on Transect #8

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	22
Broom snakeweed (*Gutierrezia sarothroae*)	7
Cheatgrass (*Bromus tectorum*)	6
Litter	20
Bareground	45
Total Live Cover	35

Table D.32. Plant cover data collected in 2012 west of the Mill site on Transect #9

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	14
Broom snakeweed (*Gutierrezia sarothroae*)	2
Galleta (*Hilaria jaamesii*)	11
Cheatgrass (*Bromus tectorum*)	3
Litter	19
Bareground	51
Total Live Cover	30

Table D.33. Plant cover data collected in 2012 west of the Mill site on Transect #10

Species and Other Cover Categories	Percent Cover
Big sagebrush (*Artemisia tridentata*)	19
Broom snakeweed (*Gutierrezia sarothroae*)	3
Galleta (*Hilaria jaamesii*)	15
Cheatgrass (*Bromus tectorum*)	3
Litter	14
Bareground	46
Total Live Cover	40

D.4.7 Leaf Area Index

Monthly leaf area index (LAI) values were estimated for the proposed ET cover at the Mill site. Three primary publications were used to estimate monthly LAI for the ET cover, including: Groeneveld (1997), Scurlock et al. (2001), and Fang et al. (2008). Table D.34 presents a compilation of LAI values based on North American data sets that were focused on semi-arid herbaceous plant communities. Scurlock et al. (2001) presented mean LAI values for 15 biomes/land cover classes that included desert, grassland, and shrubland. Leaf Area Index data was a compilation of data from the literature and represented various data collection methods. Mean LAI values reported were 1.3 (S.D. 0.85) for desert, 2.6 (S.D. 3.0) for grassland, and 2.1 (S.D. 1.6) for shrubland. Fang et al. (2008) presented LAI data for various biomes using MODIS (Moderate Resolution Imaging Spectroradiometer). These authors reported monthly LAIs for grasslands and shrublands with peak values for shrubland reported at 1.5 and 1.0 for grasslands. Finally, Groeneveld (1997) conducted field measurements of LAI in Owens Valley, CA in 1983. He reported LAI values for individual grass and shrub species and reported the following values in November for big sagebrush and in July for the remaining species: big sagebrush LAI's ranged from 0.65 to 1.8; fourwing saltbush (*Atriplex canescens*) LAI's ranged from 1.2 to 4.7; shadscale saltbush (*Atriplex confertifolia*) LAI's ranged from 1.6 to 2.6; greasewood (*Sarcobatus vermiculatus*) LAI's ranged from 1.0 to 3.3; alkali sacaton (*Sporobolus airoides*) LAI's ranged from 0.38 to 4.0; and saltgrass (*Distichlis spicata*) LAI's ranged from 0.67 to 3.9. All of the data presented in these three papers was used to estimate an average monthly LAI for the revegetated cover system assuming a well-established plant community. A maximum LAI of 2.6 was selected for peak biomass in the month of September which matches the mean grassland LAI reported by Scurlock al. (2001) and well below values reported by Groeneveld (1997). Leaf Area Index values for the remaining months was then extrapolated from the peak month using monthly values presented by Fang et al. (2008). It is important to note that the proposed species for the ET cover include both cool- and warm-season species. This combination of species will maximize the length of the growing season and transpiration from early spring to late fall. Cool-season species are more productive and use more water during the cooler times of the growing season, while warm-season species are more productive and use more water during the warmest period of the year.

Table D.34. Leaf Area Index for the ET Cover at Mill Site

Month											
Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
0	0	0.3	0.7	0.6	0.6	1.8	2.4	2.6	0.8	0.1	0

D.4.8 Project Root Biomass for Infiltration Modeling

We have chosen to use root biomass data from a seeded site in Cheyenne, Wyoming that was seeded in the 1950s with root biomass data collected about 35 years after seeding (Redente et al. 1989). Data were collected as g/m^2 and will not be converted (Table D.35). Infiltration model uses a normalized root density function, so root measurement units are irrelevant. The climatic conditions between Blanding, Utah and Cheyenne, Wyoming are similar with Blanding receiving 34 cm of precipitation and Cheyenne receiving 36 cm. Potential evapotranspiration (PET) at Blanding is 122 cm and 115 cm in Cheyenne. Finally, the precipitation to PET ratio is 0.28 for Blanding and 0.31 for Cheyenne. Table D.35 presents both anticipated root biomass and reduced biomass that is calculated based on a 75 percent reduction in biomass that has been reported in long-term drought studies (Weaver and Albertson 1936).

Table D.35. Projected root biomass data for anticipated and reduced performance for use in infiltration modelling

Depth (cm)	Root Biomass (g/m^2) Anticipated Performance	Root Biomass (g/m^2) Reduced Performance†
0-5	160	64
5-10	140	49
10-20	76	23
20-60	125	32
60-100‡	52	2

†Based on an increasing percent reduction from 60% to 80% with depth, as extended drought or reduced precipitation with potential climate change would result in less deep infiltration and therefore greater negative effect on deeper roots compared to shallower roots. ‡Maximum rooting depth under the reduced performance scenario would be 68 cm.

D.5 BIOINTRUSION

D.5.1 Plant Intrusion

Table D.36 presents percent of root mass by depth for grass and shrub species that exist or may occur on the Mill site during the performance period. It is extremely important to recognize that the rooting depths for the shrubs do not reflect the rooting depths that are expected in the cover system but represent rooting depths reported in the literature with an effort to identify the maximum rooting depths reported. Detailed rooting depth studies are rare and the majority of studies do not report root mass by depth. The shrub values reported in Table D.36 represent extrapolations from the literature using the maximum rooting depths reported and following the general findings in the literature that the majority of root growth typically is in the upper 30 cm for grasses and the upper 60 cm for shrubs growing in semiarid regions. The final note of importance that relates to the cover system is that root growth is strongly influenced by the soil which the root is growing and therefore root data from the literature must be carefully scrutinized as it is applied to specific site conditions (Munshower 1995). The shrub root data shown in Table D.36 should therefore not be interpreted to represent the expected rooting depths in the cover system since rooting depth will be controlled by the highly compacted radon attenuation layer within the cover system.

Soil texture appears to be the most important soil property determining the growth-limiting bulk density of a soil because of the effect of texture on soil pore size and mechanical resistance. A soil with a large amount of fine particles (silt and clay) will have smaller pore diameters and a higher penetration resistance at a lower bulk density than a soil with a large amount of coarse particles (sand size). Zisa et al. (1980) reported a silt loam soil had 19 percent macropore space and a measured penetration resistance of 2.5 bars at a bulk density of 1.4 g/cm^3. A coarser sandy loam soil had 28.9 percent macropore space and a penetration resistance of 1.2 bars at the same bulk density.

Roots grow in soil through large soil pores and by moving soil particles aside when the roots penetrate pores that are smaller than the root tips. When a soil is compacted to a growth-limiting level, most soil pore diameters are substantially smaller than the diameters of growing roots. In this situation, root growth is essentially halted because the roots cannot exert enough pressure to overcome the mechanical resistance and move soil particles. Other pertinent studies that relate root growth and bulk density include articles by Siegel Issem et al. 2005, Mimore and Woollard 1969, and Heilman 1981.

Most, if not all, of the root growth studies cited above that relate root growth to soil compaction and soil bulk density are field studies in native soils that have been in place for centuries or longer. These soils have therefore gone through countless wetting and drying cycles and freeze-thaw cycles and still maintain certain bulk densities that impede root growth.

Table D.36. Percent of root mass by depth for grasses and shrub species that exist or may occur at the Mill site during the performance period of 200 years.

Species	0-30 cm	30-60 cm	60-90 cm	90-120 cm	120-150 cm
Western wheatgrass[a]	65	14	12	9	0
Blue grama[a]	94	4	1	1	0

Species	0-20 cm	20-40 cm	40-60 cm	60-80 cm	80-100 cm	100-200 cm	200-300 cm	300-400 cm	400-500 cm	500-600 cm
Big sagebrush[a]	35	19	17	10	7	8	4	--[f]	--	--
Fourwing saltbush[b]	18	22	15	14	10	8	6	4	2	1
Shadscale[c]	15	20	18	14	12	8	6	4	2	1
Blackbrush[d]	35	50	15	--	--	--	--	--	--	--
Mormon tea[e]	20	35	17	13	10	4	1	--	--	--

[a]Tabler 1964; [b]Gibbens and Lenz 2001; [c]Kearney et al 1960; [d]West 1983; Manning et al. 1990;
[e] Gibbens and Lenz 2001;[f]beyond maximum rooting depth reported in the literature

It is important to note that shrub rooting depths reported in the literature do not reflect expected rooting depths in the cover system because of the presence of a highly compacted radon attenuation layer.

D.5.2 Animal Intrusion

The Dames and Moore Environmental Report (1978) included animal surveys for sites surrounding the Mill site. The Environmental Report recorded the presence or possible presence of a number of burrowing species in the Big Sagebrush community, including burrowing owl (*Bubo virginianus*), pocket mouse (*Perognathus* sp.), kangaroo mouse (*Microdipodops* sp.), vole (*Microtus* sp.), desert cottontail (*Sylvilagus audubonii*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), striped skunk (*Mephitis mephitis*), badger (*Taxidea taxus*), longtail weasel (*Mustela frenata*), and Gunnison prairie dog (*Cynomys gunnisoni*). Additional burrowing animals reported to occur in the Juniper community included pinyon mouse (*Peromyscus truei*) and deer mouse (*Peromyscus maniculatus*). The northern pocket gopher (*Thomomys talpoides*) was not observed in either community type and no mention of the species is made in the 1978 report.

D.5.3 2012 Burrowing Animal Survey

In June 2012 the area surrounding the Mill site was surveyed for burrowing animals in response to Interrogatory 11/1. A total of 100 km of transects were walked in Big Sagebrush and Juniper communities surrounding the Mill Site to determine either the presence of burrowing animals or future colonization based on existing habitat characteristics (see Figure D.2).

Transects were arranged in a systematic manner (at each location in Figure D.2) with a 50 m spacing between transects and transect lengths running between 100 and 400 m, depending upon physiographic features on the landscape. The primary focus of the survey was on three species that would potentially represent the deepest potential for burrows on the tailings cells during the performance period. These species included the badger, Gunnison prairie dog, and northern pocket gopher. Observations were made along each transect for animal sightings, animal presence in the form of tracks, scat or active burrows, burrow densities, and habitat characteristics.

During the animal survey one badger sighting was made and multiple active prairie dog colonies were observed to the north of the mill complex. There appears to be suitable habitat for the northern pocket gopher in the sagebrush communities surrounding the Mill site, but there is no indication that a population of northern pocket gophers occurs in the vicinity of the Mill site. There were no evidence of pocket gophers during surveys associated with the Environmental Report (Dames and Moore, 1978) and no evidence of pocket gophers 34 years later.

An attempt was made to estimate burrow densities for badgers but it was not always possible to confirm a badger burrow. No badger feeding areas (i.e. dug-out prey burrows) were observed along transects that were traversed. The reported burrow density for badgers may or may not be low, depending upon how active badgers are in the area. One of the seminal studies on badger ecology was conducted by Messick and Hornocker (1981) in southwestern Idaho. The authors reported badger densities of 159/50 km^2. This converts to approximately three per 100 hectares. Our survey reported the highest burrow densities at one per 80 to 100 hectares. If each burrow represented more than one individual badger, the densities potentially would be greater. Regardless, the reported burrow densities from the 2012 survey are believed to be a realistic estimate of badger presence at the Mill site.

Within the prairie dog colonies that were located in the area of the Mill site, the greatest burrow density was estimated at 148 burrows per hectare. Over the entire Mill site the prairie dog burrow density ranges from 0 to 148 burrows per hectare. Lupis et al. (2007) reported densities of active burrows in southeastern Utah in the range of 41 to 131/hectare or an average of 75 active burrows per hectare. The burrow densities reported from out 2012 survey are well within the range of a much larger study conducted by Lupis et al. (2007).

Lupis et al. (2007) provide a list of species in grasslands and shrublands in Utah considered primary and secondary habitat for the Gunnison's prairie dog as follows:

> "Perennial and annual Grasslands; or herbaceous dry meadows, including mostly forbs and grasses occurring at 640-2,740 m (2,200-9,000 ft) elevation. Principal perennial grass species include: bluebunch wheatgrass, sandburg bluegrass (Poa secunda), crested wheatgrass (Agropyron cristatum), basin wildrye (Elymus cinereus), galleta (Pleuraphis jamesii), needlegrass (Achnatherum hymenoides), sand dropseed (Sporobolus cryptandrus), blue grama (Bouteloua gracilis), Thurbers needlegrass (Achnatherum thurberianum), western wheatgrass (Pascopyum smithii), squirreltail (Sitanion hystrix), timothy (Phleum spp.), poa (Poa spp.), spike (Trisetum spicatum), Indian ricegrass (Oryzopsis hymenoides), and some sedges (Cyperaceae spp.). Principle annual grass species is cheatgrass (Bromus tectorum). Principal forb species include: yarrow (Achillea millefolium), dandelion (Taraxacum officinale), Richardson's geranium (Geranium richardsonii), penstemon (Penstemon spp.), mulesears (Wyethia amplexicaulis), golden aster (Chrysopsis villosa), arrowleaf balsamroot (Balsamorhiza sagittata), hawkbit (Agoseris pumila), larkspur (Delphinium spp.), and scarlet gilia (Gilia pulchella). Primary associated shrub species include: sagebrush (Artemesia spp.), shadscale (Atriplex confertifolia), greasewood (Sarcobatus spp.), creosote (Larrea tridentate), rabbit brush (Crysothamnus spp.), cinquefoil (Potentilla simplex), snowberry (Symphoricarpos albus), and elderberry (Sambucus spp.). Primary associated tree species is juniper (Juniperus spp.)."

> "Shrublands at 670-3,150 m (2,200-10,300 ft) elevation principally dominated by greasewood (Sarcobatus vermiculatus), shadscale, graymolly (Kochia vestita), mat-atriplex (Atriplex corrugata), Castle Valley clover (Atriplex cuneata), winterfat, budsage (Artemisia spinescens), four-wing saltbush (Atriplex canescens), halogeton (Halogeton glomeratus), Mormon tea (Ephedra spp.), horsebrush (Tetradymia canescens), snakeweed and rabbitbrush; or low elevation perennial grassland co-dominate with shrubland. Principal grassland species include: galleta, Indian ricegrass, three-awn grass (Aristida glauca) and sand dropseed. Primary associated forb species include: desert trumpet (Eriogonum inflatum). Primary associated shrub species include: sagebrush, and black brush (Coleogyne ramosissima); other associated species include seepweed (Suaeda torreyana)."

Based on the report by Lupis et al. (2007) we agree that the habitat that will be created at the Mill site following revegetation will include species consistent with prairie dog occupation.

Table D.37 presents an updated assessment of maximum burrow depths for animal species that may occur on the Mill site. Based on a review of literature for burrow depths, the species that have the potential for the deepest burrows are badger (228 cm), northern pocket gopher (150 cm), and Gunnison prairie dog (427 cm). As discussed above, both the badger and Gunnison prairie dog were observed during the 2012 animal survey, while there is no evidence that the northern pocket gopher occurs in the vicinity of the Mill site from both the 1978 and 2012 surveys.

The proposed cover system is a monolithic evapotranspiration (ET) cover that consists of the following layers from top to bottom: 15 cm of a topsoil-gravel erosion protection layer over 107 cm of a water storage, biointrusion and radon attenuation layer over 75 cm of a highly compacted radon attenuation layer over 75 cm of a grading and radon attenuation layer. The proposed cover system does not contain a biobarrier (e.g. cobble layer) to minimize potential intrusion by burrowing animals. The proposed cover system is designed to minimize burrowing animal intrusion through the use of thick layers of soil cover in combination with a highly compacted layer placed at a depth that is below the expected burrowing depths among species that may inhabit the site. The thickness of the cover (total of 272 cm), the use of a highly compacted radon attenuation layer located at a depth between 122 and 197 cm, and a final 75 cm layer below the compacted zone will all contribute to minimizing any biointrusion through the cover. Considering the animal species that may inhabit the tailings cells and the thickness and physical nature of the cover, it is not anticipated that burrowing will extend below 122 cm or into the very top portion of the highly compacted zone. Burrowing into the highly compacted radon attenuation layer that begins at a depth of 122 cm will be restricted because of the high density of this material (95 percent Standard Proctor).

Table D.37. Range of maximum burrow depths for wildlife that inhabit or may inhabit the Mill site during the required performance period of at least 200 years

Species	Maximum Depth (cm)	Source
Pocket mouse	52 to 62 35-153	Kenagy 1973; Scheriber 1978
Pinyon mouse	34	Reynolds and Wakkinen 1987
Deer mouse	13-50	Reynolds and Laundre 1988; Kritzman 1974
Kangaroo rat	24-61 20-69	Reynolds and Wakkinen 1987; Anderson and Allred 1964
Vole	15-55	Reynolds and Wakkinen 1987
Desert cottontail	Abandoned burrows and surface nest	Wilson and Reeder 2005; Chapman and Willner 1978
Long-tailed weasel	Abandoned burrows and surface nest	Feldhammer et al. 2003
Striped Skunk	90	Jackson 1961
Badger	150 to 228	Lindsey 1976; Anderson and Johns 1977
Gunnison prairie dog	30 to 427 69 to 185 68 to 82	Verdolin et al. 2008; Sheets et al 1971; Whitehead 1927
Red fox	100 to 130	Feldhammer et al. 2003; Saunders 1988
Coyote	Most common behavior is to use burrows of other animals like the badger	http://carnivora.com/topic/932884/1/
Burrowing owl	Abandoned burrows	Haug et al. 1993
Northern Pocket Gopher	10 to 30 150	Winsor and Whicker 1980; Gettinger 1975; Felthauser and McInroy 1983

D.6 SOIL REQUIREMENTS FOR SUSTAINABLE PLANT GROWTH

There are two key components to establishing an ET cover with a sustainable plant community. The first is to select long-lived species that are adapted to the environmental conditions of the site. The second is to provide a cover soil that will function as an effective plant growth medium over the long term by supplying plants with adequate amounts of water, nutrients and rooting volume.

There are a number of soil characteristics that are particularly important to achieve long-term sustainability in semi-arid environments and include the following: pH, electrical conductivity (EC), sodium levels, percent organic matter, texture, bulk density, cation exchange capacity, macronutrient concentrations, available water holding capacity, and soil microorganisms. Table D.38 presents levels for most of these soil properties that are considered necessary for long-term sustained plant growth. In addition, the table includes soil property levels from soil samples of potential cover soil collected from stock piles at the Mill site in May 2009.

The soil properties of the potential cover soil that are acceptable for sustaining long-term plant growth include: pH, EC, sodium adsorption ratio (SAR), percent clay content, and extractable phosphorus. Those soil properties that appear to be deficient and would need improvement include: percent organic matter, total nitrogen, and extractable potassium.

Cation exchange capacity was not measured in the potential cover soil, but it is believed that the cover soil will have an acceptable level for sustained plant growth based on the percent clay content and a recommendation that an organic matter amendment be added to the soil during the reclamation process. Bulk density of the emplaced cover material will be specified in the cover design and will be controlled during the construction process to be within the sustainability range shown in Table D.38.

Table D-38. Soil Properties and Their Range of Values Important for Sustainable Plant Growth, Along with Analytical Results of Soil Available for ET Cover Construction at the Mill Site

Soil Property	Level for Sustainability	Reference	Levels for On-Site Soil
pH (units)	6.6 to 8.4	Munshower (1994)	7.7 to 8.1
EC (mmhos/cm)	≤4.0	Munshower (1994)	<1.5
Sodium adsorption ratio	≤12	Munshower (1994)	<0.5
Organic matter (%)	1.0 to 3.0	Smith et al. (1987)	0 to 0.4
Texture (%)	> 50% silt and clay	Brady (1974)	> 50% silt and clay
Bulk density (g/cm^3)	1.2 to 1.8	Brady (1974)	1.59 to 1.99†
Water holding capacity (cm H_2O/cm soil)	0.08 to 0.16	Brady (1974)	0.084-0.14†
Cation exchange capacity (meq/100g)	5 to 30	Munshower (1994)	Not measured
Total nitrogen (%)	0.05 to 0.5	Harding (1954)	0.02 to 0.05
Extractable phosphorus (mg/kg)	6 to 11	Ludwick and Rogers (1976)	10 to 57
Extractable potassium (mg/kg)	60 to 120	Ludwick and Rogers (1976)	11 to 36

†Calculated values

In order for the potential cover soil to function as a normal soil and provide long-term sustainable support for the vegetation component of the ET cover, it will be amended to improve organic matter content, nitrogen and potassium levels. An organic matter amendment will also improve available water holding capacity and cation exchange capacity. The proposed organic amendment is composted biosolids. Composted biosolids have been successfully used in mined land reclamation over the past 40 years. This amendment would also provide a source of soil microorganisms that will function to cycle nutrients over time and ensure sustainable plant growth. Composted biosolids would be applied at a rate of 10 tons/acre and incorporated into the upper six inches of the water storage layer of the cover system. Composted biosolids are also a source of nitrogen, phosphorous and potassium and will serve to improve organic matter content and soil fertility. The following discussion provides the rationale for selecting composted biosolids as the amendment of choice for the cover soil.

Type of Amendment, Application Rates, and Costs – There are three possible soil amendments that would be a source of organic matter and nutrients for sustained plant growth. These amendments include composted biosolids, a combination of manure and hay, or a commercial organic fertilizer such as Biosol®. Biosol® is a highly effective organic amendment but would be cost prohibitive if the objective is to achieve 1 percent organic matter content in the soil. It would require the addition of at least 10 tons/acre to meet this organic matter target and the cost would be approximately $12,300/acre, which includes a product cost of $12,000/acre, transportation cost of $100/acre, and an application cost of $200/acre. Composted biosolids would be equally effective as Biosol®, but much less expensive. Composting of biosolids is a proven method for pathogen reduction and results in a product that is easy to handle, store, and use. The end product is usually a Class A, humus-like material without detectable levels of pathogens that can be applied as a soil amendment. Composted biosolids provide large quantities of organic matter and nutrients (such as nitrogen and phosphorus) to the soil, improves soil texture, and elevates soil exchange capacity. If composted biosolids were obtained from Farmington, NM (which appears at this time to be the closest source), the cost for a 10 ton/acre application rate would be $1,530/acre, which includes $260/acre for product cost, $1,070/acre for transportation, and $200/acre for application. The use of manure and hay would be the least effective amendment because both products have the potential of adding unwanted weed seed to the cover vegetation and manure is relatively high in nitrogen and if not properly off set with hay, there is a potential of having excessive nitrogen introduced into the cover system that would also lead to a proliferation of unwanted weeds.

Method of Application – Composted biosolids are produced by mixing biosolids (treated sewage sludge) and wood waste material. Composted biosolids are easy to apply and would be broadcast over the soil surface using a commercial manure spreader and the amendment would then be incorporated with a chisel plow or disc plow.

Limitations of Soil Amendments – Composted biosolids have few limitations as a soil amendment. Composted biosolids are often low in readily available nitrogen, but have high organic nitrogen levels that can be slowly released for plant use over time. The EPA has established rules for the land application of biosolids that address concerns about possible pathogen transmittal, nitrate pollution, and trace metal contamination (EPA, 1993 and 1995). In order to be land applied, a particular biosolid must have undergone a pathogen reduction process, must contain less than a specified amount of bacterial pathogens, and must meet limits for heavy metal concentration.

Considerable research has been conducted over the past 40 years on the interactions between biosolids, soil properties, plant growth and environmental quality. Amendment of disturbed soils with composted biosolids has been shown to increase soil organic matter, cation exchange capacity, soil nutrient levels, microbial biomass and activity, water holding capacity, and aggregate stability, and also to reduce soil bulk density and metal availability for plant uptake. The potential for successful reclamation with composted biosolids is tremendous and most of the highly beneficial properties of composted biosolids as a soil amendment come from its high organic matter content (Sopper, 1993). The use of composted biosolids is extremely important where topsoil is inadequate in amount or quality (Sopper, 1993; Munshower, 1994).

The application of composted biosolids on disturbed land generally has had a very beneficial effect on the establishment and growth of grasses and forbs (Sopper, 1993; Haering et al., 2000). It facilitates rapid establishment and vigorous growth of herbaceous plants. Sites treated with composted biosolids generally have a greater percent cover, greater aboveground production, and better developed root systems compared to non-amended sites or sites treated with just inorganic fertilizers (Sopper, 1993; Haering et al., 2000). The use of composted biosolids also aids in the establishment and growth of shrubs. Annual height and diameter growth is improved with composted biosolids and overall woody plant survival is increased if competition from herbaceous plants is not an issue (Sopper, 1993; Haering et al., 2000).

Field studies at the Climax Molybdenum Mine near Leadville, Colorado conducted by Carlson et al. (2006) examined the effect of composted biosolids on tailings reclamation over a seven-year period. The findings of this study were that composted biosolids are an effective means of establishing soil microbe and vegetation communities on tailings. The authors concluded that: over seven years and in extreme growing conditions, biosolid amendments reduced soil toxicity [by immobilizing heavy metals], neutralized acidity, and introduced constituents [e.g. nutrients and soil microbes] necessary to sustain vegetation communities on tailings capped with overburden material.

In a very long-term study conducted by Paschke et al. (2005) the effect of biosolids amendments were assessed on disturbances in a sagebrush community in northwestern Colorado. The authors reported that 24 years after biosolids were applied on fertile and infertile soil material that: "… biosolids amendments have long-lasting effects on soil fertility and plant community composition…"

The greatest limitation for the use of composted biosolids at the Mill site will be availability of the product. Availability varies over time depending upon supply and demand. Since the Mill site is in a remote location, sources of composted biosolids in the quantities needed for tailing cell reclamation are limited and advanced planning will be required to secure the quantities needed when the cover system is being constructed.

D.7 WEED MANAGEMENT

Weed management would be conducted on the Mill site by identifying the presence of any noxious weeds during annual vegetation surveys and developing a weed control plan that is specific to the species that are present (Table D.39). Noxious weed control is species dependent and both method and timing will vary from species to species.

Each survey will identify noxious weed populations and locate these populations on a map using a set of symbols to identify species, size of the infestation, and density of the population. The effectiveness of control methods will also be documented in each annual survey. In addition, immediately adjacent off-site properties will be visually surveyed to a distance of 100 feet. Inspections will be conducted by personnel familiar with the identification of noxious weeds in the area and based on Utah's Noxious Weed List.

The selected control methods will be based on the type, size, and location of the mapped noxious weeds. The treated area(s) will be monitored and re-inspected annually for new weed introductions and to evaluate the success of the control methods. Prevention is the highest priority weed management practice on non-infested lands; therefore protecting weed-free plant communities is the most economical and efficient land management practice. Prevention is best accomplished by ensuring that new weed species seed or vegetative reproductive plant parts of weeds are not introduced into new areas, and by early detection of any new weed species before they begin to spread.

Control methods may include chemical or mechanical approaches. The optimum method or methods for weed management will vary depending on a number of site-specific variables such as associated vegetation, weed type, stage of growth, and severity of the weed infestation.

Table D.39. Noxious Weed Species

Scientific Name	Common Name
Utah State—Listed Noxious Weeds	
Acroptilon repens	Russian knapweed
Cardaria spp.	Whitetop (all species)
Carduus nutans	Musk thistle
Centaurea diffusa	Diffuse knapweed
Centaurea solstitialis	Yellow star thistle
Centaurea stoebe ssp. micranthos	Spotted knapweed
Centaurea virgate ssp. Squarrosa	Squarrose knapweed
Cirsium arvense	Canada thistle
Convolvulus spp.	Bindweed (all species)
Cynodon dactylon	Bermuda grass
Elymus repens	Quackgrass
Euphorbia esula	Leafy spurge
Isatis tinctoria	Dyer's woad
Lepidium latifolium	Broadleaf pepperweed
Lythrum salicaria	Purple loosestrife
Onopordum acanthium	Scotch thistle
Sorghum almum	Perennial sorghum (all species)
Taeniatherum caput-medusae	Medusahead
San Juan County—Listed Noxious Weeds	
Aegilops cylindrical	Jointed goatgrass
Alhagi maurorum	Camelthorn
Asclepias subverticillata	Western whorled milkweed
Solanum elaeegnifolium	Silverleaf nightshade
Solanum rostratum	Buffalobur

<u>Chemical Control</u>
Chemical control consists mostly of selective and non-selective herbicides. Considerations for chemical controls include: herbicide selection, timing of application, target weed, desirable plant species being grown or that will be planted, number of applications per year and number of years a particular species will need to be treated for desired control. Also important are the health and safety factors involved, and the need to consider undesirable impacts. The use of herbicides will be in compliance with all Federal and State laws on proper use, storage, and disposal. The chemical application will be done by a licensed contractor in accordance with all applicable laws and regulations and all label instructions will be strictly followed. Applications of herbicides would

not be permitted when the instructions on the herbicide label indicate conditions that are not optimal.

Mechanical Control

Mechanical control is the physical removal of weeds from the soil and includes tilling, mowing, and pulling undesirable plant species. Tillage is most effective prior to seeding and establishment of desirable vegetation. The tillage method of weed control can be effective in eliminating noxious perennial weeds when repeated at short intervals (every 1-2 weeks) throughout the growing season. Tillage has the drawback of indiscriminately impacting all vegetation interspersed with weeds in established areas and can eliminate competitive, desirable vegetation leaving behind a prime seedbed for weeds to reinvade. Mowing can be an effective method for controlling the spread of an infestation and preventing the formation and dispersal of seeds. Mowing is most effective on weeds which spread solely or primarily by seed. In order to achieve this, it must be repeated at least twice during the growing season prior to, or shortly after bloom. Also, even the most intense mowing treatment will not kill hardy perennial weeds. Additional considerations will be made when selecting control treatments when specific situations arise regarding type, size, and location of weed infestations. Examples of this are perennial versus biennial, broadleaf versus grasses, noxious weeds interspersed with desirable vegetation, large monoculture patches, or small patches requiring spot treatment.

Treatment windows schedules, based on the control methods chosen and the noxious weeds present, will be established for each treatment area. The best time to treat perennial noxious weeds is in the spring or fall during their active growth phase. Different species will have different optimum treatment times even with the same type of control. Perennial weeds usually grow vegetatively in the spring, flower and seed in late spring and early summer, enter dormancy during the summer and actively grow again in the fall. The treatment windows selected will depend on the species present and control methods selected.

The final preparatory step is to determine the priority for areas to be treated. Prioritization ensures that the most important areas are dealt with at the most effective times. Important areas of concern include areas that may transport weed seeds. These areas include ditches, roadsides, and land equipment storage sites. Large monoculture patches are of concern wherever they occur and would always be high priority. Also, small patches of weeds would be treated to prevent expansion of weed populations.

Once the treatment plan is implemented, detailed records will be kept, and success or failure of treatment will be recorded so as to eliminate unsuccessful treatments.

D.8 REVEGETATION ACCEPTANCE GOALS/CRITERIA AND MONITORING

The following Revegetation Acceptance Goals/Criteria have been adapted from the Monticello Site and would be used at the Mill site to determine reclamation success.

Criterion 1 Species Composition

a. The vegetative cover (the percentage of ground surface covered by live plants) shall be composed of a minimum of five perennial grass species (at least four listed as native), one perennial forb and two shrub species listed in Table D.1.

Criterion 2 Vegetative Cover

a. Attain a minimum vegetative cover percentages of 40 percent.

b. Individual grass and forb species listed in Table D.1 that are used to achieve the cover criteria shall have a minimum relative cover (the cover of a plant species expressed as a percentage of total vegetative cover) of 4 percent and a maximum relative cover of 40 percent.

c. Individual species not listed in Table D.1 may be accepted as part of the cover criteria if it is demonstrated that the species is native or adapted to the area and is a desirable component of the reclaimed project site.

d. Species not listed in Table D.1, including annual weeds or other undesirable species shall not count toward the minimum vegetative cover requirement. Every attempt should be made to minimize establishment of all non-noxious weeds.

e. Reclaimed areas shall be free of state- and county-listed noxious weeds (Table D.40).

f. The vegetative cover shall be self-regenerating and permanent. Self-regeneration shall be demonstrated by evidence of reproduction, such as tillers and seed production.

Criterion 3 Shrub Density

a. A minimum shrub density of 500 stems per acre

b. Shrubs shall be healthy and have survived at least two complete growing seasons before being evaluated against success criteria

Monitoring

Plant cover would be measured annually on the tailing cells for a minimum of ten years or until the revegetation goals stated above are achieved. Cover would be measured by the point method, using a vegetation sighting scope mounted on an adjustable tripod with a level (or similar instrument). Cover would be measured for each species encountered, as well as litter, rock, and bareground. Cover measurements would be made along a minimum of ten randomly placed transects on each tailing cell that are 100 feet long. A total of 100 points would be sited at one-foot intervals along each transect to collect cover data in the categories of live vegetation, litter, rock, and bareground. Sample adequacy would be determined for each tailing cell using the following formula that identifies the minimum number of samples that are necessary to estimate the population mean at a 90 percent level of confidence. Total live vegetation cover would be used to calculate sample adequacy.

$$n = \frac{t^2 s^2}{(.10x)^2}$$

Where: n = minimum number of samples required to meet sample

adequacy requirements
s^2 = variance
t^2 = 1.64 for 90% confidence
x = sample mean

Shrub density would be measured in belt transects placed on either side of the cover transects. All shrubs would be counted within a three-foot wide strip or belt transect along each side of the transect used for point cover measurements, resulting in a belt transect that is six-feet wide and 100 feet long.

In addition to the above cover sampling, annual observations would be made of overall plant community health and sustainability. Overall health would be based on plant vigor, presence of annual weeds, and signs of plant deficiencies or toxicities. Plant community sustainability would be based on observations of reproduction, including both vegetative reproduction, such as tillering, and seed production.

If revegetated areas are not making satisfactory progress in meeting revegetation goals outlined above, then remedial actions will be implemented as needed. These actions may include fertilization/soil amendments, reseeding, weed control, and/or erosion control depending upon the cause of the problem that may exist and the best remediation approach to ensure plant community success. Potential revegetation problems that are most likely to occur based on typical revegetation projects in the semiarid west and on experiences at the Monticello Site fall into two categories. The first is poor initial plant establishment following revegetation practices and the second is poor plant growth during post-revegetation management. Poor initial plant establishment can be caused by a number of factors including unfavorable soil conditions related to texture or soil chemistry, improper seedbed preparation, improper seeding techniques, improper species selection, poor seed quality, planting in the wrong season, seed predation, and inadequate precipitation. If revegetation at the Mill site results in unacceptable initial plant establishment, the cause of this response will be investigated, the identified cause will be corrected, and the necessary revegetation practices will be applied until successful plant establishment has occurred. The most likely cause of poor initial plant establishment at the Mill site would be low precipitation and additional seedings would be required in a subsequent year(s) until precipitation improves and an adequate stand of vegetation is achieved. Additional mulching to control erosion and improve soil moisture conditions for seed germination and initial seedling growth would be part of the remedial process. Poor plant growth during post-revegetation management has been an issue at the Monticello Site as it relates to shrub establishment. The primary species that has been an issue is big sagebrush and the cause of the problem has been seedling damage associated with vole herbivory.

D.9 SUSTAINABILITY OF THE COVER DESIGN

D.9.1 CLIMATE CHANGE

Climate, more than any other factor, controls the broadscale distributions of plant species and vegetation. At finer scales, other factors such as local environmental conditions including soil nutrient status, pH, water-holding capacity and the physical elements of aspect or slope influence the potential presence or absence of a species. However, intra- and inter-specific interactions, such as competition for resources (light, water, nutrients), ultimately determine whether an individual plant is actually found at any particular location (Sykes 2009). Rapid climate change associated with increasing greenhouse gas emissions (IPCC 2007) influences current and future vegetation patterns. Other human-influenced factors are, however, also involved. Sala et al. (1997) identified five different drivers of change that can be expected to affect global biodiversity over the next 100 years. Globally, land use change was considered the most important driver of change, followed by climate change, airborne nitrogen deposition, biotic interactions (invasive species) and direct CO_2 fertilizing or water use efficiency effects.

Predicted changes in climate that may occur in the southwestern U.S. include increased atmospheric concentrations of CO_2, increased surface temperatures, changes in the amount, seasonality, and distribution of precipitation, more frequent climatic extremes, and a greater variability in climate patterns. Recent temperature increases have made the current drought in the region more severe than the natural droughts of the last several centuries. This drought has caused substantial die-off of pinyon pine trees in approximately 4,600 square miles of pinyon-juniper woodland in the Four Corners region (Breshears et al. 2005). Williams et al. (2010) examined correlations between climate and the radial growth of trees across North America. They show that conifer trees in the southwest are particularly sensitive to temperature and aridity relative to other regions. They used climate-tree growth relations calculated for the past 100 years, combined with Intergovernmental Panel on Climate Change (IPCC) climate model estimates for the 21st century to predict the likely fate of important southwest tree species such as pinyon pine. They concluded that woodlands and forests will experience substantially reduced growth rates and increase mortality at many southwest sites as the century progresses.

The specific physiological effects of increasing GHG emissions (particularly CO_2) on vegetation include increased net photosynthesis, reduced photorespiration, changes in dark respiration, and reduced stomatal conductance which decreases transpiration and increases water use efficiency (Patterson and Flint 1990). Ambient temperature affects plants directly and indirectly at each stage of their life cycle (Morison and Lawlor 1999). Water (i.e. soil moisture) is usually the abiotic factor most limiting to vegetation, especially in arid and semi-arid regions. Carbon dioxide, temperature, and soil moisture effects on plant physiology are exhibited at the whole-plant level in terms of growth and resource acquisition. In addition to the individual effects of increasing temperatures, CO_2 is the additional interactive effect on photosynthetic productivity and ecosystem-level process (Long and Hutchin 1991).

Plants are finely tuned to the seasonality of their environment, and shifts in the timing of plant activity (i.e. phenology) provide some of the most compelling evidence that species and ecosystems are being influenced by global environmental change (Cleland et al. 2007). Changes in the phenology of plants have been noted in recent decades in regions around the world (Bradley et al. 1999; Fitter and Fitter 2002; Walther et al. 2002; Parmesan and Yohe 2003). Phenology of plant species is important both at the individual and population levels. Specific timing is crucial to optimal seed set for individuals and populations; and variation among species in their phenology is an important mechanism for maintaining species coexistence in diverse plant communities by reducing competition for pollinators and other resources. Global climate change could significantly alter plant phenology because temperature influences the timing of development, both alone and through interactions with other cues, such as photoperiod.

Shifts in the relative competitive ability of plants that experience changes in CO_2, surface temperatures, or soil moisture may result in changes to their spatial distribution (Long and Hutchin 1991; Neilson and Marks 1994). Increases in temperature may enhance the competitive ability of C_4 plants (such as grasses) relative to C_3 plants (shrubs and trees) (Owensby et al. 1999), especially where soil moisture (Neilson 1993) or temperature (Esser 1992) is limiting.

There are numerous uncertainties and complexities associated with the use of all regional climate models with regard to their ability to reliably forecast longer-term future climate conditions in the North American South West (NASW) and at the Mill site. Therefore, attempts to extend the results from climate model predictions forecasting climate conditions through the end of the 21st century to timeframes of 200 to 1,000 years will likely result in further compounding of these uncertainties and result in unreliable predictions. We identified this concern in earlier discussions presented on the topic of climate change.

We have reviewed references cited in the Division's Rd 1 Interrogatories for White Mesa Revised ICTM Report on estimating the range of future climates (CNRWA 2005; NRC 2003; NRC 1997). The Center for Nuclear Waste Regulatory Analyses (CNRWA 2005) conducted an analysis of factors contributing to uncertainty in estimating future climates at Yucca Mountain. Their report concludes the following:

> "In summary, research performed within the last five years suggests that the timing of climate changes over the next 100,000 years may be difficult to infer from the patterns of climate change over the last 500,000 years due to the unusually low eccentricity of Earth's orbit and, possibly, the influence of anthropogenic greenhouses gases. After 100,000 years, the Earth's orbital climate forcing will be stronger, and the influence of greenhouse gases may have diminished so that the Pleistocene climate history may offer a better analog in terms of timing of climate changes. In terms of the characteristics of future climates (i.e., mean annual precipitation and temperature, seasonal weather patterns, and storm intensities), the characteristics inferred from paleoclimate reconstructions and present day analog records may represent the range of climate conditions that will occur in the future, even if the timing of these climates cannot be reliably estimated. The greatest uncertainty in future climate conditions relates to anthropogenic effects that may result in climates in southern Nevada that do not have analogs with present or Pleistocene climates, such as prolonged El Niño conditions. The nature, likelihood, and duration of such nonrepresentative climate conditions cannot be reliably assessed based on current research. Over longer time periods, the range of conditions inferred from the Pleistocene paleoclimate record reasonably bounds future climate during the period of geologic stability."

We agree with NRC's preferred approach of using paleoclimate data to estimate the likely range of future conditions. In fact, in our previous discussion of climate change in Attachment G (EFRI, 2012), we discussed the paleoclimate approach presented by Waugh and Petersen (1994) for the Monticello site.

Waugh and Petersen (1994) summarize future climate change as follows:

> "Global mean temperature may increase by 1.8 to 5.2^{o}C in the next century, in response to an industrial age buildup of carbon dioxide (CO_2), methane, and other gases (Houghton et al. 1992). Model projections of the magnitude of warming vary, depending on whether factors such as CO_2 fertilization, feedback from stratospheric ozone depletion, and the radiative effects of sulfate aerosols are taken into account. Model projections of precipitation responses to greenhouse warming also are inconsistent (Houghton et al. 1990; Crowley and North 1991; Washington and Meehl 1984; Wilson and Mitchell 1987; Schlesinger and Mitchell 1987). Some regions may be effectively wetter and others drier, depending on the balance of the greater potential evaporation and the greater water-holding capacity of a warmer atmosphere. Greenhouse warming may eventually be overwhelmed as the earth plunges into another ice age. Models of cyclic astronomical

> forcing of climate agree that, without anthropogenic disturbances, a long-term cooling trend that started about 6,000 years ago will continue, climaxing with a major glaciation in about 60,000 years (Imbrie and Imbrie 1980; Berger et al. 1991). In contrast, aperiodicity in the timing of past ice ages is evident in oxygen isotope records (Winograd et al. 1992). Other paleorecords suggest that certain feedback mechanisms have caused rapid and unpredictable transitions into ice ages (Berger and Labeyrie 1987; Phillips et al. 1990)."

Waugh and Petersen (1994) concluded from their investigation that despite uncertainty about drivers of future climate change, climate extremes in the next 1,000 years likely will not exceed those associated with the last glacial and interglacial periods. Therefore, paleo-records of full glacial and Altithermal climates in the Four Corners region provide reasonable ranges of possible future climate and should be incorporated in assessments of the long-term performance of tailings disposal facilities. For Monticello, Utah, full glacial and Altithermal climate reconstructions provide working levels of 2 to 10^{o} C mean annual temperature and 38 to 80 cm mean annual precipitation. If we assume that a similar range of temperature and precipitation could also occur at the Mill site, then during the next glacial phase anticipated to occur approximately 60,000 years into the future the climate would be a colder and wetter compared to current conditions, and if conditions post-glaciation result in a warm period the climate would be warmer and wetter than current conditions.

Table D.41 presents a list of possible climate scenarios for the Mill site, their likelihood of occurrence and the resulting plant community type that would develop during the required performance period. From the review of climate change literature applicable to the southwest U.S. and an analysis of the impact of various climate change scenarios, it is our conclusion that the most likely plant community type that will be maintained throughout the 200- to 1,000-year performance period is a community dominated initially by cool season grasses, with a long-term transition to dominance by warm season grasses and shrubs as atmospheric CO_2 and temperature continues to increase and precipitation ether increases or decreases.

D.7.2 Plant Community Succession and Potential for Species Colonization

Plant succession is the ecological process of directional vegetation change over time, usually beginning with relatively-short lived herbaceous plants and culminating in plant communities dominated by long-lived, generally woody species. Succession occurs on all sites. The rate of succession can be relatively rapid, especially in regions of higher rainfall, or it can be very slow, as in some desert and arctic regions, but this process of vegetation change is constantly taking place.

Two common aspects of succession are 1) an increase in vegetation structure and 2) an increase in the relative amounts of woody plants. Both of these aspects have profound implications to the function of cover systems. Vegetation structure refers to the shape of the vegetation, e.g., height, coverage, and stratification. Structure increases as succession proceeds, both above- and belowground. Aboveground, the height of the vegetation increases (e.g., grasses may be replaced by shrubs), coverage of the soil surface increases, and layering (strata) of vegetation occurs, with different species occupying different vertical layers. Similar processes occur belowground. Root systems become deeper as shallow-rooted species are replaced by deeper-rooted species, root biomass increases in lower soil depths as the number and types of species increase, and the density of the root system increases in the various layers.

Table D.40. Possible Climate Scenarios for the Mill Site, Likelihood of Occurrence and Projected Change in Plant Species Composition Compared to the Initial Grass/forb Community Established on the Soil Cover

Possible Climate Scenarios	Likelihood of Occurence[9]	Projected Plant Community Type in 1,000 Years with Seeded Grass/Forb as the Initial Community
Warmer and Dryer than Present[1]	Highly Likely	Grass/forb community with an increase in warm season species.
Warmer and Wetter than Present[2]	Highly Likely	Will depend on distribution of additional precipitation. If more precipitation in winter months, then the plant community would experience an increase in woody plants; if more precipitation in the summer months, then the plant community would continue as a grass/forb type.
Warmer than Present with Similar Total Precipitation[3]	Unlikely	Grass/forb community with an increase in warm season species.
Cooler and Wetter than Present[4]	Highly Unlikely	Shift to more woody plants because of more snow in winter months.
Cooler and Dryer than Present[5]	Highly Unlikely	Shift to more woody plants because of more snow in winter months.
Cooler than Present with Similar Precipitation[6]	Highly Unlikely	Shift to more woody plants because of more snow in winter months.
Dryer than Present with Similar Temperature[7]	Unlikely	Grass/forb community with an increase in warm season species because of less overall moisture and increase in atmospheric CO_2.
Wetter than Present with Similar Temperature[8]	Unlikely	Shift to more woody plants because of more winter precipitation.

[1]Results in less total precipitation but shift to less snow and more rain in winter months.
[2]Results in more total precipitation with shift to less snow and more rain in winter months or more rain in summer months.
[3]Results in no change in total precipitation but shift to less snow and more rain in winter months.
[4]Results in more total precipitation with shift to more snow in winter months.
[5]Results in less total precipitation but shift to more snow in winter months
[6]Results in no change in total precipitation but shift to more snow in winter months.
[7]Results in less total precipitation.
[8]Results in more total precipitation.
[9]Likelihood of occurrence based on majority of climate model estimates analyzed by Cayan et al. 2010 and Seager and Vecchi 2010, with a focus on the southwest U.S.

As the vegetation shifts from dominance by herbaceous plants (e.g., grasses), which have relatively shallow root systems but with very dense root mass in the upper profile, to dominance by woody species (e.g., shrubs), which have deeper roots systems with proportionately more roots in deeper layers, the hydrological dynamics of the system change. Early successional plant communities tend to extract most of the water they transpire from the upper soil profile. Late successional communities have greater ability to extract water from depth. This can be both a positive and a negative in the functional efficiency of covers. Because of successional changes in the vegetation, the plant-soil-water characteristics of a cover are likely to become very different over time. Conditions 200 years or more after construction are not likely to be similar to those soon after construction was completed. In some ways, conditions will be more favorable, e.g., evapotranspiration will likely be higher thus reducing the amount of deep infiltration and stability of the vegetation may be greater. In other ways, conditions will be less favorable, e.g., deeper root systems increase the concern for biointrusion. Because succession is a process that is near-universal ecologically, these changes have been accounted for in the cover design.

As stated earlier, the proposed cover system is a monolithic ET cover that consists of the following layers from top to bottom: 15 cm of a topsoil-gravel erosion protection layer over 107 cm of a water storage, biointrusion and radon attenuation layer over up to 110 to 136 cm of a highly compacted radon attenuation layer over 76 cm of a grading and radon attenuation layer. The proposed cover system does not contain a biobarrier (e.g. cobble layer) to minimize potential intrusion by plant roots during the required performance period. The proposed cover system is designed to minimize plant root intrusion through the use of thick layers of soil cover in combination with a highly compacted layer placed deep within the cover. The climax community for the Mill site is believed to be Big Sagebrush based on the current community type at the site and the relatively deep fine loamy soils that are present. If climate trends towards a warmer and dryer climate for the White Mesa area over the next 200 to 1,000 years, it is unlikely that sagebrush will remain on site and a community dominated by warm season species and more arid shrub species (e.g. shadscale saltbush, blackbrush and Mormon tea) may occur.

As discussed above, the process of succession and the effect of climate change will bring about changes in species composition in the tailings cover system. Our best forecast for the percentage of potential species colonization would be for a small percent of non-seeded species establishing during the first 50 years. The seeded community will be highly sustainable and big sagebrush would be the primary invader into the cover system. It is estimated that the established community will consist of 60 to 70 percent seeded species and 30 to 40 percent non-seeded species at end of the first 100 years. These non-seeded species will include big sagebrush and broom snakeweed, and a few grass and forb species common in the area. During the next 100 years the plant community will begin to transition to warm season species and big sagebrush will begin to diminish. By the end of the second 100 years it is estimated that the plant community will consist of 30 to 40 percent seeded and 60 to 70 percent non-seeded species and many of the non-seeded species will be warm season grasses and more arid shrub species. This trend will most likely continue through the remainder of the performance period with only 10 to 20 percent of the original seeded species still present and these would include blue grama and galleta. The remainder of the community would consist of more warm season grasses and shrubs that will have migrated north and higher in elevation with the warming climate.

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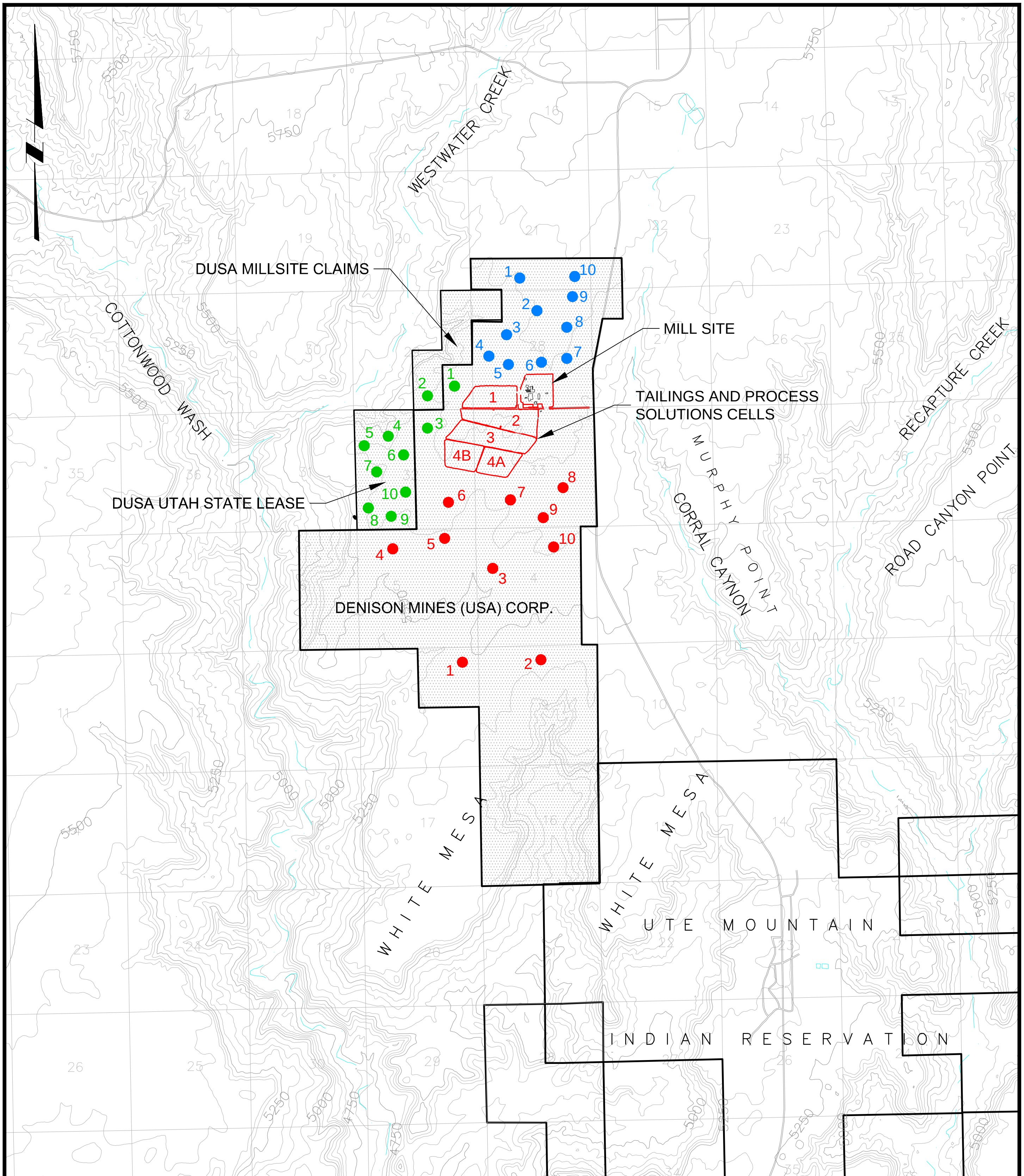


SCALE

6000' 0 6000'

LEGEND

- TRANSECT LOCATION TO NORTH OF MILL COMPLEX
- TRANSECT LOCATION TO SOUTH OF MILL COMPLEX
- TRANSECT LOCATION TO WEST OF MILL COMPLEX

Energy Fuels Resources (USA) Inc.

PROJECT

WHITE MESA MILL RECLAMATION

TITLE

LOCATION OF 2012 PLANT COVER SURVEY TRANSECTS

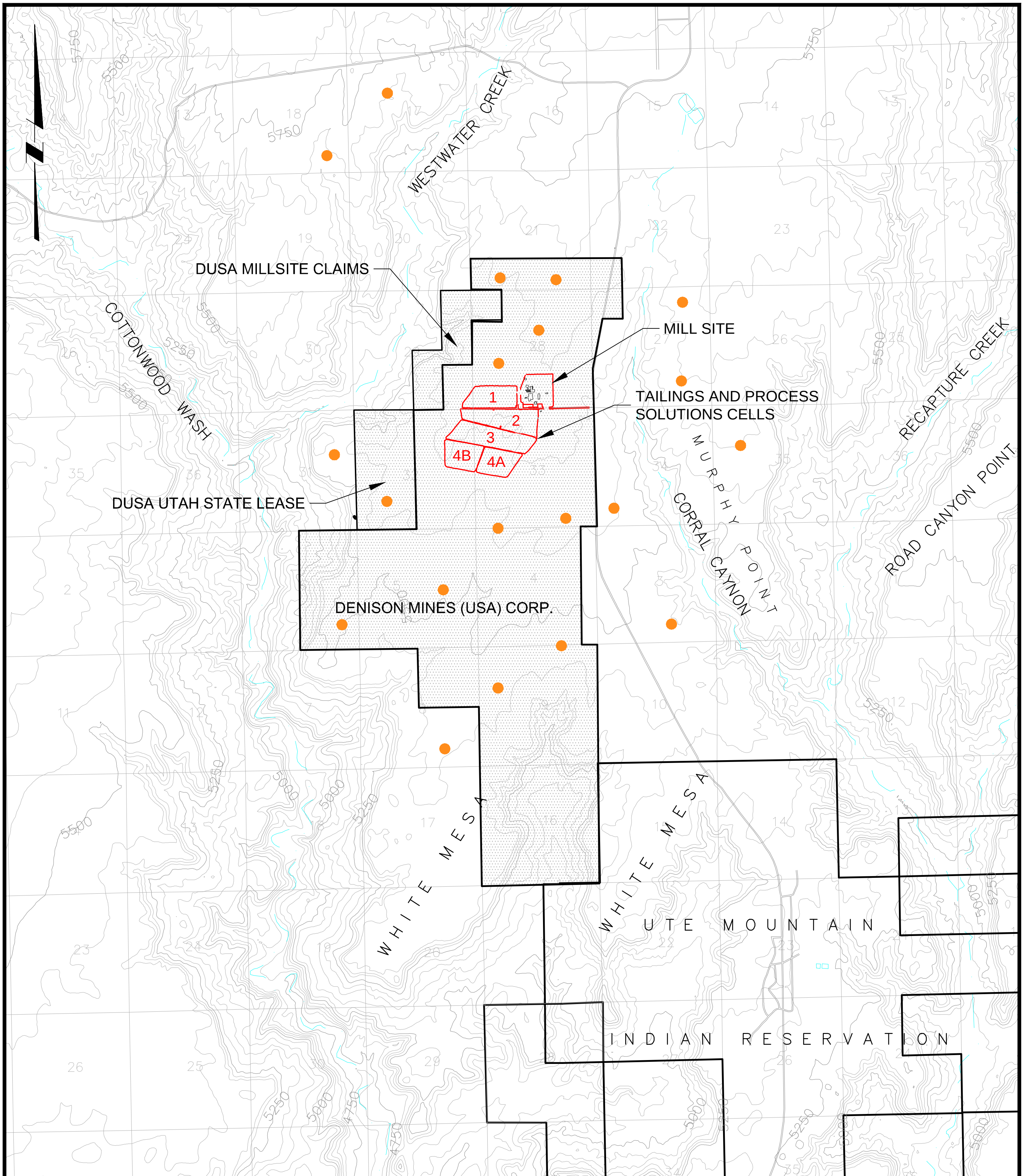
MWH

DATE AUG 2015

FIGURE D.1

FILE NAME 1009740 TRANS

L:\Design-Drafting\Clients-A-H\DENISON MINES\013-Sheet Set\2015-03-26 COVR DSN REP\1009740 TRANS



SCALE

6000' 0 6000'

LEGEND

TRANSECT LOCATION FOR ANIMAL SURVEY

L:\Design-Drafting\Clients-A-H\DENISON MINES\013-Sheet Set\2015-03-26 COVR DSN REP\1009740 TRANS

Energy Fuels Resources (USA) Inc.

PROJECT

WHITE MESA MILL RECLAMATION

TITLE

LOCATION OF 2012 ANIMAL
COVER SURVEY TRANSECTS

MWH

DATE
AUG 2015

FIGURE D.2

FILE NAME
1009740 TRANS

APPENDIX E

SLOPE STABILITY ANALYSIS

E.1 INTRODUCTION

This appendix presents the methods, input and results of slope stability analyses of the tailings cells at the Energy Fuels Resources (USA) Inc. (EFRI) White Mesa Uranium Mill (Mill). The Mill is located approximately 6.0 miles south of Blanding, Utah. These analyses were conducted according to applicable stability criteria under static and seismic conditions, including geotechnical stability criteria in NRC (2003). These analyses are an update to the slope stability analyses presented in MWH (2011) to incorporate revisions to the analyses to address State of Utah, Division of Waste Management and Radiation Control (DWMRC) (formerly Utah Division of Radiation Control, DRC) interrogatories (DRC, 2012) and review comments on EFRI responses to 2012 interrogatories (DRC, 2013). These analyses also incorporate the revised cover grading design, results of cover material testing conducted in 2010 and 2012 (summarized in Attachment B of EFRI, 2012), and the results of tailings testing conducted in 2013 (presented in MWH, 2015b).

Slope stability analyses were performed using limit equilibrium methods with the aid of the computer program SLOPE/W (GEO-SLOPE, 2007). The SLOPE/W program calculates factors of safety by any of the following methods: (1) Ordinary Fellenius, (2) Bishop's Simplified, (3) Janbu's Simplified, (4) Spencer, (5) Morgenstern-Price, (6) U.S. Army Corps of Engineers, (7) Lowe-Karafiath, and (8) Generalized Limit Equilibrium. The Morgenstern-Price method (Morgenstern and Price, 1965) with a half-sine function for inter-slice forces was selected for performing the computations in SLOPE/W. The method uses both circular and non-circular shear surfaces and satisfies both moment and force equilibrium.

E.2 CRITICAL CONDITIONS AND GEOMETRY

Slope stability analyses are typically conducted for scenarios that represent the critical conditions for post-reclamation. For the White Mesa Mill tailings cells, critical conditions for post-reclamation were evaluated and included: (1) reclaimed outside surfaces of the embankment with a 5H:1V slope, (2) existing inside surfaces of the embankments with a 2H:1V slope, and (3) conservative shear strength parameters based on previous reports.

A critical cross section, cross section A, was selected through the southern dike of Cell 4A near the southeast corner of the impoundment. The cross section location was selected based on overall impoundment height as well as base topography and is similar to the location used for the slope stability analyses presented in Titan (1996). The location of cross section A is shown in Figure E.1. The tailings are planned to be dewatered prior to placement of the final portion of cover. The phreatic surface was estimated to be five feet above the liner system for the analyses.

A second cross section, cross section B, was selected through the northern embankment of the Cell 1 Disposal Area. This location was chosen to address DRC interrogatories (DRC, 2012). The location of cross section B is shown in Figure E.2. The material placed in the Cell 1 Disposal Area will include mill debris and contaminated soils. The embankment cross section was assumed to be fully drained and therefore a phreatic surface was not included in the analyses.

Slope stability analyses were performed by calculating factors of safety along circular and non-circular failure surfaces for both static and pseudo-static conditions. Circular failure surface analyses were conducted by targeting both shallow and deep failure surfaces. Block failure surfaces through the clay liner system were evaluated for cross section B. A number of failure surfaces were analyzed in order to calculate the factor of safety for the critical failure.

E.3 MATERIAL PROPERTIES

Material strength parameters used for the slope stability analysis are based on parameters presented in Denison (2009) for the Cell 4B slope stability analyses conducted by Geosyntec, historical laboratory testing on tailings and clay materials (Advanced Terra Testing, 1996; Chen and Associates, 1987; D'Appolonia, 1982; and Western Colorado Testing, 1999), laboratory testing conducted in 2010 and 2012 on potential cover borrow materials (see Attachment B of EFRI, 2012), laboratory testing conducted in 2013 on tailings (MWH, 2015b) and typical published values. The parameters for each material are discussed below and summarized in Table E.1.

Erosion Protection: The erosion protection materials include riprap and filter material on the embankment slopes, and rock mulch on the top surface of the cover system. Typical density values for sand and gravel were used for the riprap and filter materials. The riprap and filter material strength parameters were estimated based on the lower bound typical values from Lambe (1969) for loose to medium dense sand and gravel. The rock mulch consists of topsoil material mixed with 25 percent gravel by weight. The density of the rock mulch was based on the 2012 laboratory testing results for topsoil (see Attachment B of EFRI, 2012) and applying a rock correction based on 25 percent gravel by weight. The total unit weight of the rock mulch was calculated using the estimated dry density and the long-term water content presented in the radon analyses. Effective strength parameters of the rock mulch were estimated as an angle of internal friction of 33 degrees and no cohesion, based on a maximum plasticity index (PI) of the topsoil of 10 percent (listed in the specifications), and using the generalized relationship between PI and effective angle of internal friction presented in Holtz and Kovacs (1981).

Cover System: The cover system material properties were estimated based on the updated geotechnical site investigation in April 2012. The total unit weight values used in the model for the random fill layers were estimated using 2010 and 2012 laboratory tests conducted on potential cover borrow materials (see Appendix A.2) and based on the compaction effort for each layer. The total unit weights for the cover layers were calculated using the long-term water contents for the cover layers used in the radon analyses. Effective strength parameters for the cover materials were estimated based on the maximum measured PI (30) from the 2010 and 2012 laboratory test results and using the generalized relationship between PI and effective angle of internal friction presented in Holtz and Kovacs (1981), resulting in an angle of internal friction of 29 degrees and no cohesion.

Tailings Material: The dry density of the tailings was estimated as 96 pcf, based on laboratory tests (Chen and Associates, 1987 and Western Colorado Testing, 1999) and assuming the upper bound long-term density of the tailings should be no greater than 90 percent of the average laboratory measured maximum dry density for tailings. This is the same density used for the radon analyses. The total unit weight of the tailings was calculated using the long-term water content assumed for the tailings in the radon analyses. Based on existing operations at the site, the tailings deposits are primarily fine sands with silt and some clay. The strength parameters of the tailings were conservatively estimated using the Naval Design Manual for Soil Mechanics DM7-01 (NAVFAC, 1986) as zero percent relative density silty sand. The strength parameters used for the tailings (no cohesion and an effective angle internal friction of 25 degrees) are consistent with the values presented in Denison (2009) for the Cell 4B design stability analyses.

Contaminated Soils/Mill Debris: The materials to be placed in the Cell 1 Disposal Area include contaminated soils and mill debris. The contaminated soils will be from on-site and have similar properties as the cover soils. The material properties for the contaminated soils and mill debris were conservatively assumed to be the same as the cover soils (compacted to 85 percent standard Proctor compaction).

Clay Liner: Cell 1 will be lined with a clay liner. The dry density of the clay was estimated based on laboratory tests performed on Section 16 clay (D'Appolonia, 1982; Advanced Terra Testing, 1996) and assuming the clay will be compacted to 95 percent of standard Proctor compaction. The total unit weight for the clay was calculated using the estimated dry density and a long-term water content of 14 percent. The long-term water content was estimated based on 15 bar water contents measured for Section 16 clay samples by Chen and Associates (1987) presented in Titan (1996). The strength parameters for the clay were estimated using the average measured PI (60) of samples meeting the placement specifications for minimum PI and percent passing the No. 200 sieve, and the generalized relationship between PI and effective angle of internal friction presented in Holtz and Kovacs (1981), resulting in an angle of internal friction of 24 degrees and no cohesion.

Dike and Foundation: Density and strength parameters for the existing foundation and dike material were estimated as the values presented in stability analyses performed for the design of Cell 4B by Geosyntec (Denison, 2009). The strength parameters used in the model were based on laboratory testing results from samples obtained from the existing berm between Cell 4A and 4B (Denison, 2009).

Bedrock: Failures are not anticipated to occur within the bedrock underlying the embankment, due to the relatively high strength of the underlying sedimentary rock. Therefore, the material properties for the bedrock were modelled as those consistent with sedimentary rock.

Table E.1. Material Parameters Used in Model

Material	Total Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (deg.)
Riprap	125	0	36
Riprap Filter	125	0	30
Rock mulch	110	0	33
Cover Upper Layer (85% SP compaction)	107	0	29
Cover Middle Layer (95% SP compaction)	120	0	29
Cover Lower Layer (80% SP compaction)	100	0	29
Random Fill	100	0	29
Tailings	95	0	25
Contaminated Soils/Mill Debris	107	0	29
Clay Liner	110	0	24
Dike	137	900	26
Foundation	137	900	26
Bedrock	130	10000	45

E.4 SEISMIC ANALYSIS AND SEISMICITY

Stability analyses under seismic conditions were conducted as pseudo-static analyses, where a horizontal acceleration or seismic coefficient is applied to both cross-sections. This seismic coefficient represents the horizontal accelerations applied on the structure by an earthquake. A coefficient of 0.1 g was used for the analyses based on the site-specific probabilistic seismic hazard analysis (MWH, 2015a). This seismic coefficient represents the seismic loading for the Maximum Credible Earthquake (MCE) calculated to occur during the long-term life of the embankment. A summary of the site seismicity is provided in the MWH (2015a).

A liquefaction analysis was conducted for the tailings and is presented in Appendix F (revised version provided as Attachment G to this submittal). The results indicate the tailings are not susceptible to earthquake-induced liquefaction. For materials that do not liquefy or lose shear strength with seismic shaking, seismic slope stability is analyzed by a pseudo-static approach. This consists of application of an equivalent horizontal acceleration or seismic coefficient to the structure being analyzed. The seismic coefficient represents an inertial force due to strong ground motions during the design earthquake, and is represented as a fraction of the peak ground acceleration (PGA) at the site (typically at the base of the structure). The strategy of representing the seismic coefficient as a fraction of the PGA has been adopted in review of uranium tailings facility design and documented in DOE (1989). A seismic coefficient of 2/3 of the PGA typically represents the post-reclamation conditions. MWH (2015a) estimated the mean PGA for reclaimed conditions to be 0.15g. The seismic coefficient used for the pseudo-static stability analysis is 0.10g (equal to 2/3 of the PGA).

E.5 DISCUSSION OF STABILITY ANALYSIS RESULTS

The results of stability analyses for Cross-section A and B are presented in Table E.2. These values represent the lowest calculated factor of safety from a number of individual failure surfaces for a Morgenstern-Price Analysis.

Table E.2. Slope Stability Analysis Results

Cross-Section	Failure Type	Loading Condition	Required Factors of Safety	Calculated Factors of Safety
Cross Section A - Cell 4A Embankment	Shallow Circular	Static	1.5	3.05
		Pseudo-Static	1.1	1.99
	Deep Circular	Static	1.5	3.86
		Pseudo-Static	1.1	2.53
Cross Section B – Cell 1 Embankment	Shallow Circular	Static	1.5	2.64
		Pseudo-Static	1.1	1.71
	Deep Circular	Static	1.5	2.71
		Pseudo-Static	1.1	1.76
	Block	Static	1.5	2.76
		Pseudo-Static	1.1	1.80

As shown in Table E.2, all calculated factors of safety were significantly above the NRC recommended values of 1.5 for static conditions and 1.1 for pseudo-static conditions. The model profile figures and SLOPE/W output figures for static and pseudo-static loading conditions are shown in Figures E.3 through E.14.

E.6 REFERENCES

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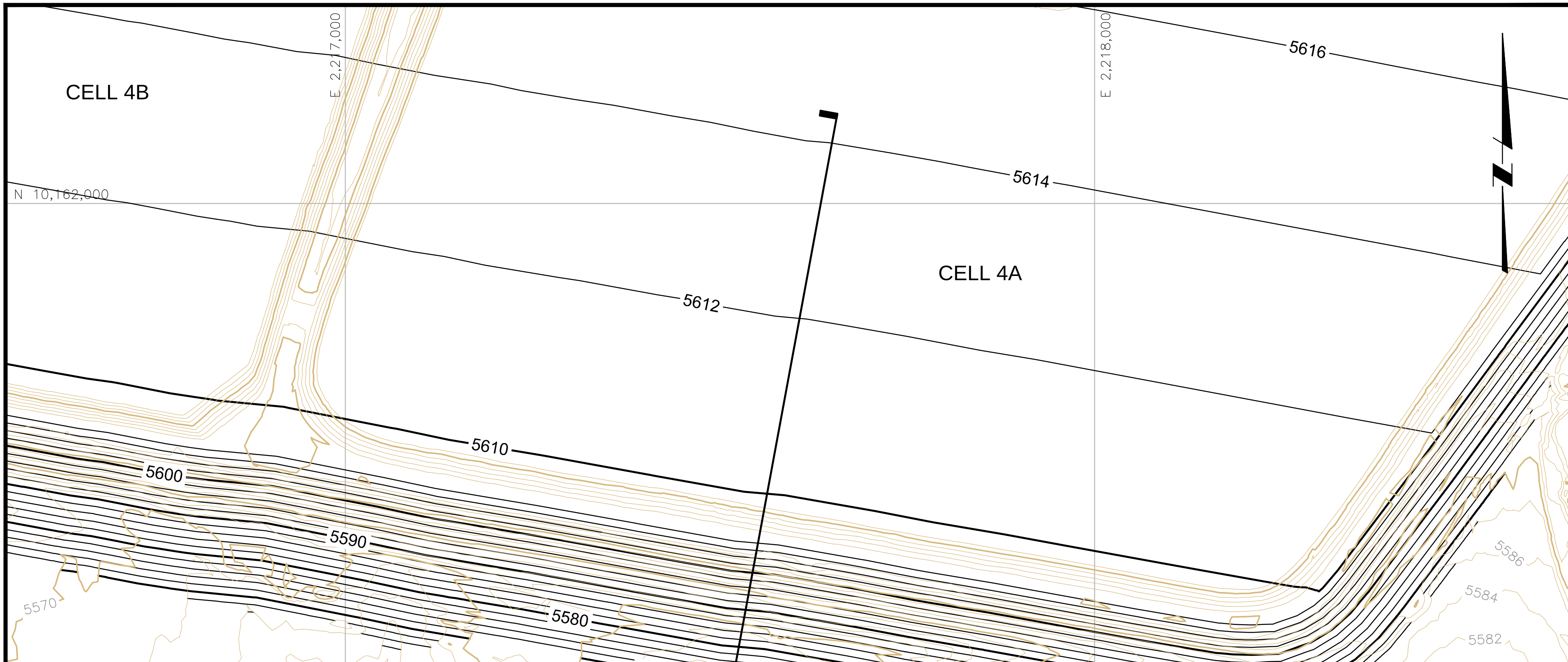
L:\Design-Drafting\Clients-A-H\ENERGY FUELS\013-Sheet Set\2015-08-31 COVER DSGN FIGS\WMM SLOPE STABILITY



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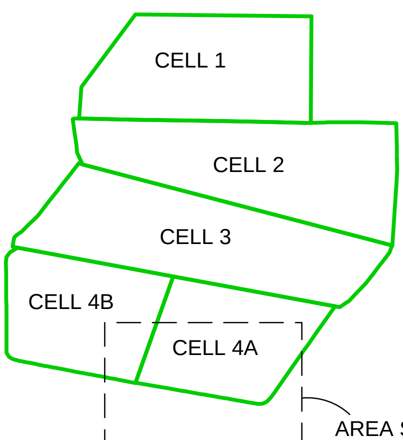
5605 — EXISTING TOPOGRAPHY BASED UPON FILE PROVIDED FROM ENERGY FUELS ON JULY 20, 2015. PER ENERGY FUELS, GROUND SURFACE CONTOURS ARE FROM 2012 AERIAL SURVEY CONDUCTED BY JONES & DeMILLE ENGINEERING INC., EXCEPT FOR CELLS 2 AND 3. CELL 2 TOPOGRAPHY FROM ENERGY FUELS SURVEY CONDUCTED OCTOBER 2013. CELL 3 TOPOGRAPHY FROM ENERGY FUELS SURVEY CONDUCTED ON JULY 8, 2014.

5605 — FINAL COVER SURFACE ELEVATION (TOP OF EROSION PROTECTION LAYER), FEET



KEY MAP

NOT TO SCALE

Energy Fuels Resources (USA) Inc.

PROJECT

WHITE MESA MILL TAILINGS RECLAMATION

TITLE

SLOPE STABILITY
CROSS SECTION A LOCATION

MWH

DATE AUG 2015

FIGURE E.1

FILE NAME WMM SLOPE STABILITY

L:\Design-Drafting\Clients-A-H\ENERGY FUELS\013-Sheet Set\2015-08-31 COVER DSGN FIGS\WMM SLOPE STAB B

LEGEND:

5605 — EXISTING TOPOGRAPHY BASED UPON FILE PROVIDED FROM ENERGY FUELS ON JULY 20, 2015. PER ENERGY FUELS, GROUND SURFACE CONTOURS ARE FROM 2012 AERIAL SURVEY CONDUCTED BY JONES & DeMILLE ENGINEERING INC., EXCEPT FOR CELLS 2 AND 3. CELL 2 TOPOGRAPHY FROM ENERGY FUELS SURVEY CONDUCTED OCTOBER 2013. CELL 3 TOPOGRAPHY FROM ENERGY FUELS SURVEY CONDUCTED ON JULY 8, 2014.

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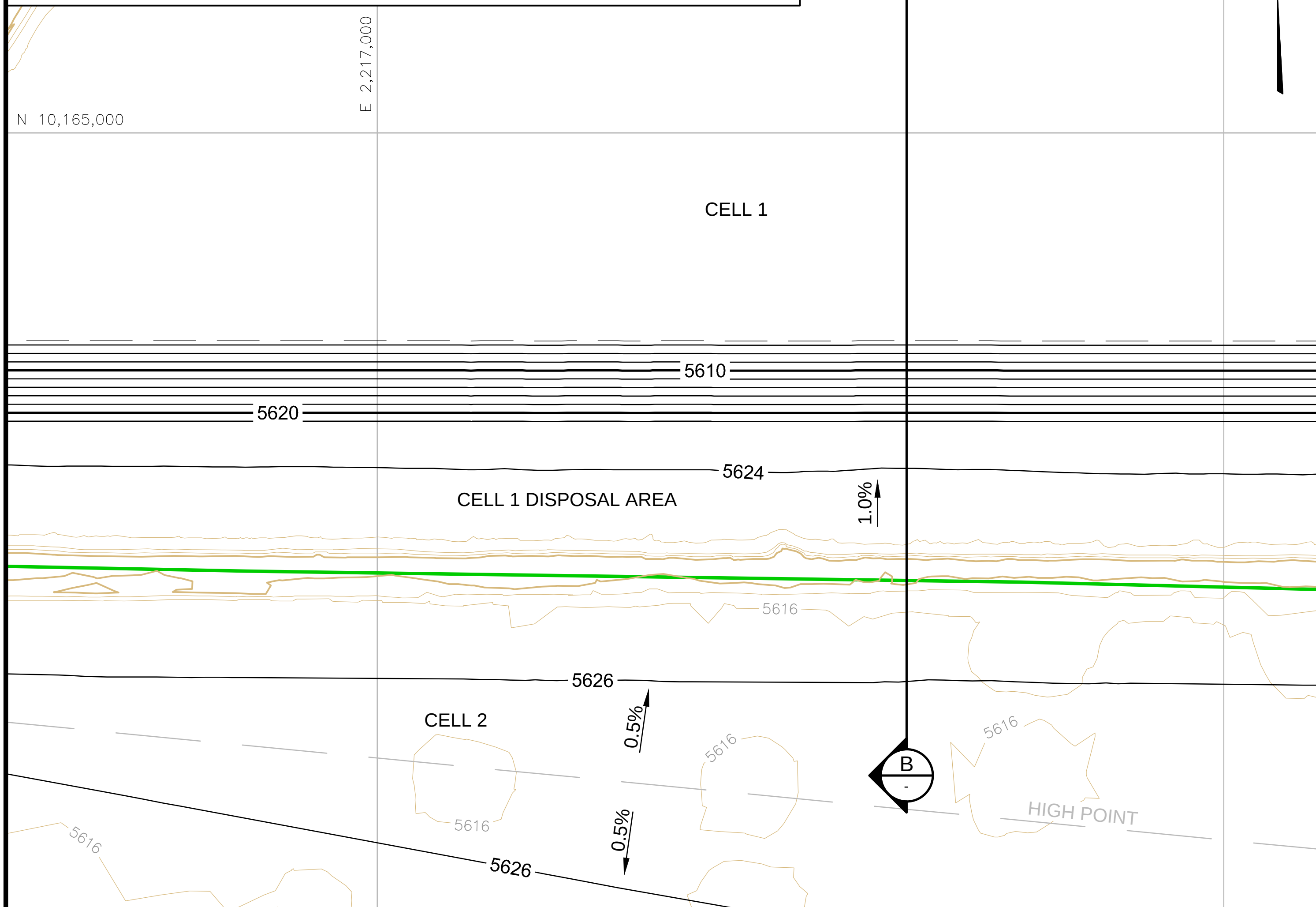
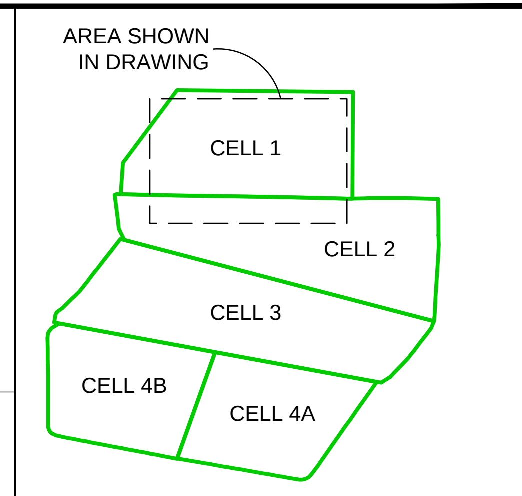




KEY MAP

NOT TO SCALE

Energy Fuels Resources (USA) Inc.

PROJECT: WHITE MESA MILL TAILINGS RECLAMATION

TITLE: SLOPE STABILITY CROSS SECTION B LOCATION

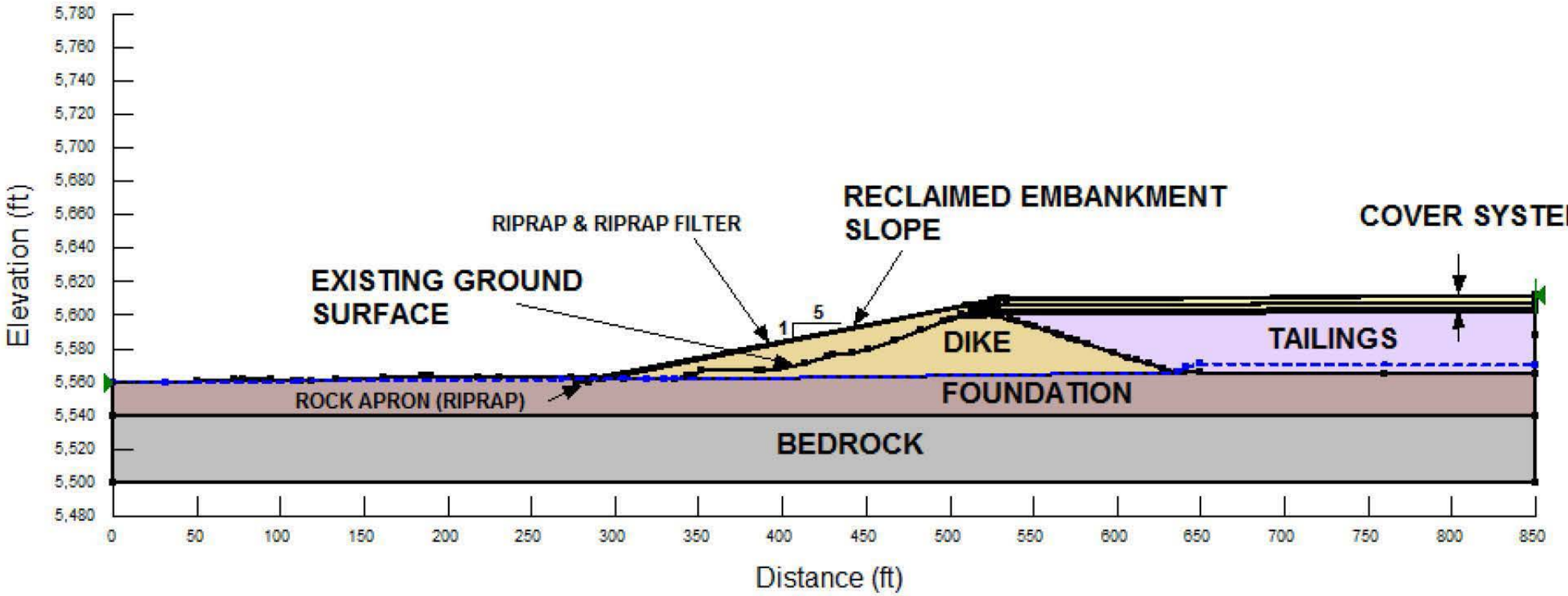
MWH

DATE: AUG 2015

FIGURE E.2

FILE NAME: WMM SLOPE STAB B

EFRI - White Mesa Mill
Cross Section A
Closure



Energy Fuels Resources (USA) Inc.

PROJECT
White Mesa Mill Reclamation

TITLE
Cross Section A on Cell 4A Slope Stability Analysis Model Profile

MWH

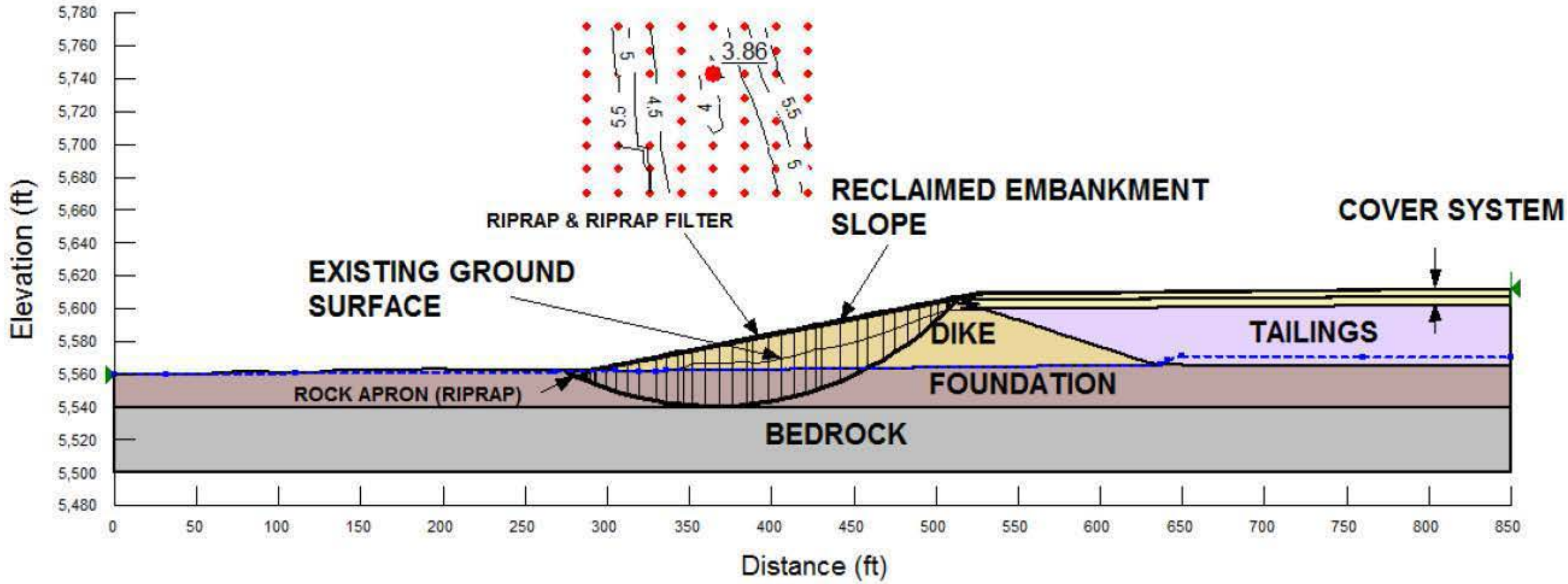
DATE AUG 2015

FIGURE E.3

FILENAME Appendix E Slope Stability Results.pptx

EFRI - White Mesa Mill
Cross Section A
Closure

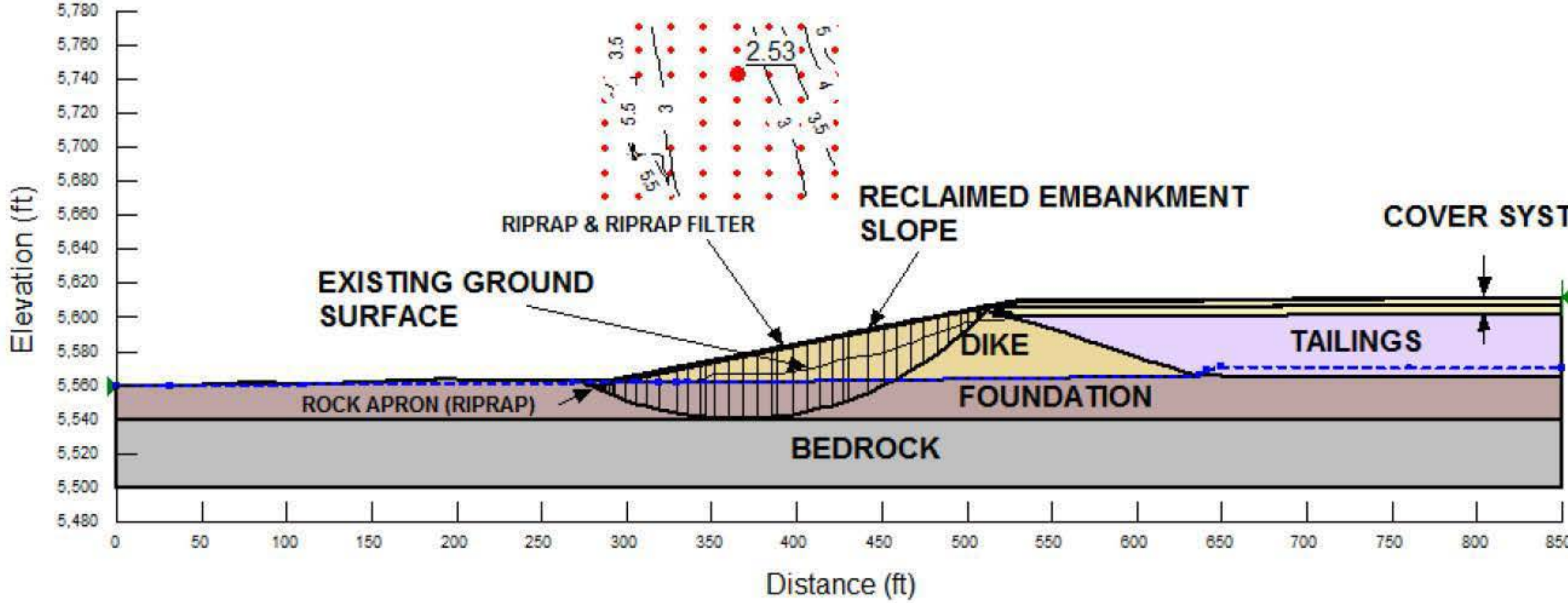
Static Loading Conditions
Required Factor of Safety: 1.5



Energy Fuels Resources (USA) Inc.	PROJECT: White Mesa Mill Reclamation
	TITLE: Cross Section A on Cell 4A Slope Stability Analysis Static Conditions - Deep Circular
MWH	DATE: AUG 2015 — FIGURE E.4
	FILENAME: Appendix E Slope Stability Results.pptx

EFRI - White Mesa Mill
Cross Section A
Closure

Pseudo-Static (k = 0.1g) Loading Conditions
Required Factor of Safety: 1.1

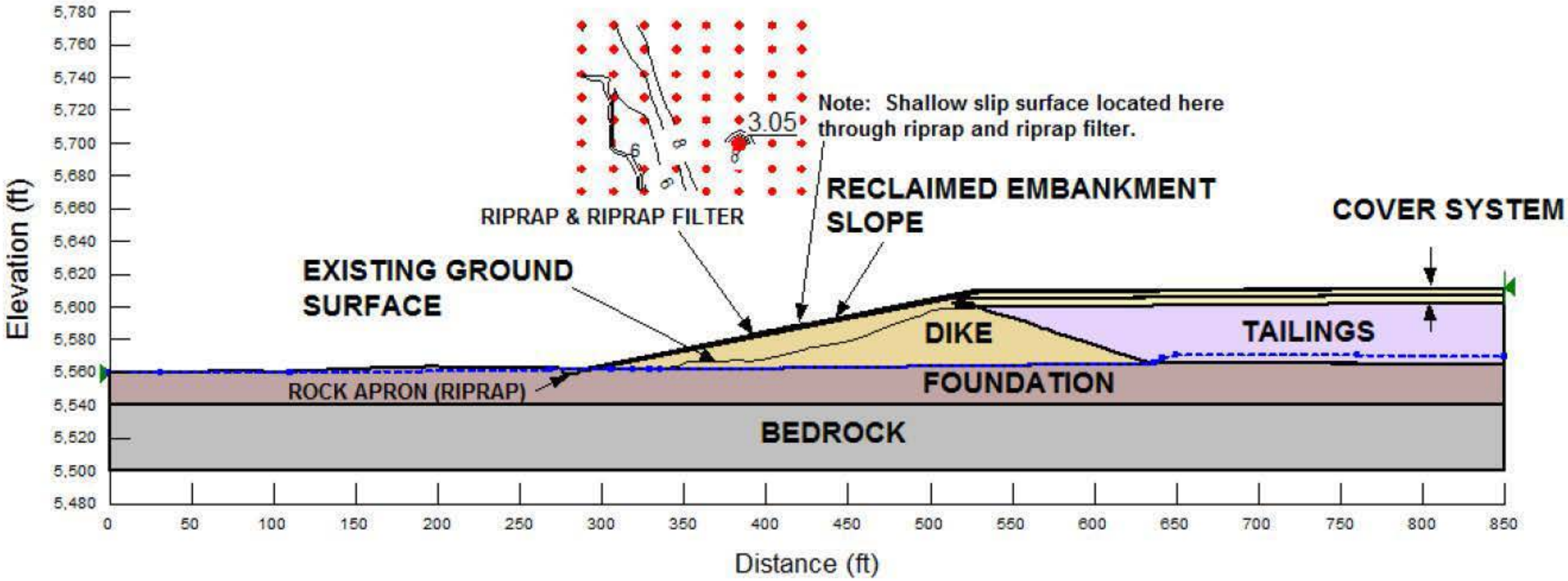


Energy Fuels Resources (USA) Inc.

PROJECT White Mesa Mill Reclamation		MWH
TITLE Cross Section A on Cell 4A Slope Stability Analysis Pseudo-Static Conditions - Deep Circular	DATE AUG 2015	FIGURE E.5
	FILENAME Appendix E Slope Stability Results.pptx	

EFRI - White Mesa Mill
Cross Section A
Closure

Static Loading Conditions
Required Factor of Safety: 1.5



Energy Fuels Resources (USA) Inc.

PROJECT
White Mesa Mill Reclamation

TITLE
Cross Section A on Cell 4A Slope Stability Analysis Static Conditions - Shallow

MWH

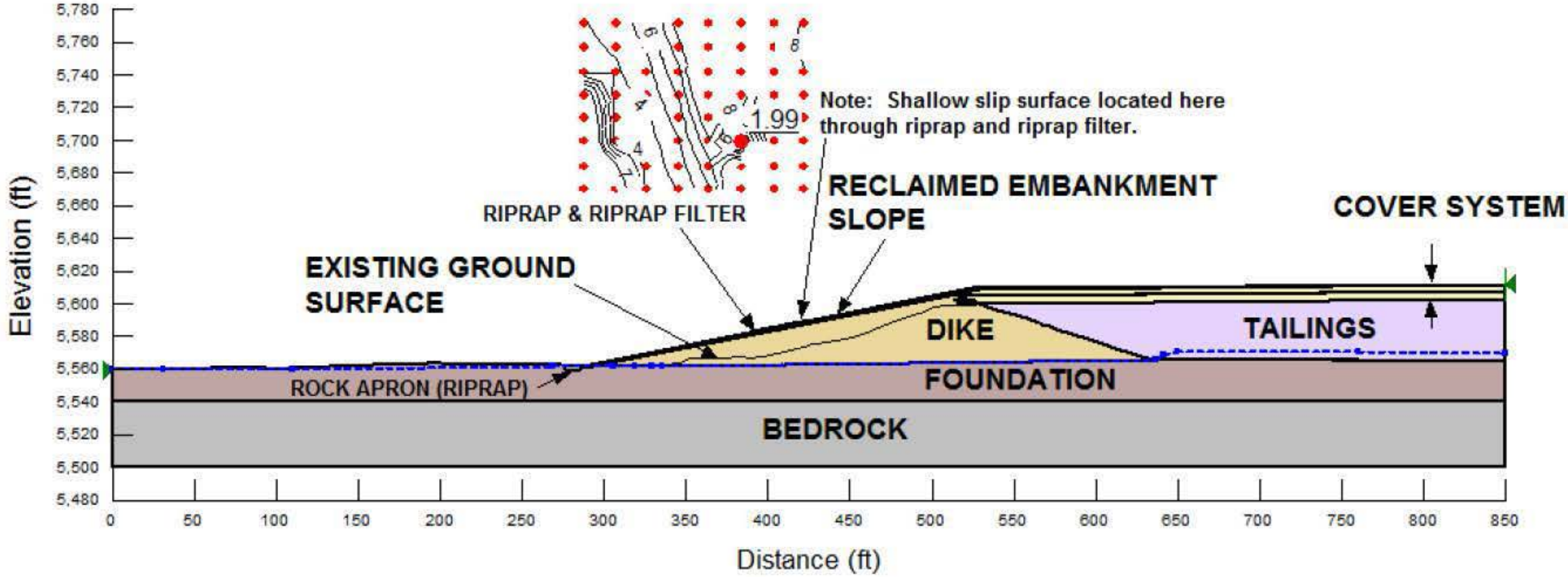
DATE AUG 2015

FIGURE E.6

FILENAME Appendix E Slope Stability Results.pptx

EFRI - White Mesa Mill
Cross Section A
Closure

Pseudo-Static (k = 0.1g) Loading Conditions
Required Factor of Safety: 1.1

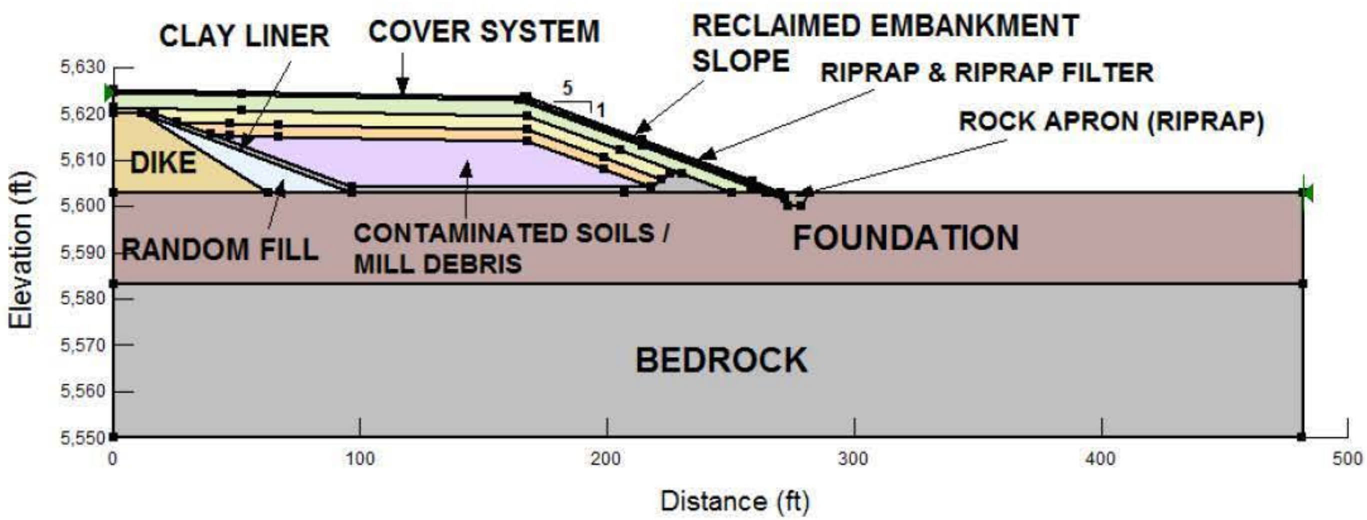


Energy Fuels Resources (USA) Inc.

PROJECT	White Mesa Mill Reclamation
TITLE	Cross Section A on Cell 4A Slope Stability Analysis Pseudo-Static Conditions - Shallow
DATE	AUG 2015
	FIGURE E.7
FILENAME	Appendix E Slope Stability Results.pptx

MWH

EFRI - White Mesa Mill
Cross Section B
Closure



Energy Fuels Resources (USA) Inc.

PROJECT
White Mesa Mill Reclamation

TITLE
Cross Section B on Cell 1 Slope Stability Analysis Model Profile

MWH

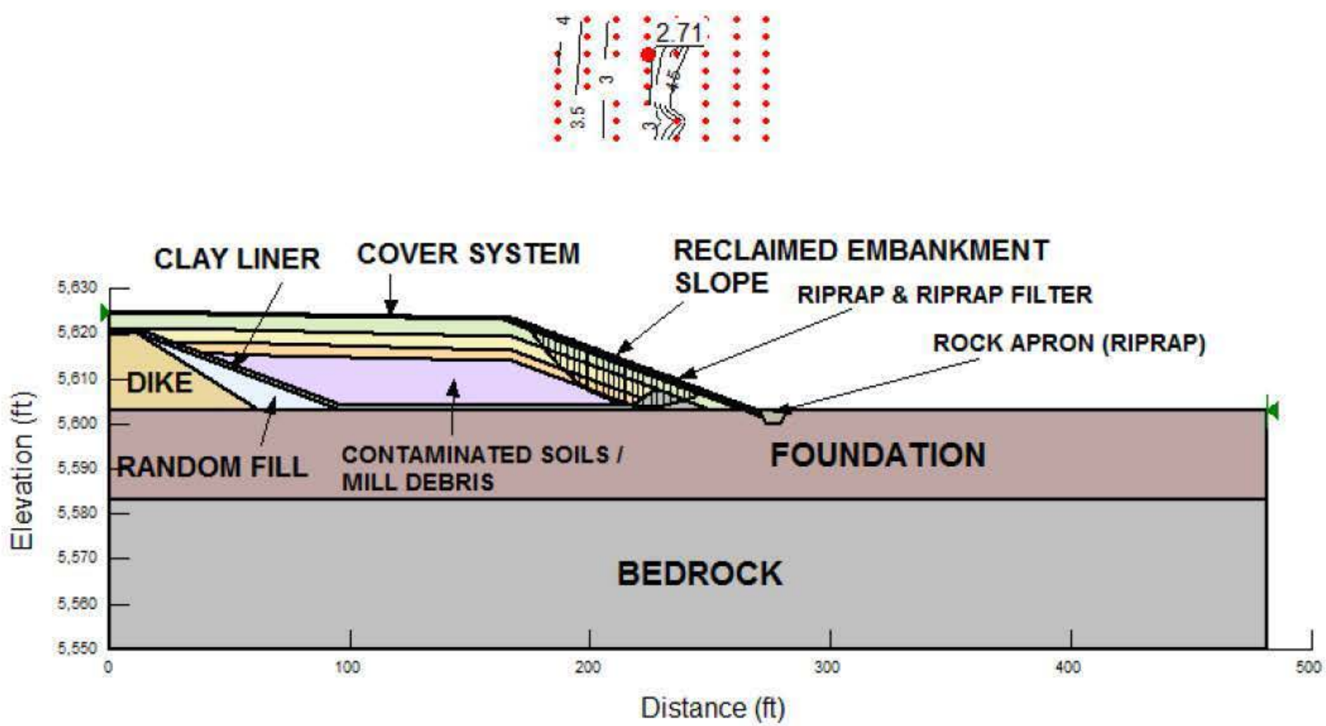
DATE AUG 2015

FIGURE E.8

FILENAME Appendix E Slope Stability Results.pptx

EFRI - White Mesa Mill
Cross Section B
Closure

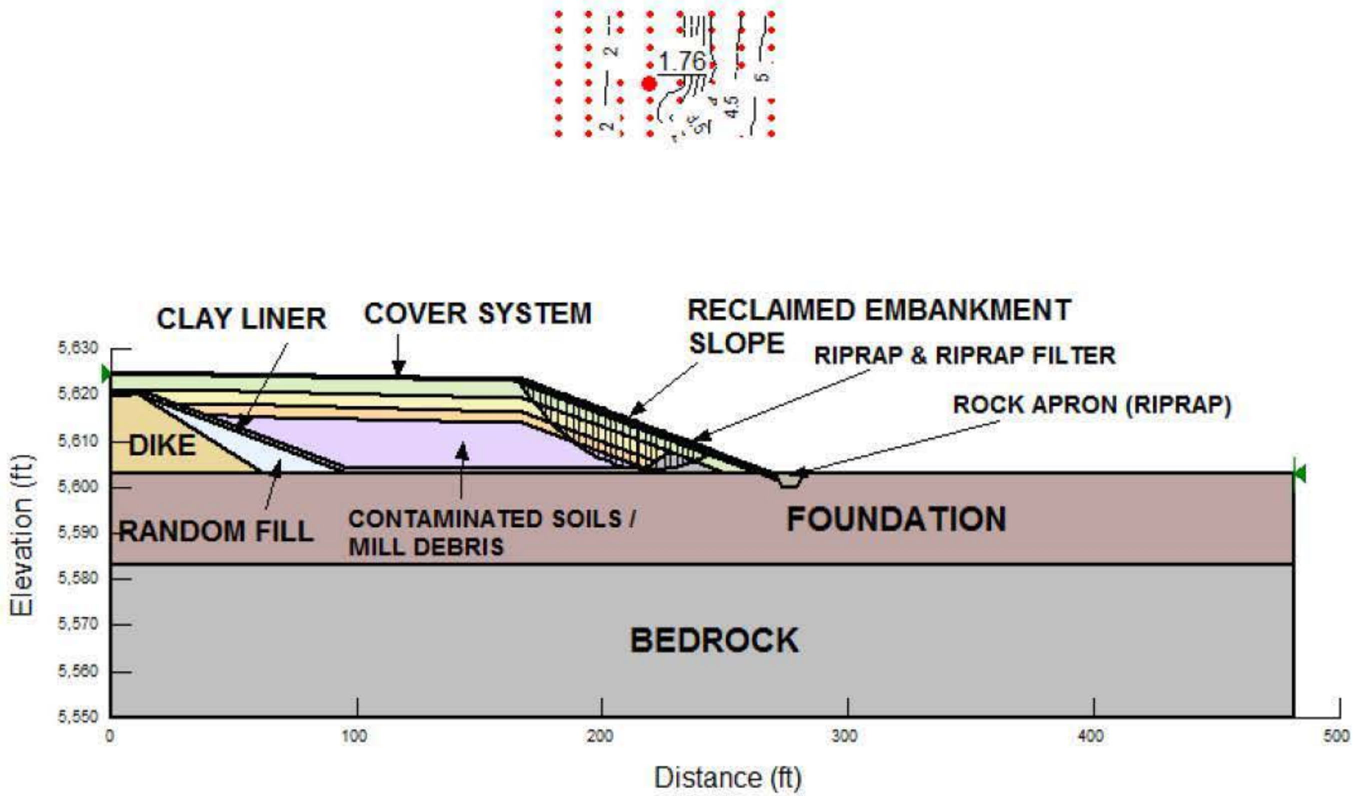
Static Loading Conditions
Required Factor of Safety: 1.5



Energy Fuels Resources (USA) Inc.	PROJECT White Mesa Mill Reclamation	MWH	
	TITLE Cross Section B on Cell 1 Slope Stability Analysis Static Conditions - Deep Circular	DATE AUG 2015	FIGURE E.9
		FILENAME Appendix E Slope Stability Results.pptx	

EFRI - White Mesa Mill
Cross Section B
Closure

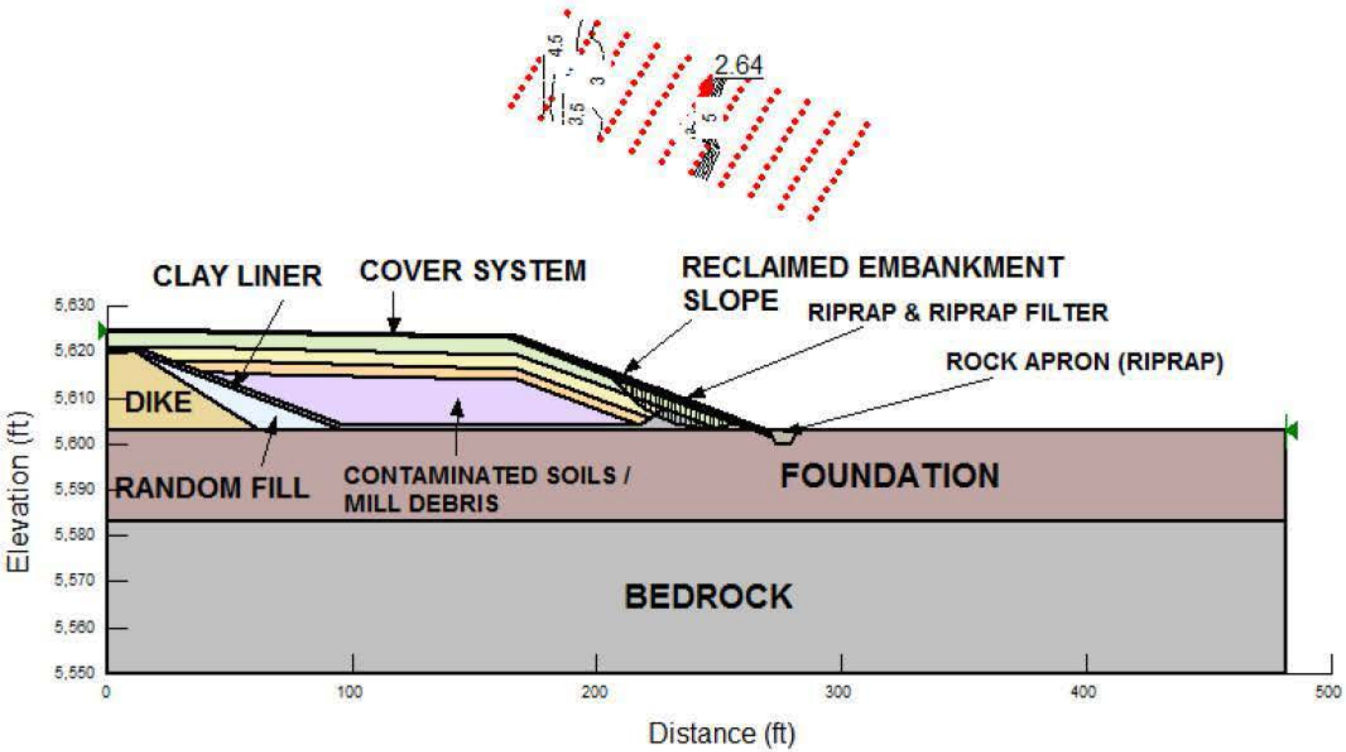
Pseudo-Static Loading Conditions
Required Factor of Safety: 1.1



Energy Fuels Resources (USA) Inc.	PROJECT White Mesa Mill Reclamation	MWH
	TITLE Cross Section B on Cell 1 Slope Stability Analysis Pseudo-Static Conditions - Deep Circular	DATE AUG 2015 — FIGURE E.10 FILENAME Appendix E Slope Stability Results.pptx

EFRI - White Mesa Mill
Cross Section B
Closure

Static Loading Conditions
Required Factor of Safety: 1.5



PROJECT	DATE	FIGURE
White Mesa Mill Reclamation	AUG 2015	FIGURE E.11

Energy Fuels Resources (USA) Inc.

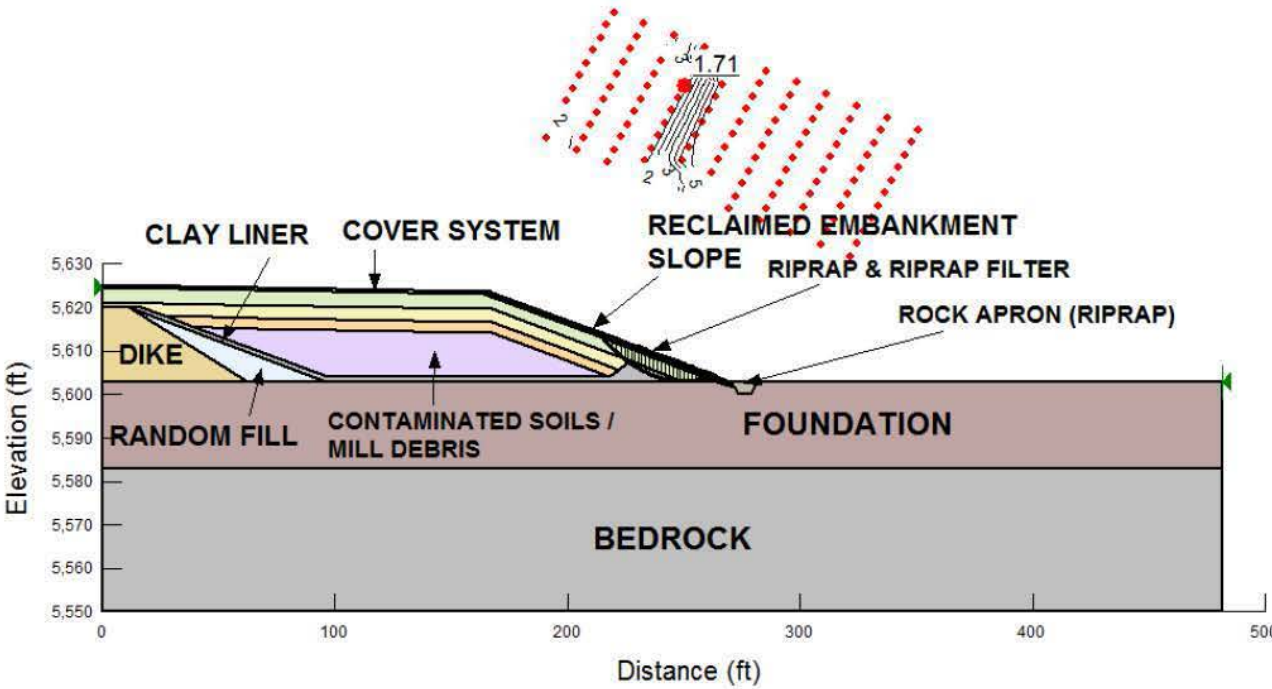
TITLE: Cross Section B on Cell 1 Slope Stability Analysis Static Conditions - Shallow Circular

MWH

FILENAME: Appendix E Slope Stability Results.pptx

EFRI - White Mesa Mill
Cross Section B
Closure

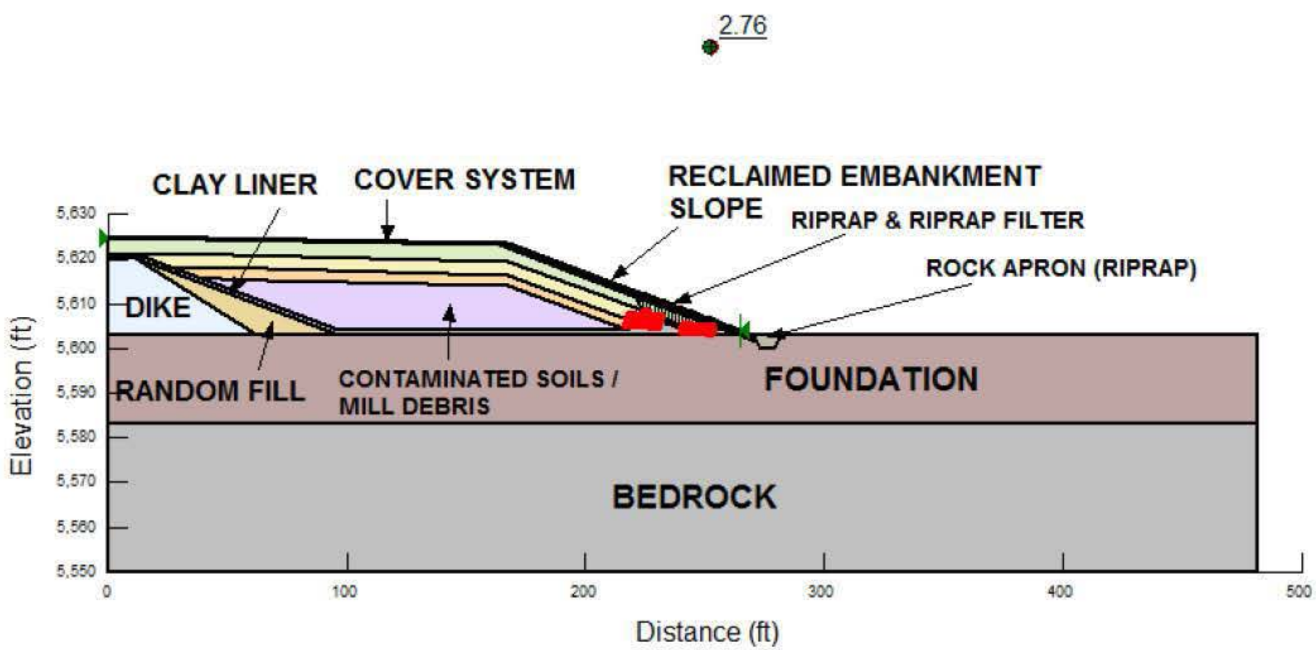
Pseudo-Static (k = 0.1g) Loading Conditions
Required Factor of Safety: 1.1



Energy Fuels Resources (USA) Inc.	PROJECT: White Mesa Mill Reclamation	MWH	
	TITLE: Cross Section B on Cell 1 Slope Stability Analysis Pseudo-Static Conditions - Shallow Circular	DATE: AUG 2015	FIGURE E.12
		FILENAME: Appendix E Slope Stability Results.pptx	

EFRI - White Mesa Mill
Cross Section B
Closure

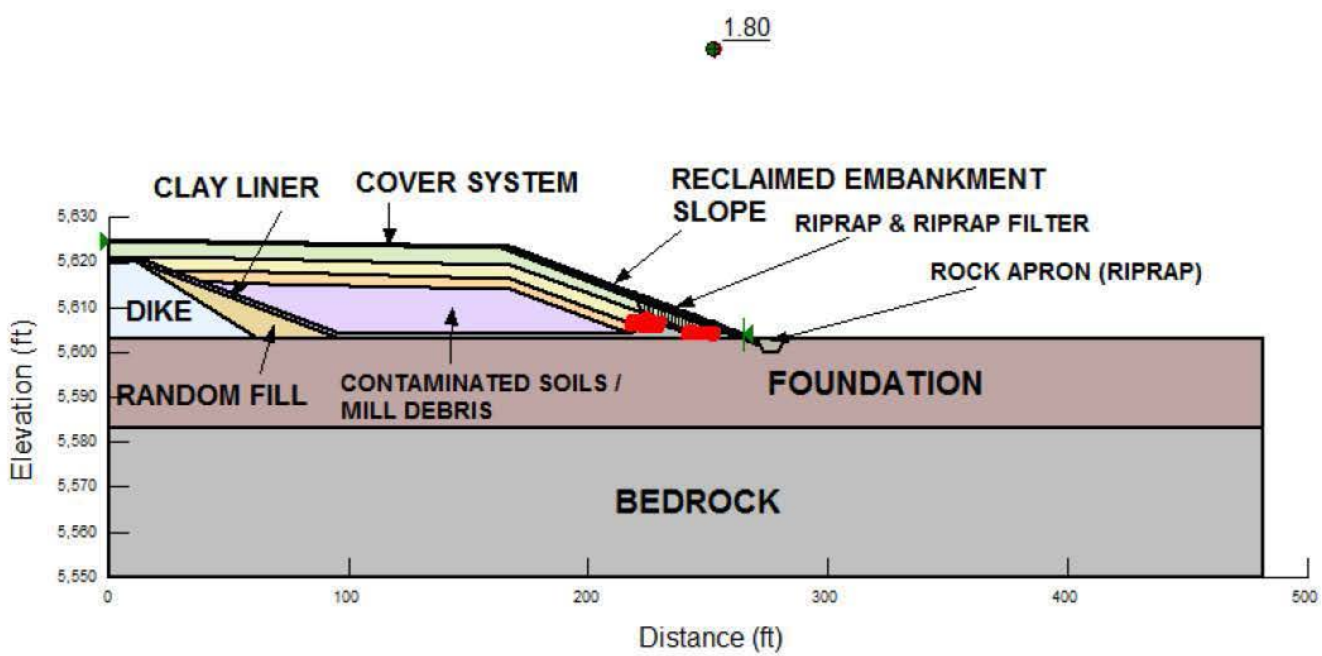
Block Failure - Static Loading
Required Factor of Safety: 1.5



Energy Fuels Resources (USA) Inc.	PROJECT: White Mesa Mill Reclamation	MWH	
	TITLE: Cross Section B on Cell 1 Slope Stability Analysis Static Conditions - Block	DATE: AUG 2015	FIGURE E.13
		FILENAME: Appendix E Slope Stability Results.pptx	

EFRI - White Mesa Mill
Cross Section B
Closure

Block Failure - Pseudo-Static (k = 0.1g) Loading Conditions
Required Factor of Safety: 1.1



Energy Fuels Resources (USA) Inc.	PROJECT White Mesa Mill Reclamation	MWH
	TITLE Cross Section B on Cell 1 Slope Stability Analysis Pseudo-Static Conditions - Block	DATE AUG 2015 / FIGURE E.14
		FILENAME Appendix E Slope Stability Results.pptx

APPENDIX F

SETTLEMENT AND LIQUEFACTION ANALYSES

F.1 BACKGROUND

This appendix presents results of settlement analyses and evaluation of liquefaction potential of tailings for the Energy Fuels Resources (USA) Inc. (EFRI) White Mesa Uranium Mill tailings disposal cells. These analyses are an update to the settlement and liquefaction analyses presented in MWH (2011) to address State of Utah, Division of Waste Management and Radiation Control (DWMRC) (formerly Utah Division of Radiation Control, DRC) interrogatories (DRC, 2012) and review comments on EFRI responses to 2012 interrogatories (DRC, 2013). These analyses also incorporate (1) the revised cover grading design, (2) results of cover material testing conducted in 2010 and 2012 (summarized in Attachment B of EFRI, 2012), (3) results of the recent site-specific probabilistic hazard analysis (presented in MWH, 2015a), (4) results of tailings testing conducted in 2013 (presented in MWH, 2015b), and (5) updated calculation methods for the seismic settlement and liquefaction potential.

Settlement analyses were conducted to evaluate settlement due to placement of final cover, dewatering of the tailings cells, long-term static (creep) settlement, and seismically induced (seismic) settlement. The results of these analyses were used to evaluate differential settlement and the potential for cover cracking. The settlement analyses are discussed in Section F.2. The tailings cells were also evaluated for liquefaction potential and discussion is provided in Section F.3.

The monolithic ET cover system evaluated in this appendix consists of the following layers from top to bottom:

- 0.5 ft (15 cm) Erosion Protection Layer (gravel-admixture)
- 3.5 ft (107 cm) Water Storage/Biointrusion/Frost Protection/Radon Attenuation Layer (loam to sandy clay)
- 3.0 to 4.0 ft (91 to 122 cm) Radon Attenuation Layer (highly compacted loam to sandy clay)
- 2.5 ft (75 cm) Radon Attenuation and Grading Layer (loam to sandy clay)

F.2 SETTLEMENT ANALYSES

F.2.1 Method of Analyses

General. One-dimensional (1-D) settlement analyses were conducted for the tailings in Cells 2 and 3 to estimate total potential future settlement of the tailings after placement of the final cover. The cone penetration testing (CPT) locations from the October 2013 tailings investigation (MWH, 2015b) were selected as the locations for the settlement analyses. The CPT locations are shown on Figure F.1, along with the settlement monument locations. All CPT locations were adjacent to settlement monuments.

The settlement analyses were conducted for two time periods as described below.

1. Settlement during active maintenance. This settlement was calculated as the settlement due to placement of the final cover and dewatering. Water levels during

active maintenance were assumed to be drawn down from water level elevations presented in MWH (2015b) for the October 2013 tailings elevation to five feet above the liner. EFRI proposes to dewater the tailings during active maintenance and draw down the water levels with in Cells 2 and 3 such that there are not issues with cover stability. This water level has been assumed as 5 feet for these analyses. Once dewatering to this water level has been completed, remaining primary consolidation due to placement of the cover will be very small.

2. Settlement after active maintenance. This settlement was calculated as the sum of settlement due to creep and seismic settlement. The water level within the tailings was assumed to be located five feet above the liner after active maintenance based EFRI's plan for dewatering during active maintenance for Cells 2 and 3.

1-D Column Geometry. Vertical soil profiles presented in MWH (2015b) for each CPT location were used in the 1-D consolidation analyses, with the water levels presented in that report being used for initial pore pressure conditions. This assumption is considered conservative since water levels will continue to decrease due to dewatering prior to final cover placement. Cover thicknesses are based on the cover design as listed above, with total cover thicknesses of 10.5 and 10 feet for Cells 2 and 3, respectively. The stress state for the layers within each column is calculated at the midpoint of each tailings layer. Additional vertical column geometry details are provided in Attachment F.1.

Total Settlement During Active Maintenance. Settlement during active maintenance is assumed to be due to primary consolidation caused by cover loading and dewatering (i.e. creep and initial compression are neglected). Settlement is calculated using the following equation:

$$S = \frac{C_C H}{1+e_0} \log \frac{\sigma'_f}{\sigma'_i}$$

Where:

S = settlement
C_c = compression index
H = thickness of tailings layer (ft)
e_i = initial void ratio of tailings
σ'_i = initial average effective overburden pressure (psf)
σ'_f = final effective vertical pressure (psf)

Total Settlement After Active Maintenance. Settlement after active maintenance is completed is assumed to be due to creep and seismic settlement.

Creep Settlement. Creep settlement was calculated using the method presented in Holtz and Kovacs (1981) and assuming a typical value for the ratio of the secondary compression index to the compression index (C_α/C_c) of 0.02 based on the upper bound average C_α estimated from laboratory testing on sand-slime and slime tailings (MWH, 2015b). The secondary settlements are based on a time period of 1,000 years.

Seismic Settlement. Seismic settlement was estimated using methods presented in Stewart et al. (2004), and seismic parameters presented in the site-specific probabilistic seismic hazard analysis for the site (MWH, 2015a). The mean peak ground acceleration (PGA) for reclaimed (long-term) conditions is 0.15 g for an average return period of 10,000 years. The mean seismic source is from a magnitude 5.5 event occurring 20 km from the site. The equations used from Stewart et al. (2004) are provided below.

Shear strain and related equations:

$$\gamma = \frac{1 + g_1 \cdot e^{g_2 \cdot P}}{1 + g_1} P \cdot 100 \text{ (units of \%)}$$

$$\text{PI} \approx 0: \quad g_1 = 0.199 \cdot (\sigma'/p_a)^{0.231} \quad g_2 = 10850 \cdot (\sigma'/p_a)^{-0.410}$$

$$\text{PI} \approx 15: \quad g_1 = 0.194 \cdot (\sigma'/p_a)^{0.265} \quad g_2 = 7490 \cdot (\sigma'/p_a)^{-0.418}$$

$$\text{PI} \approx 30: \quad g_1 = 4.0 \quad g_2 = 1400$$

$$\gamma_{eff} \frac{G_{eff}}{G_{max}} = \frac{0.65 \cdot PHA \cdot \sigma_0 \cdot r_d}{g \cdot G_{max}} \equiv P$$

Where:

γ: shear strain
PI: plasticity index
σ': effective stress
p_a : atmospheric pressure (calculated for an average elevation of 5,600 feet for the site)
G_{eff}: effective shear modulus
G_{max}: small strain shear modulus
PHA: peak horizontal acceleration
σ_o: total overburden pressure
r_d: reduction factor, ratio of actual shear stress at depth vs. theoretical "rigid body" shear stress
g: acceleration due to gravity

Volumetric strain at 15 cycles equation:

$$\varepsilon_{v,N=15} = a(\gamma_c - \gamma_{tv})^b$$

Where:

$\varepsilon_{v,\,N=15}$: volumetric strain at 15 cycles
a, b, and γ_{tv}: material-specific constants (estimated based on relative compaction, soil type, fines content, and plasticity using Figures 6.5 – 6.7 in Stewart et. al, 2004)
γ_c: shear strain (same as shear strain, γ, listed above)

Volumetric strain for design event:

$$\varepsilon_V = \varepsilon_{V,\ N=15} * C_n * 2$$

$$C_N = R\ln(N) + c$$

$$c = 1 - \ln(15)\times R$$

$$N = \frac{\left(\frac{\exp(b_1 + b_2(m - m^*))}{10^{1.5m+16.05}}\right)^{-\frac{1}{3}}}{4.9\cdot 10^6 \beta} + Sc_1 + rc_2$$

Where:

ε_V: volumetric strain for design event
C_N: normalized vertical strain
R: slope parameter (estimated as 0.36, 0.32, and 0.34 for soils with non-plastic fines, soils with low-plasticity fines, and soils with medium plasticity fines, respectively, as presented in Stewart et al., 2004 pages 86 through 89)
N: equivalent number of uniform strain cycles
c: slope parameter estimated from equation listed above
b_1: 1.53 (Stewart et al., 2004)
b_2: 1.51 (Stewart et al., 2004)
c_1: 0.75 (Stewart et al., 2004)
c_2: 0.095 (Stewart et al., 2004)
β: 3.2 (Stewart et al., 2004)
m: 5.8 (Stewart et al., 2004)*
m: design earthquake magnitude
r: site-source distance (km)
S: equal to 0 if rock or shallow soil (<20m) underlies the fill and 1 if >20m underlies the fill

F.2.2. Material Properties

EFRI conducted a tailings investigation of Cells 2 and 3 in October 2013 at the White Mesa Mill site to collect site-specific tailings data to supplement existing tailings data used for the settlement analyses. The results are presented in MWH (2015b). The tailings profiles and properties used for the settlement analyses are based on the results presented in MWH (2015b). Parameters used for the cover materials are based on cover material testing conducted in 2010 and 2012 (summarized in Attachment B of EFRI, 2012). Parameters used for the settlement analyses are summarized in Table F.1 and discussed in the following paragraph. Additional detail on soil properties and consolidation parameters used in the analyses are provided in Attachments F.1 through F.3.

Table F.1 Summary of Soil Parameters used for Settlement Analyses

Material Type	Initial Dry Density (pcf)	Specific Gravity	Initial void Ratio, e	Average Percent Passing No. 200 Sieve (%)	Com-pression Index, C_c	Secondary Com-pression Index, C_α
Erosion Protection Layer (topsoil)	100[1]	2.61[1]	0.61[2]	51[1]	0.14[3]	NA
Erosion Protection Layer (rock mulch)	106[1]	2.62[1]	0.54[2]	45[1]	0.14[3]	NA
Evapotransporation Cover Layer	100[1]	2.63[1]	0.64[2]	51[1]	0.14[3]	NA
High-Compaction Cover Layer	112[1]	2.63[1]	0.46[2]	51[1]	0.14[3]	NA
Platform Fill/Interim Cover	94[1]	2.63[1]	0.74[2]	51[1]	0.14[3]	NA
Sand Tailings	97[5]	2.70[5]	0.74[2]	18[5]	0.12[6]	0.002[4]
Sand-Slime Tailings	88[5]	2.80[5]	0.99[2]	47[5]	0.24[5]	0.005[4]
Slime Tailings	78[5]	2.86[5]	1.29 [2]	71[5]	0.28[5]	0.006[4]

[1]From laboratory values presented in EFRI (2012)
[2]Calculated value
[3] Calculated from empirical equation for soil types similar to cover material (as presented in Holtz and Kovacs, 1981).
[4] Estimated from laboratory results presented in MWH (2015b), upper bound average $C\alpha$ for sand-slime and slime tailings of 0.02
[5]From laboratory results presented in MWH (2015b)
[6]Based on lab testing performed on uranium tailings sands and presented in Keshian and Rager (1988)

Additional assumptions for soil parameters used in the analyses are provided below.

- For the consolidation, dewatering, and creep settlement analyses, the moist unit weight for all tailings layers (saturated and unsaturated) was estimated as the saturated unit weight which results in a conservative estimate of loading.
- For the consolidation, dewatering, and creep settlement analyses, properties of the layers of tailings between the liner and the bottom of the CPT depth were estimated as sand-slime tailings. The sand-slime tailings comprise approximately 65 percent of the total tailings in Cells 2 and 3.
- For calculating loading conditions for seismic settlement and evaluation of liquefaction, the moist unit weight for unsaturated tailings layers were estimated based on the long-term moisture content of the tailings as presented in the radon emanation modeling.
- Initial stress conditions for liquefaction analyses were estimated using CPT data from MWH (2015b) assuming the initial conditions in the future will be the same as in October 2013. This is conservative as it does not account for the effects of consolidation and aging that will occur in the tailings during the active maintenance period. For the seismic settlement analyses of Cell 3, the average shear wave velocities with depth measured for Cell 2 tailings were used in the analyses to partially account for consolidation and aging that will occur during this period. These values range from 460 to 600 feet per second. Tailings in Cell 2 were placed earlier than Cell 3 and have been actively dewatered since 2009. This use of the shear wave velocities measured in October 2013 is conservative for these analyses for both tailings cells since further densification of the tailings will occur during the active maintenance period.

F.2.3 Results

As discussed previously, settlement analyses were conducted for two time periods to estimate future settlement (1) settlement during active maintenance due to final cover placement and dewatering, and (2) settlement after active maintenance due to creep and seismic settlement. The results are summarized in Tables F.2 and F.3 and Figures F.2 and F.3. The spreadsheet calculations of are provided in Attachments F.1 (settlement due to dewatering of tailings and placement of final cover), F.2 (creep settlement), and F.3 (seismic settlement). Total settlement during active maintenance is conservatively estimated to range from 0.9 to 1.6 feet. Total remaining settlement due to dewatering from 5 feet above the liner to the liner is approximately 0.01 feet. Total potential future settlement due to creep is estimated to range from 0.05 to 0.09 feet, and due to seismic settlement is estimated to range from 0.23 to 0.62 feet. The total potential future long-term settlement due to creep and seismic settlement of the tailings is estimated to range from 0.29 to 0.71 feet**.** The estimates of total long term settlement were calculated by summing the static creep settlement estimate and the seismic settlement estimates. As such, these estimates are considered to be somewhat conservative as they are not independent (i.e. as long-term static creep progresses, void ratio reduction will occur and the potential for seismic settlement will reduce over time as a result).

Table F.2 Future Settlement During Active Maintenance

Location	Settlement due to Consolidation and Dewatering Prior to t_1 (ft)
2W2	1.09
2W3	1.15
2W4-C	1.29
2W5-C	1.26
2W6-S	1.29
2W7-C	1.17
2E1	1.30
3-1S	0.88
3-2C	1.19
3-3S	1.47
3-4N	1.56
3-6N	1.34
3-8N	1.03
3-8S	1.06

Notes:
t_1 corresponds to dewatering of the tailings to a level 5 feet above the liner

Table F.3 Future Settlement After Active Maintenance

Location	Settlement due to 1000 years of Creep (ft)	Seismic Settlement (ft)	Total Potential Future Settlement after Active Maintenance (ft)
2W2	0.06	0.35	0.41
2W3	0.05	0.36	0.42
2W4-C	0.05	0.43	0.48
2W5-C	0.07	0.49	0.56
2W6-S	0.06	0.48	0.54
2W7-C	0.06	0.35	0.40
2E1	0.07	0.47	0.54
3-1S	0.05	0.23	0.29
3-2C	0.05	0.40	0.45
3-3S	0.09	0.41	0.50
3-4N	0.09	0.62	0.71
3-6N	0.06	0.54	0.60
3-8N	0.05	0.34	0.39
3-8S	0.08	0.35	0.43

F.2.4 Differential Settlement and Cover Cracking Potential

Differential Settlement. After placement of the final cover and during active maintenance, additional fill may be placed in any low areas to maintain positive drainage of the cover surface. Therefore, the critical time period where differential settlement is a concern for the cover grading (i.e. potential for slope reversal) is after active maintenance is complete. Potential maximum future settlement after active maintenance is estimated as 0.29 to 0.71 feet. Based on the settlement analyses results as shown on Figure F.2, the critical location for the ratio of maximum differential settlement over distance is estimated to occur between the CPT location 3-3S and the dike between Cells 3 and 4A (conservatively assuming no settlement of the dike fill). Although the differential settlement is higher between CPT location 3-4N and 3-6N and the dike between Cells 2 and 3, differential settlement at these location would result in an increase in cover slope, therefore the former location is more critical for slope reversal. Locations on Cell 2 with higher settlement (2W4-C, 2W5-C, 2W6-S) than the 3-3S location are located within the center of Cell 2, however the highest differential settlement associated with these points is lower than the selected critical case.

The total potential differential settlement between 3-3S and the dike between Cells 3 and 4A is 0.50 feet over a distance of approximately 175 feet. The estimated differential settlement is sufficiently low such that ponding and slope reversal is not expected to occur. These calculations are based on conservative assumptions for seismic settlement with little to no credit taken for densification of tailings prior to placement of final cover and during active maintenance of the tailings cells. In addition, as mentioned above, creep and seismic settlement are not independent, however they have been treated as such in the calculations. Actual differential settlement for long-term (after active maintenance) conditions is expected to be lower.

Cover Cracking. Cover cracking analyses were performed for the highly-compacted radon barrier. The critical location for the cover cracking analyses for maximum differential settlement due to final cover placement, dewatering of tailings, creep, and a seismic event is 2.27 feet between the settlement monument 3-4N and dike between Cells 2 and 3 as shown on Figure F.3. This location has the maximum differential settlement over the shortest horizontal distance. The maximum differential settlement, assuming there is no settlement of the dike, is 2.27 feet. The horizontal distance between the two locations is approximately 150 feet.

Morrison-Knudsen Environmental Corporation (1993) presents a method for determining the tensile strain required to cause cracking of the radon barrier as a function of the plasticity index (PI) of the soil. The tensile strain at cracking is calculated by the equation below:

$$\varepsilon_f (\%) = 0.05 + 0.003 \times (PI)$$

where: $\varepsilon_f(\%)$ = tensile strain to cause cracking of the radon barrier
PI = plasticity index of radon barrier

The PI value for the highly compacted radon attenuation layer was estimated as the weighted average (based on soil volumes) of the measured PIs (11) for composite samples collected during the 2010 and 2012 borrow investigations (see Attachment B of EFRI, 2012). Using this value for PI, the minimum tensile strain that will induce cracking is 0.08 percent. The maximum settlement-induced horizontal tensile strain on the radon attenuation layer must be less than 0.08 percent so that cover cracking will not occur.

The horizontal movement at the top of the radon barrier can be calculated based on the following equation (Lee and Shen, 1969), which is referenced in NUREG 1620 (NRC, 2003) for cover cracking analysis:

$$m = \frac{2}{3} H\alpha$$

where: m = horizontal movement in feet
H = thickness of relatively incompressible material (in this analysis H is the thickness of the highly compacted radon barrier)
α = local slope of the settlement profile (expressed as decimal fraction)

Horizontal movement at the maximum tailing thickness is calculated to be 0.035 feet using a maximum thickness of relatively incompressible material of 3.5 feet, and a total differential settlement of 2.27 feet over 150 feet. The thickness of relatively incompressible material was estimated assuming a maximum 3.5-ft highly compacted radon barrier for Cell 3. The peak horizontal movement is assumed to be twice the average horizontal movement based on relationships presented in Gourc et al. (2010) and Rajesh and Viswanadham (2010). The peak horizontal movement is then calculated as 0.07.

The horizontal strain between any two settlement monitoring locations is the maximum horizontal movement divided by the horizontal distance (0.07 ft/150 ft). Using these values, the maximum horizontal strain is calculated as 0.05 percent. This value is lower than the maximum allowable strain of 0.08 percent and indicates that cracking of the radon attenuation layer due to settlement is not expected.

F.3 LIQUEFACTION ANALYSIS

F.3.1 Method of Analysis

Two procedures were used to evaluate the potential for liquefaction of the tailings based on the results of the CPT soundings. These methods (Idriss and Boulanger, 2008; Youd et al., 2001) are described below. The average factor of safety calculated from the two methods was used as the factor of safety for evaluating the liquefaction potential of the tailings.

Idriss and Boulanger (2008). The Idriss and Boulanger (2008) liquefaction triggering method estimates the cyclic stress ratio (CSR) based on the seismic design criteria and estimates the cyclic resistance ratio (CRR) based on the CPT readings and site conditions. CSR is calculated using a simplified procedure to estimate earthquake induced stresses, calculated using the following relationship:

$$CSR_{M=7.5,\sigma'_{vc}=1} = 0.65\frac{a_{max}}{g}\frac{\sigma_{vc}}{\sigma'_{vc}}\frac{1}{MSF}\frac{1}{K_\sigma}\frac{1}{K_\alpha}$$

Where:

a_{max}: maximum horizontal ground surface acceleration
σ_{vc}': effective vertical confining stress
σ_{vc}: total vertical confining stress
MSF: earthquake magnitude scaling factor
K_σ: overburden correction factor
K_α: static shear stress correction factor
g: acceleration due to gravity

The equations for the correction factors applied to the CSR for this evaluation are the following:

$$r_d = \exp(\alpha(z) + \beta(z)M)$$

$$\alpha(z) = -1.012 - 1.126\sin\left(\frac{z}{11.73} + 5.133\right)$$

$$\beta(z) = 0.106 + 0.118\sin\left(\frac{z}{11.28} + 5.142\right)$$

$$\text{MSF} = 6.9\exp\left(\frac{-M}{4}\right) - 0.058 \quad \leq 1.8$$

$$K_\sigma = 1 - C_\sigma \ln\left(\frac{\sigma'_{vc}}{P_a}\right) \leq 1.1$$

$$C_\sigma = \frac{1}{37.3 - 8.27(q_{c1N})^{0.264}} \leq 0.3$$

Where:

r_d: shear stress reduction coefficient
q_{c1N}: tip resistance normalized to atmospheric pressure and overburden pressure
z: depth below ground surface

P_a: atmospheric pressure (calculated for an average elevation of 5,600 feet for the site)
M: design earthquake magnitude

The tailings pile was evaluated assuming essentially flat ground, and ignored the effects of the slope at the edge of the tailings pile. Thus, a static shear stress correction factor of $K_\alpha=1$ was used for all calculations.

The relationship for CRR is based on liquefaction case histories and is expressed as:

$$\mathrm{CRR}_{M=7.5,\sigma'_{vc}=1} = \exp\left(\frac{q_{c1Ncs}}{540} + \left(\frac{q_{c1Ncs}}{67}\right)^2 - \left(\frac{q_{c1Ncs}}{80}\right)^3 + \left(\frac{q_{c1Ncs}}{114}\right)^4 - 3\right)$$

Where:

q_{c1Ncs}: equivalent clean-sand corrected normalized tip resistance

$$q_{c1Ncs} = q_{c1N} + \Delta q_{c1N}$$

$$\Delta q_{c1N} = \left(5.4 + \frac{q_{c1N}}{16}\right) \cdot \exp\left(1.63 + \frac{9.7}{\mathrm{FC}+0.01} - \left(\frac{15.7}{\mathrm{FC}+0.01}\right)^2\right)$$

FC = Fines Content in %

The factor of safety against liquefaction was computed as:

$$FS_{liq} = \frac{\mathrm{CRR}_{M=7.5,\sigma'_{vc}=1}}{\mathrm{CSR}_{M=7.5,\sigma'_{vc}=1}}$$

The correlation between CSR, CRR, and q_{c1N} is shown in Figure 67 of Idriss and Boulanger (2008).

Youd et al. (2001). The Youd et al. (2001) liquefaction triggering method estimates the CSR based on the seismic design criteria and estimates the CRR based on the CPT readings and site conditions. CSR is calculated using a simplified procedure to estimate earthquake induced stresses, calculated using the following relationship:

$$CSR_{M=7.5,\sigma'_{vc}=1} = 0.65\frac{a_{max}}{g}\frac{\sigma_{vc}}{\sigma'_{vc}}\frac{1}{MSF}\frac{1}{K_\sigma}\frac{1}{K_\alpha}$$

Where:

a_{max}: maximum horizontal ground surface acceleration
σ_{vc}': effective vertical confining stress
σ_{vc}: total vertical confining stress
r_d: shear stress reduction coefficient

MSF: earthquake magnitude scaling factor
K_σ: overburden correction factor
K_α: static shear stress correction factor
g: acceleration due to gravity

The equations for the correction factors applied to the CSR for this evaluation are the following:

$$r_d = 1.0 - 0.00765z \quad \text{for } z \leq 9.15 \text{ m}$$

$$r_d = 1.174 - 0.0267z \quad \text{for } 9.15 \text{ m} < z \leq 23 \text{ m}$$

Revised Idriss Scaling Factor: $\text{MSF} = 10^{2.24}/M_w^{2.56}$

$$K_\sigma = (\sigma'_{vo}/P_a)^{(f-1)}$$

Where:

z: Depth below ground surface
M_w: Design earthquake magnitude
P_a: Atmospheric Pressure
σ_{vc}': effective vertical overburden pressure
f=0.7 to 0.8 for 40% ≤ relative density, D_r ≤ 60%
0.6 to 0.7 for 60% < relative density, D_r ≤ 80%

$$D_r = \sqrt{\frac{q_{c1n}}{300}}$$

The tailings pile was evaluated assuming flat ground conditions. Thus, a static shear stress correction factor of *K_α=1* was used for all calculations.

The relationship for CRR is based on liquefaction case histories and is expressed as:

$$\text{If } (q_{c1N})_{cs} < 50 \quad \text{CRR}_{7.5} = 0.833[(q_{c1N})_{cs}/1{,}000] + 0.05$$
$$\text{If } 50 \leq (q_{c1N})_{cs} < 160 \quad \text{CRR}_{7.5} = 93[(q_{c1N})_{cs}/1{,}000]^3 + 0.08$$

Where:

$q_{c1Ncs} = K_c * q_{c1N}$

$$\text{for } I_c \leq 1.64 \quad K_c = 1.0$$

$$\text{for } I_c > 1.64 \quad K_c = -0.403I_c^4 + 5.581I_c^3 - 21.63I_c^2 + 33.75I_c - 17.88$$

The factor of safety against liquefaction was computed as:

$$FS_{liq} = \frac{\mathrm{CRR}_{M=7.5,\sigma'_{vc}=1}}{\mathrm{CSR}_{M=7.5,\sigma'_{vc}=1}}$$

The correlation between CSR, CRR, and q_{c1N} is shown in Figure 4 of Youd et al. (2001).

F.3.2. Material Properties

Liquefaction evaluation was performed for all CPT locations from the October 2013 tailings investigation (MWH, 2015b). The liquefaction evaluation used the same assumptions for soil profile, water table elevation, and density of the tailings material as described above for the long-term settlement analyses. Other parameters used for the evaluation were based on CPT data as presented in Attachment F.4 and as outlined in Idriss and Boulanger (2008) and Youd et al. (2001). It is assumed that the compacted cover materials are not susceptible to liquefaction and therefore were not included in the analyses.

F.3.3. Site Seismicity

Results of the site-specific probabilistic seismic hazard analysis presented in MWH (2015a) were used in the analysis of liquefaction potential. The mean peak ground acceleration for reclaimed (long-term) conditions is 0.15 g for an average return period of 10,000 years. The mean seismic source is from a magnitude 5.5 event occurring 20 km from the site.

F.3.4 Results

Table F.4 presents a summary of the results of the liquefaction analysis. Further details of the calculation can be found in Attachment F.4.

Table F.4 Summary of Liquefaction Results

Location	Minimum Factor of Safety
2W2	2.58
2W3	2.37
2W4-C	2.11
2W5-C	2.08
2W6-S	2.24
2W7-C	2.10
2E1	1.96
3-1S	2.41
3-2C	2.59
3-3S	2.36
3-4N	2.46
3-6N	2.30
3-8N	2.84
3-8S	2.38

Based on the factors of safety presented in Table F.4, the tailings are judged not to be susceptible to earthquake-induced liquefaction. The computed factors of safety against liquefaction range from 2.0 to 2.6.

F.4 CONCLUSIONS

Evaluation total settlement due to final cover placement and dewatering indicates potential future settlement during the active maintenance to range from approximately 0.9 to 1.6 feet. During this time, additional fill can be placed in any low areas in order to maintain positive drainage of the cover surface. The total predicted future long-term settlement that could occur (due to creep and seismic settlement) after the maintenance time period is complete is estimated to range from approximately 0.3 to 0.7 feet. The estimates of total long-term settlement were calculated by summing the static creep settlement estimate and the seismic settlement estimates. As such, these estimates are considered to be somewhat conservative as they are not independent (i.e. as long-term static creep progresses, void ratio reduction will occur and the potential for seismic settlement will reduce over time as a result). The estimated differential settlement after completion of active maintenance is sufficiently low that slope reversal and ponding is not expected to occur on a cover slope of 0.5 to 1.0 percent. In addition, the results indicate that cracking of the highly-compacted radon barrier due to settlement-induced strains is not expected. The results of the liquefaction analyses indicate the tailings are not susceptible to earthquake-induced liquefaction.

Similar results are expected for Cells 4A and 4B. Although Cells 4A and 4B have higher tailings thicknesses, these cells have a more effective dewatering systems and a low water level requirement for dewatering. These cells also have a slightly steeper average cover slope (approximately 0.8 percent) than Cells 2 and 3.

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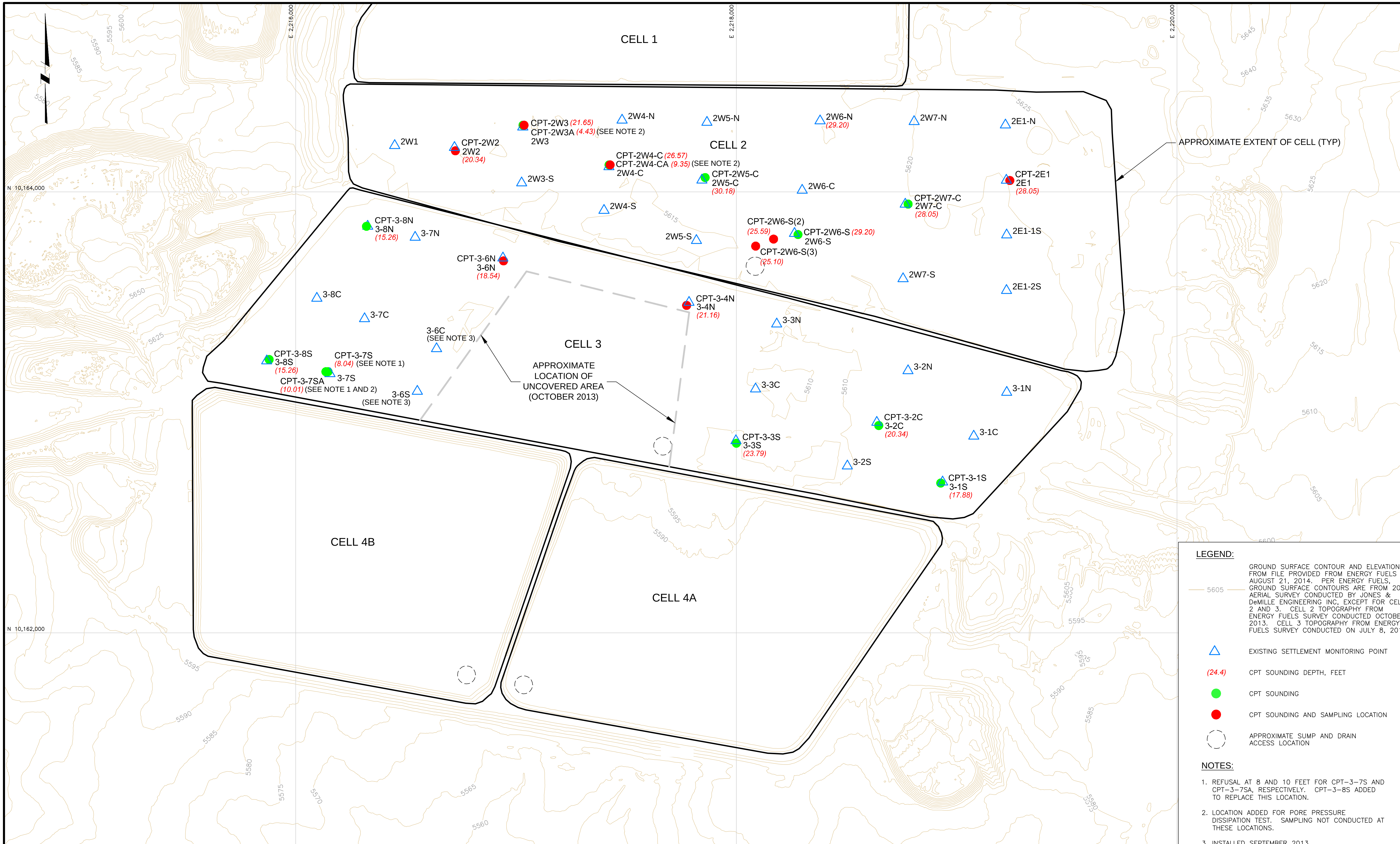


L:\Design-Drafting\Clients-A-H\ENERGY FUELS\013-Sheet Set\2015-08-31 COVER DSGN FIGS\WMM CPT LOC

Energy Fuels Resources (USA) Inc.

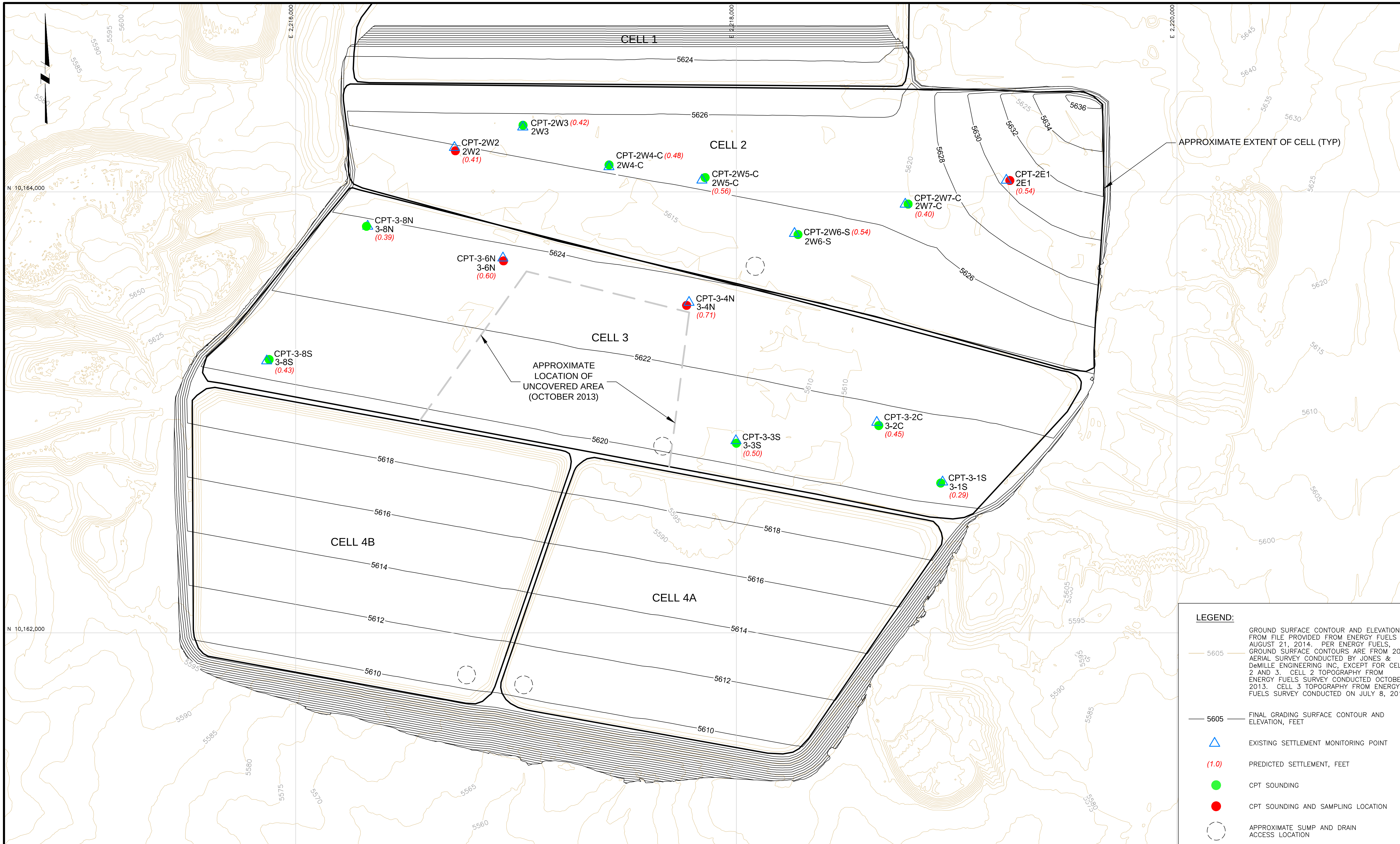
PROJECT
ENERGY FUELS - WHITE MESA
OCTOBER 2013 TAILINGS INVESTIGATION

TITLE
TAILINGS CPT SOUNDING AND SAMPLING LOCATIONS

MWH

FIGURE F.1

FILE NAME: WMM CPT LOC
DATE: AUG 2015



L:\Design-Drafting\Clients-A-H\ENERGY FUELS\013-Sheet Set\2015-08-31 COVER DSGN FIGS\WMM CPT SETL A

Energy Fuels Resources (USA) Inc.

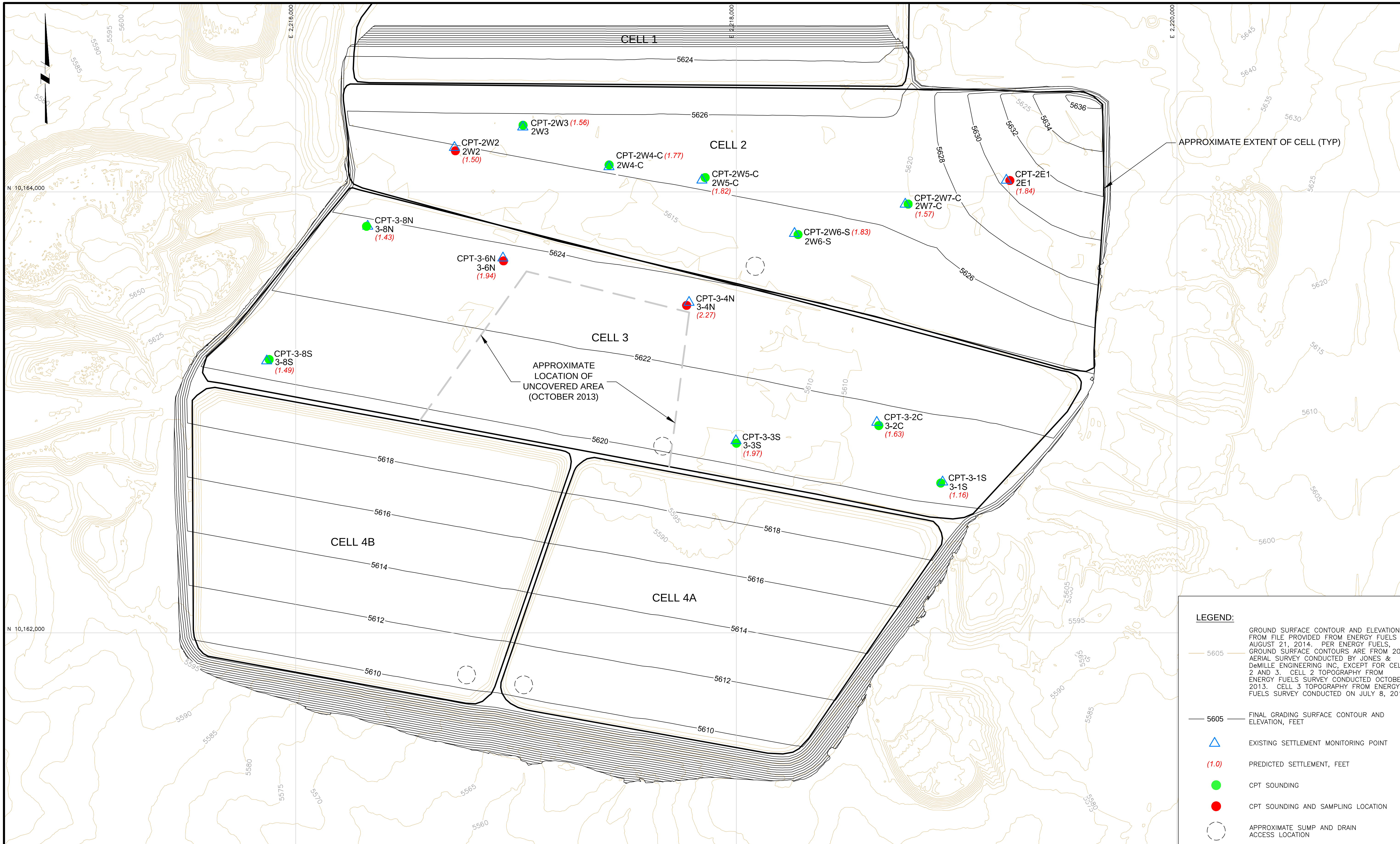
PROJECT
ENERGY FUELS - WHITE MESA
OCTOBER 2013 TAILINGS INVESTIGATION

TITLE
PREDICTED SETTLEMENT AFTER ACTIVE MAINTENANCE

MWH

FIGURE F.2

FILE NAME: WMM CPT SETL A
DATE: AUG 2015



L:\Design-Drafting\Clients-A-H\ENERGY FUELS\013-Sheet Set\2015-08-31 COVER DSGN FIGS\WMM CPT SETL B

Energy Fuels Resources (USA) Inc.

PROJECT
ENERGY FUELS - WHITE MESA
OCTOBER 2013 TAILINGS INVESTIGATION

TITLE
TOTAL PREDICTED FUTURE SETTLEMENT

MWH

FIGURE F.3

FILE NAME: WMM CPT SETL B
DATE: AUG 2015

ATTACHMENT F.1

SETTLEMENT CALCULATIONS FOR SETTLEMENT DUE TO DEWATERING THE TAILINGS AND PLACMENT OF THE FINAL COVER

Notes

t_0 corresponds to beginning of final cover placement — Assumes 99% of consolidation due to existing stress conditions has taken place

t_1 corresponds to dewatering of the tailings to a level 5 feet above the liner

t_2 corresponds to completion of dewatering

SOIL PROPERTIES

TAILINGS

	Specific Gravity, G_s	
2.70	Specific gravity of tailing sands, $G_{s\text{-}TSand}$	Based on lab testing performed on uranium tailings sands and presented in Keshian and Rager (1988)
2.80	Specific gravity of tailing sand-slimes, $G_{s\text{-}TS\text{-}S}$	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
2.86	Specific gravity of tailing slimes, $G_{s\text{-}TSlime}$	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
	Fines Content	
18%	Fines content of tailings sands (%)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
47%	Fines content of tailings sand-slimes (%)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
71%	Fines content of tailings slimes (%)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
	Dry Unit Weight, γ_d	
97	In-situ dry unit weight of tailings sands at t_0, $\gamma_{d0\text{-}Tsand}$ (pcf)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
88	In-situ dry unit weight of tailings sand-slimes at t_0, $\gamma_{d0\text{-}TS\text{-}S}$ (pcf)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
78	In-situ dry unit weight of tailings slimes at t_0, $\gamma_{d0\text{-}Tslime}$ (pcf)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
	Saturated Unit Weight, γ_{sat}	
123	In-situ saturated unit weight of tailings sands at t_0, $\gamma_{sat0\text{-}Tsand}$ (pcf)	Calculated
119	In-situ saturated unit weight of tailings sand-slimes at t_0, $\gamma_{sat0\text{-}TS\text{-}S}$ (pcf)	Calculated
113	In-situ saturated unit weight of tailings slimes at t_0, $\gamma_{sat0\text{-}Tslime}$ (pcf)	Calculated
	Moist Unit Weight, γ_m	
123	Moist unit weight of tailings sands, $\gamma_{m\text{-}Tsand}$ (pcf)	Calculated, assuming 100% degree of saturation (conservative estimate of loading from these layers)
119	Moist unit weight of tailings sand-slimes, $\gamma_{m\text{-}TS\text{-}S}$ (pcf)	Calculated, assuming 100% degree of saturation (conservative estimate of loading from these layers)
113	Moist unit weight of tailings slimes, $\gamma_{m\text{-}Tslime}$ (pcf)	Calculated, assuming 100% degree of saturation (conservative estimate of loading from these layers)
	Void Ratio, e	
0.74	Void ratio of tailing sands at t_0, $e_{0\text{-}TSand}$	Calculated
0.99	Void ratio of tailing sand-slimes at t_0, $e_{0\text{-}TS\text{-}S}$	Calculated
1.29	Void ratio of tailing slimes at t_0, $e_{0\text{-}TSlime}$	Calculated
	Saturated Water Content, w_{Sat}	
27%	Saturated water content of tailings sands at t_0, $w_{sat0\text{-}TSand}$ (%)	Calculated
35%	Saturated water content of tailings sand-slimes at t_0, $w_{sat0\text{-}TS\text{-}S}$ (%)	Calculated
45%	Saturated water content of tailings slimes at t_0, $w_{sat0\text{-}TSlime}$ (%)	Calculated
	Water Content of Moist Tailings, $w_{m\text{-}T}$	
27%	Water content of moist tailings sands, $w_{m\text{-}TSand}$ (%)	Calculated, assuming 100% saturation (conservative value used to estimate loading from these layers, actual long-term water content will be lower)
35%	Water content of moist tailings sand-slimes, $w_{m\text{-}TS\text{-}S}$ (%)	Calculated, assuming 100% saturation (conservative value used to estimate loading from these layers, actual long-term water content will be lower)
45%	Water content of moist tailings slimes, $w_{m\text{-}TSlime}$ (%)	Calculated, assuming 100% saturation (conservative value used to estimate loading from these layers, actual long-term water content will be lower)
	Compression Index, C_c	
0.12	Compression index of tailings sands, $C_{c\text{-}TSand}$	Based on lab testing performed on uranium tailings sands and presented in Keshian and Rager (1988)
0.24	Compression index of tailings sand-slimes, $C_{c\text{-}TS\text{-}S}$	Median value from lab testing of tailings sand-slimes samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
0.28	Compression index of tailings slimes, $C_{c\text{-}TSlime}$	Median value from lab testing of tailings slimes samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
	Other	
62.4	Unit Weight of Water, γ_W	
5.0	Height of water table above liner at t_1, $H_{sat\text{-}1}$ (ft)	Assumed for end of active maintenance
0.0	Height of water table above liner at t_2, $H_{sat\text{-}2}$ (ft)	

82.4	Atmospheric Pressure, P_a (kPa)	Calculated assuming elev=5600' amsl. http://www.engineeringtoolbox.com/air-altitude-pressure-d_462.html
1722.0	Atmospheric Pressure, P_a (psf)	Unit conversion calculation
5.2%	Long-term moisture content of tailings, $w_{tailings}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
0.020	Ratio of Secondary Compression Index to Primary Compression Index, C_α/C_c	Estimated from laboratory results presented in MWH (2015b), upper bound average C_α for sand-slime and slime tailings of 0.02

COVER SOIL

Specific Gravity, G_s		
2.61	Specific gravity of topsoil, $G_{s\text{-}Topsoil}$	From Attachment H - Radon Emanation Modeling including with this submittal
2.62	Specific gravity of rock mulch, $G_{s\text{-}mulch}$	From Attachment H - Radon Emanation Modeling including with this submittal
2.63	Specific gravity of cover soil, $G_{s\text{-}cover}$	From Attachment H - Radon Emanation Modeling including with this submittal
Unit Weight, γ		
118.0	Maximum dry unit weight of cover soil $\gamma_{cover\text{-}max}$ (pcf)	Average calculated from laboratory testing results (UWM, 2012)
100.7	Moist unit weight of cover soil at 80% relative compaction, $\gamma_{cover80}$ (pcf)	Calculated
107.0	Moist unit weight of cover soil at 85% relative compaction, $\gamma_{cover85}$ (pcf)	Calculated
119.6	Moist unit weight of cover soil at 95% relative compaction, $\gamma_{cover95}$ (pcf)	Calculated
127.5	Saturated unit weight of cover soil at 80% relative compaction, $\gamma_{cover80\text{-}sat}$ (pcf)	Calculated
100	Dry unit weight of topsoil layer at 85% relative compaction, $\gamma_{topsoil5}$ (pcf)	From Attachment H - Radon Emanation Modeling including with this submittal
105	Moist unit weight of topsoil layer at 85% relative compaction, $\gamma_{topsoil5}$ (pcf)	Calculated
106	Dry unit weight of rock mulch layer at 85% relative compaction, $\gamma_{mulch85}$ (pcf)	From Attachment H - Radon Emanation Modeling including with this submittal
110	Moist unit weight of rock mulch layer at 85% relative compaction, $\gamma_{mulch85}$ (pcf)	From Attachment H - Radon Emanation Modeling including with this submittal
Void Ratio, e		
0.74	Void Ratio of cover soil at 80% relative compaction, $e_{cover80}$	Calculated
0.64	Void Ratio of cover soil at 85% relative compaction, $e_{cover85}$	Calculated
0.46	Void Ratio of cover soil at 95% relative compaction, $e_{cover95}$	Calculated
0.61	Void Ratio of topsoil at 85% relative compaction, $e_{topsoil85}$	Calculated from porosity presented in Attachment H - Radon Emanation Modeling including with this submittal
0.54	Void Ratio of rock mulch at 85% relative compaction, $e_{mulch85}$	Calculated from porosity presented in Attachment H - Radon Emanation Modeling including with this submittal
Other		
6.7%	Long-term moisture content of cover soil, w_{cover} (%)	Estimated based on measured 15bar water content. (UWM, 2012)
5.2%	Long-term moisture content of topsoil, $w_{topsoil}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
4.0%	Long-term moisture content of rock mulch, $w_{rockmulch}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
0.14	Compression index of cover soil, $C_{c\text{-}cover}$	Calculated from empirical equation for soil types similar to cover material (as presented in Holtz and Kovacs, 1981. Page 341). $C_c = 0.30*(e_0\text{-}0.27)$

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2W2

FINAL COVER

5625.87	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
4.00	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
2.02	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1111.60	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5613.10	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5607.7	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013
5598.51	Water surface elevation at t_1 (ft amsl)	
5593.51	Water surface elevation at t_2 (ft amsl)	

2W2

CONSOLIDATION SETTLEMENT

Soil Layer	Elevation at Top of Layer at t_0, $z_{i\text{-}top0}$ (ft amsl) [1]	Elevation at Midpoint of Layer at t_0, $z_{i\text{-}mid0}$ (ft amsl)	Elevation at Bottom of Layer at t_0, $z_{i\text{-}bott0}$ (ft amsl) [1]	Thickness of Layer at t_0, H (ft)	Material Type [1]	Effective Stress at Midpoint of Layer at t_0, $\sigma'_{i\text{-}mid0}$ (psf)	Effective Stress at Bottom of Layer at t_0, $\sigma'_{i\text{-}bott0}$ (psf)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Effective Stress at Midpoint of Layer at t_2, $\sigma'_{i\text{-}mid2}$ (psf)	Effective Stress at Bottom of Layer at t_2, $\sigma'_{i\text{-}bott2}$ (psf)	Consolidtion of Layer from t_0 to t_1 due to Final Cover Placement and Dewatering, $\delta_{ci\text{-}t1}$ (ft)	Consolidtion of Layer from t_1 to t_2 due to Dewatering, $\delta_{ci\text{-}t2}$ (ft)
Layer 1	5615.85	5614.30	5612.74	3.11	Int. Cover	156.63	313.25	1268.22	1424.85	1268.22	1424.85	0.23	0.00
Layer 2	5612.74	5612.25	5611.76	0.98	Sand-Slime	371.55	429.85	1483.15	1541.44	1483.15	1541.44	0.07	0.00
Layer 3	5611.76	5611.68	5611.59	0.17	Slime	439.46	449.08	1551.06	1560.68	1551.06	1560.68	0.01	0.00
Layer 4	5611.59	5611.43	5611.27	0.32	Sand	468.83	488.59	1580.43	1600.19	1580.43	1600.19	0.01	0.00
Layer 5	5611.27	5611.19	5611.10	0.17	Sand-Slime	498.70	508.81	1610.30	1620.41	1610.30	1620.41	0.01	0.00
Layer 6	5611.10	5610.69	5610.28	0.82	Slime	555.20	601.58	1666.79	1713.18	1666.79	1713.18	0.05	0.00
Layer 7	5610.28	5610.20	5610.12	0.16	Sand-Slime	611.10	620.61	1722.69	1732.21	1722.69	1732.21	0.01	0.00
Layer 8	5610.12	5609.88	5609.63	0.49	Slime	648.33	676.05	1759.93	1787.64	1759.93	1787.64	0.03	0.00
Layer 9	5609.63	5609.38	5609.13	0.50	Sand-Slime	705.79	735.53	1817.39	1847.13	1817.39	1847.13	0.02	0.00
Layer 10	5609.13	5608.56	5607.99	1.14	Slime	800.02	864.50	1911.61	1976.09	1911.61	1976.09	0.05	0.00
Layer 11	5607.99	5607.83	5607.66	0.33	Sand-Slime	884.13	898.77	1995.73	2015.36	1995.73	2015.36	0.01	0.00
Layer 12	5607.66	5607.25	5606.84	0.82	Slime	919.56	940.36	2061.74	2108.12	2061.74	2108.12	0.04	0.00
Layer 13	5606.84	5606.51	5606.18	0.66	Sand-Slime	959.03	977.70	2147.38	2186.64	2147.38	2186.64	0.03	0.00
Layer 14	5606.18	5605.94	5605.69	0.49	Slime	990.13	1002.56	2214.36	2242.07	2214.36	2242.07	0.02	0.00
Layer 15	5605.69	5605.53	5605.36	0.33	Sand-Slime	1011.89	1021.22	2261.70	2281.33	2261.70	2281.33	0.01	0.00
Layer 16	5605.36	5605.20	5605.03	0.33	Slime	1029.59	1037.96	2300.00	2318.67	2300.00	2318.67	0.01	0.00
Layer 17	5605.03	5604.87	5604.70	0.33	Sand-Slime	1047.30	1056.63	2338.30	2357.93	2338.30	2357.93	0.01	0.00
Layer 18	5604.70	5604.46	5604.21	0.49	Slime	1069.06	1081.49	2385.64	2413.36	2385.64	2413.36	0.02	0.00
Layer 19	5604.21	5604.05	5603.88	0.33	Sand-Slime	1090.82	1100.16	2432.99	2452.62	2432.99	2452.62	0.01	0.00
Layer 20	5603.88	5603.39	5602.90	0.98	Slime	1125.01	1149.87	2508.05	2563.48	2508.05	2563.48	0.04	0.00
Layer 21	5602.90	5602.82	5602.74	0.16	Sand-Slime	1154.40	1158.92	2573.00	2582.52	2573.00	2582.52	0.01	0.00
Layer 22	5602.74	5602.33	5601.92	0.82	Slime	1179.72	1200.52	2628.90	2675.28	2628.90	2675.28	0.03	0.00
Layer 23	5601.92	5601.67	5601.42	0.50	Sand-Slime	1214.66	1228.80	2705.03	2734.77	2705.03	2734.77	0.02	0.00
Layer 24	5601.42	5601.34	5601.26	0.16	Slime	1232.86	1236.92	2743.82	2752.87	2743.82	2752.87	0.01	0.00
Layer 25	5601.26	5601.18	5601.10	0.16	Sand-Slime	1241.45	1245.97	2762.39	2771.91	2762.39	2771.91	0.01	0.00
Layer 26	5601.10	5600.69	5600.28	0.82	Slime	1266.77	1287.57	2818.29	2864.67	2818.29	2864.67	0.03	0.00
Layer 27	5600.28	5599.87	5599.46	0.82	Sand-Slime	1310.76	1333.96	2913.45	2962.23	2913.45	2962.23	0.03	0.00
Layer 28	5599.46	5598.72	5597.98	1.48	Slime	1371.50	1409.03	3045.94	3096.58	3045.94	3129.65	0.06	0.00
Layer 29	5597.98	5597.90	5597.82	0.16	Sand-Slime	1413.56	1418.08	3101.11	3105.63	3139.17	3148.69	0.01	0.00
Layer 30	5597.82	5597.49	5597.16	0.66	Slime	1434.82	1451.56	3122.37	3139.11	3186.02	3223.35	0.03	0.00
Layer 31	5597.16	5596.83	5596.50	0.66	Sand-Slime	1470.23	1488.90	3157.78	3176.45	3262.61	3301.88	0.03	0.00
Layer 32	5596.50	5596.34	5596.18	0.32	Slime	1497.02	1505.13	3184.57	3192.68	3319.98	3338.08	0.01	0.00
Layer 33	5596.18	5595.85	5595.52	0.66	Sand-Slime	1523.80	1542.47	3211.35	3230.02	3377.34	3416.60	0.03	0.00
Layer 34	5595.52	5594.52	5593.51	2.01	Sand-Slime	1599.33	1656.18	3286.88	3343.73	3536.16	3530.31	0.08	0.01

Total Consolidtion of Profile at t_1, $\delta_{c\text{-}t1}$ (ft):	**1.09**
Total Consolidtion of Profile at t_2, $\delta_{c\text{-}t2}$ (ft):	**0.01**

Notes:

[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

2W3

FINAL COVER

5626.27	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
4.00	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
2.55	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1164.98	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5613.80	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5607.6	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013
5597.75	Water surface elevation at t_1 (ft amsl)	
5592.75	Water surface elevation at t_2 (ft amsl)	

2W3

CONSOLIDATION SETTLEMENT

Soil Layer	Elevation at Top of Layer at t_0, $z_{i\text{-}top0}$ (ft amsl) [1]	Elevation at Midpoint of Layer at t_0, $z_{i\text{-}mid0}$ (ft amsl)	Elevation at Bottom of Layer at t_0, $z_{i\text{-}bott0}$ (ft amsl) [1]	Thickness of Layer at t_0, H (ft)	Material Type [1]	Effective Stress at Midpoint of Layer at t_0, $\sigma'_{i\text{-}mid0}$ (psf)	Effective Stress at Bottom of Layer at t_0, $\sigma'_{i\text{-}bott0}$ (psf)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Effective Stress at Midpoint of Layer at t_2, $\sigma'_{i\text{-}mid2}$ (psf)	Effective Stress at Bottom of Layer at t_2, $\sigma'_{i\text{-}bott2}$ (psf)	Consolidation of Layer from t_0 to t_1 due to Final Cover Placement and Dewatering, $\delta_{ci\text{-}t1}$ (ft)	Consolidtion of Layer from t_1 to t_2 due to Dewatering, $\delta_{ci\text{-}t2}$ (ft)
Layer 1	5615.72	5614.17	5612.61	3.11	Int. Cover	156.63	313.25	1321.61	1478.24	1321.61	1478.24	0.23	0.00
Layer 2	5612.61	5612.37	5612.12	0.49	Sand-Slime	342.40	371.55	1507.38	1536.53	1507.38	1536.53	0.04	0.00
Layer 3	5612.12	5612.04	5611.95	0.17	Slime	381.17	390.78	1546.15	1555.76	1546.15	1555.76	0.01	0.00
Layer 4	5611.95	5611.46	5610.97	0.98	Sand-Slime	449.08	507.37	1614.06	1672.36	1614.06	1672.36	0.07	0.00
Layer 5	5610.97	5610.81	5610.64	0.33	Slime	526.04	544.71	1691.02	1709.69	1691.02	1709.69	0.02	0.00
Layer 6	5610.64	5609.82	5609.00	1.64	Sand-Slime	642.26	739.82	1807.24	1904.80	1807.24	1904.80	0.09	0.00
Layer 7	5609.00	5608.92	5608.83	0.17	Slime	749.43	759.05	1914.42	1924.03	1914.42	1924.03	0.01	0.00
Layer 8	5608.83	5608.59	5608.34	0.49	Sand-Slime	788.20	817.35	1953.18	1982.33	1953.18	1982.33	0.02	0.00
Layer 9	5608.34	5608.26	5608.18	0.16	Slime	826.40	835.45	1991.38	2000.43	1991.38	2000.43	0.01	0.00
Layer 10	5608.18	5608.10	5608.01	0.17	Sand-Slime	845.56	855.67	2010.54	2020.65	2010.54	2020.65	0.01	0.00
Layer 11	5608.01	5607.84	5607.67	0.34	Slime	874.90	894.14	2039.89	2059.12	2039.89	2059.12	0.02	0.00
Layer 12	5607.67	5607.02	5606.37	1.30	Sand-Slime	934.65	971.42	2136.45	2213.78	2136.45	2213.78	0.06	0.00
Layer 13	5606.37	5606.21	5606.05	0.32	Slime	979.54	987.65	2231.88	2249.98	2231.88	2249.98	0.01	0.00
Layer 14	5606.05	5604.98	5603.91	2.14	Sand-Slime	1048.19	1108.72	2377.28	2504.58	2377.28	2504.58	0.09	0.00
Layer 15	5603.91	5603.26	5602.60	1.31	Slime	1141.94	1175.17	2578.68	2652.78	2578.68	2652.78	0.06	0.00
Layer 16	5602.60	5601.62	5600.63	1.97	Sand-Slime	1230.89	1286.62	2769.96	2887.15	2769.96	2887.15	0.08	0.00
Layer 17	5600.63	5600.47	5600.30	0.33	Slime	1294.99	1303.36	2905.82	2924.48	2905.82	2924.48	0.01	0.00
Layer 18	5600.30	5600.14	5599.98	0.32	Sand-Slime	1312.41	1321.46	2943.52	2962.55	2943.52	2962.55	0.01	0.00
Layer 19	5599.98	5599.08	5598.17	1.81	Slime	1367.37	1413.28	3064.93	3167.31	3064.93	3167.31	0.08	0.00
Layer 20	5598.17	5597.85	5597.52	0.65	Sand-Slime	1431.66	1450.05	3205.98	3230.29	3205.98	3244.64	0.03	0.00
Layer 21	5597.52	5597.36	5597.19	0.33	Slime	1458.42	1466.79	3238.66	3247.03	3263.31	3281.98	0.01	0.00
Layer 22	5597.19	5596.54	5595.88	1.31	Sand-Slime	1503.84	1540.90	3284.09	3321.14	3359.90	3437.83	0.05	0.00
Layer 23	5595.88	5595.55	5595.22	0.66	Slime	1557.64	1574.38	3337.88	3354.62	3475.16	3512.49	0.03	0.00
Layer 24	5595.22	5595.06	5594.89	0.33	Sand-Slime	1583.71	1593.04	3363.96	3373.29	3532.12	3551.75	0.01	0.00
Layer 25	5594.89	5594.65	5594.40	0.49	Slime	1605.47	1617.90	3385.72	3398.15	3579.47	3607.19	0.02	0.00
Layer 26	5594.40	5594.24	5594.07	0.33	Sand-Slime	1627.23	1636.57	3407.48	3416.81	3626.82	3646.45	0.01	0.00
Layer 27	5594.07	5593.41	5592.75	1.32	Sand-Slime	1673.91	1711.24	3454.15	3491.49	3724.97	3721.12	0.05	0.00

Total Consolidtion of Profile at t_1, $\delta_{c\text{-}t1}$ (ft):	**1.15**
Total Consolidtion of Profile at t_2, $\delta_{c\text{-}t2}$ (ft):	**0.01**

Notes:

[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

2W4-C

FINAL COVER

5626.19	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
4.00	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
1.95	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1104.55	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5611.20	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5608.1	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013
5593.51	Water surface elevation at t_1 (ft amsl)	
5588.51	Water surface elevation at t_2 (ft amsl)	

2W4-C

CONSOLIDATION SETTLEMENT

Soil Layer	Elevation at Top of Layer at t_0, z_{i-top0} (ft amsl) [1]	Elevation at Midpoint of Layer at t_0, z_{i-mid0} (ft amsl)	Elevation at Bottom of Layer at t_0, $z_{i-bott0}$ (ft amsl) [1]	Thickness of Layer at t_0, H (ft)	Material Type [1]	Effective Stress at Midpoint of Layer at t_0, σ'_{i-mid0} (psf)	Effective Stress at Bottom of Layer at t_0, $\sigma'_{i-bott0}$ (psf)	Effective Stress at Midpoint of Layer at t_1, σ'_{i-mid1} (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i-bott1}$ (psf)	Effective Stress at Midpoint of Layer at t_2, σ'_{i-mid2} (psf)	Effective Stress at Bottom of Layer at t_2, $\sigma'_{i-bott2}$ (psf)	Consolidtion of Layer from t_0 to t_1 due to Final Cover Placement and Dewatering, δ_{ci-t1} (ft)	Consolidtion of Layer from t_1 to t_2 due to Dewatering, δ_{ci-t2} (ft)
Layer 1	5616.24	5614.68	5613.12	3.12	Int. Cover	157.13	314.26	1261.68	1418.81	1261.68	1418.81	0.23	0.00
Layer 2	5613.12	5613.04	5612.96	0.16	Sand	324.14	334.02	1428.69	1438.56	1428.69	1438.56	0.01	0.00
Layer 3	5612.96	5611.32	5609.68	3.28	Sand-Slime	529.13	724.24	1633.68	1828.79	1633.68	1828.79	0.19	0.00
Layer 4	5609.68	5609.60	5609.51	0.17	Slime	733.86	743.48	1838.41	1848.02	1838.41	1848.02	0.01	0.00
Layer 5	5609.51	5608.28	5607.05	2.46	Sand-Slime	889.81	969.38	1994.36	2140.69	1994.36	2140.69	0.10	0.00
Layer 6	5607.05	5606.89	5606.73	0.32	Slime	977.49	985.61	2158.79	2176.89	2158.79	2176.89	0.01	0.00
Layer 7	5606.73	5606.57	5606.40	0.33	Sand-Slime	994.94	1004.28	2196.52	2216.15	2196.52	2216.15	0.01	0.00
Layer 8	5606.40	5606.32	5606.23	0.17	Slime	1008.59	1012.90	2225.77	2235.38	2225.77	2235.38	0.01	0.00
Layer 9	5606.23	5605.41	5604.59	1.64	Sand-Slime	1059.29	1105.68	2332.94	2430.50	2332.94	2430.50	0.07	0.00
Layer 10	5604.59	5604.51	5604.43	0.16	Slime	1109.74	1113.80	2439.55	2448.60	2439.55	2448.60	0.01	0.00
Layer 11	5604.43	5604.27	5604.10	0.33	Sand-Slime	1123.13	1132.46	2468.23	2487.86	2468.23	2487.86	0.01	0.00
Layer 12	5604.10	5603.94	5603.77	0.33	Slime	1140.83	1149.20	2506.52	2525.19	2506.52	2525.19	0.01	0.00
Layer 13	5603.77	5601.89	5600.00	3.77	Sand-Slime	1255.84	1362.48	2749.45	2973.71	2749.45	2973.71	0.16	0.00
Layer 14	5600.00	5599.43	5598.85	1.15	Slime	1391.65	1420.81	3038.76	3103.81	3038.76	3103.81	0.05	0.00
Layer 15	5598.85	5598.44	5598.03	0.82	Sand-Slime	1444.01	1467.20	3152.59	3201.37	3152.59	3201.37	0.03	0.00
Layer 16	5598.03	5597.95	5597.87	0.16	Slime	1471.26	1475.32	3210.42	3219.47	3210.42	3219.47	0.01	0.00
Layer 17	5597.87	5597.63	5597.38	0.49	Sand-Slime	1489.18	1503.04	3248.61	3277.76	3248.61	3277.76	0.02	0.00
Layer 18	5597.38	5597.22	5597.05	0.33	Slime	1511.41	1519.78	3296.43	3315.09	3296.43	3315.09	0.01	0.00
Layer 19	5597.05	5596.64	5596.23	0.82	Sand-Slime	1542.97	1566.17	3363.87	3412.65	3363.87	3412.65	0.03	0.00
Layer 20	5596.23	5595.82	5595.41	0.82	Slime	1586.97	1607.76	3459.03	3505.41	3459.03	3505.41	0.03	0.00
Layer 21	5595.41	5595.08	5594.75	0.66	Sand-Slime	1626.43	1645.10	3544.68	3583.94	3544.68	3583.94	0.03	0.00
Layer 22	5594.75	5594.67	5594.59	0.16	Slime	1649.16	1653.22	3592.99	3602.04	3592.99	3602.04	0.01	0.00
Layer 23	5594.59	5594.43	5594.26	0.33	Sand-Slime	1662.55	1671.89	3621.67	3641.30	3621.67	3641.30	0.01	0.00
Layer 24	5594.26	5594.10	5593.93	0.33	Slime	1680.26	1688.63	3659.96	3678.63	3659.96	3678.63	0.01	0.00
Layer 25	5593.93	5591.80	5589.67	4.26	Sand-Slime	1809.12	1929.62	3825.33	3945.83	3932.04	4185.45	0.17	0.00
Layer 26	5589.67	5589.09	5588.51	1.16	Sand-Slime	1962.43	1995.24	3978.64	4011.45	4254.45	4251.07	0.04	0.00

Total Consolidtion of Profile at t_1, δ_{c-t1} (ft):	1.29
Total Consolidtion of Profile at t_2, δ_{c-t2} (ft):	0.01

Notes:

[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

2W5-C

FINAL COVER

5626.29	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
4.00	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
2.43	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1152.89	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5604.20	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5604.2	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013).
5589.01	Water surface elevation at t_1 (ft amsl)	
5584.01	Water surface elevation at t_2 (ft amsl)	

2W5-C

CONSOLIDATION SETTLEMENT

Soil Layer	Elevation at Top of Layer at t_0, z_{i-top0} (ft amsl) [1]	Elevation at Midpoint of Layer at t_0, z_{i-mid0} (ft amsl)	Elevation at Bottom of Layer at t_0, $z_{i-bott0}$ (ft amsl) [1]	Thickness of Layer at t_0, H (ft)	Material Type [1]	Effective Stress at Midpoint of Layer at t_0, σ'_{i-mid0} (psf)	Effective Stress at Bottom of Layer at t_0, $\sigma'_{i-bott0}$ (psf)	Effective Stress at Midpoint of Layer at t_1, σ'_{i-mid1} (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i-bott1}$ (psf)	Effective Stress at Midpoint of Layer at t_2, σ'_{i-mid2} (psf)	Effective Stress at Bottom of Layer at t_2, $\sigma'_{i-bott2}$ (psf)	Consolidtion of Layer from t_0 to t_1 due to Final Cover Placement and Dewatering, δ_{ci-t1} (ft)
Layer 1	5615.86	5614.31	5612.75	3.11	Int. Cover	156.63	313.25	1309.52	1466.15	1309.52	1466.15	0.23
Layer 2	5612.75	5612.59	5612.42	0.33	Sand-Slime	332.88	352.51	1485.78	1505.41	1485.78	1505.41	0.03
Layer 3	5612.42	5612.09	5611.76	0.66	Sand	393.26	434.01	1546.16	1586.90	1546.16	1586.90	0.03
Layer 4	5611.76	5611.60	5611.44	0.32	Sand-Slime	453.04	472.08	1605.94	1624.97	1605.94	1624.97	0.02
Layer 5	5611.44	5611.11	5610.78	0.66	Sand	512.82	553.57	1665.72	1706.47	1665.72	1706.47	0.02
Layer 6	5610.78	5609.96	5609.14	1.64	Sand-Slime	651.13	748.68	1804.02	1901.58	1804.02	1901.58	0.09
Layer 7	5609.14	5608.90	5608.65	0.49	Sand	778.94	809.19	1931.83	1962.08	1931.83	1962.08	0.01
Layer 8	5608.65	5604.88	5601.10	7.55	Sand-Slime	1258.30	1513.98	2411.20	2860.32	2411.20	2860.32	0.26
Layer 9	5601.10	5601.02	5600.94	0.16	Sand	1518.87	1523.75	2870.19	2880.07	2870.19	2880.07	0.00
Layer 10	5600.94	5600.12	5599.30	1.64	Sand-Slime	1570.14	1616.53	2977.63	3075.18	2977.63	3075.18	0.06
Layer 11	5599.30	5599.14	5598.97	0.33	Slime	1624.90	1633.27	3093.85	3112.52	3093.85	3112.52	0.01
Layer 12	5598.97	5596.92	5594.87	4.10	Sand-Slime	1749.24	1865.21	3356.41	3600.30	3356.41	3600.30	0.14
Layer 13	5594.87	5594.46	5594.05	0.82	Slime	1886.01	1906.81	3646.68	3693.06	3646.68	3693.06	0.03
Layer 14	5594.05	5593.81	5593.56	0.49	Sand-Slime	1920.67	1934.53	3722.21	3751.36	3722.21	3751.36	0.02
Layer 15	5593.56	5593.48	5593.39	0.17	Slime	1938.84	1943.15	3760.98	3770.59	3760.98	3770.59	0.01
Layer 16	5593.39	5592.57	5591.75	1.64	Sand-Slime	1989.54	2035.93	3868.15	3965.70	3868.15	3965.70	0.06
Layer 17	5591.75	5591.59	5591.42	0.33	Slime	2044.30	2052.67	3984.37	4003.04	3984.37	4003.04	0.01
Layer 18	5591.42	5589.46	5587.49	3.93	Sand-Slime	2163.83	2275.00	4236.82	4375.75	4236.82	4470.59	0.14
Layer 19	5587.49	5587.33	5587.16	0.33	Slime	2283.37	2291.74	4384.12	4392.49	4489.26	4507.93	0.01
Layer 20	5587.16	5586.75	5586.34	0.82	Sand	2316.78	2341.82	4417.53	4442.57	4558.55	4609.17	0.02
Layer 21	5586.34	5586.18	5586.01	0.33	Sand-Slime	2351.15	2360.49	4451.90	4461.24	4628.81	4648.44	0.01
Layer 22	5586.01	5585.85	5585.68	0.33	Sand	2370.56	2380.64	4471.31	4481.39	4668.81	4689.18	0.01
Layer 23	5585.68	5584.85	5584.01	1.67	Sand-Slime	2427.88	2475.11	4528.63	4575.86	4788.52	4783.66	0.05

Total Consolidtion of Profile at t_1, δ_{c-t1} (ft):	**1.26**
Total Consolidtion of Profile at t_2, δ_{c-t2} (ft):	**0.01**

Notes:

[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

2W6-S

FINAL COVER

5625.41	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
4.00	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
1.56	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1065.26	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5604.40	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5604.4	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013
5588.59	Water surface elevation at t_1 (ft amsl)	
5583.59	Water surface elevation at t_2 (ft amsl)	

2W6-S

CONSOLIDATION SETTLEMENT

Soil Layer	Elevation at Top of Layer at t_0, $z_{i\text{-}top0}$ (ft amsl) [1]	Elevation at Midpoint of Layer at t_0, $z_{i\text{-}mid0}$ (ft amsl)	Elevation at Bottom of Layer at t_0, $z_{i\text{-}bott0}$ (ft amsl) [1]	Thickness of Layer at t_0, H (ft)	Material Type [1]	Effective Stress at Midpoint of Layer at t_0, $\sigma'_{i\text{-}mid0}$ (psf)	Effective Stress at Bottom of Layer at t_0, $\sigma'_{i\text{-}bott0}$ (psf)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Effective Stress at Midpoint of Layer at t_2, $\sigma'_{i\text{-}mid2}$ (psf)	Effective Stress at Bottom of Layer at t_2, $\sigma'_{i\text{-}bott2}$ (psf)	Consolidtion of Layer from t_0 to t_1 due to Final Cover Placement and Dewatering, $\delta_{ci\text{-}t1}$ (ft)	Consolidtion of Layer from t_1 to t_2 due to Dewatering, $\delta_{ci\text{-}t2}$ (ft)
Layer 1	5615.85	5614.29	5612.73	3.12	Int. Cover	157.13	314.26	1222.39	1379.53	1222.39	1379.53	0.22	0.00
Layer 2	5612.73	5612.49	5612.24	0.49	Sand-Slime	343.41	372.56	1408.67	1437.82	1408.67	1437.82	0.04	0.00
Layer 3	5612.24	5612.16	5612.07	0.17	Sand	383.05	393.55	1448.32	1458.81	1448.32	1458.81	0.01	0.00
Layer 4	5612.07	5611.66	5611.25	0.82	Sand-Slime	442.33	491.10	1507.59	1556.37	1507.59	1556.37	0.05	0.00
Layer 5	5611.25	5611.01	5610.76	0.49	Sand	521.36	551.61	1586.62	1616.87	1586.62	1616.87	0.02	0.00
Layer 6	5610.76	5609.78	5608.79	1.97	Sand-Slime	668.79	785.98	1734.06	1851.24	1734.06	1851.24	0.10	0.00
Layer 7	5608.79	5608.63	5608.46	0.33	Slime	804.65	823.31	1869.91	1888.58	1869.91	1888.58	0.01	0.00
Layer 8	5608.46	5608.30	5608.14	0.32	Sand	843.07	862.82	1908.33	1928.09	1908.33	1928.09	0.01	0.00
Layer 9	5608.14	5607.40	5606.66	1.48	Sand-Slime	950.86	1038.90	2016.13	2104.17	2016.13	2104.17	0.06	0.00
Layer 10	5606.66	5606.50	5606.33	0.33	Slime	1057.57	1076.23	2122.83	2141.50	2122.83	2141.50	0.01	0.00
Layer 11	5606.33	5606.09	5605.84	0.49	Sand-Slime	1105.38	1134.53	2170.65	2199.79	2170.65	2199.79	0.02	0.00
Layer 12	5605.84	5605.51	5605.18	0.66	Slime	1171.86	1209.19	2237.13	2274.46	2237.13	2274.46	0.02	0.00
Layer 13	5605.18	5604.86	5604.53	0.65	Sand-Slime	1247.86	1286.53	2313.12	2351.79	2313.12	2351.79	0.02	0.00
Layer 14	5604.53	5604.28	5604.03	0.50	Slime	1307.32	1320.00	2380.07	2408.35	2380.07	2408.35	0.02	0.00
Layer 15	5604.03	5603.95	5603.87	0.16	Sand-Slime	1324.53	1329.05	2417.87	2427.39	2417.87	2427.39	0.01	0.00
Layer 16	5603.87	5602.64	5601.41	2.46	Slime	1391.45	1453.84	2566.53	2705.68	2566.53	2705.68	0.08	0.00
Layer 17	5601.41	5601.17	5600.92	0.49	Sand-Slime	1467.70	1481.56	2734.83	2763.98	2734.83	2763.98	0.02	0.00
Layer 18	5600.92	5600.84	5600.75	0.17	Slime	1485.87	1490.19	2773.59	2783.21	2773.59	2783.21	0.01	0.00
Layer 19	5600.75	5600.67	5600.59	0.16	Sand-Slime	1494.71	1499.24	2792.73	2802.24	2792.73	2802.24	0.01	0.00
Layer 20	5600.59	5600.18	5599.77	0.82	Slime	1520.03	1540.83	2848.63	2895.01	2848.63	2895.01	0.03	0.00
Layer 21	5599.77	5599.20	5598.62	1.15	Sand-Slime	1573.36	1605.89	2963.42	3031.83	2963.42	3031.83	0.04	0.00
Layer 22	5598.62	5598.21	5597.80	0.82	Slime	1626.69	1647.49	3078.21	3124.59	3078.21	3124.59	0.03	0.00
Layer 23	5597.80	5596.98	5596.16	1.64	Sand-Slime	1693.88	1740.26	3222.15	3319.70	3222.15	3319.70	0.06	0.00
Layer 24	5596.16	5595.92	5595.67	0.49	Slime	1752.69	1765.12	3347.42	3375.14	3347.42	3375.14	0.02	0.00
Layer 25	5595.67	5595.51	5595.34	0.33	Sand-Slime	1774.45	1783.79	3394.77	3414.40	3394.77	3414.40	0.01	0.00
Layer 26	5595.34	5595.26	5595.18	0.16	Slime	1787.85	1791.90	3423.45	3432.50	3423.45	3432.50	0.01	0.00
Layer 27	5595.18	5592.72	5590.26	4.92	Sand-Slime	1931.07	2070.24	3725.17	4017.84	3725.17	4017.84	0.17	0.00
Layer 28	5590.26	5590.18	5590.09	0.17	Slime	2074.55	2078.86	4027.45	4037.07	4027.45	4037.07	0.01	0.00
Layer 29	5590.09	5588.62	5587.14	2.95	Sand-Slime	2162.30	2245.75	4212.55	4297.55	4212.55	4388.03	0.10	0.00
Layer 30	5587.14	5586.90	5586.65	0.49	Sand	2260.71	2275.67	4312.52	4327.48	4418.28	4448.54	0.01	0.00
Layer 31	5586.65	5585.12	5583.59	3.06	Sand-Slime	2362.23	2448.78	4414.03	4500.59	4630.56	4621.64	0.10	0.01

Total Consolidtion of Profile at t_1, $\delta_{c\text{-}t1}$ (ft):	**1.29**
Total Consolidtion of Profile at t_2, $\delta_{c\text{-}t2}$ (ft):	**0.01**

Notes:

[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

2W7-C

FINAL COVER

5626.65	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
4.00	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
-0.95	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
812.44	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5613.10	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5611.5	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013
5595.40	Water surface elevation at t_1 (ft amsl)	
5590.40	Water surface elevation at t_2 (ft amsl)	

2W7-C

CONSOLIDATION SETTLEMENT

Soil Layer	Elevation at Top of Layer at t_0, $z_{i\text{-}top0}$ (ft amsl) [1]	Elevation at Midpoint of Layer at t_0, $z_{i\text{-}mid0}$ (ft amsl)	Elevation at Bottom of Layer at t_0, $z_{i\text{-}bott0}$ (ft amsl) [1]	Thickness of Layer at t_0, H (ft)	Material Type [1]	Effective Stress at Midpoint of Layer at t_0, $\sigma'_{i\text{-}mid0}$ (psf)	Effective Stress at Bottom of Layer at t_0, $\sigma'_{i\text{-}bott0}$ (psf)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Effective Stress at Midpoint of Layer at t_2, $\sigma'_{i\text{-}mid2}$ (psf)	Effective Stress at Bottom of Layer at t_2, $\sigma'_{i\text{-}bott2}$ (psf)	Consolidation of Layer from t_0 to t_1 due to Final Cover Placement and Dewatering, $\delta_{ci\text{-}t1}$ (ft)	Consolidtion of Layer from t_1 to t_2 due to Dewatering, $\delta_{ci\text{-}t2}$ (ft)
Layer 1	5619.60	5618.04	5616.48	3.12	Int. Cover	157.13	314.26	969.58	1126.71	969.58	1126.71	0.20	0.00
Layer 2	5616.48	5615.17	5613.86	2.62	Sand-Slime	470.11	625.97	1282.56	1438.41	1282.56	1438.41	0.14	0.00
Layer 3	5613.86	5613.78	5613.69	0.17	Slime	635.58	645.20	1448.03	1457.64	1448.03	1457.64	0.01	0.00
Layer 4	5613.69	5612.79	5611.89	1.80	Sand-Slime	752.27	859.35	1564.72	1671.79	1564.72	1671.79	0.07	0.00
Layer 5	5611.89	5611.81	5611.72	0.17	Slime	868.96	878.58	1681.41	1691.02	1681.41	1691.02	0.01	0.00
Layer 6	5611.72	5610.99	5610.25	1.47	Sand-Slime	935.13	976.71	1778.47	1865.91	1778.47	1865.91	0.05	0.00
Layer 7	5610.25	5610.17	5610.08	0.17	Slime	981.03	985.34	1875.53	1885.14	1875.53	1885.14	0.01	0.00
Layer 8	5610.08	5610.00	5609.92	0.16	Sand-Slime	989.86	994.39	1894.66	1904.18	1894.66	1904.18	0.01	0.00
Layer 9	5609.92	5609.84	5609.75	0.17	Slime	998.70	1003.01	1913.79	1923.41	1913.79	1923.41	0.01	0.00
Layer 10	5609.75	5606.15	5602.54	7.21	Sand-Slime	1206.95	1410.89	2352.30	2781.19	2352.30	2781.19	0.25	0.00
Layer 11	5602.54	5602.21	5601.88	0.66	Slime	1427.63	1444.37	2818.53	2855.86	2818.53	2855.86	0.02	0.00
Layer 12	5601.88	5601.80	5601.72	0.16	Sand-Slime	1448.90	1453.42	2865.38	2874.89	2865.38	2874.89	0.01	0.00
Layer 13	5601.72	5601.56	5601.39	0.33	Slime	1461.79	1470.16	2893.56	2912.23	2893.56	2912.23	0.01	0.00
Layer 14	5601.39	5600.74	5600.08	1.31	Sand-Slime	1507.22	1544.27	2990.15	3068.08	2990.15	3068.08	0.05	0.00
Layer 15	5600.08	5600.00	5599.91	0.17	Slime	1548.58	1552.90	3077.69	3087.31	3077.69	3087.31	0.01	0.00
Layer 16	5599.91	5599.83	5599.75	0.16	Sand	1557.78	1562.67	3097.19	3107.07	3097.19	3107.07	0.00	0.00
Layer 17	5599.75	5599.67	5599.58	0.17	Sand-Slime	1567.48	1572.29	3117.18	3127.29	3117.18	3127.29	0.01	0.00
Layer 18	5599.58	5599.26	5598.93	0.65	Slime	1588.77	1605.26	3164.06	3200.82	3164.06	3200.82	0.02	0.00
Layer 19	5598.93	5598.52	5598.11	0.82	Sand-Slime	1628.45	1651.65	3249.60	3298.38	3249.60	3298.38	0.03	0.00
Layer 20	5598.11	5597.62	5597.12	0.99	Slime	1676.76	1701.87	3354.38	3410.38	3354.38	3410.38	0.04	0.00
Layer 21	5597.12	5596.96	5596.80	0.32	Sand-Slime	1710.92	1719.97	3429.41	3448.45	3429.41	3448.45	0.01	0.00
Layer 22	5596.80	5596.72	5596.63	0.17	Slime	1724.28	1728.59	3458.06	3467.68	3458.06	3467.68	0.01	0.00
Layer 23	5596.63	5596.39	5596.14	0.49	Sand-Slime	1742.45	1756.31	3496.83	3525.97	3496.83	3525.97	0.02	0.00
Layer 24	5596.14	5596.06	5595.98	0.16	Slime	1760.37	1764.43	3535.02	3544.07	3535.02	3544.07	0.01	0.00
Layer 25	5595.98	5595.57	5595.16	0.82	Sand-Slime	1787.62	1810.82	3592.85	3626.66	3592.85	3641.63	0.03	0.00
Layer 26	5595.16	5594.83	5594.50	0.66	Slime	1827.56	1844.30	3643.40	3660.14	3678.96	3716.30	0.02	0.00
Layer 27	5594.50	5594.42	5594.34	0.16	Sand-Slime	1848.82	1853.35	3664.66	3669.19	3725.81	3735.33	0.01	0.00
Layer 28	5594.34	5594.09	5593.84	0.50	Slime	1866.03	1878.71	3681.87	3694.55	3763.61	3791.89	0.02	0.00
Layer 29	5593.84	5593.60	5593.35	0.49	Sand-Slime	1892.57	1906.43	3708.41	3722.27	3821.04	3850.19	0.02	0.00
Layer 30	5593.35	5593.27	5593.19	0.16	Slime	1910.49	1914.55	3726.33	3730.39	3859.24	3868.29	0.01	0.00
Layer 31	5593.19	5592.62	5592.04	1.15	Sand-Slime	1947.08	1979.61	3762.92	3795.44	3936.70	4005.11	0.04	0.00
Layer 32	5592.04	5591.80	5591.55	0.49	Slime	1992.04	2004.46	3807.87	3820.30	4032.82	4060.54	0.02	0.00
Layer 33	5591.55	5590.98	5590.40	1.15	Sand-Slime	2036.99	2069.52	3852.83	3885.36	4128.95	4125.60	0.04	0.00

Total Consolidtion of Profile at t_1, $\delta_{c\text{-}t1}$ (ft):	1.17
Total Consolidtion of Profile at t_2, $\delta_{c\text{-}t2}$ (ft):	0.01

Notes:

[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

2E1

FINAL COVER

5630.46	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
4.00	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
2.51	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1160.95	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5610.80	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5610.8	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013
5595.46	Water surface elevation at t_1 (ft amsl)	
5590.46	Water surface elevation at t_2 (ft amsl)	

2E1

CONSOLIDATION SETTLEMENT

Soil Layer	Elevation at Top of Layer at t_0, $z_{i\text{-}top0}$ (ft amsl) [1]	Elevation at Midpoint of Layer at t_0, $z_{i\text{-}mid0}$ (ft amsl)	Elevation at Bottom of Layer at t_0, $z_{i\text{-}bott0}$ (ft amsl) [1]	Thickness of Layer at t_0, H (ft)	Material Type [1]	Effective Stress at Midpoint of Layer at t_0, $\sigma'_{i\text{-}mid0}$ (psf)	Effective Stress at Bottom of Layer at t_0, $\sigma'_{i\text{-}bott0}$ (psf)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Effective Stress at Midpoint of Layer at t_2, $\sigma'_{i\text{-}mid2}$ (psf)	Effective Stress at Bottom of Layer at t_2, $\sigma'_{i\text{-}bott2}$ (psf)	Consolidtion of Layer from t_0 to t_1 due to Final Cover Placement and Dewatering, $\delta_{ci\text{-}t1}$ (ft)	Consolidtion of Layer from t_1 to t_2 due to Dewatering, $\delta_{ci\text{-}t2}$ (ft)
Layer 1	5619.95	5618.39	5616.83	3.12	Int. Cover	157.13	314.26	1318.08	1475.21	1318.08	1475.21	0.23	0.00
Layer 2	5616.83	5616.50	5616.17	0.66	Sand	355.01	395.75	1515.96	1556.71	1515.96	1556.71	0.03	0.00
Layer 3	5616.17	5615.93	5615.68	0.49	Sand-Slime	424.90	454.05	1585.85	1615.00	1585.85	1615.00	0.03	0.00
Layer 4	5615.68	5615.52	5615.35	0.33	Slime	472.72	491.38	1633.67	1652.33	1633.67	1652.33	0.02	0.00
Layer 5	5615.35	5615.19	5615.02	0.33	Sand-Slime	511.01	530.64	1671.96	1691.60	1671.96	1691.60	0.02	0.00
Layer 6	5615.02	5614.61	5614.20	0.82	Sand	581.27	631.89	1742.22	1792.84	1742.22	1792.84	0.03	0.00
Layer 7	5614.20	5613.79	5613.38	0.82	Sand-Slime	680.67	729.45	1841.62	1890.40	1841.62	1890.40	0.04	0.00
Layer 8	5613.38	5613.22	5613.06	0.32	Sand	749.20	768.96	1910.16	1929.91	1910.16	1929.91	0.01	0.00
Layer 9	5613.06	5610.44	5607.81	5.25	Sand-Slime	1058.48	1206.98	2242.21	2554.51	2242.21	2554.51	0.21	0.00
Layer 10	5607.81	5607.73	5607.64	0.17	Slime	1211.30	1215.61	2564.13	2573.74	2564.13	2573.74	0.01	0.00
Layer 11	5607.64	5607.56	5607.48	0.16	Sand-Slime	1220.13	1224.66	2583.26	2592.78	2583.26	2592.78	0.01	0.00
Layer 12	5607.48	5607.40	5607.31	0.17	Slime	1228.97	1233.28	2602.40	2612.01	2602.40	2612.01	0.01	0.00
Layer 13	5607.31	5606.58	5605.84	1.47	Sand-Slime	1274.86	1316.44	2699.45	2786.90	2699.45	2786.90	0.06	0.00
Layer 14	5605.84	5605.76	5605.67	0.17	Slime	1320.75	1325.07	2796.51	2806.13	2796.51	2806.13	0.01	0.00
Layer 15	5605.67	5605.51	5605.35	0.32	Sand-Slime	1334.12	1343.17	2825.17	2844.20	2825.17	2844.20	0.01	0.00
Layer 16	5605.35	5605.27	5605.18	0.17	Slime	1347.48	1351.79	2853.82	2863.43	2853.82	2863.43	0.01	0.00
Layer 17	5605.18	5601.49	5597.80	7.38	Sand-Slime	1560.54	1769.29	3302.44	3741.44	3302.44	3741.44	0.29	0.00
Layer 18	5597.80	5597.64	5597.47	0.33	Slime	1777.66	1786.03	3760.11	3778.77	3760.11	3778.77	0.01	0.00
Layer 19	5597.47	5595.83	5594.19	3.28	Sand-Slime	1878.81	1971.58	3973.89	4089.75	3973.89	4169.00	0.13	0.00
Layer 20	5594.19	5594.03	5593.86	0.33	Slime	1979.95	1988.32	4098.12	4106.49	4187.67	4206.33	0.01	0.00
Layer 21	5593.86	5593.70	5593.54	0.32	Sand-Slime	1997.38	2006.43	4115.54	4124.60	4225.37	4244.40	0.01	0.00
Layer 22	5593.54	5593.38	5593.21	0.33	Slime	2014.80	2023.17	4132.97	4141.34	4263.07	4281.74	0.01	0.00
Layer 23	5593.21	5592.55	5591.89	1.32	Sand-Slime	2060.50	2097.84	4178.67	4216.01	4360.26	4438.78	0.05	0.00
Layer 24	5591.89	5591.18	5590.46	1.43	Sand-Slime	2138.29	2178.74	4256.46	4296.91	4523.84	4519.67	0.05	0.00

Total Consolidtion of Profile at t_1, $\delta_{c\text{-}t1}$ (ft):	**1.30**
Total Consolidtion of Profile at t_2, $\delta_{c\text{-}t2}$ (ft):	**0.01**

Notes:

[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

3-1S

FINAL COVER

5620.47	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
0.41	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
887.10	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5608.00	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5604.4	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013
5595.59	Water surface elevation at t_1 (ft amsl)	
5590.59	Water surface elevation at t_2 (ft amsl)	

3-1S

CONSOLIDATION SETTLEMENT

Soil Layer	Elevation at Top of Layer at t_0, $z_{i\text{-}top0}$ (ft amsl) [1]	Elevation at Midpoint of Layer at t_0, $z_{i\text{-}mid0}$ (ft amsl)	Elevation at Bottom of Layer at t_0, $z_{i\text{-}bott0}$ (ft amsl) [1]	Thickness of Layer at t_0, H (ft)	Material Type [1]	Effective Stress at Midpoint of Layer at t_0, $\sigma'_{i\text{-}mid0}$ (psf)	Effective Stress at Bottom of Layer at t_0, $\sigma'_{i\text{-}bott0}$ (psf)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Effective Stress at Midpoint of Layer at t_2, $\sigma'_{i\text{-}mid2}$ (psf)	Effective Stress at Bottom of Layer at t_2, $\sigma'_{i\text{-}bott2}$ (psf)	Consolidtion of Layer from t_0 to t_1 due to Final Cover Placement and Dewatering, $\delta_{ci\text{-}t1}$ (ft)	Consolidtion of Layer from t_1 to t_2 due to Dewatering, $\delta_{ci\text{-}t2}$ (ft)
Layer 1	5612.56	5611.00	5609.44	3.12	Int. Cover	157.13	314.26	1044.24	1201.37	1044.24	1201.37	0.21	0.00
Layer 2	5609.44	5608.71	5607.97	1.47	Slime	397.41	480.56	1284.51	1367.66	1284.51	1367.66	0.09	0.00
Layer 3	5607.97	5607.89	5607.80	0.17	Sand-Slime	490.67	500.78	1377.78	1387.89	1377.78	1387.89	0.01	0.00
Layer 4	5607.80	5606.49	5605.18	2.62	Sand	662.53	824.29	1549.64	1711.39	1549.64	1711.39	0.07	0.00
Layer 5	5605.18	5604.93	5604.68	0.50	Sand-Slime	854.03	883.77	1741.13	1770.88	1741.13	1770.88	0.02	0.00
Layer 6	5604.68	5604.44	5604.19	0.49	Sand	913.71	928.67	1801.13	1831.38	1801.13	1831.38	0.01	0.00
Layer 7	5604.19	5603.78	5603.37	0.82	Sand-Slime	951.87	975.06	1880.16	1928.94	1880.16	1928.94	0.03	0.00
Layer 8	5603.37	5603.13	5602.88	0.49	Sand	990.03	1004.99	1959.19	1989.44	1959.19	1989.44	0.01	0.00
Layer 9	5602.88	5602.72	5602.55	0.33	Sand-Slime	1014.32	1023.66	2009.07	2028.70	2009.07	2028.70	0.01	0.00
Layer 10	5602.55	5602.47	5602.39	0.16	Slime	1027.72	1031.77	2037.75	2046.80	2037.75	2046.80	0.01	0.00
Layer 11	5602.39	5601.24	5600.09	2.30	Sand-Slime	1096.83	1161.89	2183.62	2320.43	2183.62	2320.43	0.08	0.00
Layer 12	5600.09	5600.01	5599.93	0.16	Sand	1166.77	1171.66	2330.31	2340.19	2330.31	2340.19	0.00	0.00
Layer 13	5599.93	5597.96	5595.99	3.94	Sand-Slime	1283.11	1394.55	2574.56	2808.94	2574.56	2808.94	0.14	0.00
Layer 14	5595.99	5595.91	5595.83	0.16	Slime	1398.61	1402.67	2817.99	2827.04	2817.99	2827.04	0.01	0.00
Layer 15	5595.83	5595.26	5594.68	1.15	Sand-Slime	1435.20	1467.72	2874.54	2907.07	2895.44	2963.85	0.04	0.00
Layer 16	5594.68	5592.64	5590.59	4.09	Sand-Slime	1583.41	1699.10	3022.76	3138.45	3207.15	3195.23	0.14	0.01

Total Consolidtion of Profile at t_1, $\delta_{c\text{-}t1}$ (ft):	**0.88**
Total Consolidtion of Profile at t_2, $\delta_{c\text{-}t2}$ (ft):	**0.01**

Notes:

[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

3-2C

FINAL COVER

5621.51	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.19	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1167.12	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5605.30	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5602.7	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013
5591.64	Water surface elevation at t_1 (ft amsl)	
5586.64	Water surface elevation at t_2 (ft amsl)	

3-2C

CONSOLIDATION SETTLEMENT

Soil Layer	Elevation at Top of Layer at t_0, $z_{i\text{-}top0}$ (ft amsl) [1]	Elevation at Midpoint of Layer at t_0, $z_{i\text{-}mid0}$ (ft amsl)	Elevation at Bottom of Layer at t_0, $z_{i\text{-}bott0}$ (ft amsl) [1]	Thickness of Layer at t_0, H (ft)	Material Type [1]	Effective Stress at Midpoint of Layer at t_0, $\sigma'_{i\text{-}mid0}$ (psf)	Effective Stress at Bottom of Layer at t_0, $\sigma'_{i\text{-}bott0}$ (psf)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Effective Stress at Midpoint of Layer at t_2, $\sigma'_{i\text{-}mid2}$ (psf)	Effective Stress at Bottom of Layer at t_2, $\sigma'_{i\text{-}bott2}$ (psf)	Consolidation of Layer from t_0 to t_1 due to Final Cover Placement and Dewatering, $\delta_{ci\text{-}t1}$ (ft)	Consolidtion of Layer from t_1 to t_2 due to Dewatering, $\delta_{ci\text{-}t2}$ (ft)
Layer 1	5610.82	5609.27	5607.71	3.11	Int. Cover	156.63	313.25	1323.75	1480.37	1323.75	1480.37	0.23	0.00
Layer 2	5607.71	5607.63	5607.54	0.17	Sand	323.75	334.24	1490.87	1501.36	1490.87	1501.36	0.01	0.00
Layer 3	5607.54	5607.46	5607.38	0.16	Sand-Slime	343.76	353.28	1510.88	1520.40	1510.88	1520.40	0.01	0.00
Layer 4	5607.38	5606.89	5606.39	0.99	Slime	409.28	465.28	1576.40	1632.40	1576.40	1632.40	0.07	0.00
Layer 5	5606.39	5605.98	5605.57	0.82	Sand-Slime	514.05	562.83	1681.17	1729.95	1681.17	1729.95	0.05	0.00
Layer 6	5605.57	5605.41	5605.24	0.33	Slime	581.50	600.16	1748.62	1767.28	1748.62	1767.28	0.02	0.00
Layer 7	5605.24	5605.08	5604.92	0.32	Sand-Slime	619.20	638.24	1786.32	1805.36	1786.32	1805.36	0.02	0.00
Layer 8	5604.92	5604.59	5604.26	0.66	Slime	675.57	712.90	1842.69	1880.02	1842.69	1880.02	0.04	0.00
Layer 9	5604.26	5600.82	5597.37	6.89	Sand-Slime	1004.51	1199.40	2289.88	2699.73	2289.88	2699.73	0.30	0.00
Layer 10	5597.37	5597.29	5597.21	0.16	Slime	1203.45	1207.51	2708.78	2717.83	2708.78	2717.83	0.01	0.00
Layer 11	5597.21	5596.96	5596.71	0.50	Sand-Slime	1221.66	1235.80	2747.58	2777.32	2747.58	2777.32	0.02	0.00
Layer 12	5596.71	5596.22	5595.73	0.98	Slime	1260.66	1285.51	2832.75	2888.18	2832.75	2888.18	0.04	0.00
Layer 13	5595.73	5594.99	5594.25	1.48	Sand-Slime	1327.37	1369.24	2976.22	3064.26	2976.22	3064.26	0.06	0.00
Layer 14	5594.25	5594.17	5594.09	0.16	Slime	1373.30	1377.35	3073.31	3082.36	3073.31	3082.36	0.01	0.00
Layer 15	5594.09	5593.52	5592.94	1.15	Sand-Slime	1409.88	1442.41	3150.77	3219.18	3150.77	3219.18	0.05	0.00
Layer 16	5592.94	5592.78	5592.61	0.33	Slime	1450.78	1459.15	3237.84	3256.51	3237.84	3256.51	0.01	0.00
Layer 17	5592.61	5592.20	5591.79	0.82	Sand-Slime	1482.35	1505.54	3305.29	3354.07	3305.29	3354.07	0.03	0.00
Layer 18	5591.79	5591.63	5591.46	0.33	Slime	1513.91	1522.28	3371.80	3380.17	3372.73	3391.40	0.01	0.00
Layer 19	5591.46	5591.22	5590.97	0.49	Sand-Slime	1536.14	1550.00	3394.03	3407.89	3420.55	3449.70	0.02	0.00
Layer 20	5590.97	5590.89	5590.81	0.16	Slime	1554.06	1558.12	3411.95	3416.00	3458.75	3467.80	0.01	0.00
Layer 21	5590.81	5590.65	5590.48	0.33	Sand-Slime	1567.45	1576.78	3425.34	3434.67	3487.43	3507.06	0.01	0.00
Layer 22	5590.48	5588.56	5586.64	3.84	Sand-Slime	1685.40	1794.02	3543.29	3651.91	3735.48	3724.29	0.15	0.01

Total Consolidtion of Profile at t_1, $\delta_{c\text{-}t1}$ (ft):	**1.19**
Total Consolidtion of Profile at t_2, $\delta_{c\text{-}t2}$ (ft):	**0.01**

Notes:

[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

3-3S

FINAL COVER

5620.49	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.36	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1184.24	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5605.60	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5601.5	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013
5582.14	Water surface elevation at t_1 (ft amsl)	
5577.14	Water surface elevation at t_2 (ft amsl)	

3-3S

CONSOLIDATION SETTLEMENT

Soil Layer	Elevation at Top of Layer at t_0, $z_{i\text{-}top0}$ (ft amsl) [1]	Elevation at Midpoint of Layer at t_0, $z_{i\text{-}mid0}$ (ft amsl)	Elevation at Bottom of Layer at t_0, $z_{i\text{-}bott0}$ (ft amsl) [1]	Thickness of Layer at t_0, H (ft)	Material Type [1]	Effective Stress at Midpoint of Layer at t_0, $\sigma'_{i\text{-}mid0}$ (psf)	Effective Stress at Bottom of Layer at t_0, $\sigma'_{i\text{-}bott0}$ (psf)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Effective Stress at Midpoint of Layer at t_2, $\sigma'_{i\text{-}mid2}$ (psf)	Effective Stress at Bottom of Layer at t_2, $\sigma'_{i\text{-}bott2}$ (psf)	Consolidtion of Layer from t_0 to t_1 due to Final Cover Placement and Dewatering, $\delta_{ci\text{-}t1}$ (ft)	Consolidtion of Layer from t_1 to t_2 due to Dewatering, $\delta_{ci\text{-}t2}$ (ft)
Layer 1	5609.63	5608.08	5606.52	3.11	Int. Cover	156.63	313.25	1340.87	1497.50	1340.87	1497.50	0.23	0.00
Layer 2	5606.52	5606.11	5605.70	0.82	Sand	363.88	414.50	1548.12	1598.75	1548.12	1598.75	0.04	0.00
Layer 3	5605.70	5605.45	5605.20	0.50	Sand-Slime	444.25	473.99	1628.49	1658.23	1628.49	1658.23	0.03	0.00
Layer 4	5605.20	5604.47	5603.73	1.47	Sand	564.74	655.50	1748.99	1839.74	1748.99	1839.74	0.05	0.00
Layer 5	5603.73	5602.50	5601.27	2.46	Sand-Slime	801.83	932.57	1986.07	2132.41	1986.07	2132.41	0.12	0.00
Layer 6	5601.27	5601.11	5600.94	0.33	Slime	940.94	949.31	2151.07	2169.74	2151.07	2169.74	0.01	0.00
Layer 7	5600.94	5600.86	5600.78	0.16	Sand-Slime	953.83	958.36	2179.26	2188.78	2179.26	2188.78	0.01	0.00
Layer 8	5600.78	5600.62	5600.45	0.33	Slime	966.73	975.10	2207.44	2226.11	2207.44	2226.11	0.01	0.00
Layer 9	5600.45	5599.55	5598.64	1.81	Sand-Slime	1026.29	1077.49	2333.78	2441.45	2333.78	2441.45	0.08	0.00
Layer 10	5598.64	5598.23	5597.82	0.82	Slime	1098.29	1119.09	2487.83	2534.21	2487.83	2534.21	0.04	0.00
Layer 11	5597.82	5597.58	5597.33	0.49	Sand-Slime	1132.95	1146.81	2563.36	2592.51	2563.36	2592.51	0.02	0.00
Layer 12	5597.33	5597.25	5597.17	0.16	Slime	1150.87	1154.92	2601.56	2610.61	2601.56	2610.61	0.01	0.00
Layer 13	5597.17	5596.35	5595.53	1.64	Sand-Slime	1201.31	1247.70	2708.16	2805.72	2708.16	2805.72	0.07	0.00
Layer 14	5595.53	5595.45	5595.36	0.17	Slime	1252.01	1256.32	2815.34	2824.95	2815.34	2824.95	0.01	0.00
Layer 15	5595.36	5595.20	5595.03	0.33	Sand-Slime	1265.66	1274.99	2844.58	2864.21	2844.58	2864.21	0.01	0.00
Layer 16	5595.03	5594.71	5594.38	0.65	Slime	1291.48	1307.97	2900.98	2937.74	2900.98	2937.74	0.03	0.00
Layer 17	5594.38	5593.89	5593.39	0.99	Sand-Slime	1335.97	1363.97	2996.64	3055.53	2996.64	3055.53	0.04	0.00
Layer 18	5593.39	5593.07	5592.74	0.65	Slime	1380.46	1396.94	3092.29	3129.06	3092.29	3129.06	0.03	0.00
Layer 19	5592.74	5592.17	5591.59	1.15	Sand-Slime	1429.47	1462.00	3197.47	3265.88	3197.47	3265.88	0.05	0.00
Layer 20	5591.59	5591.51	5591.43	0.16	Slime	1466.06	1470.12	3274.93	3283.98	3274.93	3283.98	0.01	0.00
Layer 21	5591.43	5590.94	5590.44	0.99	Sand-Slime	1498.12	1526.12	3342.87	3401.76	3342.87	3401.76	0.04	0.00
Layer 22	5590.44	5590.36	5590.28	0.16	Slime	1530.18	1534.24	3410.81	3419.86	3410.81	3419.86	0.01	0.00
Layer 23	5590.28	5589.71	5589.13	1.15	Sand-Slime	1566.77	1599.30	3488.27	3556.68	3488.27	3556.68	0.05	0.00
Layer 24	5589.13	5588.97	5588.80	0.33	Sand	1609.37	1619.45	3577.05	3597.42	3577.05	3597.42	0.01	0.00
Layer 25	5588.80	5587.57	5586.34	2.46	Sand-Slime	1689.03	1758.62	3743.76	3890.09	3743.76	3890.09	0.10	0.00
Layer 26	5586.34	5586.10	5585.85	0.49	Sand	1773.58	1788.54	3920.34	3950.59	3920.34	3950.59	0.01	0.00
Layer 27	5585.85	5581.50	5577.14	8.71	Sand-Slime	2034.91	2281.28	4428.47	4674.84	4468.72	4443.33	0.36	0.00

Total Consolidtion of Profile at t_1, $\delta_{c\text{-}t1}$ (ft):	1.47
Total Consolidtion of Profile at t_2, $\delta_{c\text{-}t2}$ (ft):	0.00

Notes:

[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

3-4N

FINAL COVER		
5623.36	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
7.16	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1567.00	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION		
5606.00	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5600.6	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013
5583.71	Water surface elevation at t_1 (ft amsl)	
5578.71	Water surface elevation at t_2 (ft amsl)	

3-4N

CONSOLIDATION SETTLEMENT

Soil Layer	Elevation at Top of Layer at t_0, $z_{i\text{-}top0}$ (ft amsl) [1]	Elevation at Midpoint of Layer at t_0, $z_{i\text{-}mid0}$ (ft amsl)	Elevation at Bottom of Layer at t_0, $z_{i\text{-}bott0}$ (ft amsl) [1]	Thickness of Layer at t_0, H (ft)	Material Type [1]	Effective Stress at Midpoint of Layer at t_0, $\sigma'_{i\text{-}mid0}$ (psf)	Effective Stress at Bottom of Layer at t_0, $\sigma'_{i\text{-}bott0}$ (psf)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Effective Stress at Midpoint of Layer at t_2, $\sigma'_{i\text{-}mid2}$ (psf)	Effective Stress at Bottom of Layer at t_2, $\sigma'_{i\text{-}bott2}$ (psf)	Consolidtion of Layer from t_0 to t_1 due to Final Cover Placement and Dewatering, $\delta_{ci\text{-}t1}$ (ft)	Consolidtion of Layer from t_1 to t_2 due to Dewatering, $\delta_{ci\text{-}t2}$ (ft)
Layer 1	5608.70	5607.14	5605.58	3.12	Int. Cover	157.13	314.26	1724.13	1881.26	1724.13	1881.26	0.26	0.00
Layer 2	5605.58	5604.60	5603.61	1.97	Sand	435.88	557.51	2002.88	2124.50	2002.88	2124.50	0.09	0.00
Layer 3	5603.61	5601.32	5599.02	4.59	Sand-Slime	830.54	1006.24	2397.54	2670.58	2397.54	2670.58	0.26	0.00
Layer 4	5599.02	5598.20	5597.38	1.64	Slime	1047.84	1089.43	2763.35	2856.11	2763.35	2856.11	0.08	0.00
Layer 5	5597.38	5597.22	5597.05	0.33	Sand-Slime	1098.77	1108.10	2875.74	2895.37	2875.74	2895.37	0.02	0.00
Layer 6	5597.05	5596.72	5596.39	0.66	Sand	1128.26	1148.41	2936.12	2976.86	2936.12	2976.86	0.02	0.00
Layer 7	5596.39	5596.31	5596.23	0.16	Slime	1152.47	1156.53	2985.91	2994.96	2985.91	2994.96	0.01	0.00
Layer 8	5596.23	5596.07	5595.90	0.33	Sand-Slime	1165.86	1175.20	3014.59	3034.22	3014.59	3034.22	0.02	0.00
Layer 9	5595.90	5595.82	5595.74	0.16	Sand	1180.08	1184.97	3044.10	3053.98	3044.10	3053.98	0.00	0.00
Layer 10	5595.74	5595.66	5595.57	0.17	Slime	1189.28	1193.59	3063.60	3073.21	3063.60	3073.21	0.01	0.00
Layer 11	5595.57	5595.49	5595.41	0.16	Sand-Slime	1198.12	1202.64	3082.73	3092.25	3082.73	3092.25	0.01	0.00
Layer 12	5595.41	5595.00	5594.59	0.82	Slime	1223.44	1244.24	3138.63	3185.01	3138.63	3185.01	0.04	0.00
Layer 13	5594.59	5594.43	5594.26	0.33	Sand-Slime	1253.57	1262.91	3204.64	3224.27	3204.64	3224.27	0.02	0.00
Layer 14	5594.26	5594.10	5593.93	0.33	Slime	1271.28	1279.65	3242.94	3261.60	3242.94	3261.60	0.02	0.00
Layer 15	5593.93	5590.74	5587.54	6.39	Sand-Slime	1460.39	1641.14	3641.72	4021.83	3641.72	4021.83	0.31	0.00
Layer 16	5587.54	5583.13	5578.71	8.83	Sand-Slime	1890.90	2140.66	4510.59	4760.35	4547.09	4521.36	0.40	0.00

Total Consolidtion of Profile at t_1, $\delta_{c\text{-}t1}$ (ft):	**1.56**
Total Consolidtion of Profile at t_2, $\delta_{c\text{-}t2}$ (ft):	**0.00**

Notes:

[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

3-6N

FINAL COVER

5623.62	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
8.68	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1720.10	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5604.20	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5599.3	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013
5590.44	Water surface elevation at t_1 (ft amsl)	
5585.44	Water surface elevation at t_2 (ft amsl)	

3-6N

CONSOLIDATION SETTLEMENT

Soil Layer	Elevation at Top of Layer at t_0, $z_{i\text{-}top0}$ (ft amsl) [1]	Elevation at Midpoint of Layer at t_0, $z_{i\text{-}mid0}$ (ft amsl)	Elevation at Bottom of Layer at t_0, $z_{i\text{-}bott0}$ (ft amsl) [1]	Thickness of Layer at t_0, H (ft)	Material Type [1]	Effective Stress at Midpoint of Layer at t_0, $\sigma'_{i\text{-}mid0}$ (psf)	Effective Stress at Bottom of Layer at t_0, $\sigma'_{i\text{-}bott0}$ (psf)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Effective Stress at Midpoint of Layer at t_2, $\sigma'_{i\text{-}mid2}$ (psf)	Effective Stress at Bottom of Layer at t_2, $\sigma'_{i\text{-}bott2}$ (psf)	Consolidation of Layer from t_0 to t_1 due to Final Cover Placement and Dewatering, $\delta_{ci\text{-}t1}$ (ft)	Consolidtion of Layer from t_1 to t_2 due to Dewatering, $\delta_{ci\text{-}t2}$ (ft)
Layer 1	5607.44	5605.88	5604.32	3.12	Int. Cover	157.13	314.26	1877.23	2034.36	1877.23	2034.36	0.27	0.00
Layer 2	5604.32	5604.24	5604.16	0.16	Sand-Slime	323.78	333.30	2043.88	2053.40	2043.88	2053.40	0.02	0.00
Layer 3	5604.16	5604.00	5603.83	0.33	Sand	353.67	374.04	2073.77	2094.14	2073.77	2094.14	0.02	0.00
Layer 4	5603.83	5603.67	5603.50	0.33	Sand-Slime	393.67	413.30	2113.77	2133.40	2113.77	2133.40	0.03	0.00
Layer 5	5603.50	5603.18	5602.85	0.65	Slime	450.07	486.84	2170.17	2206.94	2170.17	2206.94	0.05	0.00
Layer 6	5602.85	5602.44	5602.03	0.82	Sand-Slime	535.61	584.39	2255.71	2304.49	2255.71	2304.49	0.06	0.00
Layer 7	5602.03	5601.78	5601.53	0.50	Slime	612.67	640.96	2332.77	2361.06	2332.77	2361.06	0.04	0.00
Layer 8	5601.53	5601.29	5601.04	0.49	Sand-Slime	670.10	699.25	2390.20	2419.35	2390.20	2419.35	0.03	0.00
Layer 9	5601.04	5600.96	5600.88	0.16	Sand	709.13	719.01	2429.23	2439.11	2429.23	2439.11	0.01	0.00
Layer 10	5600.88	5600.72	5600.55	0.33	Sand-Slime	738.64	758.27	2458.74	2478.37	2458.74	2478.37	0.02	0.00
Layer 11	5600.55	5600.39	5600.22	0.33	Slime	776.94	795.60	2497.03	2515.70	2497.03	2515.70	0.02	0.00
Layer 12	5600.22	5600.06	5599.89	0.33	Sand-Slime	815.23	834.86	2535.33	2554.96	2535.33	2554.96	0.02	0.00
Layer 13	5599.89	5599.48	5599.07	0.82	Slime	881.24	912.03	2601.34	2647.73	2601.34	2647.73	0.05	0.00
Layer 14	5599.07	5598.91	5598.74	0.33	Sand-Slime	921.36	930.69	2667.36	2686.99	2667.36	2686.99	0.02	0.00
Layer 15	5598.74	5598.09	5597.43	1.31	Slime	963.92	997.15	2761.08	2835.18	2761.08	2835.18	0.07	0.00
Layer 16	5597.43	5597.27	5597.10	0.33	Sand-Slime	1006.48	1015.82	2854.81	2874.44	2854.81	2874.44	0.02	0.00
Layer 17	5597.10	5594.48	5591.86	5.24	Slime	1148.72	1281.63	3170.84	3467.23	3170.84	3467.23	0.28	0.00
Layer 18	5591.86	5590.88	5589.89	1.97	Sand-Slime	1337.35	1393.07	3584.42	3667.28	3584.42	3701.60	0.10	0.00
Layer 19	5589.89	5589.40	5588.90	0.99	Slime	1418.18	1443.29	3692.39	3717.50	3757.60	3813.60	0.05	0.00
Layer 20	5588.90	5587.17	5585.44	3.46	Sand-Slime	1541.16	1639.03	3815.37	3913.24	4019.42	4009.34	0.16	0.01

Total Consolidtion of Profile at t_1, $\delta_{c\text{-}t1}$ (ft):	**1.34**
Total Consolidtion of Profile at t_2, $\delta_{c\text{-}t2}$ (ft):	**0.01**

Notes:

[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

3-8N

FINAL COVER

5623.82	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
7.95	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1646.57	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5604.90	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5600.3	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013
5595.24	Water surface elevation at t_1 (ft amsl)	
5590.24	Water surface elevation at t_2 (ft amsl)	

3-8N

CONSOLIDATION SETTLEMENT

Soil Layer	Elevation at Top of Layer at t_0, z_{i-top0} (ft amsl) [1]	Elevation at Midpoint of Layer at t_0, z_{i-mid0} (ft amsl)	Elevation at Bottom of Layer at t_0, $z_{i-bott0}$ (ft amsl) [1]	Thickness of Layer at t_0, H (ft)	Material Type [1]	Effective Stress at Midpoint of Layer at t_0, σ'_{i-mid0} (psf)	Effective Stress at Bottom of Layer at t_0, $\sigma'_{i-bott0}$ (psf)	Effective Stress at Midpoint of Layer at t_1, σ'_{i-mid1} (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i-bott1}$ (psf)	Effective Stress at Midpoint of Layer at t_2, σ'_{i-mid2} (psf)	Effective Stress at Bottom of Layer at t_2, $\sigma'_{i-bott2}$ (psf)	Consolidation of Layer from t_0 to t_1 due to Final Cover Placement and Dewatering, δ_{ci-t1} (ft)	Consolidtion of Layer from t_1 to t_2 due to Dewatering, δ_{ci-t2} (ft)
Layer 1	5608.37	5606.81	5605.25	3.12	Int. Cover	157.13	314.26	1803.70	1960.83	1803.70	1960.83	0.27	0.00
Layer 2	5605.25	5605.17	5605.09	0.16	Slime	323.31	332.36	1969.88	1978.93	1969.88	1978.93	0.02	0.00
Layer 3	5605.09	5605.01	5604.92	0.17	Sand	342.86	353.35	1989.43	1999.92	1989.43	1999.92	0.01	0.00
Layer 4	5604.92	5604.60	5604.27	0.65	Sand-Slime	392.02	430.68	2038.59	2077.25	2038.59	2077.25	0.06	0.00
Layer 5	5604.27	5604.11	5603.94	0.33	Sand	451.06	471.43	2097.63	2118.00	2097.63	2118.00	0.02	0.00
Layer 6	5603.94	5603.78	5603.61	0.33	Sand-Slime	491.06	510.69	2137.63	2157.26	2137.63	2157.26	0.03	0.00
Layer 7	5603.61	5602.55	5601.48	2.13	Sand	642.19	773.69	2288.76	2420.26	2288.76	2420.26	0.08	0.00
Layer 8	5601.48	5598.45	5595.41	6.07	Sand-Slime	1022.14	1193.83	2781.34	3142.42	2781.34	3142.42	0.32	0.00
Layer 9	5595.41	5595.33	5595.24	0.17	Slime	1198.14	1202.45	3152.03	3151.04	3152.03	3161.65	0.01	0.00
Layer 10	5595.24	5594.18	5593.11	2.13	Sand-Slime	1262.70	1322.95	3211.29	3271.54	3288.35	3415.06	0.10	0.00
Layer 11	5593.11	5591.68	5590.24	2.87	Sand-Slime	1404.13	1485.31	3352.72	3433.90	3585.78	3577.42	0.13	0.01

Total Consolidtion of Profile at t_1, δ_{c-t1} (ft):	**1.03**
Total Consolidtion of Profile at t_2, δ_{c-t2} (ft):	**0.01**

Notes:

[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

3-8S

FINAL COVER

5620.45	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
4.25	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1273.89	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5603.50	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5600.6	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013
5590.63	Water surface elevation at t_1 (ft amsl)	
5585.63	Water surface elevation at t_2 (ft amsl)	

3-8S

CONSOLIDATION SETTLEMENT

Soil Layer	Elevation at Top of Layer at t_0, $z_{i\text{-}top0}$ (ft amsl) [1]	Elevation at Midpoint of Layer at t_0, $z_{i\text{-}mid0}$ (ft amsl)	Elevation at Bottom of Layer at t_0, $z_{i\text{-}bott0}$ (ft amsl) [1]	Thickness of Layer at t_0, H (ft)	Material Type [1]	Effective Stress at Midpoint of Layer at t_0, $\sigma'_{i\text{-}mid0}$ (psf)	Effective Stress at Bottom of Layer at t_0, $\sigma'_{i\text{-}bott0}$ (psf)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Effective Stress at Midpoint of Layer at t_2, $\sigma'_{i\text{-}mid2}$ (psf)	Effective Stress at Bottom of Layer at t_2, $\sigma'_{i\text{-}bott2}$ (psf)	Consolidtion of Layer from t_0 to t_1 due to Final Cover Placement and Dewatering, $\delta_{ci\text{-}t1}$ (ft)	Consolidtion of Layer from t_1 to t_2 due to Dewatering, $\delta_{ci\text{-}t2}$ (ft)
Layer 1	5608.70	5607.15	5605.59	3.11	Int. Cover	156.63	313.25	1430.52	1587.14	1430.52	1587.14	0.24	0.00
Layer 2	5605.59	5605.02	5604.44	1.15	Sand	384.25	455.25	1658.14	1729.14	1658.14	1729.14	0.05	0.00
Layer 3	5604.44	5604.28	5604.11	0.33	Sand-Slime	474.88	494.51	1748.77	1768.40	1748.77	1768.40	0.02	0.00
Layer 4	5604.11	5604.03	5603.95	0.16	Sand	504.39	514.27	1778.28	1788.15	1778.28	1788.15	0.01	0.00
Layer 5	5603.95	5603.54	5603.13	0.82	Sand-Slime	563.04	611.82	1836.93	1885.71	1836.93	1885.71	0.05	0.00
Layer 6	5603.13	5601.33	5599.52	3.61	Sand	834.69	990.80	2108.58	2331.45	2108.58	2331.45	0.10	0.00
Layer 7	5599.52	5599.36	5599.19	0.33	Sand-Slime	1000.13	1009.46	2351.08	2370.71	2351.08	2370.71	0.01	0.00
Layer 8	5599.19	5599.03	5598.86	0.33	Sand	1019.54	1029.62	2391.09	2411.46	2391.09	2411.46	0.01	0.00
Layer 9	5598.86	5596.89	5594.92	3.94	Sand-Slime	1141.06	1252.51	2645.83	2880.21	2645.83	2880.21	0.17	0.00
Layer 10	5594.92	5594.84	5594.76	0.16	Slime	1256.57	1260.63	2889.26	2898.31	2889.26	2898.31	0.01	0.00
Layer 11	5594.76	5594.60	5594.43	0.33	Sand-Slime	1269.96	1279.30	2917.94	2937.57	2917.94	2937.57	0.01	0.00
Layer 12	5594.43	5594.11	5593.78	0.65	Slime	1295.78	1312.27	2974.33	3011.10	2974.33	3011.10	0.03	0.00
Layer 13	5593.78	5593.62	5593.45	0.33	Sand-Slime	1321.60	1330.94	3030.73	3050.36	3030.73	3050.36	0.01	0.00
Layer 14	5593.45	5589.54	5585.63	7.82	Sand-Slime	1552.13	1773.32	3447.52	3668.72	3515.54	3492.75	0.33	0.01

Total Consolidtion of Profile at t_1, $\delta_{c\text{-}t1}$ (ft):	**1.06**
Total Consolidtion of Profile at t_2, $\delta_{c\text{-}t2}$ (ft):	**0.01**

Notes:

[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

ATTACHMENT F.2

CREEP SETTLEMENT CALCULATIONS

Notes

	t_0 corresponds to beginning of final cover placement	Assumes 99% of consolidation due to existing stress conditions has taken place
	t_1 corresponds to dewatering of the tailings to a level 5 feet above the liner	
	t_2 corresponds to completion of dewatering	

SOIL PROPERTIES

TAILINGS

Specific Gravity, G_s		
2.70	Specific gravity of tailing sands, $G_{s\text{-}TSand}$	Based on lab testing performed on uranium tailings sands and presented in Keshian and Rager (1988)
2.80	Specific gravity of tailing sand-slimes, $G_{s\text{-}TS\text{-}S}$	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
2.86	Specific gravity of tailing slimes, $G_{s\text{-}TSlime}$	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
Fines Content		
18%	Fines content of tailings sands (%)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
47%	Fines content of tailings sand-slimes (%)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
71%	Fines content of tailings slimes (%)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
Dry Unit Weight, γ_d		
97	In-situ dry unit weight of tailings sands at t_0, $\gamma_{d0\text{-}Tsand}$ (pcf)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
88	In-situ dry unit weight of tailings sand-slimes at t_0, $\gamma_{d0\text{-}TS\text{-}S}$ (pcf)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
78	In-situ dry unit weight of tailings slimes at t_0, $\gamma_{d0\text{-}Tslime}$ (pcf)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
Saturated Unit Weight, γ_{sat}		
123	In-situ saturated unit weight of tailings sands at t_0, $\gamma_{sat0\text{-}Tsand}$ (pcf)	Calculated
119	In-situ saturated unit weight of tailings sand-slimes at t_0, $\gamma_{sat0\text{-}TS\text{-}S}$ (pcf)	Calculated
113	In-situ saturated unit weight of tailings slimes at t_0, $\gamma_{sat0\text{-}Tslime}$ (pcf)	Calculated
Moist Unit Weight, γ_m		
123	Moist unit weight of tailings sands, $\gamma_{m\text{-}Tsand}$ (pcf)	Calculated, assuming 100% degree of saturation (conservative estimate of loading from these layers)
119	Moist unit weight of tailings sand-slimes, $\gamma_{m\text{-}TS\text{-}S}$ (pcf)	Calculated, assuming 100% degree of saturation (conservative estimate of loading from these layers)
113	Moist unit weight of tailings slimes, $\gamma_{m\text{-}Tslime}$ (pcf)	Calculated, assuming 100% degree of saturation (conservative estimate of loading from these layers)
Void Ratio, e		
0.74	Void ratio of tailing sands at t_0, $e_{0\text{-}TSand}$	Calculated
0.99	Void ratio of tailing sand-slimes at t_0, $e_{0\text{-}TS\text{-}S}$	Calculated
1.29	Void ratio of tailing slimes at t_0, $e_{0\text{-}TSlime}$	Calculated
Saturated Water Content, w_{Sat}		
27%	Saturated water content of tailings sands at t_0, $w_{sat0\text{-}TSand}$ (%)	Calculated
35%	Saturated water content of tailings sand-slimes at t_0, $w_{sat0\text{-}TS\text{-}S}$ (%)	Calculated
45%	Saturated water content of tailings slimes at t_0, $w_{sat0\text{-}TSlime}$ (%)	Calculated
Water Content of Moist Tailings, $w_{m\text{-}T}$		
27%	Water content of moist tailings sands, $w_{m\text{-}TSand}$ (%)	Calculated, assuming 100% saturation (conservative value used to estimate loading from these layers, actual long-term water content will be lower)
35%	Water content of moist tailings sand-slimes, $w_{m\text{-}TS\text{-}S}$ (%)	Calculated, assuming 100% saturation (conservative value used to estimate loading from these layers, actual long-term water content will be lower)
45%	Water content of moist tailings slimes, $w_{m\text{-}TSlime}$ (%)	Calculated, assuming 100% saturation (conservative value used to estimate loading from these layers, actual long-term water content will be lower)
Compression Index, C_c		
0.12	Compression index of tailings sands, $C_{c\text{-}TSand}$	Based on lab testing performed on uranium tailings sands and presented in Keshian and Rager (1988)
0.24	Compression index of tailings sand-slimes, $C_{c\text{-}TS\text{-}S}$	Median value from lab testing of tailings sand-slimes samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
0.28	Compression index of tailings slimes, $C_{c\text{-}TSlime}$	Median value from lab testing of tailings slimes samples obtained on-site (Tailings Data Analysis Report. MWH, 2015)
Normalized Blow Count, N_{60}		
17	Normalized Blow Count for saturated tailings sands, $N_{60\text{-}TSand}$	
7	Normalized Blow Count for saturated tailings sand-slimes, $N_{60\text{-}TS\text{-}S}$	
4	Normalized Blow Count for saturated tailings slimes, $N_{60\text{-}Tslime}$	

23	Normalized Blow Count for unsaturated tailings sands, $N_{60\text{-}TSand}$	
14	Normalized Blow Count for unsaturated tailings sand-slimes, $N_{60\text{-}TS\text{-}S}$	Blow counts for material types calculated using method presented in Guide to Cone Penetration Testing for Geotechnical Engineering, 5th Ed. (Robertson and Cabal, 2012).
10	Normalized Blow Count for unsaturated tailings slimes, $N_{60\text{-}Tslime}$	
Other		
62.4	Unit Weight of Water, γ_W	
5.0	Height of water table above liner at t_1, $H_{sat\text{-}1}$ (ft)	Assumed for end of active maintenance
0.0	Height of water table above liner at t_2, $H_{sat\text{-}2}$ (ft)	
82.4	Atmospheric Pressure, P_a (kPa)	Calculated assuming elev=5600' amsl. http://www.engineeringtoolbox.com/air-altitude-pressure-d_462.html
1722.0	Atmospheric Pressure, P_a (psf)	Unit conversion calculation
5.2%	Long-term moisture content of tailings, $w_{tailings}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
0.020	Ratio of Secondary Compression Index to Primary Compression Index, C_α/C_c	Estimated from laboratory results presented in MWH (2015b), upper bound average $C\alpha$ for sand-slime and slime tailings of 0.02

COVER SOIL

Specific Gravity, G_s		
2.61	Specific gravity of topsoil, $G_{s\text{-}Topsoil}$	From Attachment H - Radon Emanation Modeling including with this submittal
2.62	Specific gravity of rock mulch, $G_{s\text{-}mulch}$	From Attachment H - Radon Emanation Modeling including with this submittal
2.63	Specific gravity of cover soil, $G_{s\text{-}cover}$	From Attachment H - Radon Emanation Modeling including with this submittal
Unit Weight, γ		
118.0	Maximum dry unit weight of cover soil $\gamma_{cover\text{-}max}$ (pcf)	Average calculated from laboratory testing results (UWM, 2012)
100.7	Moist unit weight of cover soil at 80% relative compaction, $\gamma_{cover80}$ (pcf)	Calculated
107.0	Moist unit weight of cover soil at 85% relative compaction, $\gamma_{cover85}$ (pcf)	Calculated
119.6	Moist unit weight of cover soil at 95% relative compaction, $\gamma_{cover95}$ (pcf)	Calculated
127.5	Saturated unit weight of cover soil at 80% relative compaction, $\gamma_{cover80\text{-}sat}$ (pcf)	Calculated
100	Dry unit weight of topsoil layer at 85% relative compaction, $\gamma_{topsoil5}$ (pcf)	From Attachment H - Radon Emanation Modeling including with this submittal
105	Moist unit weight of topsoil layer at 85% relative compaction, $\gamma_{topsoil5}$ (pcf)	Calculated
106	Dry unit weight of rock mulch layer at 85% relative compaction, $\gamma_{mulch85}$ (pcf)	From Attachment H - Radon Emanation Modeling including with this submittal
110	Moist unit weight of rock mulch layer at 85% relative compaction, $\gamma_{mulch85}$ (pcf)	From Attachment H - Radon Emanation Modeling including with this submittal
Void Ratio, e		
0.74	Void Ratio of cover soil at 80% relative compaction, $e_{cover80}$	Calculated
0.64	Void Ratio of cover soil at 85% relative compaction, $e_{cover85}$	Calculated
0.46	Void Ratio of cover soil at 95% relative compaction, $e_{cover95}$	Calculated
0.61	Void Ratio of topsoil at 85% relative compaction, $e_{topsoil85}$	Calculated from porosity presented in Attachment H - Radon Emanation Modeling including with this submittal
0.54	Void Ratio of rock mulch at 85% relative compaction, $e_{mulch85}$	Calculated from porosity presented in Attachment H - Radon Emanation Modeling including with this submittal
Other		
6.7%	Long-term moisture content of cover soil, w_{cover} (%)	Estimated based on measured 15bar water content. (UWM, 2012)
5.2%	Long-term moisture content of topsoil, $w_{topsoil}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
4.0%	Long-term moisture content of rock mulch, $w_{rockmulch}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
0.14	Compression index of cover soil, $C_{c\text{-}cover}$	Calculated from empirical equation for soil types similar to cover material (as presented in Holtz and Kovacs, 1981. Page 341). $C_c = 0.30*(e_0\text{-}0.27)$

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2W2

FINAL COVER		
5625.87	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
4.00	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
2.02	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1111.60	Additional Stress due to Final Cover Placement $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION		
5613.10	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5607.7	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013).
5598.51	Water surface elevation at t_1 (ft amsl)	
5593.51	Water surface elevation at t_2 (ft amsl)	

2W2

CREEP SETTLEMENT

Soil Layer	Material Type [1]	Thickness of Layer at t_0, H (ft)	Elevation at Top of Layer at t_1, $z_{i\text{-top1}}$ (ft amsl)	Elevation at Midpoint of Layer at t_1, $z_{i\text{-mid1}}$ (ft amsl)	Elevation at Bottom of Layer at t_1, $z_{i\text{-bott1}}$ (ft amsl)	Thickness of Layer at t_1, H (ft)	Height above liner (ft)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-mid1}}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-bott1}}$ (psf)	Void Ratio at t_0, e_0	Void Ratio at t_1, e_1	Secondary Compression Index, C_α	Change in Void Ratio due to 1000 years of Creep, Δe	Final Void Ratio After 1,000 years, e_{final}	Settlement due to 1000 years of Creep, δ_{creep} (ft)
Erosion Protection Layer	Erosion Protection Layer		5624.78	5624.53	5624.28	0.50	31.27	NA	NA	NA	NA	NA	NA	NA	NA
Rooting Zone	Rooting Zone		5624.28	5622.53	5620.78	3.50	30.77	NA	NA	NA	NA	NA	NA	NA	NA
High-Compaction Layer	High-Compaction Layer		5620.78	5618.78	5616.78	4.00	27.27	NA	NA	NA	NA	NA	NA	NA	NA
Platform Fill	Platform Fill		5616.78	5615.77	5614.76	2.02	23.27	NA	NA	NA	NA	NA	NA	NA	NA
Layer 1	Int. Cover		5614.76	5613.32	5611.88	2.88	21.25	NA	NA	NA	NA	NA	NA	NA	NA
Layer 2	Sand-Slime		5611.88	5611.42	5610.97	0.91	18.37	NA	NA	NA	NA	NA	NA	NA	NA
Layer 3	Slime		5610.97	5610.89	5610.81	0.16	17.46	NA	NA	NA	NA	NA	NA	NA	NA
Layer 4	Sand		5610.81	5610.65	5610.50	0.31	17.30	NA	NA	NA	NA	NA	NA	NA	NA
Layer 5	Sand-Slime		5610.50	5610.42	5610.34	0.16	16.99	NA	NA	NA	NA	NA	NA	NA	NA
Layer 6	Slime		5610.34	5609.95	5609.57	0.77	16.83	NA	NA	NA	NA	NA	NA	NA	NA
Layer 7	Sand-Slime		5609.57	5609.49	5609.42	0.15	16.06	NA	NA	NA	NA	NA	NA	NA	NA
Layer 8	Slime		5609.42	5609.18	5608.95	0.46	15.91	NA	NA	NA	NA	NA	NA	NA	NA
Layer 9	Sand-Slime		5608.95	5608.71	5608.48	0.48	15.44	NA	NA	NA	NA	NA	NA	NA	NA
Layer 10	Slime		5608.48	5607.93	5607.39	1.09	14.97	NA	NA	NA	NA	NA	NA	NA	NA
Layer 11	Sand-Slime		5607.39	5607.23	5607.07	0.32	13.88	NA	NA	NA	NA	NA	NA	NA	NA
Layer 12	Slime		5607.07	5606.68	5606.29	0.78	13.56	NA	NA	NA	NA	NA	NA	NA	NA
Layer 13	Sand-Slime		5606.29	5605.97	5605.66	0.63	12.78	NA	NA	NA	NA	NA	NA	NA	NA
Layer 14	Slime		5605.66	5605.42	5605.19	0.47	12.15	NA	NA	NA	NA	NA	NA	NA	NA
Layer 15	Sand-Slime		5605.19	5605.03	5604.87	0.32	11.68	NA	NA	NA	NA	NA	NA	NA	NA
Layer 16	Slime		5604.87	5604.71	5604.56	0.32	11.36	NA	NA	NA	NA	NA	NA	NA	NA
Layer 17	Sand-Slime		5604.56	5604.40	5604.24	0.32	11.05	NA	NA	NA	NA	NA	NA	NA	NA
Layer 18	Slime		5604.24	5604.01	5603.77	0.47	10.73	NA	NA	NA	NA	NA	NA	NA	NA
Layer 19	Sand-Slime		5603.77	5603.61	5603.46	0.32	10.26	NA	NA	NA	NA	NA	NA	NA	NA
Layer 20	Slime		5603.46	5602.99	5602.52	0.94	9.95	NA	NA	NA	NA	NA	NA	NA	NA
Layer 21	Sand-Slime		5602.52	5602.44	5602.36	0.15	9.01	NA	NA	NA	NA	NA	NA	NA	NA
Layer 22	Slime		5602.36	5601.97	5601.58	0.79	8.85	NA	NA	NA	NA	NA	NA	NA	NA
Layer 23	Sand-Slime		5601.58	5601.34	5601.10	0.48	8.07	NA	NA	NA	NA	NA	NA	NA	NA
Layer 24	Slime		5601.10	5601.02	5600.95	0.15	7.59	NA	NA	NA	NA	NA	NA	NA	NA
Layer 25	Sand-Slime		5600.95	5600.87	5600.79	0.15	7.44	NA	NA	NA	NA	NA	NA	NA	NA
Layer 26	Slime		5600.79	5600.40	5600.01	0.79	7.28	NA	NA	NA	NA	NA	NA	NA	NA
Layer 27	Sand-Slime		5600.01	5599.62	5599.22	0.79	6.50	NA	NA	NA	NA	NA	NA	NA	NA
Layer 28	Slime		5599.22	5598.51	5597.80	1.42	5.71	1548.29	3096.58	1.29	1.19	0.006	0.023	1.17	0.015
Layer 29	Sand-Slime		5597.80	5597.73	5597.65	0.15	4.29	1552.82	3105.63	0.99	0.90	0.005	0.020	0.88	0.002
Layer 30	Slime		5597.65	5597.34	5597.02	0.63	4.14	1569.56	3139.11	1.29	1.19	0.006	0.023	1.17	0.007
Layer 31	Sand-Slime		5597.02	5596.70	5596.39	0.63	3.51	1588.23	3176.45	0.99	0.91	0.005	0.020	0.89	0.007
Layer 32	Slime		5596.39	5596.23	5596.08	0.31	2.88	1596.34	3192.68	1.29	1.20	0.006	0.023	1.17	0.003
Layer 33	Sand-Slime		5596.08	5595.76	5595.44	0.63	2.57	1615.01	3230.02	0.99	0.91	0.005	0.020	0.89	0.007
Layer 34	Sand-Slime		5595.44	5594.48	5593.51	1.93	1.93	1671.86	3343.73	0.99	0.91	0.005	0.020	0.89	0.020
														TOTAL:	0.06

Notes:
[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015

2W3

FINAL COVER

5626.27	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
4.00	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
2.55	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1164.98	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5613.80	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5607.6	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013).
5597.75	Water surface elevation at t_1 (ft amsl)	
5592.75	Water surface elevation at t_2 (ft amsl)	

2W3

CREEP SETTLEMENT

Soil Layer	Material Type [1]	Elevation at Top of Layer at t_1, $z_{i\text{-top}1}$ (ft amsl)	Elevation at Midpoint of Layer at t_1, $z_{i\text{-mid}1}$ (ft amsl)	Elevation at Bottom of Layer at t_1, $z_{i\text{-bott}1}$ (ft amsl)	Thickness of Layer at t_1, H (ft)	Height above liner (ft)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-mid}1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-bott}1}$ (psf)	Void Ratio at t_0, e_0	Void Ratio at t_1, e_1	Secondary Compression Index, C_α	Change in Void Ratio due to 1000 years of Creep, Δe	Final Void Ratio After 1,000 years, e_{final}	Settlement due to 1000 years of Creep, δ_{creep} (ft)
Erosion Protection Layer	Erosion Protection Layer	5625.12	5624.87	5624.62	0.50	32.37	NA	NA	NA	NA	NA	NA	NA	NA
Rooting Zone	Rooting Zone	5624.62	5622.87	5621.12	3.50	31.87	NA	NA	NA	NA	NA	NA	NA	NA
High-Compaction Layer	High-Compaction Layer	5621.12	5619.12	5617.12	4.00	28.37	NA	NA	NA	NA	NA	NA	NA	NA
Platform Fill	Platform Fill	5617.12	5615.85	5614.57	2.55	24.37	NA	NA	NA	NA	NA	NA	NA	NA
Layer 1	Int. Cover	5614.57	5613.13	5611.70	2.88	21.82	NA	NA	NA	NA	NA	NA	NA	NA
Layer 2	Sand-Slime	5611.70	5611.47	5611.24	0.45	18.95	NA	NA	NA	NA	NA	NA	NA	NA
Layer 3	Slime	5611.24	5611.17	5611.09	0.16	18.49	NA	NA	NA	NA	NA	NA	NA	NA
Layer 4	Sand-Slime	5611.09	5610.63	5610.17	0.91	18.34	NA	NA	NA	NA	NA	NA	NA	NA
Layer 5	Slime	5610.17	5610.02	5609.86	0.31	17.42	NA	NA	NA	NA	NA	NA	NA	NA
Layer 6	Sand-Slime	5609.86	5609.09	5608.31	1.55	17.11	NA	NA	NA	NA	NA	NA	NA	NA
Layer 7	Slime	5608.31	5608.23	5608.15	0.16	15.56	NA	NA	NA	NA	NA	NA	NA	NA
Layer 8	Sand-Slime	5608.15	5607.92	5607.68	0.47	15.40	NA	NA	NA	NA	NA	NA	NA	NA
Layer 9	Slime	5607.68	5607.61	5607.53	0.15	14.93	NA	NA	NA	NA	NA	NA	NA	NA
Layer 10	Sand-Slime	5607.53	5607.45	5607.37	0.16	14.78	NA	NA	NA	NA	NA	NA	NA	NA
Layer 11	Slime	5607.37	5607.21	5607.04	0.32	14.62	NA	NA	NA	NA	NA	NA	NA	NA
Layer 12	Sand-Slime	5607.04	5606.42	5605.80	1.24	14.29	NA	NA	NA	NA	NA	NA	NA	NA
Layer 13	Slime	5605.80	5605.65	5605.49	0.31	13.05	NA	NA	NA	NA	NA	NA	NA	NA
Layer 14	Sand-Slime	5605.49	5604.47	5603.45	2.05	12.74	NA	NA	NA	NA	NA	NA	NA	NA
Layer 15	Slime	5603.45	5602.82	5602.19	1.25	10.70	NA	NA	NA	NA	NA	NA	NA	NA
Layer 16	Sand-Slime	5602.19	5601.25	5600.31	1.89	9.44	NA	NA	NA	NA	NA	NA	NA	NA
Layer 17	Slime	5600.31	5600.15	5599.99	0.32	7.56	NA	NA	NA	NA	NA	NA	NA	NA
Layer 18	Sand-Slime	5599.99	5599.84	5599.68	0.31	7.24	NA	NA	NA	NA	NA	NA	NA	NA
Layer 19	Slime	5599.68	5598.82	5597.95	1.73	6.93	NA	NA	NA	NA	NA	NA	NA	NA
Layer 20	Sand-Slime	5597.95	5597.64	5597.33	0.62	5.20	3205.98	3230.29	0.99	0.90	0.005	0.020	0.88	0.006
Layer 21	Slime	5597.33	5597.17	5597.01	0.32	4.58	3238.66	3247.03	1.29	1.19	0.006	0.023	1.17	0.003
Layer 22	Sand-Slime	5597.01	5596.39	5595.76	1.26	4.26	3284.09	3321.14	0.99	0.90	0.005	0.020	0.88	0.013
Layer 23	Slime	5595.76	5595.44	5595.12	0.63	3.01	3337.88	3354.62	1.29	1.20	0.006	0.023	1.17	0.007
Layer 24	Sand-Slime	5595.12	5594.97	5594.81	0.32	2.37	3363.96	3373.29	0.99	0.91	0.005	0.020	0.89	0.003
Layer 25	Slime	5594.81	5594.57	5594.34	0.47	2.06	3385.72	3398.15	1.29	1.20	0.006	0.023	1.17	0.005
Layer 26	Sand-Slime	5594.34	5594.18	5594.02	0.32	1.59	3407.48	3416.81	0.99	0.91	0.005	0.020	0.89	0.003
Layer 27	Sand-Slime	5594.02	5593.38	5592.75	1.27	1.27	3454.15	3491.49	0.99	0.91	0.005	0.020	0.89	0.013
													TOTAL:	**0.05**

Notes:

[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

2W4-C

FINAL COVER

5626.19	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
4.00	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
1.95	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1104.55	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5611.20	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5608.1	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013).
5593.51	Water surface elevation at t_1 (ft amsl)	
5588.51	Water surface elevation at t_2 (ft amsl)	

2W4-C

CREEP SETTLEMENT

Soil Layer	Material Type [1]	Elevation at Top of Layer at t_1, $z_{i\text{-}top1}$ (ft amsl)	Elevation at Midpoint of Layer at t_1, $z_{i\text{-}mid1}$ (ft amsl)	Elevation at Bottom of Layer at t_1, $z_{i\text{-}bott1}$ (ft amsl)	Thickness of Layer at t_1, H (ft)	Height above liner (ft)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Void Ratio at t_0, e_0	Void Ratio at t_1, e_1	Secondary Compression Index, C_α	Change in Void Ratio due to 1000 years of Creep, Δe	Final Void Ratio After 1,000 years, e_{final}	Settlement due to 1000 years of Creep, δ_{creep} (ft)
Erosion Protection Layer	Erosion Protection Layer	5624.90	5624.65	5624.40	0.50	36.39	NA	NA	NA	NA	NA	NA	NA	NA
Rooting Zone	Rooting Zone	5624.40	5622.65	5620.90	3.50	35.89	NA	NA	NA	NA	NA	NA	NA	NA
High-Compaction Layer	High-Compaction Layer	5620.90	5618.90	5616.90	4.00	32.39	NA	NA	NA	NA	NA	NA	NA	NA
Platform Fill	Platform Fill	5616.90	5615.92	5614.95	1.95	28.39	NA	NA	NA	NA	NA	NA	NA	NA
Layer 1	Int. Cover	5614.95	5613.50	5612.05	2.89	26.44	NA	NA	NA	NA	NA	NA	NA	NA
Layer 2	Sand	5612.05	5611.98	5611.90	0.15	23.54	NA	NA	NA	NA	NA	NA	NA	NA
Layer 3	Sand-Slime	5611.90	5610.36	5608.82	3.09	23.39	NA	NA	NA	NA	NA	NA	NA	NA
Layer 4	Slime	5608.82	5608.73	5608.65	0.16	20.31	NA	NA	NA	NA	NA	NA	NA	NA
Layer 5	Sand-Slime	5608.65	5607.48	5606.30	2.36	20.14	NA	NA	NA	NA	NA	NA	NA	NA
Layer 6	Slime	5606.30	5606.14	5605.99	0.31	17.79	NA	NA	NA	NA	NA	NA	NA	NA
Layer 7	Sand-Slime	5605.99	5605.83	5605.68	0.32	17.48	NA	NA	NA	NA	NA	NA	NA	NA
Layer 8	Slime	5605.68	5605.59	5605.51	0.16	17.17	NA	NA	NA	NA	NA	NA	NA	NA
Layer 9	Sand-Slime	5605.51	5604.73	5603.94	1.57	17.00	NA	NA	NA	NA	NA	NA	NA	NA
Layer 10	Slime	5603.94	5603.86	5603.79	0.15	15.43	NA	NA	NA	NA	NA	NA	NA	NA
Layer 11	Sand-Slime	5603.79	5603.63	5603.47	0.32	15.28	NA	NA	NA	NA	NA	NA	NA	NA
Layer 12	Slime	5603.47	5603.31	5603.15	0.32	14.96	NA	NA	NA	NA	NA	NA	NA	NA
Layer 13	Sand-Slime	5603.15	5601.35	5599.54	3.61	14.64	NA	NA	NA	NA	NA	NA	NA	NA
Layer 14	Slime	5599.54	5598.99	5598.44	1.10	11.03	NA	NA	NA	NA	NA	NA	NA	NA
Layer 15	Sand-Slime	5598.44	5598.04	5597.65	0.79	9.93	NA	NA	NA	NA	NA	NA	NA	NA
Layer 16	Slime	5597.65	5597.57	5597.50	0.15	9.14	NA	NA	NA	NA	NA	NA	NA	NA
Layer 17	Sand-Slime	5597.50	5597.26	5597.03	0.47	8.99	NA	NA	NA	NA	NA	NA	NA	NA
Layer 18	Slime	5597.03	5596.87	5596.71	0.32	8.52	NA	NA	NA	NA	NA	NA	NA	NA
Layer 19	Sand-Slime	5596.71	5596.32	5595.92	0.79	8.20	NA	NA	NA	NA	NA	NA	NA	NA
Layer 20	Slime	5595.92	5595.53	5595.14	0.79	7.41	NA	NA	NA	NA	NA	NA	NA	NA
Layer 21	Sand-Slime	5595.14	5594.82	5594.51	0.63	6.63	NA	NA	NA	NA	NA	NA	NA	NA
Layer 22	Slime	5594.51	5594.43	5594.35	0.15	6.00	NA	NA	NA	NA	NA	NA	NA	NA
Layer 23	Sand-Slime	5594.35	5594.19	5594.04	0.32	5.84	NA	NA	NA	NA	NA	NA	NA	NA
Layer 24	Slime	5594.04	5593.88	5593.72	0.32	5.53	NA	NA	NA	NA	NA	NA	NA	NA
Layer 25	Sand-Slime	5593.72	5591.67	5589.63	4.09	5.21	3825.33	3945.83	0.99	0.91	0.005	0.020	0.89	0.042
Layer 26	Sand-Slime	5589.63	5589.07	5588.51	1.12	1.12	3978.64	4011.45	0.99	0.91	0.005	0.020	0.89	0.011
													TOTAL:	**0.05**

Notes:
[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

2W5-C

FINAL COVER

5626.29	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
4.00	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
2.43	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1152.89	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5604.20	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5604.2	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013).
5589.01	Water surface elevation at t_1 (ft amsl)	
5584.01	Water surface elevation at t_2 (ft amsl)	

2W5-C

CREEP SETTLEMENT

Soil Layer	Material Type [1]	Elevation at Top of Layer at t_1, $z_{i\text{-top1}}$ (ft amsl)	Elevation at Midpoint of Layer at t_1, $z_{i\text{-mid1}}$ (ft amsl)	Elevation at Bottom of Layer at t_1, $z_{i\text{-bott1}}$ (ft amsl)	Thickness of Layer at t_1, H (ft)	Height above liner (ft)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-mid1}}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-bott1}}$ (psf)	Void Ratio at t_0, e_0	Void Ratio at t_1, e_1	Secondary Compression Index, C_α	Change in Void Ratio due to 1000 years of Creep, Δe	Final Void Ratio After 1,000 years, e_{final}	Settlement due to 1000 years of Creep, δ_{creep} (ft)
Erosion Protection Layer	Erosion Protection Layer	5625.03	5624.78	5624.53	0.50	41.02	NA	NA	NA	NA	NA	NA	NA	NA
Rooting Zone	Rooting Zone	5624.53	5622.78	5621.03	3.50	40.52	NA	NA	NA	NA	NA	NA	NA	NA
High-Compaction Layer	High-Compaction Layer	5621.03	5619.03	5617.03	4.00	37.02	NA	NA	NA	NA	NA	NA	NA	NA
Platform Fill	Platform Fill	5617.03	5615.82	5614.60	2.43	33.02	NA	NA	NA	NA	NA	NA	NA	NA
Layer 1	Int. Cover	5614.60	5613.16	5611.73	2.88	30.59	NA	NA	NA	NA	NA	NA	NA	NA
Layer 2	Sand-Slime	5611.73	5611.57	5611.42	0.30	27.72	NA	NA	NA	NA	NA	NA	NA	NA
Layer 3	Sand	5611.42	5611.10	5610.79	0.63	27.41	NA	NA	NA	NA	NA	NA	NA	NA
Layer 4	Sand-Slime	5610.79	5610.64	5610.49	0.30	26.78	NA	NA	NA	NA	NA	NA	NA	NA
Layer 5	Sand	5610.49	5610.17	5609.85	0.64	26.48	NA	NA	NA	NA	NA	NA	NA	NA
Layer 6	Sand-Slime	5609.85	5609.08	5608.30	1.55	25.84	NA	NA	NA	NA	NA	NA	NA	NA
Layer 7	Sand	5608.30	5608.06	5607.82	0.48	24.29	NA	NA	NA	NA	NA	NA	NA	NA
Layer 8	Sand-Slime	5607.82	5604.18	5600.53	7.29	23.81	NA	NA	NA	NA	NA	NA	NA	NA
Layer 9	Sand	5600.53	5600.45	5600.37	0.16	16.52	NA	NA	NA	NA	NA	NA	NA	NA
Layer 10	Sand-Slime	5600.37	5599.58	5598.79	1.58	16.36	NA	NA	NA	NA	NA	NA	NA	NA
Layer 11	Slime	5598.79	5598.63	5598.47	0.32	14.78	NA	NA	NA	NA	NA	NA	NA	NA
Layer 12	Sand-Slime	5598.47	5596.49	5594.51	3.96	14.46	NA	NA	NA	NA	NA	NA	NA	NA
Layer 13	Slime	5594.51	5594.12	5593.72	0.79	10.50	NA	NA	NA	NA	NA	NA	NA	NA
Layer 14	Sand-Slime	5593.72	5593.48	5593.25	0.47	9.71	NA	NA	NA	NA	NA	NA	NA	NA
Layer 15	Slime	5593.25	5593.17	5593.08	0.16	9.24	NA	NA	NA	NA	NA	NA	NA	NA
Layer 16	Sand-Slime	5593.08	5592.29	5591.50	1.58	9.07	NA	NA	NA	NA	NA	NA	NA	NA
Layer 17	Slime	5591.50	5591.34	5591.18	0.32	7.49	NA	NA	NA	NA	NA	NA	NA	NA
Layer 18	Sand-Slime	5591.18	5589.29	5587.39	3.79	7.17	4236.82	4375.75	0.99	0.92	0.005	0.020	0.90	0.039
Layer 19	Slime	5587.39	5587.23	5587.07	0.32	3.38	4384.12	4392.49	1.29	1.21	0.006	0.023	1.19	0.003
Layer 20	Sand	5587.07	5586.67	5586.27	0.80	3.06	4417.53	4442.57	0.74	0.70	0.002	0.010	0.69	0.005
Layer 21	Sand-Slime	5586.27	5586.11	5585.95	0.32	2.26	4451.90	4461.24	0.99	0.92	0.005	0.020	0.90	0.003
Layer 22	Sand	5585.95	5585.79	5585.63	0.32	1.94	4471.31	4481.39	0.74	0.70	0.002	0.010	0.69	0.002
Layer 23	Sand-Slime	5585.63	5584.82	5584.01	1.62	1.62	4528.63	4575.86	0.99	0.92	0.005	0.020	0.90	0.016
													TOTAL:	**0.07**

Notes:
[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

2W6-S

FINAL COVER		
5625.41	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
4.00	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
1.56	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1065.26	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION		
5604.40	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5604.4	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013).
5588.59	Water surface elevation at t_1 (ft amsl)	
5583.59	Water surface elevation at t_2 (ft amsl)	

2W6-S

CREEP SETTLEMENT

Soil Layer	Material Type [1]	Elevation at Top of Layer at t_1, $z_{i\text{-}top1}$ (ft amsl)	Elevation at Midpoint of Layer at t_1, $z_{i\text{-}mid1}$ (ft amsl)	Elevation at Bottom of Layer at t_1, $z_{i\text{-}bott1}$ (ft amsl)	Thickness of Layer at t_1, H (ft)	Height above liner (ft)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Void Ratio at t_0, e_0	Void Ratio at t_1, e_1	Secondary Compression Index, C_α	Change in Void Ratio due to 1000 years of Creep, Δe	Final Void Ratio After 1,000 years, e_{final}	Settlement due to 1000 years of Creep, δ_{creep} (ft)
Erosion Protection Layer	Erosion Protection Layer	5624.12	5623.87	5623.62	0.50	40.53	NA	NA	NA	NA	NA	NA	NA	NA
Rooting Zone	Rooting Zone	5623.62	5621.87	5620.12	3.50	40.03	NA	NA	NA	NA	NA	NA	NA	NA
High-Compaction Layer	High-Compaction Layer	5620.12	5618.12	5616.12	4.00	36.53	NA	NA	NA	NA	NA	NA	NA	NA
Platform Fill	Platform Fill	5616.12	5615.34	5614.56	1.56	32.53	NA	NA	NA	NA	NA	NA	NA	NA
Layer 1	Int. Cover	5614.56	5613.11	5611.67	2.90	30.97	NA	NA	NA	NA	NA	NA	NA	NA
Layer 2	Sand-Slime	5611.67	5611.44	5611.21	0.45	28.08	NA	NA	NA	NA	NA	NA	NA	NA
Layer 3	Sand	5611.21	5611.13	5611.05	0.16	27.62	NA	NA	NA	NA	NA	NA	NA	NA
Layer 4	Sand-Slime	5611.05	5610.67	5610.28	0.77	27.46	NA	NA	NA	NA	NA	NA	NA	NA
Layer 5	Sand	5610.28	5610.04	5609.81	0.47	26.69	NA	NA	NA	NA	NA	NA	NA	NA
Layer 6	Sand-Slime	5609.81	5608.87	5607.94	1.87	26.22	NA	NA	NA	NA	NA	NA	NA	NA
Layer 7	Slime	5607.94	5607.78	5607.62	0.32	24.35	NA	NA	NA	NA	NA	NA	NA	NA
Layer 8	Sand	5607.62	5607.47	5607.31	0.31	24.03	NA	NA	NA	NA	NA	NA	NA	NA
Layer 9	Sand-Slime	5607.31	5606.60	5605.89	1.42	23.72	NA	NA	NA	NA	NA	NA	NA	NA
Layer 10	Slime	5605.89	5605.73	5605.57	0.32	22.30	NA	NA	NA	NA	NA	NA	NA	NA
Layer 11	Sand-Slime	5605.57	5605.33	5605.10	0.47	21.98	NA	NA	NA	NA	NA	NA	NA	NA
Layer 12	Slime	5605.10	5604.78	5604.46	0.64	21.51	NA	NA	NA	NA	NA	NA	NA	NA
Layer 13	Sand-Slime	5604.46	5604.15	5603.83	0.63	20.87	NA	NA	NA	NA	NA	NA	NA	NA
Layer 14	Slime	5603.83	5603.59	5603.35	0.48	20.24	NA	NA	NA	NA	NA	NA	NA	NA
Layer 15	Sand-Slime	5603.35	5603.27	5603.19	0.15	19.76	NA	NA	NA	NA	NA	NA	NA	NA
Layer 16	Slime	5603.19	5602.00	5600.81	2.38	19.60	NA	NA	NA	NA	NA	NA	NA	NA
Layer 17	Sand-Slime	5600.81	5600.57	5600.34	0.47	17.22	NA	NA	NA	NA	NA	NA	NA	NA
Layer 18	Slime	5600.34	5600.26	5600.17	0.16	16.75	NA	NA	NA	NA	NA	NA	NA	NA
Layer 19	Sand-Slime	5600.17	5600.10	5600.02	0.15	16.58	NA	NA	NA	NA	NA	NA	NA	NA
Layer 20	Slime	5600.02	5599.62	5599.23	0.79	16.43	NA	NA	NA	NA	NA	NA	NA	NA
Layer 21	Sand-Slime	5599.23	5598.67	5598.11	1.11	15.64	NA	NA	NA	NA	NA	NA	NA	NA
Layer 22	Slime	5598.11	5597.72	5597.32	0.79	14.52	NA	NA	NA	NA	NA	NA	NA	NA
Layer 23	Sand-Slime	5597.32	5596.53	5595.74	1.58	13.73	NA	NA	NA	NA	NA	NA	NA	NA
Layer 24	Slime	5595.74	5595.50	5595.26	0.47	12.15	NA	NA	NA	NA	NA	NA	NA	NA
Layer 25	Sand-Slime	5595.26	5595.10	5594.95	0.32	11.67	NA	NA	NA	NA	NA	NA	NA	NA
Layer 26	Slime	5594.95	5594.87	5594.79	0.15	11.36	NA	NA	NA	NA	NA	NA	NA	NA
Layer 27	Sand-Slime	5594.79	5592.42	5590.04	4.75	11.20	NA	NA	NA	NA	NA	NA	NA	NA
Layer 28	Slime	5590.04	5589.96	5589.88	0.16	6.45	NA	NA	NA	NA	NA	NA	NA	NA
Layer 29	Sand-Slime	5589.88	5588.45	5587.03	2.85	6.29	4212.55	4297.55	0.99	0.92	0.005	0.020	0.90	0.029
Layer 30	Sand	5587.03	5586.79	5586.55	0.48	3.44	4312.52	4327.48	0.74	0.70	0.002	0.010	0.69	0.003
Layer 31	Sand-Slime	5586.55	5585.07	5583.59	2.96	2.96	4414.03	4500.59	0.99	0.92	0.005	0.020	0.90	0.030
													TOTAL:	**0.06**

Notes:

[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

2W7-C

FINAL COVER

5626.65	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
4.00	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
-0.95	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
812.44	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5613.10	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5611.5	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013).
5595.40	Water surface elevation at t_1 (ft amsl)	
5590.40	Water surface elevation at t_2 (ft amsl)	

2W7-C

CREEP SETTLEMENT

Soil Layer	Material Type [1]	Elevation at Top of Layer at t_1, $z_{i\text{-}top1}$ (ft amsl)	Elevation at Midpoint of Layer at t_1, $z_{i\text{-}mid1}$ (ft amsl)	Elevation at Bottom of Layer at t_1, $z_{i\text{-}bott1}$ (ft amsl)	Thickness of Layer at t_1, H (ft)	Height above liner (ft)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Void Ratio at t_0, e_0	Void Ratio at t_1, e_1	Secondary Compression Index, C_α	Change in Void Ratio due to 1000 years of Creep, Δe	Final Void Ratio After 1,000 years, e_{final}	Settlement due to 1000 years of Creep, δ_{creep} (ft)
Erosion Protection Layer	Erosion Protection Layer	5625.48	5625.23	5624.98	0.50	35.08	NA	NA	NA	NA	NA	NA	NA	NA
Rooting Zone	Rooting Zone	5624.98	5623.23	5621.48	3.50	34.58	NA	NA	NA	NA	NA	NA	NA	NA
High-Compaction Layer	High-Compaction Layer	5621.48	5619.48	5617.48	4.00	31.08	NA	NA	NA	NA	NA	NA	NA	NA
Platform Fill	Platform Fill	5617.48	5617.95	5618.43	-0.95	27.08	NA	NA	NA	NA	NA	NA	NA	NA
Layer 1	Int. Cover	5618.43	5616.97	5615.51	2.92	28.03	NA	NA	NA	NA	NA	NA	NA	NA
Layer 2	Sand-Slime	5615.51	5614.27	5613.03	2.48	25.11	NA	NA	NA	NA	NA	NA	NA	NA
Layer 3	Slime	5613.03	5612.94	5612.86	0.16	22.63	NA	NA	NA	NA	NA	NA	NA	NA
Layer 4	Sand-Slime	5612.86	5612.00	5611.13	1.73	22.46	NA	NA	NA	NA	NA	NA	NA	NA
Layer 5	Slime	5611.13	5611.05	5610.97	0.16	20.73	NA	NA	NA	NA	NA	NA	NA	NA
Layer 6	Sand-Slime	5610.97	5610.26	5609.55	1.42	20.57	NA	NA	NA	NA	NA	NA	NA	NA
Layer 7	Slime	5609.55	5609.47	5609.38	0.16	19.15	NA	NA	NA	NA	NA	NA	NA	NA
Layer 8	Sand-Slime	5609.38	5609.31	5609.23	0.15	18.98	NA	NA	NA	NA	NA	NA	NA	NA
Layer 9	Slime	5609.23	5609.15	5609.07	0.16	18.83	NA	NA	NA	NA	NA	NA	NA	NA
Layer 10	Sand-Slime	5609.07	5605.59	5602.11	6.96	18.67	NA	NA	NA	NA	NA	NA	NA	NA
Layer 11	Slime	5602.11	5601.79	5601.47	0.64	11.71	NA	NA	NA	NA	NA	NA	NA	NA
Layer 12	Sand-Slime	5601.47	5601.39	5601.32	0.15	11.07	NA	NA	NA	NA	NA	NA	NA	NA
Layer 13	Slime	5601.32	5601.16	5601.00	0.32	10.92	NA	NA	NA	NA	NA	NA	NA	NA
Layer 14	Sand-Slime	5601.00	5600.37	5599.74	1.26	10.60	NA	NA	NA	NA	NA	NA	NA	NA
Layer 15	Slime	5599.74	5599.65	5599.57	0.16	9.34	NA	NA	NA	NA	NA	NA	NA	NA
Layer 16	Sand	5599.57	5599.49	5599.42	0.16	9.17	NA	NA	NA	NA	NA	NA	NA	NA
Layer 17	Sand-Slime	5599.42	5599.33	5599.25	0.16	9.02	NA	NA	NA	NA	NA	NA	NA	NA
Layer 18	Slime	5599.25	5598.94	5598.63	0.63	8.85	NA	NA	NA	NA	NA	NA	NA	NA
Layer 19	Sand-Slime	5598.63	5598.23	5597.84	0.79	8.23	NA	NA	NA	NA	NA	NA	NA	NA
Layer 20	Slime	5597.84	5597.36	5596.88	0.95	7.44	NA	NA	NA	NA	NA	NA	NA	NA
Layer 21	Sand-Slime	5596.88	5596.73	5596.57	0.31	6.48	NA	NA	NA	NA	NA	NA	NA	NA
Layer 22	Slime	5596.57	5596.49	5596.41	0.16	6.17	NA	NA	NA	NA	NA	NA	NA	NA
Layer 23	Sand-Slime	5596.41	5596.17	5595.94	0.47	6.01	NA	NA	NA	NA	NA	NA	NA	NA
Layer 24	Slime	5595.94	5595.86	5595.78	0.15	5.54	NA	NA	NA	NA	NA	NA	NA	NA
Layer 25	Sand-Slime	5595.78	5595.39	5594.99	0.79	5.38	3592.85	3626.66	0.99	0.91	0.005	0.020	0.89	0.008
Layer 26	Slime	5594.99	5594.68	5594.36	0.64	4.59	3643.40	3660.14	1.29	1.20	0.006	0.023	1.18	0.007
Layer 27	Sand-Slime	5594.36	5594.28	5594.20	0.15	3.96	3664.66	3669.19	0.99	0.91	0.005	0.020	0.89	0.002
Layer 28	Slime	5594.20	5593.96	5593.72	0.48	3.80	3681.87	3694.55	1.29	1.21	0.006	0.023	1.18	0.005
Layer 29	Sand-Slime	5593.72	5593.49	5593.25	0.47	3.32	3708.41	3722.27	0.99	0.92	0.005	0.020	0.90	0.005
Layer 30	Slime	5593.25	5593.17	5593.09	0.15	2.85	3726.33	3730.39	1.29	1.21	0.006	0.023	1.18	0.002
Layer 31	Sand-Slime	5593.09	5592.54	5591.98	1.11	2.69	3762.92	3795.44	0.99	0.92	0.005	0.020	0.90	0.011
Layer 32	Slime	5591.98	5591.75	5591.51	0.47	1.58	3807.87	3820.30	1.29	1.21	0.006	0.023	1.19	0.005
Layer 33	Sand-Slime	5591.51	5590.96	5590.40	1.11	1.11	3852.83	3885.36	0.99	0.92	0.005	0.020	0.90	0.011
													TOTAL:	**0.06**

Notes:
[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

2E1

FINAL COVER

5630.46	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
4.00	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
2.51	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1160.95	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5610.80	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5610.8	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013).
5595.46	Water surface elevation at t_1 (ft amsl)	
5590.46	Water surface elevation at t_2 (ft amsl)	

2E1

CREEP SETTLEMENT

Soil Layer	Material Type [1]	Elevation at Top of Layer at t_1, $z_{i\text{-}top1}$ (ft amsl)	Elevation at Midpoint of Layer at t_1, $z_{i\text{-}mid1}$ (ft amsl)	Elevation at Bottom of Layer at t_1, $z_{i\text{-}bott1}$ (ft amsl)	Thickness of Layer at t_1, H (ft)	Height above liner (ft)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Void Ratio at t_0, e_0	Void Ratio at t_1, e_1	Secondary Compression Index, C_α	Change in Void Ratio due to 1000 years of Creep, Δe	Final Void Ratio After 1,000 years, e_{final}	Settlement due to 1000 years of Creep, δ_{creep} (ft)
Erosion Protection Layer	Erosion Protection Layer	5629.16	5628.91	5628.66	0.50	38.70	NA	NA	NA	NA	NA	NA	NA	NA
Rooting Zone	Rooting Zone	5628.66	5626.91	5625.16	3.50	38.20	NA	NA	NA	NA	NA	NA	NA	NA
High-Compaction Layer	High-Compaction Layer	5625.16	5623.16	5621.16	4.00	34.70	NA	NA	NA	NA	NA	NA	NA	NA
Platform Fill	Platform Fill	5621.16	5619.91	5618.65	2.51	30.70	NA	NA	NA	NA	NA	NA	NA	NA
Layer 1	Int. Cover	5618.65	5617.21	5615.76	2.89	28.19	NA	NA	NA	NA	NA	NA	NA	NA
Layer 2	Sand	5615.76	5615.45	5615.13	0.63	25.30	NA	NA	NA	NA	NA	NA	NA	NA
Layer 3	Sand-Slime	5615.13	5614.91	5614.68	0.46	24.67	NA	NA	NA	NA	NA	NA	NA	NA
Layer 4	Slime	5614.68	5614.52	5614.37	0.31	24.22	NA	NA	NA	NA	NA	NA	NA	NA
Layer 5	Sand-Slime	5614.37	5614.21	5614.06	0.31	23.91	NA	NA	NA	NA	NA	NA	NA	NA
Layer 6	Sand	5614.06	5613.66	5613.27	0.79	23.60	NA	NA	NA	NA	NA	NA	NA	NA
Layer 7	Sand-Slime	5613.27	5612.88	5612.49	0.78	22.81	NA	NA	NA	NA	NA	NA	NA	NA
Layer 8	Sand	5612.49	5612.33	5612.18	0.31	22.03	NA	NA	NA	NA	NA	NA	NA	NA
Layer 9	Sand-Slime	5612.18	5609.66	5607.14	5.04	21.72	NA	NA	NA	NA	NA	NA	NA	NA
Layer 10	Slime	5607.14	5607.05	5606.97	0.16	16.68	NA	NA	NA	NA	NA	NA	NA	NA
Layer 11	Sand-Slime	5606.97	5606.90	5606.82	0.15	16.51	NA	NA	NA	NA	NA	NA	NA	NA
Layer 12	Slime	5606.82	5606.74	5606.66	0.16	16.36	NA	NA	NA	NA	NA	NA	NA	NA
Layer 13	Sand-Slime	5606.66	5605.95	5605.24	1.41	16.20	NA	NA	NA	NA	NA	NA	NA	NA
Layer 14	Slime	5605.24	5605.16	5605.08	0.16	14.78	NA	NA	NA	NA	NA	NA	NA	NA
Layer 15	Sand-Slime	5605.08	5604.93	5604.77	0.31	14.62	NA	NA	NA	NA	NA	NA	NA	NA
Layer 16	Slime	5604.77	5604.69	5604.61	0.16	14.31	NA	NA	NA	NA	NA	NA	NA	NA
Layer 17	Sand-Slime	5604.61	5601.06	5597.52	7.09	14.15	NA	NA	NA	NA	NA	NA	NA	NA
Layer 18	Slime	5597.52	5597.36	5597.20	0.32	7.06	NA	NA	NA	NA	NA	NA	NA	NA
Layer 19	Sand-Slime	5597.20	5595.63	5594.05	3.15	6.74	3973.89	4089.75	0.99	0.91	0.005	0.020	0.89	0.032
Layer 20	Slime	5594.05	5593.89	5593.73	0.32	3.59	4098.12	4106.49	1.29	1.20	0.006	0.023	1.18	0.003
Layer 21	Sand-Slime	5593.73	5593.58	5593.43	0.31	3.27	4115.54	4124.60	0.99	0.91	0.005	0.020	0.89	0.003
Layer 22	Slime	5593.43	5593.27	5593.11	0.32	2.97	4132.97	4141.34	1.29	1.20	0.006	0.023	1.18	0.003
Layer 23	Sand-Slime	5593.11	5592.47	5591.84	1.27	2.65	4178.67	4216.01	0.99	0.91	0.005	0.020	0.89	0.013
Layer 24	Sand-Slime	5591.84	5591.15	5590.46	1.38	1.38	4256.46	4296.91	0.99	0.91	0.005	0.020	0.89	0.014
													TOTAL:	0.07

Notes:

[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

3-1S

FINAL COVER

5620.47	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
0.41	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
887.10	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5608.00	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5604.4	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013).
5595.59	Water surface elevation at t_1 (ft amsl)	
5590.59	Water surface elevation at t_2 (ft amsl)	

3-1S

CREEP SETTLEMENT

Soil Layer	Material Type [1]	Elevation at Top of Layer at t_1, $z_{i\text{-top}1}$ (ft amsl)	Elevation at Midpoint of Layer at t_1, $z_{i\text{-mid}1}$ (ft amsl)	Elevation at Bottom of Layer at t_1, $z_{i\text{-bott}1}$ (ft amsl)	Thickness of Layer at t_1, H (ft)	Height above liner (ft)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-mid}1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-bott}1}$ (psf)	Void Ratio at t_0, e_0	Void Ratio at t_1, e_1	Secondary Compression Index, C_α	Change in Void Ratio due to 1000 years of Creep, Δe	Final Void Ratio After 1,000 years, e_{final}	Settlement due to 1000 years of Creep, δ_{creep} (ft)
Erosion Protection Layer	Erosion Protection Layer	5619.59	5619.34	5619.09	0.50	29.00	NA	NA	NA	NA	NA	NA	NA	NA
Rooting Zone	Rooting Zone	5619.09	5617.34	5615.59	3.50	28.50	NA	NA	NA	NA	NA	NA	NA	NA
High-Compaction Layer	High-Compaction Layer	5615.59	5613.84	5612.09	3.50	25.00	NA	NA	NA	NA	NA	NA	NA	NA
Platform Fill	Platform Fill	5612.09	5611.89	5611.68	0.41	21.50	NA	NA	NA	NA	NA	NA	NA	NA
Layer 1	Int. Cover	5611.68	5610.23	5608.77	2.91	21.09	NA	NA	NA	NA	NA	NA	NA	NA
Layer 2	Slime	5608.77	5608.08	5607.39	1.38	18.18	NA	NA	NA	NA	NA	NA	NA	NA
Layer 3	Sand-Slime	5607.39	5607.31	5607.23	0.16	16.80	NA	NA	NA	NA	NA	NA	NA	NA
Layer 4	Sand	5607.23	5605.95	5604.68	2.55	16.64	NA	NA	NA	NA	NA	NA	NA	NA
Layer 5	Sand-Slime	5604.68	5604.44	5604.20	0.48	14.09	NA	NA	NA	NA	NA	NA	NA	NA
Layer 6	Sand	5604.20	5603.96	5603.72	0.48	13.61	NA	NA	NA	NA	NA	NA	NA	NA
Layer 7	Sand-Slime	5603.72	5603.32	5602.93	0.79	13.13	NA	NA	NA	NA	NA	NA	NA	NA
Layer 8	Sand	5602.93	5602.69	5602.45	0.48	12.34	NA	NA	NA	NA	NA	NA	NA	NA
Layer 9	Sand-Slime	5602.45	5602.29	5602.13	0.32	11.86	NA	NA	NA	NA	NA	NA	NA	NA
Layer 10	Slime	5602.13	5602.05	5601.97	0.15	11.54	NA	NA	NA	NA	NA	NA	NA	NA
Layer 11	Sand-Slime	5601.97	5600.86	5599.76	2.22	11.38	NA	NA	NA	NA	NA	NA	NA	NA
Layer 12	Sand	5599.76	5599.68	5599.60	0.16	9.17	NA	NA	NA	NA	NA	NA	NA	NA
Layer 13	Sand-Slime	5599.60	5597.70	5595.80	3.80	9.01	NA	NA	NA	NA	NA	NA	NA	NA
Layer 14	Slime	5595.80	5595.73	5595.65	0.15	5.21	NA	NA	NA	NA	NA	NA	NA	NA
Layer 15	Sand-Slime	5595.65	5595.10	5594.54	1.11	5.06	2874.54	2907.07	0.99	0.91	0.005	0.020	0.89	0.011
Layer 16	Sand-Slime	5594.54	5592.57	5590.59	3.95	3.95	3022.76	3138.45	0.99	0.92	0.005	0.020	0.90	0.040
													TOTAL:	**0.05**

Notes:
[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

3-2C

FINAL COVER

5621.51	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.19	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1167.12	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5605.30	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5602.7	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013).
5591.64	Water surface elevation at t_1 (ft amsl)	
5586.64	Water surface elevation at t_2 (ft amsl)	

3-2C

CREEP SETTLEMENT

Soil Layer	Material Type [1]	Elevation at Top of Layer at t_1, $z_{i\text{-top1}}$ (ft amsl)	Elevation at Midpoint of Layer at t_1, $z_{i\text{-mid1}}$ (ft amsl)	Elevation at Bottom of Layer at t_1, $z_{i\text{-bott1}}$ (ft amsl)	Thickness of Layer at t_1, H (ft)	Height above liner (ft)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-mid1}}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-bott1}}$ (psf)	Void Ratio at t_0, e_0	Void Ratio at t_1, e_1	Secondary Compression Index, C_α	Change in Void Ratio due to 1000 years of Creep, Δe	Final Void Ratio After 1,000 years, e_{final}	Settlement due to 1000 years of Creep, δ_{creep} (ft)
Erosion Protection Layer	Erosion Protection Layer	5620.32	5620.07	5619.82	0.50	33.68	NA	NA	NA	NA	NA	NA	NA	NA
Rooting Zone	Rooting Zone	5619.82	5618.07	5616.32	3.50	33.18	NA	NA	NA	NA	NA	NA	NA	NA
High-Compaction Layer	High-Compaction Layer	5616.32	5614.57	5612.82	3.50	29.68	NA	NA	NA	NA	NA	NA	NA	NA
Platform Fill	Platform Fill	5612.82	5611.23	5609.63	3.19	26.18	NA	NA	NA	NA	NA	NA	NA	NA
Layer 1	Int. Cover	5609.63	5608.19	5606.76	2.88	22.99	NA	NA	NA	NA	NA	NA	NA	NA
Layer 2	Sand	5606.76	5606.67	5606.59	0.16	20.12	NA	NA	NA	NA	NA	NA	NA	NA
Layer 3	Sand-Slime	5606.59	5606.52	5606.45	0.15	19.95	NA	NA	NA	NA	NA	NA	NA	NA
Layer 4	Slime	5606.45	5605.99	5605.53	0.92	19.81	NA	NA	NA	NA	NA	NA	NA	NA
Layer 5	Sand-Slime	5605.53	5605.14	5604.76	0.77	18.89	NA	NA	NA	NA	NA	NA	NA	NA
Layer 6	Slime	5604.76	5604.60	5604.45	0.31	18.12	NA	NA	NA	NA	NA	NA	NA	NA
Layer 7	Sand-Slime	5604.45	5604.30	5604.15	0.30	17.81	NA	NA	NA	NA	NA	NA	NA	NA
Layer 8	Slime	5604.15	5603.83	5603.52	0.62	17.51	NA	NA	NA	NA	NA	NA	NA	NA
Layer 9	Sand-Slime	5603.52	5600.22	5596.93	6.59	16.88	NA	NA	NA	NA	NA	NA	NA	NA
Layer 10	Slime	5596.93	5596.85	5596.78	0.15	10.29	NA	NA	NA	NA	NA	NA	NA	NA
Layer 11	Sand-Slime	5596.78	5596.54	5596.30	0.48	10.14	NA	NA	NA	NA	NA	NA	NA	NA
Layer 12	Slime	5596.30	5595.83	5595.36	0.94	9.66	NA	NA	NA	NA	NA	NA	NA	NA
Layer 13	Sand-Slime	5595.36	5594.65	5593.94	1.42	8.72	NA	NA	NA	NA	NA	NA	NA	NA
Layer 14	Slime	5593.94	5593.86	5593.79	0.15	7.30	NA	NA	NA	NA	NA	NA	NA	NA
Layer 15	Sand-Slime	5593.79	5593.24	5592.69	1.10	7.15	NA	NA	NA	NA	NA	NA	NA	NA
Layer 16	Slime	5592.69	5592.53	5592.37	0.32	6.05	NA	NA	NA	NA	NA	NA	NA	NA
Layer 17	Sand-Slime	5592.37	5591.98	5591.59	0.79	5.73	NA	NA	NA	NA	NA	NA	NA	NA
Layer 18	Slime	5591.59	5591.43	5591.27	0.32	4.95	3371.80	3380.17	1.29	1.19	0.006	0.023	1.17	0.003
Layer 19	Sand-Slime	5591.27	5591.03	5590.80	0.47	4.63	3394.03	3407.89	0.99	0.90	0.005	0.020	0.88	0.005
Layer 20	Slime	5590.80	5590.72	5590.65	0.15	4.16	3411.95	3416.00	1.29	1.19	0.006	0.023	1.17	0.002
Layer 21	Sand-Slime	5590.65	5590.49	5590.33	0.32	4.01	3425.34	3434.67	0.99	0.90	0.005	0.020	0.88	0.003
Layer 22	Sand-Slime	5590.33	5588.49	5586.64	3.69	3.69	3543.29	3651.91	0.99	0.91	0.005	0.020	0.89	0.038
													TOTAL:	**0.05**

Notes:
[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

3-3S

FINAL COVER

5620.49	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.36	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1184.24	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5605.60	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5601.5	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013).
5582.14	Water surface elevation at t_1 (ft amsl)	
5577.14	Water surface elevation at t_2 (ft amsl)	

3-3S

CREEP SETTLEMENT

Soil Layer	Material Type [1]	Elevation at Top of Layer at t_1, $z_{i\text{-}top1}$ (ft amsl)	Elevation at Midpoint of Layer at t_1, $z_{i\text{-}mid1}$ (ft amsl)	Elevation at Bottom of Layer at t_1, $z_{i\text{-}bott1}$ (ft amsl)	Thickness of Layer at t_1, H (ft)	Height above liner (ft)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Void Ratio at t_0, e_0	Void Ratio at t_1, e_1	Secondary Compression Index, C_α	Change in Void Ratio due to 1000 years of Creep, Δe	Final Void Ratio After 1,000 years, e_{final}	Settlement due to 1000 years of Creep, δ_{creep} (ft)
Erosion Protection Layer	Erosion Protection Layer	5619.02	5618.77	5618.52	0.50	41.88	NA	NA	NA	NA	NA	NA	NA	NA
Rooting Zone	Rooting Zone	5618.52	5616.77	5615.02	3.50	41.38	NA	NA	NA	NA	NA	NA	NA	NA
High-Compaction Layer	High-Compaction Layer	5615.02	5613.27	5611.52	3.50	37.88	NA	NA	NA	NA	NA	NA	NA	NA
Platform Fill	Platform Fill	5611.52	5609.84	5608.16	3.36	34.38	NA	NA	NA	NA	NA	NA	NA	NA
Layer 1	Int. Cover	5608.16	5606.72	5605.29	2.88	31.02	NA	NA	NA	NA	NA	NA	NA	NA
Layer 2	Sand	5605.29	5604.89	5604.50	0.78	28.15	NA	NA	NA	NA	NA	NA	NA	NA
Layer 3	Sand-Slime	5604.50	5604.27	5604.04	0.47	27.36	NA	NA	NA	NA	NA	NA	NA	NA
Layer 4	Sand	5604.04	5603.33	5602.62	1.42	26.90	NA	NA	NA	NA	NA	NA	NA	NA
Layer 5	Sand-Slime	5602.62	5601.44	5600.27	2.34	25.48	NA	NA	NA	NA	NA	NA	NA	NA
Layer 6	Slime	5600.27	5600.12	5599.96	0.32	23.13	NA	NA	NA	NA	NA	NA	NA	NA
Layer 7	Sand-Slime	5599.96	5599.88	5599.80	0.15	22.82	NA	NA	NA	NA	NA	NA	NA	NA
Layer 8	Slime	5599.80	5599.65	5599.49	0.32	22.66	NA	NA	NA	NA	NA	NA	NA	NA
Layer 9	Sand-Slime	5599.49	5598.62	5597.76	1.73	22.35	NA	NA	NA	NA	NA	NA	NA	NA
Layer 10	Slime	5597.76	5597.36	5596.97	0.78	20.62	NA	NA	NA	NA	NA	NA	NA	NA
Layer 11	Sand-Slime	5596.97	5596.74	5596.50	0.47	19.83	NA	NA	NA	NA	NA	NA	NA	NA
Layer 12	Slime	5596.50	5596.43	5596.35	0.15	19.36	NA	NA	NA	NA	NA	NA	NA	NA
Layer 13	Sand-Slime	5596.35	5595.57	5594.78	1.57	19.21	NA	NA	NA	NA	NA	NA	NA	NA
Layer 14	Slime	5594.78	5594.70	5594.62	0.16	17.64	NA	NA	NA	NA	NA	NA	NA	NA
Layer 15	Sand-Slime	5594.62	5594.46	5594.30	0.32	17.48	NA	NA	NA	NA	NA	NA	NA	NA
Layer 16	Slime	5594.30	5593.99	5593.68	0.62	17.16	NA	NA	NA	NA	NA	NA	NA	NA
Layer 17	Sand-Slime	5593.68	5593.21	5592.73	0.95	16.54	NA	NA	NA	NA	NA	NA	NA	NA
Layer 18	Slime	5592.73	5592.42	5592.11	0.62	15.59	NA	NA	NA	NA	NA	NA	NA	NA
Layer 19	Sand-Slime	5592.11	5591.56	5591.01	1.10	14.97	NA	NA	NA	NA	NA	NA	NA	NA
Layer 20	Slime	5591.01	5590.93	5590.86	0.15	13.87	NA	NA	NA	NA	NA	NA	NA	NA
Layer 21	Sand-Slime	5590.86	5590.38	5589.91	0.95	13.72	NA	NA	NA	NA	NA	NA	NA	NA
Layer 22	Slime	5589.91	5589.83	5589.75	0.15	12.77	NA	NA	NA	NA	NA	NA	NA	NA
Layer 23	Sand-Slime	5589.75	5589.20	5588.65	1.10	12.61	NA	NA	NA	NA	NA	NA	NA	NA
Layer 24	Sand	5588.65	5588.49	5588.33	0.32	11.51	NA	NA	NA	NA	NA	NA	NA	NA
Layer 25	Sand-Slime	5588.33	5587.15	5585.97	2.36	11.19	NA	NA	NA	NA	NA	NA	NA	NA
Layer 26	Sand	5585.97	5585.73	5585.49	0.48	8.83	NA	NA	NA	NA	NA	NA	NA	NA
Layer 27	Sand-Slime	5585.49	5581.32	5577.14	8.35	8.35	4428.47	4674.84	0.99	0.90	0.005	0.020	0.88	0.086
													TOTAL:	0.09

Notes:
[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

3-4N

FINAL COVER

5623.36	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
7.16	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1567.00	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5606.00	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5600.6	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013).
5583.71	Water surface elevation at t_1 (ft amsl)	
5578.71	Water surface elevation at t_2 (ft amsl)	

3-4N

CREEP SETTLEMENT

Soil Layer	Material Type [1]	Elevation at Top of Layer at t_1, $z_{i\text{-}top1}$ (ft amsl)	Elevation at Midpoint of Layer at t_1, $z_{i\text{-}mid1}$ (ft amsl)	Elevation at Bottom of Layer at t_1, $z_{i\text{-}bott1}$ (ft amsl)	Thickness of Layer at t_1, H (ft)	Height above liner (ft)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Void Ratio at t_0, e_0	Void Ratio at t_1, e_1	Secondary Compression Index, C_α	Change in Void Ratio due to 1000 years of Creep, Δe	Final Void Ratio After 1,000 years, e_{final}	Settlement due to 1000 years of Creep, δ_{creep} (ft)
Erosion Protection Layer	Erosion Protection Layer	5621.80	5621.55	5621.30	0.50	43.09	NA	NA	NA	NA	NA	NA	NA	NA
Rooting Zone	Rooting Zone	5621.30	5619.55	5617.80	3.50	42.59	NA	NA	NA	NA	NA	NA	NA	NA
High-Compaction Layer	High-Compaction Layer	5617.80	5616.05	5614.30	3.50	39.09	NA	NA	NA	NA	NA	NA	NA	NA
Platform Fill	Platform Fill	5614.30	5610.72	5607.14	7.16	35.59	NA	NA	NA	NA	NA	NA	NA	NA
Layer 1	Int. Cover	5607.14	5605.71	5604.29	2.86	28.43	NA	NA	NA	NA	NA	NA	NA	NA
Layer 2	Sand	5604.29	5603.35	5602.41	1.88	25.58	NA	NA	NA	NA	NA	NA	NA	NA
Layer 3	Sand-Slime	5602.41	5600.24	5598.07	4.33	23.70	NA	NA	NA	NA	NA	NA	NA	NA
Layer 4	Slime	5598.07	5597.29	5596.52	1.56	19.36	NA	NA	NA	NA	NA	NA	NA	NA
Layer 5	Sand-Slime	5596.52	5596.36	5596.20	0.31	17.81	NA	NA	NA	NA	NA	NA	NA	NA
Layer 6	Sand	5596.20	5595.88	5595.56	0.64	17.49	NA	NA	NA	NA	NA	NA	NA	NA
Layer 7	Slime	5595.56	5595.49	5595.41	0.15	16.85	NA	NA	NA	NA	NA	NA	NA	NA
Layer 8	Sand-Slime	5595.41	5595.25	5595.10	0.31	16.70	NA	NA	NA	NA	NA	NA	NA	NA
Layer 9	Sand	5595.10	5595.02	5594.94	0.16	16.39	NA	NA	NA	NA	NA	NA	NA	NA
Layer 10	Slime	5594.94	5594.86	5594.78	0.16	16.23	NA	NA	NA	NA	NA	NA	NA	NA
Layer 11	Sand-Slime	5594.78	5594.70	5594.63	0.15	16.07	NA	NA	NA	NA	NA	NA	NA	NA
Layer 12	Slime	5594.63	5594.24	5593.85	0.78	15.92	NA	NA	NA	NA	NA	NA	NA	NA
Layer 13	Sand-Slime	5593.85	5593.69	5593.53	0.31	15.14	NA	NA	NA	NA	NA	NA	NA	NA
Layer 14	Slime	5593.53	5593.38	5593.22	0.31	14.82	NA	NA	NA	NA	NA	NA	NA	NA
Layer 15	Sand-Slime	5593.22	5590.18	5587.14	6.08	14.51	NA	NA	NA	NA	NA	NA	NA	NA
Layer 16	Sand-Slime	5587.14	5582.92	5578.71	8.43	8.43	4510.59	4760.35	0.99	0.89	0.005	0.020	0.88	0.087
													TOTAL:	0.09

Notes:
[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

3-6N

FINAL COVER		
5623.62	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
8.68	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1720.10	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION		
5604.20	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5599.3	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013).
5590.44	Water surface elevation at t_1 (ft amsl)	
5585.44	Water surface elevation at t_2 (ft amsl)	

3-6N

CREEP SETTLEMENT

Soil Layer	Material Type [1]	Elevation at Top of Layer at t_1, $z_{i\text{-}top1}$ (ft amsl)	Elevation at Midpoint of Layer at t_1, $z_{i\text{-}mid1}$ (ft amsl)	Elevation at Bottom of Layer at t_1, $z_{i\text{-}bott1}$ (ft amsl)	Thickness of Layer at t_1, H (ft)	Height above liner (ft)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Void Ratio at t_0, e_0	Void Ratio at t_1, e_1	Secondary Compression Index, C_α	Change in Void Ratio due to 1000 years of Creep, Δe	Final Void Ratio After 1,000 years, e_{final}	Settlement due to 1000 years of Creep, δ_{creep} (ft)
Erosion Protection Layer	Erosion Protection Layer	5622.28	5622.03	5621.78	0.50	36.84	NA	NA	NA	NA	NA	NA	NA	NA
Rooting Zone	Rooting Zone	5621.78	5620.03	5618.28	3.50	36.34	NA	NA	NA	NA	NA	NA	NA	NA
High-Compaction Layer	High-Compaction Layer	5618.28	5616.53	5614.78	3.50	32.84	NA	NA	NA	NA	NA	NA	NA	NA
Platform Fill	Platform Fill	5614.78	5610.44	5606.10	8.68	29.34	NA	NA	NA	NA	NA	NA	NA	NA
Layer 1	Int. Cover	5606.10	5604.67	5603.25	2.85	20.66	NA	NA	NA	NA	NA	NA	NA	NA
Layer 2	Sand-Slime	5603.25	5603.18	5603.11	0.14	17.81	NA	NA	NA	NA	NA	NA	NA	NA
Layer 3	Sand	5603.11	5602.95	5602.79	0.31	17.67	NA	NA	NA	NA	NA	NA	NA	NA
Layer 4	Sand-Slime	5602.79	5602.64	5602.49	0.30	17.35	NA	NA	NA	NA	NA	NA	NA	NA
Layer 5	Slime	5602.49	5602.19	5601.90	0.60	17.05	NA	NA	NA	NA	NA	NA	NA	NA
Layer 6	Sand-Slime	5601.90	5601.52	5601.14	0.76	16.46	NA	NA	NA	NA	NA	NA	NA	NA
Layer 7	Slime	5601.14	5600.91	5600.67	0.46	15.70	NA	NA	NA	NA	NA	NA	NA	NA
Layer 8	Sand-Slime	5600.67	5600.45	5600.22	0.46	15.23	NA	NA	NA	NA	NA	NA	NA	NA
Layer 9	Sand	5600.22	5600.14	5600.06	0.15	14.78	NA	NA	NA	NA	NA	NA	NA	NA
Layer 10	Sand-Slime	5600.06	5599.91	5599.75	0.31	14.62	NA	NA	NA	NA	NA	NA	NA	NA
Layer 11	Slime	5599.75	5599.60	5599.44	0.31	14.31	NA	NA	NA	NA	NA	NA	NA	NA
Layer 12	Sand-Slime	5599.44	5599.29	5599.13	0.31	14.00	NA	NA	NA	NA	NA	NA	NA	NA
Layer 13	Slime	5599.13	5598.75	5598.36	0.77	13.69	NA	NA	NA	NA	NA	NA	NA	NA
Layer 14	Sand-Slime	5598.36	5598.20	5598.05	0.31	12.92	NA	NA	NA	NA	NA	NA	NA	NA
Layer 15	Slime	5598.05	5597.43	5596.81	1.24	12.61	NA	NA	NA	NA	NA	NA	NA	NA
Layer 16	Sand-Slime	5596.81	5596.66	5596.50	0.31	11.37	NA	NA	NA	NA	NA	NA	NA	NA
Layer 17	Slime	5596.50	5594.02	5591.54	4.96	11.06	NA	NA	NA	NA	NA	NA	NA	NA
Layer 18	Sand-Slime	5591.54	5590.61	5589.67	1.87	6.10	3584.42	3667.28	0.99	0.88	0.005	0.020	0.86	0.019
Layer 19	Slime	5589.67	5589.21	5588.74	0.94	4.23	3692.39	3717.50	1.29	1.17	0.006	0.023	1.15	0.010
Layer 20	Sand-Slime	5588.74	5587.09	5585.44	3.30	3.30	3815.37	3913.24	0.99	0.89	0.005	0.020	0.87	0.034
													TOTAL:	0.06

Notes:
[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

3-8N

FINAL COVER		
5623.82	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
7.95	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1646.57	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION		
5604.90	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5600.3	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013).
5595.24	Water surface elevation at t_1 (ft amsl)	
5590.24	Water surface elevation at t_2 (ft amsl)	

3-8N

CREEP SETTLEMENT

Soil Layer	Material Type [1]	Elevation at Top of Layer at t_1, $z_{i\text{-}top1}$ (ft amsl)	Elevation at Midpoint of Layer at t_1, $z_{i\text{-}mid1}$ (ft amsl)	Elevation at Bottom of Layer at t_1, $z_{i\text{-}bott1}$ (ft amsl)	Thickness of Layer at t_1, H (ft)	Height above liner (ft)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-}mid1}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-}bott1}$ (psf)	Void Ratio at t_0, e_0	Void Ratio at t_1, e_1	Secondary Compression Index, C_α	Change in Void Ratio due to 1000 years of Creep, Δe	Final Void Ratio After 1,000 years, e_{final}	Settlement due to 1000 years of Creep, δ_{creep} (ft)
Erosion Protection Layer	Erosion Protection Layer	5622.79	5622.54	5622.29	0.50	32.55	NA	NA	NA	NA	NA	NA	NA	NA
Rooting Zone	Rooting Zone	5622.29	5620.54	5618.79	3.50	32.05	NA	NA	NA	NA	NA	NA	NA	NA
High-Compaction Layer	High-Compaction Layer	5618.79	5617.04	5615.29	3.50	28.55	NA	NA	NA	NA	NA	NA	NA	NA
Platform Fill	Platform Fill	5615.29	5611.31	5607.34	7.95	25.05	NA	NA	NA	NA	NA	NA	NA	NA
Layer 1	Int. Cover	5607.34	5605.91	5604.48	2.85	17.10	NA	NA	NA	NA	NA	NA	NA	NA
Layer 2	Slime	5604.48	5604.41	5604.34	0.14	14.24	NA	NA	NA	NA	NA	NA	NA	NA
Layer 3	Sand	5604.34	5604.26	5604.18	0.16	14.10	NA	NA	NA	NA	NA	NA	NA	NA
Layer 4	Sand-Slime	5604.18	5603.88	5603.58	0.59	13.94	NA	NA	NA	NA	NA	NA	NA	NA
Layer 5	Sand	5603.58	5603.43	5603.27	0.31	13.34	NA	NA	NA	NA	NA	NA	NA	NA
Layer 6	Sand-Slime	5603.27	5603.12	5602.97	0.30	13.03	NA	NA	NA	NA	NA	NA	NA	NA
Layer 7	Sand	5602.97	5601.94	5600.92	2.05	12.73	NA	NA	NA	NA	NA	NA	NA	NA
Layer 8	Sand-Slime	5600.92	5598.04	5595.17	5.75	10.68	NA	NA	NA	NA	NA	NA	NA	NA
Layer 9	Slime	5595.17	5595.09	5595.00	0.16	4.93	3152.03	3151.04	1.29	1.17	0.006	0.023	1.15	0.002
Layer 10	Sand-Slime	5595.00	5593.99	5592.98	2.03	4.76	3211.29	3271.54	0.99	0.89	0.005	0.020	0.87	0.021
Layer 11	Sand-Slime	5592.98	5591.61	5590.24	2.74	2.74	3352.72	3433.90	0.99	0.89	0.005	0.020	0.88	0.028
													TOTAL:	**0.05**

Notes:
[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

3-8S

FINAL COVER

5620.45	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)	From cover deisgn grading plan AutoCAD file
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of Water Storage/Rooting Zone (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
3.50	Thickness of High Compaction Layer (ft)	From Appendix C - Radon Emanation Modeling (MWH, 2015)
4.25	Thickness of Random/Platform Fill on on top of existing interim cover (ft)	Calculated
1273.89	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)	Calculated

PROFILE INFORMATION

5603.50	Water surface elevation during CPT investigation (ft amsl)	From on-site investigation (Tailings Data Analysis Report. MWH, 2015)
5600.6	Water surface elevation at t_0 (ft amsl)	Minimum of 5' below top of tailings or water surface elevation at time of CPT testing (2013).
5590.63	Water surface elevation at t_1 (ft amsl)	
5585.63	Water surface elevation at t_2 (ft amsl)	

3-8S

CREEP SETTLEMENT

Soil Layer	Material Type [1]	Elevation at Top of Layer at t_1, $z_{i\text{-top1}}$ (ft amsl)	Elevation at Midpoint of Layer at t_1, $z_{i\text{-mid1}}$ (ft amsl)	Elevation at Bottom of Layer at t_1, $z_{i\text{-bott1}}$ (ft amsl)	Thickness of Layer at t_1, H (ft)	Height above liner (ft)	Effective Stress at Midpoint of Layer at t_1, $\sigma'_{i\text{-mid1}}$ (psf)	Effective Stress at Bottom of Layer at t_1, $\sigma'_{i\text{-bott1}}$ (psf)	Void Ratio at t_0, e_0	Void Ratio at t_1, e_1	Secondary Compression Index, C_α	Change in Void Ratio due to 1000 years of Creep, Δe	Final Void Ratio After 1,000 years, e_{final}	Settlement due to 1000 years of Creep, δ_{creep} (ft)
Erosion Protection Layer	Erosion Protection Layer	5619.39	5619.14	5618.89	0.50	33.76	NA	NA	NA	NA	NA	NA	NA	NA
Rooting Zone	Rooting Zone	5618.89	5617.14	5615.39	3.50	33.26	NA	NA	NA	NA	NA	NA	NA	NA
High-Compaction Layer	High-Compaction Layer	5615.39	5613.64	5611.89	3.50	29.76	NA	NA	NA	NA	NA	NA	NA	NA
Platform Fill	Platform Fill	5611.89	5609.76	5607.64	4.25	26.26	NA	NA	NA	NA	NA	NA	NA	NA
Layer 1	Int. Cover	5607.64	5606.20	5604.77	2.87	22.01	NA	NA	NA	NA	NA	NA	NA	NA
Layer 2	Sand	5604.77	5604.22	5603.67	1.10	19.14	NA	NA	NA	NA	NA	NA	NA	NA
Layer 3	Sand-Slime	5603.67	5603.52	5603.36	0.31	18.04	NA	NA	NA	NA	NA	NA	NA	NA
Layer 4	Sand	5603.36	5603.29	5603.21	0.15	17.73	NA	NA	NA	NA	NA	NA	NA	NA
Layer 5	Sand-Slime	5603.21	5602.82	5602.44	0.77	17.58	NA	NA	NA	NA	NA	NA	NA	NA
Layer 6	Sand	5602.44	5600.69	5598.93	3.51	16.81	NA	NA	NA	NA	NA	NA	NA	NA
Layer 7	Sand-Slime	5598.93	5598.77	5598.62	0.32	13.30	NA	NA	NA	NA	NA	NA	NA	NA
Layer 8	Sand	5598.62	5598.45	5598.29	0.32	12.99	NA	NA	NA	NA	NA	NA	NA	NA
Layer 9	Sand-Slime	5598.29	5596.41	5594.53	3.77	12.66	NA	NA	NA	NA	NA	NA	NA	NA
Layer 10	Slime	5594.53	5594.45	5594.37	0.15	8.90	NA	NA	NA	NA	NA	NA	NA	NA
Layer 11	Sand-Slime	5594.37	5594.22	5594.06	0.32	8.74	NA	NA	NA	NA	NA	NA	NA	NA
Layer 12	Slime	5594.06	5593.75	5593.44	0.62	8.43	NA	NA	NA	NA	NA	NA	NA	NA
Layer 13	Sand-Slime	5593.44	5593.28	5593.12	0.32	7.81	NA	NA	NA	NA	NA	NA	NA	NA
Layer 14	Sand-Slime	5593.12	5589.38	5585.63	7.49	7.49	3447.52	3668.72	0.99	0.90	0.005	0.020	0.88	0.077
													TOTAL:	**0.08**

Notes:
[1] From on-site investigation (Tailings Data Analysis Report. MWH, 2015)

ATTACHMENT F.3

SEISMIC SETTLEMENT CALCULATIONS

Notes

t_0 corresponds to beginning of final cover placement — Assumes 99% of consolidation due to existing stress conditions has taken place

t_1 corresponds to dewatering of the tailings to a level 5 feet above the liner

t_2 corresponds to completion of dewatering

SOIL PROPERTIES

TAILINGS

Value	Parameter	Source
Specific Gravity, G_s		
2.70	Specific gravity of tailing sands, $G_{s\text{-}TSand}$	Based on testing performed on other uranium tailings and presented in Keshian and Rager (1988)
2.80	Specific gravity of tailing sand-slimes, $G_{s\text{-}TS\text{-}S}$	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
2.86	Specific gravity of tailing slimes, $G_{s\text{-}TSlime}$	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
Fines Content		
18%	Fines content of tailings sands (%)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
47%	Fines content of tailings sand-slimes (%)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
71%	Fines content of tailings slimes (%)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
Dry Unit Weight, γ_d		
97	In-situ dry unit weight of tailings sands at t_0, $\gamma_{d0\text{-}Tsand}$ (pcf)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
88	In-situ dry unit weight of tailings sand-slimes at t_0, $\gamma_{d0\text{-}TS\text{-}S}$ (pcf)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
78	In-situ dry unit weight of tailings slimes at t_0, $\gamma_{d0\text{-}Tslime}$ (pcf)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
Saturated Unit Weight, γ_{sat}		
123	In-situ saturated unit weight of tailings sands at t_0, $\gamma_{sat0\text{-}Tsand}$ (pcf)	Calculated
119	In-situ saturated unit weight of tailings sand-slimes at t_0, $\gamma_{sat0\text{-}TS\text{-}S}$ (pcf)	Calculated
113	In-situ saturated unit weight of tailings slimes at t_0, $\gamma_{sat0\text{-}Tslime}$ (pcf)	Calculated
Moist Unit Weight, γ_m		
103	Moist unit weight of tailings sands, $\gamma_{m\text{-}Tsand}$ (pcf)	Calculated, assuming long-term water content from laboratory testing (Tailings Data Analysis Report. MWH, 2015b)
93	Moist unit weight of tailings sand-slimes, $\gamma_{m\text{-}TS\text{-}S}$ (pcf)	Calculated, assuming long-term water content from laboratory testing (Tailings Data Analysis Report. MWH, 2015b)
83	Moist unit weight of tailings slimes, $\gamma_{m\text{-}Tslime}$ (pcf)	Calculated, assuming long-term water content from laboratory testing (Tailings Data Analysis Report. MWH, 2015b)
Void Ratio, e		
0.74	Void ratio of tailing sands at t_0, $e_{0\text{-}TSand}$	Calculated
0.99	Void ratio of tailing sand-slimes at t_0, $e_{0\text{-}TS\text{-}S}$	Calculated
1.29	Void ratio of tailing slimes at t_0, $e_{0\text{-}TSlime}$	Calculated
Saturated Water Content, w_{Sat}		
27%	Saturated water content of tailings sands at t_0, $w_{sat0\text{-}TSand}$ (%)	Calculated
35%	Saturated water content of tailings sand-slimes at t_0, $w_{sat0\text{-}TS\text{-}S}$ (%)	Calculated
45%	Saturated water content of tailings slimes at t_0, $w_{sat0\text{-}TSlime}$ (%)	Calculated
Water Content of Moist Tailings, $w_{m\text{-}T}$		
6%	Water content of moist tailings sands, $w_{m\text{-}TSand}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
6%	Water content of moist tailings sand-slimes, $w_{m\text{-}TS\text{-}S}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
6%	Water content of moist tailings slimes, $w_{m\text{-}TSlime}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
Plasticity Index, PI		
0	Plasticity index of tailings sands, PI_{TSand}	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
10	Plasticity index of tailings sand-slimes, $PI_{TS\text{-}S}$	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
16	Plasticity index of tailings slimes, PI_{TSlime}	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
Seismic Settlement Coefficients		
2.2	Coefficient "a" of Unsaturated Sand Tailings	From Stewart, et al (2004), page 86, Figure 6.5
5.0	Coefficient "a" of Saturated Sand Tailings	From Stewart, et al (2004), page 86, Figure 6.5
2.0	Coefficient "a" of Sand-Slime Tailings	From Stewart, et al (2004), page 89, Figure 6.7
2.0	Coefficient "a" of Slime Tailings	From Stewart, et al (2004), page 89, Figure 6.7
1.00	Coefficient "b" of Sand Tailings	From Stewart, et al (2004), page 86, Figure 6.5
0.65	Coefficient "b" of Sand-Slime Tailings	From Stewart, et al (2004), page 89, Figure 6.7
0.65	Coefficient "b" of Slime Tailings	From Stewart, et al (2004), page 89, Figure 6.7
0.01%	Strain threshold value of Sand Tailings, γtv	From Stewart, et al (2004), page 86, Figure 6.5
0.03%	Strain threshold value of Sand-Slime Tailings, γtv	From Stewart, et al (2004), page 89, Figure 6.7
0.03%	Strain threshold value of Slime Tailings, γtv	From Stewart, et al (2004), page 89, Figure 6.7
0.36	Coefficient "R" of Sand Tailings	From Stewart, et al (2004), page 86, for soils with non-plastic fines
0.34	Coefficient "R" of Sand-Slime Tailings	From Stewart, et al (2004), page 89, for soils with medium plasticity fines
0.34	Coefficient "R" of Slime Tailings	From Stewart, et al (2004), page 89, for soils with medium plasticity fines

Other

5.0	Height of water table above liner at t_1, H_{sat-1} (ft)	Assumed for end of active maintenance
0.0	Height of water table above liner at t_2, H_{sat-2} (ft)	
6.0%	Long-term moisture content of tailings, $w_{tailings}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
508	Shear Wave Velocity of Tailings, V_s (ft/sec)	Conservatively assumed to be the average of the shear wave velocities measured in Cell 2 tailings

COVER SOIL

Specific Gravity, G_s

2.61	Specific gravity of topsoil, $G_{s\text{-Topsoil}}$	From Attachment H - Radon Emanation Modeling including with this submittal
2.62	Specific gravity of rock mulch, $G_{s\text{-mulch}}$	From Attachment H - Radon Emanation Modeling including with this submittal
2.63	Specific gravity of cover soil, $G_{s\text{-cover}}$	From Attachment H - Radon Emanation Modeling including with this submittal

Unit Weight, γ

118.0	Maximum dry unit weight of cover soil $\gamma_{cover\text{-}max}$ (pcf)	Average calculated from laboratory testing results (UWM, 2012)
100.7	Moist unit weight of cover soil at 80% relative compaction, $\gamma_{cover80}$ (pcf)	Calculated
107.0	Moist unit weight of cover soil at 85% relative compaction, $\gamma_{cover85}$ (pcf)	Calculated
119.6	Moist unit weight of cover soil at 95% relative compaction, $\gamma_{cover95}$ (pcf)	Calculated
100	Dry unit weight of topsoil layer at 85% relative compaction, $\gamma_{topsoil5}$ (pcf)	From Attachment H - Radon Emanation Modeling including with this submittal
105	Moist unit weight of topsoil layer at 85% relative compaction, $\gamma_{topsoil5}$ (pcf)	Calculated
106	Dry unit weight of rock mulch layer at 85% relative compaction, $\gamma_{mulch85}$ (pcf)	Calculated
110	Moist unit weight of rock mulch layer at 85% relative compaction, $\gamma_{mulch85}$ (pcf)	From Attachment H - Radon Emanation Modeling including with this submittal

Void Ratio, e

0.74	Void Ratio of cover soil at 80% relative compaction, $e_{cover80}$	Calculated
0.64	Void Ratio of cover soil at 85% relative compaction, $e_{cover85}$	Calculated
0.46	Void Ratio of cover soil at 95% relative compaction, $e_{cover95}$	Calculated
0.61	Void Ratio of topsoil at 85% relative compaction, $e_{topsoil85}$	Calculated from porosity presented in Attachment H - Radon Emanation Modeling including with this submittal
0.54	Void Ratio of rock mulch at 85% relative compaction, $e_{mulch85}$	Calculated from porosity presented in Attachment H - Radon Emanation Modeling including with this submittal

Seismic Settlement Coefficients

1.2	Coefficient "a" of Erosion Protection/Topsoil Cover	From Stewart, et al (2004), page 88, Figure 6.6
2.0	Coefficient "a" of General Cover Soil	From Stewart, et al (2004), page 89, Figure 6.7
0.65	Coefficient "a" of High-Compaction Layer	From Stewart, et al (2004), page 89, Figure 6.7
0.80	Coefficient "b" of Erosion Protection/Topsoil Cover	From Stewart, et al (2004), page 88, Figure 6.6
0.65	Coefficient "b" of General Cover Soil	From Stewart, et al (2004), page 89, Figure 6.7
0.75	Coefficient "b" of High-Compaction Layer	From Stewart, et al (2004), page 89, Figure 6.7
0.04%	Strain threshold value of Erosion Protection/Topsoil Cover, γtv	From Stewart, et al (2004), page 88, Figure 6.6
0.03%	Strain threshold value of General Cover Soil, γtv	From Stewart, et al (2004), page 89, Figure 6.7
0.02%	Strain threshold value of High-Compaction Layer, γtv	From Stewart, et al (2004), page 89, Figure 6.7
0.32	Coefficient "R" of Erosion Protection/Topsoil Cover	From Stewart, et al (2004), page 88, for soils with low plasticity fines
0.34	Coefficient "R" of General Cover Soil	From Stewart, et al (2004), page 89, for soils with medium plasticity fines
0.34	Coefficient "R" of High-Compaction Layer	From Stewart, et al (2004), page 89, for soils with medium plasticity fines

Other

6.7%	Long-term moisture content of cover soil, w_{cover} (%)	Estimated based on measured 15bar water content. (UWM, 2012)
5.2%	Long-term moisture content of topsoil, $w_{topsoil}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
4.0%	Long-term moisture content of rock mulch, $w_{rockmulch}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
0.14	Compression index of cover soil, $C_{c\text{-cover}}$	Calculated from empirical equation presented in Holtz and Kovacs, 1981. Page 341. $C_c = 0.30*(e_0-0.27)$
51%	Fines content of cover soil (%)	Mean value from laboratory analyses presented in previous response to interrogatories (EFRI, 2012)
11	Plasticity Index of cover soil, PI	Weighted Average from 2010 and 2012 laboratory testing (laboratory results presented in EFRI, 2012)
508	Shear Wave Velocity of Cover Soil, V_s (ft/sec)	Conservatively assumed to be the average of the shear wave velocities measured in Cell 2 tailings

SEISMIC PARAMETERS

0.15	Maximum horizontal acceleration at the ground surface, a_{max}/g	From Probabilistic Seismic Hazard Analysis (MWH, 2015a)
5.5	Magnitude of Design Event, M	From Probabilistic Seismic Hazard Analysis (MWH, 2015a)
20	Site-Source Distance, r (km)	From Probabilistic Seismic Hazard Analysis (MWH, 2015a)
1.00	Stress reduction factor, r_d	Conservatively assumed.
7.51	Equiv. Number of Uniform Strain Cycles, N	Calculated from Stewart, et al (2004), Equation 6.11, page 79, S parameter =0 since shallow soil and rock underlie the tailings (<20m) below tailings
594	Average shear wave velocity for cover, Vs (ft/s)	Conservatively estimated as upper bound average Vs for tailings in Cell 2 in October 2013 (Tailings Data Analysis Report. MWH, 2015b)
495	Average shear wave velocity for tailings (3' - 9.4'), Vs (ft/s)	Conservatively estimated as average Vs over depth range for tailings in Cell 2 in October 2013 (Tailings Data Analysis Report. MWH, 2015b)
460	Average shear wave velocity for tailings (9.4' - 14.4'), Vs (ft/s)	Conservatively estimated as average Vs over depth range for tailings in Cell 2 in October 2013 (Tailings Data Analysis Report. MWH, 2015b)
500	Average shear wave velocity for tailings (14.4' - 19.6'), Vs (ft/s)	Conservatively estimated as average Vs over depth range for tailings in Cell 2 in October 2013 (Tailings Data Analysis Report. MWH, 2015b)
538	Average shear wave velocity for tailings (19.6' - 24.7'), Vs (ft/s)	Conservatively estimated as average Vs over depth range for tailings in Cell 2 in October 2013 (Tailings Data Analysis Report. MWH, 2015b)
594	Average shear wave velocity for tailings (24.7' - liner), Vs (ft/s)	Conservatively estimated as average Vs over depth range for tailings in Cell 2 in October 2013 (Tailings Data Analysis Report. MWH, 2015b)

MISCELLANEOUS PARAMETERS

62.4	Unit Weight of Water, γ_w	
82.4	Atmospheric Pressure, P_a (kPa)	Calculated assuming elev=5600' amsl. http://www.engineeringtoolbox.com/air-altitude-pressure-d_462.html
1722.0	Atmospheric Pressure, P_a (psf)	Unit conversion calculation

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WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W2

Data File:	13-52106_SP2W2-BSC-CPT
Location:	White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da	

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5613.10	Water surface elevation during CPT investigation (ft a
5607.57	Water surface elevation at t_0 (ft amsl)
5598.51	Water surface elevation at t_1 (ft amsl)
5593.51	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earth
7.51	Equiv. Number of Uniform Strain Cycles, N

5615.85	Ground Surface Elevation at time of CPT (ft amsl)
5625.87	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after plac
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
2.02	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1111.60	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5593.51	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5625.62	5625.37	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5623.62	5621.87	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5619.87	5617.87	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334	1.83	508	1.9E-03	4.8E+02	6.8E-05	11	0.153	12419	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######	5616.86	5615.85	2.02	0.050	101	0.556	0.505	0.00	0.00	0.556	0.505	2.75	508	1.6E-03	4.0E+02	1.2E-04	11	0.170	10466	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %
0.164	5615.69	19.0	0.292	19.0	2.8	1.22	1.53%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	32.317	449.21	37.57	2302	1.54%	1.4	51%
0.328	5615.52	27.6	0.767	27.6	3.0	1.32	2.78%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	46.937	652.42	54.55	1671	2.78%	1.7	51%
0.492	5615.36	63.0	1.250	63.0	2.6	1.13	1.98%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	107.100	######	124.42	2542	1.98%	1.5	51%
0.656	5615.19	130.6	1.407	130.6	1.2	0.53	1.08%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	221.952	######	257.80	3950	1.08%	1.3	51%
0.820	5615.03	202.3	0.922	202.3	2.2	0.96	0.46%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	343.859	######	399.40	4896	0.46%	0.9	51%
0.984	5614.87	189.1	1.391	189.0	4.1	1.77	0.74%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	321.351	######	373.28	3813	0.74%	1.1	51%
1.148	5614.70	207.8	1.514	207.8	0.1	0.04	0.73%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	353.311	######	410.35	3593	0.73%	1.1	51%
1.312	5614.54	81.3	1.745	81.3	0.7	0.29	2.15%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	138.142	######	160.45	1229	2.15%	1.6	51%
1.476	5614.37	52.5	1.382	52.5	-0.3	-0.14	2.63%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	89.284	######	103.69	705	2.64%	1.8	51%
1.640	5614.21	40.7	1.041	40.7	0.1	0.02	2.56%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	69.241	962.45	80.42	492	2.56%	1.8	51%
1.804	5614.05	34.3	0.916	34.3	-0.7	-0.29	2.67%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	58.310	810.51	67.72	376	2.68%	1.9	51%
1.968	5613.88	64.5	1.005	64.5	0.8	0.33	1.56%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	109.582	######	127.28	649	1.56%	1.6	51%
2.133	5613.72	88.7	1.082	88.7	0.0	0.00	1.22%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	150.858	######	175.21	825	1.22%	1.4	51%
2.297	5613.55	88.1	1.355	88.1	0.0	0.00	1.54%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	149.685	######	173.85	760	1.54%	1.5	51%
2.461	5613.39	81.2	1.017	81.2	0.2	0.08	1.25%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	138.091	######	160.39	655	1.25%	1.5	51%
2.625	5613.23	71.1	0.910	71.1	0.7	0.32	1.28%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.70	120.887	######	140.41	537	1.28%	1.5	51%
2.789	5613.06	61.0	0.753	61.0	-0.9	-0.37	1.24%	Interim Cover	0.050	100.7	0.14	0.00	0.14	1	1.70	103.632	######	120.35	437	1.24%	1.6	51%
2.953	5612.90	57.1	0.690	57.1	-0.9	-0.37	1.21%	Interim Cover	0.050	100.7	0.15	0.01	0.14	1	1.70	97.036	######	112.69	400	1.21%	1.6	51%
3.117	5612.73	50.5	0.655	50.5	-0.1	-0.05	1.30%	Interim Cover	0.050	100.7	0.16	0.01	0.15	1	1.70	85.792	######	99.63	346	1.30%	1.6	51%
3.281	5612.57	52.1	0.800	52.1	-0.1	-0.06	1.53%	Sand-Slime Tailin	0.059	119.0	0.17	0.02	0.15	1	1.70	88.604	######	102.91	346	1.54%	1.7	47%
3.445	5612.41	55.0	0.793	55.0	0.1	0.03	1.44%	Sand-Slime Tailin	0.059	119.0	0.18	0.02	0.15	1	1.70	93.449	######	108.54	354	1.45%	1.7	47%
3.609	5612.24	40.3	0.780	40.3	-1.0	-0.44	1.93%	Sand-Slime Tailin	0.059	119.0	0.19	0.03	0.16	1	1.70	68.544	952.76	79.60	252	1.94%	1.8	47%
3.773	5612.08	31.5	0.543	31.5	0.5	0.23	1.72%	Sand-Slime Tailin	0.059	119.0	0.20	0.03	0.16	1	1.70	53.584	744.82	62.24	191	1.73%	1.9	47%
3.937	5611.91	30.6	0.621	30.6	-0.2	-0.08	2.03%	Sand-Slime Tailin	0.059	119.0	0.21	0.04	0.17	1	1.70	52.088	724.02	60.49	180	2.04%	2.0	47%
4.101	5611.75	25.9	0.747	25.9	1.3	0.55	2.89%	Sand-Slime Tailin	0.059	119.0	0.22	0.04	0.17	1	1.70	43.962	611.07	51.07	148	2.91%	2.1	47%
4.265	5611.58	25.9	0.883	25.9	7.3	3.14	3.41%	Sand-Slime Tailin	0.059	119.0	0.22	0.05	0.18	1	1.70	43.979	611.31	51.17	145	3.44%	2.2	71%
4.429	5611.42	89.9	1.190	89.6	44.0	19.08	1.32%	Sand Tailings	0.062	123.5	0.23	0.05	0.18	1	1.70	152.354	######	177.49	491	1.33%	1.6	18%
4.593	5611.26	84.3	1.536	84.2	21.1	9.16	1.82%	Sand Tailings	0.062	123.5	0.25	0.06	0.19	1	1.70	143.140	######	166.51	448	1.83%	1.7	18%
4.757	5611.09	45.9	1.208	45.9	6.9	3.00	2.63%	Sand-Slime Tailin	0.059	119.0	0.25	0.06	0.19	1	1.70	78.030	######	90.71	238	2.64%	2.0	47%
4.921	5610.93	20.0	0.909	20.0	1.7	0.72	4.54%	Sand-Slime Tailin	0.059	119.0	0.26	0.07	0.20	1	1.70	34.051	473.31	39.57	101	4.60%	2.4	71%
5.085	5610.76	10.4	0.273	10.4	2.2	0.96	2.62%	Slime Tailings	0.057	113.1	0.27	0.07	0.20	1	1.70	17.697	245.99	20.58	51	2.69%	2.4	71%
5.249	5610.60	7.0	0.186	7.0	4.3	1.87	2.65%	Slime Tailings	0.057	113.1	0.28	0.08	0.20	1	1.70	11.866	164.94	13.83	33	2.77%	2.6	71%
5.413	5610.44	5.8	0.170	5.8	4.1	1.77	2.93%	Slime Tailings	0.057	113.1	0.29	0.08	0.21	1	1.70	9.809	136.35	11.44	26	3.09%	2.7	71%
5.577	5610.27	5.5	0.100	5.5	4.8	2.09	1.81%	Slime Tailings	0.057	113.1	0.30	0.09	0.21	1	1.70	9.367	130.20	10.94	25	1.91%	2.6	71%
5.741	5610.11	10.8	0.134	10.8	6.8	2.96	1.24%	Sand-Slime Tailin	0.059	119.0	0.31	0.09	0.22	1	1.70	18.360	255.20	21.41	48	1.27%	2.2	47%
5.905	5609.94	7.7	0.162	7.6	3.3	1.43	2.12%	Slime Tailings	0.057	113.1	0.32	0.10	0.22	1	1.70	12.971	180.30	15.11	33	2.21%	2.5	71%
6.069	5609.78	6.6	0.117	6.6	3.7	1.61	1.76%	Slime Tailings	0.057	113.1	0.33	0.10	0.23	1	1.70	11.254	156.43	13.12	28	1.85%	2.5	71%
6.234	5609.62	7.5	0.098	7.5	4.8	2.07	1.30%	Slime Tailings	0.057	113.1	0.34	0.11	0.23	1	1.70	12.767	177.46	14.89	31	1.36%	2.4	71%
6.398	5609.45	8.5	0.058	8.5	5.5	2.39	0.68%	Sand-Slime Tailin	0.059	119.0	0.35	0.11	0.23	1	1.70	14.399	200.15	16.79	35	0.71%	2.2	47%
6.562	5609.29	11.8	0.109	11.7	5.3	2.29	0.93%	Sand-Slime Tailin	0.059	119.0	0.36	0.12	0.24	1	1.70	19.941	277.18	23.23	48	0.96%	2.2	47%
6.726	5609.12	9.5	0.147	9.5	5.2	2.27	1.54%	Sand-Slime Tailin	0.059	119.0	0.37	0.12	0.24	1	1.70	16.150	224.49	18.82	38	1.60%	2.4	47%
6.890	5608.96	7.6	0.165	7.5	7.0	3.04	2.18%	Slime Tailings	0.057	113.1	0.38	0.13	0.25	1	1.70	12.801	177.93	14.95	29	2.29%	2.6	71%
7.054	5608.80	5.6	0.138	5.5	9.3	4.03	2.48%	Slime Tailings	0.057	113.1	0.39	0.13	0.25	1	1.70	9.350	129.97	10.97	20	2.67%	2.7	71%
7.218	5608.63	5.1	0.118	5.0	12.3	5.33	2.33%	Slime Tailings	0.057	113.1	0.40	0.14	0.26	1	1.70	8.483	117.91	10.00	18	2.53%	2.7	71%
7.382	5608.47	4.8	0.099	4.7	14.7	6.38	2.05%	Slime Tailings	0.057	113.1	0.41	0.14	0.26	1	1.70	8.058	112.01	9.54	17	2.24%	2.7	71%
7.546	5608.30	4.8	0.131	4.7	16.7	7.23	2.74%	Slime Tailings	0.057	113.1	0.41	0.15	0.26	1	1.70	7.956	110.59	9.45	16	3.00%	2.8	71%
7.710	5608.14	5.1	0.119	5.0	19.0	8.22	2.35%	Slime Tailings	0.057	113.1	0.42	0.15	0.27	1	1.70	8.415	116.97	10.01	17	2.56%	2.8	71%
7.874	5607.98	6.7	0.130	6.5	20.7	8.95	1.95%	Slime Tailings	0.057	113.1	0.43	0.16	0.27	1	1.70	11.118	154.54	13.17	23	2.08%	2.6	71%
8.038	5607.81	7.3	0.077	7.3	16.0	6.91	1.05%	Sand-Slime Tailin	0.059	119.0	0.44	0.16	0.28	1	1.70	12.325	171.32	14.51	25	1.11%	2.4	47%
8.202	5607.65	8.5	0.080	8.4	14.3	6.19	0.94%	Sand-Slime Tailin	0.059	119.0	0.45	0.17	0.28	1	1.70	14.297	198.73	16.78	28	0.99%	2.4	47%
8.366	5607.48	6.1	0.091	6.1	11.4	4.95	1.49%	Slime Tailings	0.057	113.1	0.46	0.18	0.29	1	1.70	10.285	142.96	12.09	20	1.61%	2.6	71%
8.530	5607.32	4.7	0.067	4.7	13.0	5.62	1.41%	Slime Tailings	0.057	113.1	0.47	0.18	0.29	1	1.70	7.922	110.12	9.36	15	1.57%	2.7	71%
8.694	5607.16	5.0	0.101	4.9	16.1	6.98	2.04%	Slime Tailings	0.057	113.1	0.48	0.19	0.29	1	1.70	8.245	114.61	9.77	15	2.26%	2.8	71%
8.858	5606.99	5.0	0.075	4.9	20.4	8.84	1.49%	Slime Tailings	0.057	113.1	0.49	0.19	0.30	1	1.70	8.364	116.26	9.97	15	1.65%	2.7	71%
9.022	5606.83	7.8	0.111	7.7	23.6	10.24	1.42%	Slime Tailings	0.057	113.1	0.50	0.20	0.30	1	1.70	13.022	181.01	15.42	24	1.52%	2.5	71%
9.186	5606.66	8.8	0.109	8.7	14.2	6.17	1.24%	Sand-Slime Tailin	0.059	119.0	0.51	0.20	0.31	1	1.70	14.739	204.87	17.29	27	1.32%	2.4	47%
9.350	5606.50	11.9	0.108	11.8	12.8	5.55	0.91%	Sand-Slime Tailin	0.059	119.0	0.52	0.21	0.31	1	1.70	20.043	278.60	23.48	36	0.95%	2.3	47%
9.514	5606.34	10.3	0.138	10.2	9.1	3.92	1.35%	Sand-Slime Tailin	0.059	119.0	0.53	0.21	0.32	1	1.70	17.340	241.03	20.25	31	1.42%	2.4	47%
9.678	5606.17	8.8	0.125	8.7	12.4	5.39	1.42%	Sand-Slime Tailin	0.059	119.0	0.54	0.22	0.32	1	1.70	14.858	206.53	17.41	26	1.51%	2.5	47%
9.842	5606.01	7.8	0.130	7.7	15.8	6.85	1.68%	Slime Tailings	0.057	113.1	0.55	0.22	0.33	1	1.70	13.022	181.01	15.32	22	1.80%	2.6	71%
10.006	5605.84	5.8	0.162	5.7	21.9	9.49	2.79%	Slime Tailings	0.057	113.1	0.56	0.23	0.33	1	1.70	9.656	134.22	11.48	16	3.08%	2.8	71%
10.170	5605.68	6.7	0.084	6.5	21.8	9.43	1.26%	Slime Tailings	0.057	113.1	0.57	0.23	0.33	1	1.70	11.101	154.30	13.16	18	1.38%	2.6	71%
10.335	5605.52	10.0	0.096	9.8	21.2	9.19	0.96%	Sand-Slime Tailin	0.059	119.0	0.58	0.24	0.34	1	1.70	16.728	232.52	19.69	28	1.02%	2.4	47%
10.499	5605.35	8.9	0.103	8.8	20.2	8.74	1.16%	Sand-Slime Tailin	0.059	119.0	0.59	0.24	0.34	1	1.70	14.892	207.00	17.54	24	1.24%	2.5	47%
10.663	5605.19	7.0	0.126	6.9	26.1	11.32	1.79%	Slime Tailings	0.057	113.1	0.59	0.25	0.35	1	1.70	11.662	162.10	13.87	18	1.96%	2.7	71%
10.827	5605.02	7.3	0.113	7.1	29.0	12.55	1.55%	Slime Tailings	0.057	113.1	0.60	0.25	0.35	1	1.70	12.087	168.01	14.40	19	1.69%	2.6	71%
10.991	5604.86	8.8	0.076	8.6	29.8	12.92	0.86%	Sand-Slime Tailin	0.059	119.0	0.61	0.26	0.35	1	1.70	14.586	202.75	17.31	23	0.93%	2.4	47%
11.155	5604.70	10.2	0.109	10.0	19.3	8.38	1.07%	Sand-Slime Tailin	0.059	119.0	0.62	0.26	0.36	1	1.70	17.068	237.25	20.06	26	1.14%	2.4	47%
11.319	5604.53	8.3	0.156	8.2	20.1	8.71	1.87%	Slime Tailings	0.057	113.1	0.63	0.27	0.37	1	1.70	13.940	193.77	16.44	21	2.03%	2.6	71%
11.483	5604.37	7.8	0.195	7.6	32.3	13.99	2.49%	Slime Tailings	0.057	113.1	0.64	0.27	0.37	1	1.70	12.971	180.30	15.46	19	2.71%	2.7	71%
11.647	5604.20	8.0	0.126	7.8	34.4	14.89	1.57%	Slime Tailings	0.057	113.1	0.65	0.28	0.37	1	1.70	13.311	185.02	15.88	20	1.70%	2.6	71%
11.811	5604.04	9.1	0.108	8.9	32.1	13.92	1.19%	Sand-Slime Tailin	0.059	119.0	0.66	0.28	0.38	1	1.70	15.045	209.13	17.87	22	1.29%	2.5	47%
11.975	5603.88	8.0	0.097	7.8	31.7	13.74	1.21%	Sand-Slime Tailin	0.059	119.0	0.67	0.29	0.38	1	1.70	13.311	185.02	15.85	19	1.32%	2.6	47%
12.139	5603.71	7.7	0.106	7.5	40.4	17.50	1.37%	Slime Tailings	0.057	113.1	0.68	0.29	0.39	1	1.70	12.682	176.28	15.23	18	1.51%	2.6	71%
12.303	5603.55	7.5	0.110	7.3	39.6	17.17	1.46%	Slime Tailings	0.057	113.1	0.69	0.30	0.39	1	1.70	12.325	171.32	14.81	18	1.60%	2.7	71%
12.467	5603.38	7.0	0.102	6.8	37.4	16.22	1.45%	Slime Tailings	0.057	113.1	0.70	0.30	0.40	1	1.70	11.509	159.98	13.84	16	1.60%	2.7	71%
12.631	5603.22	7.0	0.092	6.8	30.6	13.25	1.32%	Slime Tailings	0.057	113.1	0.71	0.31	0.40	1	1.70	11.543	160.45	13.78	16	1.45%	2.7	71%
12.795	5603.05	6.2	0.105	6.0	36.6	15.85	1.68%	Slime Tailings	0.057	113.1	0.72	0.31	0.41	1	1.70	10.234	142.25	12.34	14	1.90%	2.8	71%
12.959	5602.89	7.8	0.124	7.5	43.8	18.98	1.60%	Slime Tailings	0.057	113.1	0.73	0.32	0.41	1	1.70	12.733	176.99	15.33	17	1.76%	2.7	71%
13.123	5602.73	10.5	0.147	10.3	32.1	13.89	1.40%	Sand-Slime Tailin	0.059	119.0	0.74	0.32	0.42	1	1.70	17.493	243.15	20.71	24	1.51%	2.5	47%
13.287	5602.56	8.1	0.177	8.0	30.0	13.02	2.18%	Slime Tailings	0.057	113.1	0.75	0.33	0.42	1	1.70	13.515	187.86	16.07	18	2.40%	2.7	71%
13.451	5602.40	6.8	0.135	6.6	34.3	14.86	1.98%	Slime Tailings	0.057	113.1	0.75	0.33	0.42	1	1.70	11.237	156.19	13.47	14	2.22%	2.8	71%
13.615	5602.23	7.9	0.138	7.7	36.4	15.78	1.74%	Slime Tailings	0.057	113.1	0.76	0.34	0.43	1	1.70	13.141	182.66	15.65	17	1.92%	2.7	71%
13.779	5602.07	6.3	0.125	6.2	26.0	11.28	1.97%	Slime Tailings	0.057	113.1	0.77	0.34	0.43	1	1.70	10.489	145.80	12.50	13	2.25%	2.8	71%
13.943	5601.91	8.1	0.120	7.9	29.9	12.95	1.49%	Slime Tailings	0.057	113.1	0.78	0.35	0.43	1	1.70	13.396	186.21	15.87	17	1.65%	2.7	71%
14.107	5601.74	16.0	0.167	16.0	7.3	3.14	1.04%	Sand-Slime Tailin	0.059	119.0	0.79	0.35	0.44	1	1.69	27.077	376.37	31.49	35	1.10%	2.3	47%
14.271	5601.58	12.3	0.154	12.2	9.6	4.16	1.25%	Sand-Slime Tailin	0.059	119.0	0.80	0.36	0.44	1	1.66	20.342	282.76	23.74	26	1.34%	2.5	47%
14.436	5601.41	9.4	0.143	9.3	15.0	6.48	1.52%	Sand-Slime Tailin	0.059	119.0	0.81	0.36	0.45	1	1.67	15.535	215.94	18.15	20	1.65%	2.6	47%
14.600	5601.25	7.8	0.109	7.7	29.2	12.64	1.39%	Slime Tailings	0.057	113.1	0.82	0.37	0.45	1	1.71	13.213	183.66	15.40	16	1.55%	2.7	71%
14.764	5601.09	8.3	0.128	8.2	28.0	12.14	1.54%	Sand-Slime Tailin	0.059	119.0	0.83	0.37	0.46	1	1.69	13.847	192.47	16.26	17	1.72%	2.6	47%
14.928	5600.92	7.5	0.153	7.1	63.0	27.30	2.03%	Slime Tailings	0.057	113.1	0.84	0.38	0.46	1	1.63	11.651	161.95	14.28	15	2.29%	2.8	71%
15.092	5600.76	7.7	0.237	7.3	69.8	30.26	3.08%	Slime Tailings	0.057	113.1	0.85	0.39	0.46	1	1.62	11.780	163.74	14.50	15	3.46%	2.9	71%
15.256	5600.59	9.1	0.255	9.0	23.2	10.06	2.79%	Slime Tailings	0.057	113.1	0.86	0.39	0.47	1	1.61	14.882	206.86	17.80	19	3.09%	2.8	71%
15.420	5600.43	10.0	0.246	9.8	31.0	13.41	2.45%	Slime Tailings	0.057	113.1	0.87	0.40	0.47	1	1.60	15.709	218.35	18.60	19	2.69%	2.7	71%
15.584	5600.27	9.3	0.199	9.1	28.5	12.35	2.14%	Slime Tailings	0.057	113.1	0.88	0.40	0.48	1	1.59	14.475	201.20	17.31	18	2.36%	2.7	71%
15.748	5600.10	9.5	0.138	9.2	48.8	21.16	1.45%	Sand-Slime Tailin	0.059	119.0	0.88	0.41	0.48	1	1.58	14.476	201.21	17.33	18	1.60%	2.6	47%
15.912	5599.94	9.5	0.075	9.3	47.2	20.47	0.79%	Sand-Slime Tailin	0.059	119.0	0.90	0.41	0.49	1	1.56	14.461	201.01	17.33	18	0.87%	2.5	47%
16.076	5599.77	10.5	0.073	10.3	43.2	18.73	0.70%	Sand-Slime Tailin	0.059	119.0	0.91	0.42	0.49	1	1.55	15.931	221.43	19.00	20	0.77%	2.4	47%
16.240	5599.61	29.3	0.191	29.0	50.3	21.81	0.65%	Sand-Slime Tailin	0.059	119.0	0.92	0.42	0.50	1	1.41	41.329	574.48	48.52	57	0.67%	2.0	47%
16.404	5599.45	22.6	0.359	22.6	8.2	3.54	1.59%	Sand-Slime Tailin	0.059	119.0	0.93	0.43	0.50	1	1.45	32.779	455.63	38.16	43	1.65%	2.3	47%
16.568	5599.28	14.1	0.339	14.0	6.7	2.91	2.40%	Slime Tailings	0.057	113.1	0.94	0.43	0.51	1	1.54	21.504	298.91	25.12	27	2.56%	2.6	71%
16.732	5599.12	8.8	0.276	8.7	23.2	10.05	3.13%	Slime Tailings	0.057	113.1	0.95	0.44	0.51	1	1.51	13.104	182.14	15.47	16	3.50%	2.9	71%
16.896	5598.95	8.5	0.241	8.2	42.7	18.51	2.84%	Slime Tailings	0.057	113.1	0.96	0.44	0.51	1	1.50	12.346	171.60	14.80	15	3.17%	2.8	71%
17.060	5598.79	8.4	0.229	8.2	54.7	23.72	2.72%	Slime Tailings	0.057	113.1	0.96	0.45	0.52	1	1.49	12.174	169.22	14.65	15	3.04%	2.8	71%
17.224	5598.63	8.3	0.174	7.9	66.5	28.82	2.09%	Slime Tailings	0.057	113.1	0.97	0.45	0.52	1	1.48	11.717	162.87	14.32	15	2.37%	2.8	71%

Conditions at t_1 / Liquefaction Triggering Analyses

(Idriss & Boulanger (2008): Cyclic Stress Ratio, Cyclic Resistance Ratio; Youd et al. (2001): Cyclic Stress Ratio)

Depth at time of CPT (ft)	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	I&B r_d	I&B C_σ	I&B K_σ	I&B K_α	I&B CSR M=7.5, s'v=1atm	Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	I&B FoS	Youd r_d	D_r	f	Youd K_σ	Youd K_α	Youd CSR M=7.5, s'v=1atm	Kc	Youd qc_{1n-cs}	Youd (CRR) M=7.5, s'v=1atm	Youd FoS	Avg FoS	Liquefiable? 1=Yes 2=No
0.164	0.56	0.00	0.56	0	1.00	0.06	1.03	1.0	0.059	43.50	81.07	0.114	1.92	0.98	0.35	0.80	2.53	1.0	0.017	1.00	37.57	0.081	196.84	99.38	2
0.328	0.57	0.00	0.57	0	1.00	0.07	1.03	1.0	0.060	49.46	104.02	0.149	2.51	0.98	0.43	0.79	2.32	1.0	0.019	1.03	55.95	0.096	116.62	59.56	2
0.492	0.58	0.00	0.58	0	1.00	0.13	1.05	1.0	0.061	73.98	198.41	1.000	16.46	0.98	0.64	0.68	3.13	1.0	0.014	1.00	124.42	0.259	209.31	112.89	2
0.656	0.59	0.00	0.59	0	1.00	0.30	1.10	1.0	0.064	120.79	378.59	1.000	15.73	0.98	0.93	0.60	3.68	1.0	0.012	1.00	257.80	1.000	606.04	310.88	2
0.820	0.60	0.00	0.60	0	1.00	0.30	1.10	1.0	0.064	170.48	569.88	1.000	15.73	0.97	1.15	0.60	3.37	1.0	0.013	1.00	399.40	1.000	485.02	250.37	2
0.984	0.61	0.00	0.61	0	1.00	0.30	1.10	1.0	0.064	161.32	534.60	1.000	15.73	0.97	1.12	0.60	3.13	1.0	0.014	1.00	373.28	1.000	404.34	210.03	2
1.148	0.61	0.00	0.61	0	1.00	0.30	1.10	1.0	0.064	174.33	584.68	1.000	15.73	0.97	1.17	0.60	2.95	1.0	0.015	1.00	410.35	1.000	346.72	181.22	2
1.312	0.62	0.00	0.62	0	1.00	0.18	1.06	1.0	0.061	86.63	247.08	1.000	16.36	0.97	0.73	0.63	2.56	1.0	0.017	1.00	160.45	1.000	303.50	159.93	2
1.476	0.63	0.00	0.63	0	1.00	0.11	1.03	1.0	0.060	66.71	170.40	0.412	6.88	0.97	0.59	0.71	2.05	1.0	0.021	1.07	111.44	0.209	56.33	31.61	2
1.640	0.64	0.00	0.64	0	1.00	0.09	1.03	1.0	0.059	58.54	138.96	0.229	3.86	0.97	0.52	0.74	1.83	1.0	0.023	1.11	89.28	0.146	35.52	19.69	2
1.804	0.65	0.00	0.65	0	1.00	0.08	1.02	1.0	0.059	54.08	121.80	0.183	3.10	0.97	0.48	0.76	1.71	1.0	0.025	1.17	78.96	0.126	27.80	15.45	2
1.968	0.65	0.00	0.65	0	1.00	0.13	1.04	1.0	0.060	74.99	202.27	1.000	16.71	0.97	0.65	0.67	2.02	1.0	0.021	1.00	127.28	0.272	55.07	35.89	2
2.133	0.66	0.00	0.66	0	1.00	0.20	1.05	1.0	0.061	91.81	267.02	1.000	16.46	0.97	0.76	0.62	2.22	1.0	0.019	1.00	175.21	1.000	187.13	101.80	2
2.297	0.67	0.00	0.67	0	1.00	0.20	1.05	1.0	0.061	91.33	265.18	1.000	16.52	0.97	0.76	0.62	2.15	1.0	0.020	1.00	173.85	1.000	173.84	95.18	2
2.461	0.68	0.00	0.68	0	1.00	0.18	1.04	1.0	0.060	86.61	246.99	1.000	16.67	0.97	0.73	0.63	2.03	1.0	0.021	1.00	160.39	1.000	162.31	89.49	2
2.625	0.69	0.00	0.69	0	1.00	0.15	1.03	1.0	0.059	79.60	220.01	1.000	16.82	0.97	0.68	0.66	1.90	1.0	0.023	1.00	140.41	0.337	51.37	34.09	2
2.789	0.70	0.00	0.70	0	0.99	0.12	1.03	1.0	0.059	72.56	192.91	0.840	14.23	0.97	0.63	0.68	1.78	1.0	0.024	1.00	120.35	0.242	35.00	24.61	2
2.953	0.70	0.00	0.70	0	0.99	0.12	1.02	1.0	0.059	69.87	182.56	0.580	9.86	0.97	0.61	0.69	1.74	1.0	0.025	1.00	112.69	0.213	30.14	20.00	2
3.117	0.71	0.00	0.71	0	0.99	0.11	1.02	1.0	0.059	65.28	164.91	0.362	6.18	0.97	0.58	0.71	1.67	1.0	0.026	1.00	99.63	0.172	23.81	14.99	2
3.281	0.72	0.00	0.72	0	0.99	0.11	1.02	1.0	0.058	66.39	169.30	0.401	6.85	0.97	0.59	0.71	1.67	1.0	0.026	1.03	105.93	0.191	25.57	16.21	2
3.445	0.73	0.00	0.73	0	0.99	0.11	1.02	1.0	0.058	68.37	176.90	0.489	8.38	0.97	0.60	0.70	1.68	1.0	0.025	1.01	109.63	0.203	26.38	17.38	2
3.609	0.74	0.00	0.74	0	0.99	0.09	1.01	1.0	0.058	58.22	137.81	0.225	3.88	0.97	0.52	0.74	1.54	1.0	0.028	1.14	91.09	0.150	19.01	11.45	2
3.773	0.75	0.00	0.75	0	0.99	0.08	1.01	1.0	0.058	52.13	114.37	0.168	2.91	0.97	0.46	0.77	1.46	1.0	0.029	1.17	72.98	0.116	14.28	8.59	2
3.937	0.76	0.00	0.76	0	0.99	0.08	1.01	1.0	0.058	51.52	112.01	0.164	2.84	0.97	0.45	0.78	1.44	1.0	0.030	1.24	75.19	0.120	14.30	8.57	2
4.101	0.77	0.00	0.77	0	0.99	0.07	1.01	1.0	0.058	48.21	99.29	0.141	2.46	0.97	0.41	0.79	1.39	1.0	0.031	1.51	76.95	0.122	14.26	8.36	2
4.265	0.78	0.00	0.78	0	0.99	0.07	1.01	1.0	0.057	47.91	99.07	0.141	2.45	0.97	0.41	0.79	1.39	1.0	0.031	1.64	84.13	0.135	15.41	8.93	2
4.429	0.79	0.00	0.79	0	0.99	0.21	1.02	1.0	0.058	67.47	244.96	1.000	17.24	0.97	0.77	0.62	1.82	1.0	0.023	1.00	177.49	1.000	110.72	63.98	2
4.593	0.80	0.00	0.80	0	0.98	0.19	1.01	1.0	0.058	64.66	231.17	1.000	17.33	0.97	0.75	0.63	1.76	1.0	0.024	1.03	171.98	1.000	107.80	62.57	2
4.757	0.81	0.00	0.81	0	0.98	0.10	1.01	1.0	0.057	62.12	152.83	0.285	4.98	0.97	0.55	0.73	1.51	1.0	0.028	1.27	114.89	0.221	23.26	14.12	2
4.921	0.82	0.00	0.82	0	0.98	0.06	1.00	1.0	0.057	43.87	83.44	0.117	2.06	0.97	0.36	0.80	1.34	1.0	0.032	2.26	89.35	0.146	15.08	8.57	2
5.085	0.83	0.00	0.83	0	0.98	0.05	1.00	1.0	0.057	37.25	57.84	0.085	1.50	0.96	0.26	0.80	1.34	1.0	0.032	2.38	48.99	0.091	9.17	5.34	2
5.249	0.84	0.00	0.84	0	0.98	0.05	1.00	1.0	0.057	34.91	48.74	0.076	1.34	0.96	0.21	0.80	1.33	1.0	0.032	3.12	43.13	0.086	8.50	4.92	2
5.413	0.85	0.00	0.85	0	0.98	0.05	1.00	1.0	0.057	34.07	45.52	0.073	1.29	0.96	0.20	0.80	1.33	1.0	0.032	3.77	43.19	0.086	8.34	4.82	2
5.577	0.86	0.00	0.86	0	0.98	0.05	1.00	1.0	0.057	33.90	44.84	0.073	1.28	0.96	0.19	0.80	1.32	1.0	0.032	3.11	34.07	0.078	7.46	4.37	2
5.741	0.87	0.00	0.87	0	0.98	0.05	1.00	1.0	0.057	37.81	59.22	0.087	1.54	0.96	0.27	0.80	1.32	1.0	0.032	1.72	36.93	0.081	7.52	4.53	2
5.905	0.88	0.00	0.88	0	0.98	0.05	1.00	1.0	0.056	35.35	50.45	0.078	1.38	0.96	0.22	0.80	1.31	1.0	0.032	2.77	41.86	0.085	7.76	4.57	2
6.069	0.89	0.00	0.89	0	0.98	0.05	1.00	1.0	0.056	34.66	47.77	0.075	1.34	0.96	0.21	0.80	1.31	1.0	0.032	2.83	37.11	0.081	7.27	4.30	2
6.234	0.89	0.00	0.89	0	0.98	0.05	1.00	1.0	0.056	35.27	50.16	0.078	1.38	0.96	0.22	0.80	1.30	1.0	0.033	2.29	34.07	0.078	6.91	4.15	2
6.398	0.90	0.00	0.90	0	0.97	0.05	1.00	1.0	0.056	36.19	52.98	0.080	1.43	0.96	0.24	0.80	1.30	1.0	0.033	1.68	28.28	0.074	6.36	3.90	2
6.562	0.91	0.00	0.91	0	0.97	0.05	1.00	1.0	0.056	38.45	61.67	0.090	1.60	0.96	0.28	0.80	1.29	1.0	0.033	1.57	36.41	0.080	6.82	4.21	2
6.726	0.92	0.00	0.92	0	0.97	0.05	1.00	1.0	0.056	36.90	55.72	0.083	1.49	0.96	0.25	0.80	1.29	1.0	0.033	2.20	41.40	0.084	7.04	4.26	2
6.890	0.93	0.00	0.93	0	0.97	0.05	1.00	1.0	0.056	35.30	50.25	0.078	1.39	0.96	0.22	0.80	1.28	1.0	0.033	3.06	45.80	0.088	7.22	4.31	2
7.054	0.94	0.00	0.94	0	0.97	0.05	1.00	1.0	0.056	33.91	44.88	0.073	1.30	0.96	0.19	0.80	1.28	1.0	0.033	4.10	45.03	0.088	7.05	4.18	2
7.218	0.95	0.00	0.95	0	0.97	0.05	1.00	1.0	0.056	33.57	43.58	0.072	1.28	0.96	0.18	0.80	1.27	1.0	0.033	4.31	43.09	0.086	6.81	4.05	2
7.382	0.96	0.00	0.96	0	0.97	0.04	1.00	1.0	0.056	33.41	42.95	0.071	1.28	0.96	0.18	0.80	1.27	1.0	0.033	4.26	40.64	0.084	6.55	3.91	2
7.546	0.97	0.00	0.97	0	0.97	0.04	0.99	1.0	0.056	33.38	42.82	0.071	1.28	0.96	0.18	0.80	1.27	1.0	0.033	4.96	46.83	0.089	6.84	4.06	2
7.710	0.98	0.00	0.98	0	0.97	0.05	0.99	1.0	0.056	33.57	43.58	0.072	1.29	0.96	0.18	0.80	1.26	1.0	0.033	4.48	44.87	0.087	6.62	3.95	2
7.874	0.99	0.00	0.99	0	0.96	0.05	0.99	1.0	0.055	34.67	47.84	0.075	1.36	0.96	0.21	0.80	1.26	1.0	0.034	3.41	44.85	0.087	6.52	3.94	2
8.038	1.00	0.00	1.00	0	0.96	0.05	0.99	1.0	0.055	35.39	49.90	0.077	1.40	0.96	0.22	0.80	1.25	1.0	0.034	2.44	35.45	0.080	5.84	3.62	2
8.202	1.01	0.00	1.01	0	0.96	0.05	0.99	1.0	0.055	36.19	52.97	0.080	1.46	0.96	0.24	0.80	1.25	1.0	0.034	2.14	35.85	0.080	5.77	3.61	2
8.366	1.02	0.00	1.02	0	0.96	0.05	0.99	1.0	0.055	34.30	46.38	0.074	1.34	0.96	0.20	0.80	1.25	1.0	0.034	3.33	40.24	0.084	5.95	3.64	2
8.530	1.03	0.00	1.03	0	0.96	0.04	0.99	1.0	0.055	33.35	42.71	0.071	1.29	0.96	0.18	0.80	1.24	1.0	0.034	4.02	37.64	0.081	5.71	3.50	2
8.694	1.04	0.00	1.04	0	0.96	0.05	0.99	1.0	0.055	33.49	43.27	0.071	1.30	0.96	0.18	0.80	1.24	1.0	0.034	4.60	44.99	0.087	6.06	3.68	2
8.858	1.05	0.00	1.05	0	0.96	0.05	0.99	1.0	0.055	33.56	43.52	0.072	1.30	0.96	0.18	0.80	1.24	1.0	0.034	4.00	39.87	0.083	5.68	3.49	2
9.022	1.05	0.00	1.05	0	0.96	0.05	0.99	1.0	0.055	35.46	50.87	0.078	1.43	0.96	0.23	0.80	1.23	1.0	0.034	2.84	43.84	0.087	5.83	3.63	2
9.186	1.06	0.00	1.06	0	0.96	0.05	0.99	1.0	0.055	36.37	53.66	0.081	1.48	0.96	0.24	0.80	1.23	1.0	0.034	2.50	43.16	0.086	5.71	3.60	2
9.350	1.07	0.00	1.07	0	0.96	0.05	0.99	1.0	0.055	38.52	61.96	0.090	1.65	0.95	0.28	0.80	1.22	1.0	0.034	1.81	42.45	0.085	5.59	3.62	2
9.514	1.08	0.00	1.08	0	0.95	0.05	0.99	1.0	0.054	37.40	57.65	0.085	1.57	0.95	0.26	0.80	1.22	1.0	0.034	2.36	47.79	0.090	5.79	3.68	2
9.678	1.09	0.00	1.09	0	0.95	0.05	0.99	1.0	0.054	36.41	53.82	0.081	1.49	0.95	0.24	0.80	1.22	1.0	0.035	2.72	47.30	0.089	5.69	3.59	2
9.842	1.10	0.00	1.10	0	0.95	0.05	0.99	1.0	0.054	35.42	50.74	0.078	1.44	0.95	0.23	0.80	1.21	1.0	0.035	3.25	49.79	0.091	5.75	3.59	2
10.006	1.11	0.00	1.11	0	0.95	0.05	0.99	1.0	0.054	34.09	45.57	0.073	1.35	0.95	0.20	0.80	1.21	1.0	0.035	5.13	58.89	0.099	6.14	3.75	2
10.170	1.12	0.00	1.12	0	0.95	0.05	0.99	1.0	0.054	34.67	47.83	0.075	1.39	0.95	0.21	0.80	1.21	1.0	0.035	3.29	43.25	0.086	5.27	3.33	2
10.335	1.13	0.00	1.13	0	0.95	0.05	0.99	1.0	0.054	37.21	56.90	0.084	1.56	0.95	0.26	0.80	1.20	1.0	0.035	2.20	43.26	0.086	5.20	3.38	2
10.499	1.14	0.00	1.14	0	0.95	0.05	0.99	1.0	0.054	36.45	54.00	0.081	1.51	0.95	0.24	0.80	1.20	1.0	0.035	2.60	45.66	0.088	5.26	3.38	2
10.663	1.15	0.00	1.15	0	0.95	0.05	0.99	1.0	0.054	34.92	48.78	0.076	1.41	0.95	0.21	0.80	1.20	1.0	0.035	3.80	52.67	0.094	5.52	3.47	2
10.827	1.16	0.00	1.16	0	0.95	0.05	0.99	1.0	0.054	35.10	49.50	0.077	1.43	0.95	0.22	0.80	1.20	1.0	0.035	3.49	50.26	0.092	5.36	3.39	2
10.991	1.17	0.00	1.17	0	0.94	0.05	0.98	1.0	0.054	36.37	53.68	0.081	1.51	0.95	0.24	0.80	1.19	1.0	0.035	2.41	41.68	0.085	4.88	3.19	2
11.155	1.18	0.00	1.18	0	0.94	0.05	0.98	1.0	0.054	37.34	57.40	0.085	1.59	0.95	0.26	0.80	1.19	1.0	0.035	2.37	47.58	0.090	5.10	3.34	2
11.319	1.19	0.00	1.19	0	0.94	0.05	0.98	1.0	0.054	35.81	52.25	0.080	1.49	0.95	0.23	0.80	1.19	1.0	0.035	3.54	58.25	0.098	5.53	3.51	2
11.483	1.20	0.00	1.20	0	0.94	0.05	0.98	1.0	0.054	35.47	50.94	0.078	1.47	0.95	0.23	0.80	1.18	1.0	0.035	4.27	66.05	0.107	5.94	3.70	2
11.647	1.21	0.00	1.21	0	0.94	0.05	0.98	1.0	0.053	35.62	51.50	0.079	1.48	0.95	0.23	0.80	1.18	1.0	0.035	3.41	54.19	0.095	5.22	3.35	2
11.811	1.22	0.00	1.22	0	0.94	0.05	0.98	1.0	0.053	36.57	54.44	0.082	1.54	0.95	0.24	0.80	1.18	1.0	0.035	2.80	50.01	0.092	4.98	3.26	2
11.975	1.23	0.00	1.23	0	0.94	0.05	0.98	1.0	0.053	35.86	51.71	0.079	1.49	0.95	0.23	0.80	1.18	1.0	0.036	3.12	49.38	0.091	4.90	3.19	2
12.139	1.24	0.00	1.24	0	0.94	0.05	0.98	1.0	0.053	35.39	50.62	0.078	1.47	0.95	0.23	0.80	1.17	1.0	0.036	3.42	52.15	0.093	4.96	3.21	2
12.303	1.25	0.00	1.25	0	0.94	0.05	0.98	1.0	0.053	34.95	48.90	0.076	1.44	0.95	0.22	0.80	1.17	1.0	0.036	3.90	54.45	0.095	5.00	3.22	2
12.467	1.25	0.00	1.25	0	0.93	0.05	0.98	1.0	0.053	34.77	48.20	0.076	1.43	0.95	0.21	0.80	1.17	1.0	0.036	4.07	54.72	0.095	4.96	3.20	2
12.631	1.26	0.00	1.26	0	0.93	0.05	0.98	1.0	0.053	34.89	48.67	0.076	1.44	0.95	0.21	0.80	1.17	1.0	0.036	3.74	51.51	0.093	4.78	3.11	2
12.795	1.27	0.00	1.27	0	0.93	0.05	0.98	1.0	0.053	34.38	46.72	0.074	1.41	0.95	0.20	0.80	1.16	1.0	0.036	4.56	56.24	0.097	4.93	3.17	2
12.959	1.28	0.00	1.28	0	0.93	0.05	0.98	1.0	0.053	35.43	50.75	0.078	1.48	0.95	0.23	0.80	1.16	1.0	0.036	3.79	58.13	0.098	4.97	3.23	2
13.123	1.29	0.00	1.29	0	0.93	0.05	0.98	1.0	0.053	37.57	58.28	0.086	1.64	0.95	0.26	0.80	1.16	1.0	0.036	2.87	59.45	0.100	4.98	3.31	2
13.287	1.30	0.00	1.30	0	0.93	0.05	0.98	1.0	0.053	35.68	51.75	0.079	1.51	0.95	0.23	0.80	1.16	1.0	0.036	4.27	68.65	0.110	5.46	3.48	2
13.451	1.31	0.00	1.31	0	0.93	0.05	0.98	1.0	0.052	34.78	48.25	0.076	1.44	0.95	0.21	0.80	1.15	1.0	0.036	4.72	63.58	0.104	5.10	3.27	2
13.615	1.32	0.00	1.32	0	0.93	0.05	0.98	1.0	0.052	35.53	51.16	0.079	1.50	0.94	0.23	0.80	1.15	1.0	0.036	4.01	62.70	0.103	5.01	3.25	2
13.779	1.33	0.00	1.33	0	0.92	0.05	0.98	1.0	0.052	34.44	46.95	0.075	1.43	0.94	0.20	0.80	1.15	1.0	0.036	5.08	63.48	0.104	5.00	3.21	2
13.943	1.34	0.00	1.34	0	0.92	0.05	0.98	1.0	0.052	35.64	51.59	0.079	1.51	0.94	0.23	0.80	1.15	1.0	0.036	3.74	59.68	0.100	4.76	3.14	2
14.107	1.35	0.00	1.35	0	0.92	0.06	0.97	1.0	0.052	40.97	71.38	0.101	1.95	0.94	0.32	0.80	1.14	1.0	0.036	1.96	59.56	0.100	4.71	3.33	2
14.271	1.36	0.00	1.36	0	0.92	0.05	0.97	1.0	0.052	38.63	62.37	0.091	1.74	0.94	0.28	0.80	1.14	1.0	0.036	2.56	60.83	0.101	4.72	3.23	2
14.436	1.37	0.00	1.37	0	0.92	0.05	0.98	1.0	0.052	36.69	54.92	0.082	1.59	0.94	0.25	0.80	1.14	1.0	0.036	3.44	62.76	0.103	4.77	3.18	2
14.600	1.38	0.00	1.38	0	0.92	0.05	0.98	1.0	0.052	35.34	50.41	0.078	1.50	0.94	0.22	0.80	1.14	1.0	0.037	3.86	58.13	0.098	4.51	3.01	2
14.764	1.39	0.00	1.39	0	0.92	0.05	0.98	1.0	0.052	35.60	50.72	0.078	1.51	0.94	0.22	0.80	1.14	1.0	0.037	3.58	54.12	0.095	4.31	2.91	2
14.928	1.40	0.00	1.40	0	0.92	0.05	0.98	1.0	0.052	35.06	49.34	0.077	1.49	0.94	0.22	0.80	1.13	1.0	0.037	4.75	67.81	0.109	4.91	3.20	2
15.092	1.41	0.00	1.41	0	0.91	0.05	0.98	1.0	0.052	35.14	49.64	0.077	1.49	0.94	0.22	0.80	1.13	1.0	0.037	5.66	82.06	0.131	5.87	3.68	2
15.256	1.41	0.00	1.41	0	0.91	0.05	0.97	1.0	0.051	36.04	53.13	0.081	1.57	0.94	0.24	0.80	1.13	1.0	0.037	4.81	82.21	0.132	5.83	3.70	2
15.420	1.42	0.00	1.42	0	0.91	0.05	0.97	1.0	0.051	36.57	55.17	0.083	1.61	0.94	0.25	0.80	1.13	1.0	0.037	4.26	79.34	0.126	5.55	3.58	2
15.584	1.43	0.00	1.43	0	0.91	0.05	0.97	1.0	0.051	36.06	53.20	0.081	1.57	0.94	0.24	0.80	1.13	1.0	0.037	4.26	73.00	0.116	5.06	3.32	2
15.748	1.44	0.00	1.44	0	0.91	0.05	0.97	1.0	0.051	36.39	53.76	0.081	1.59	0.94	0.24	0.80	1.12	1.0	0.037	3.55	61.75	0.102	4.40	2.99	2
15.912	1.45	0.00	1.45	0	0.91	0.05	0.97	1.0	0.051	36.38	53.71	0.081	1.59	0.94	0.24	0.80	1.12	1.0	0.037	2.79	48.31	0.090	3.86	2.72	2
16.076	1.46	0.00	1.46	0	0.91	0.05	0.97	1.0	0.051	36.96	55.96	0.083	1.64	0.94	0.25	0.80	1.12	1.0	0.037	2.47	46.86	0.089	3.77	2.70	2
16.240	1.47	0.00	1.47	0	0.91	0.07	0.96	1.0	0.050	47.32	95.84	0.136	2.70	0.94	0.40	0.80	1.12	1.0	0.037	1.31	63.59	0.104	4.36	3.53	2
16.404	1.48	0.00	1.48	0	0.90	0.06	0.97	1.0	0.050	43.68	81.84	0.115	2.28	0.94	0.36	0.80	1.11	1.0	0.037	2.05	78.17	0.124	5.18	3.73	2
16.568	1.49	0.00	1.49	0	0.90	0.06	0.97	1.0	0.051	38.65	63.25	0.092	1.81	0.94	0.29	0.80	1.11	1.0	0.037	3.46	85.09	0.137	5.67	3.74	2
16.732	1.50	0.00	1.50	0	0.90	0.05	0.97	1.0	0.051	35.48	50.95	0.078	1.55	0.94	0.23	0.80	1.11	1.0	0.037	5.53	85.58	0.138	5.67	3.61	2
16.896	1.51	0.00	1.51	0	0.90	0.05	0.97	1.0	0.051	35.24	50.05	0.078	1.53	0.94	0.22	0.80	1.11	1.0	0.037	4.85	71.80	0.114	4.65	3.09	2
17.060	1.52	0.00	1.52	0	0.90	0.05	0.97	1.0	0.051	35.22	49.96	0.077	1.53	0.94	0.22	0.80	1.11	1.0	0.037	4.86	71.61	0.114	4.61	3.07	2
17.224	1.53	0.00	1.53	0	0.90	0.05	0.97	1.0	0.050	35.08	49.40	0.077	1.52	0.94	0.22	0.80	1.11	1.0	0.037	4.91	70.38	0.112	4.50	3.01	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.347

Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
3.10	594	1.6E-03	5.5E+02	1.0E-04	11	0.175	9996	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.15	594	1.6E-03	5.5E+02	1.0E-04	11	0.176	9936	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.20	594	1.6E-03	5.5E+02	1.0E-04	11	0.177	9877	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.25	594	1.6E-03	5.5E+02	1.0E-04	11	0.177	9819	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.30	594	1.6E-03	5.5E+02	1.1E-04	11	0.178	9762	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.35	594	1.6E-03	5.5E+02	1.1E-04	11	0.179	9707	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.40	594	1.6E-03	5.5E+02	1.1E-04	11	0.179	9652	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.45	594	1.6E-03	5.5E+02	1.1E-04	11	0.180	9599	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.50	594	1.6E-03	5.5E+02	1.1E-04	11	0.180	9547	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.55	594	1.6E-03	5.5E+02	1.1E-04	11	0.181	9495	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.60	594	1.6E-03	5.5E+02	1.1E-04	11	0.182	9444	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.65	594	1.6E-03	5.5E+02	1.2E-04	11	0.182	9395	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.70	594	1.6E-03	5.5E+02	1.2E-04	11	0.183	9346	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.75	594	1.6E-03	5.5E+02	1.2E-04	11	0.183	9298	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.80	594	1.6E-03	5.5E+02	1.2E-04	11	0.184	9251	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.85	594	1.6E-03	5.5E+02	1.2E-04	11	0.184	9205	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.90	594	1.6E-03	5.5E+02	1.2E-04	11	0.185	9159	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.95	594	1.6E-03	5.5E+02	1.2E-04	11	0.186	9114	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.00	495	1.6E-03	3.8E+02	1.8E-04	11	0.186	9070	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.02%	0.0000
4.05	495	1.8E-03	4.5E+02	1.6E-04	10	0.187	9259	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.10	495	1.8E-03	4.5E+02	1.6E-04	10	0.188	9208	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.15	495	1.8E-03	4.5E+02	1.6E-04	10	0.188	9158	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.20	495	1.8E-03	4.5E+02	1.6E-04	10	0.189	9108	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.25	495	1.8E-03	4.5E+02	1.6E-04	10	0.190	9059	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.30	495	1.8E-03	4.5E+02	1.7E-04	10	0.190	9012	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.35	495	1.8E-03	4.3E+02	1.8E-04	16	0.443	7376	0.03%	2.00	0.65	0.03%	0.002	0.34	0.079	0.765	0.29%	0.0005
4.40	495	1.9E-03	4.7E+02	1.6E-04	0	0.195	11235	0.03%	2.20	1.00	0.01%	0.000	0.36	0.025	0.751	0.07%	0.0001
4.45	495	1.9E-03	4.7E+02	1.7E-04	0	0.196	11177	0.03%	2.20	1.00	0.01%	0.000	0.36	0.025	0.751	0.07%	0.0001
4.50	495	1.8E-03	4.5E+02	1.7E-04	10	0.193	8828	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.55	495	1.8E-03	4.3E+02	1.9E-04	16	0.445	7228	0.03%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.47%	0.0008
4.60	495	1.8E-03	4.3E+02	1.9E-04	16	0.446	7195	0.04%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.51%	0.0008
4.65	495	1.8E-03	4.3E+02	1.9E-04	16	0.446	7162	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.55%	0.0009
4.70	495	1.8E-03	4.3E+02	1.9E-04	16	0.447	7130	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.59%	0.0010
4.75	495	1.8E-03	4.3E+02	1.9E-04	16	0.448	7098	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.62%	0.0010
4.80	495	1.8E-03	4.5E+02	1.9E-04	10	0.196	8586	0.03%	2.00	0.65	0.03%	0.001	0.34	0.079	0.765	0.15%	0.0002
4.85	495	1.8E-03	4.3E+02	2.0E-04	16	0.449	7034	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.69%	0.0011
4.90	495	1.8E-03	4.3E+02	2.0E-04	16	0.449	7003	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.73%	0.0012
4.95	495	1.8E-03	4.3E+02	2.0E-04	16	0.450	6973	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.76%	0.0012
5.00	495	1.8E-03	4.5E+02	1.9E-04	10	0.198	8436	0.03%	2.00	0.65	0.03%	0.002	0.34	0.079	0.765	0.35%	0.0006
5.05	495	1.8E-03	4.5E+02	2.0E-04	10	0.199	8399	0.03%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.39%	0.0006
5.10	495	1.8E-03	4.5E+02	2.0E-04	10	0.199	8362	0.03%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.43%	0.0007
5.15	495	1.8E-03	4.3E+02	2.1E-04	16	0.452	6853	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.89%	0.0015
5.20	495	1.8E-03	4.3E+02	2.1E-04	16	0.452	6825	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.92%	0.0015
5.25	495	1.8E-03	4.3E+02	2.2E-04	16	0.453	6797	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.95%	0.0016
5.30	495	1.8E-03	4.3E+02	2.2E-04	16	0.453	6770	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.98%	0.0016
5.35	495	1.8E-03	4.3E+02	2.2E-04	16	0.454	6743	0.05%	2.00	0.65	0.03%	0.007	0.34	0.079	0.765	1.01%	0.0017
5.40	495	1.8E-03	4.3E+02	2.2E-04	16	0.454	6717	0.05%	2.00	0.65	0.03%	0.007	0.34	0.079	0.765	1.04%	0.0017
5.45	495	1.8E-03	4.3E+02	2.2E-04	16	0.454	6691	0.05%	2.00	0.65	0.03%	0.007	0.34	0.079	0.765	1.07%	0.0018
5.50	495	1.8E-03	4.5E+02	2.2E-04	10	0.203	8097	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.70%	0.0011
5.55	495	1.8E-03	4.5E+02	2.2E-04	10	0.204	8064	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.73%	0.0012
5.60	495	1.8E-03	4.3E+02	2.3E-04	16	0.456	6612	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.17%	0.0019
5.65	495	1.8E-03	4.3E+02	2.3E-04	16	0.456	6588	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.19%	0.0020
5.70	495	1.8E-03	4.3E+02	2.3E-04	16	0.457	6563	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.22%	0.0020
5.75	495	1.8E-03	4.3E+02	2.4E-04	16	0.457	6539	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.25%	0.0021
5.80	495	1.8E-03	4.3E+02	2.4E-04	16	0.458	6515	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.28%	0.0021
5.85	495	1.8E-03	4.5E+02	2.3E-04	10	0.206	7885	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.91%	0.0015
5.90	460	1.8E-03	3.9E+02	2.7E-04	10	0.207	7855	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.57%	0.0026
5.95	460	1.8E-03	3.9E+02	2.7E-04	10	0.207	7826	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.60%	0.0026
6.00	460	1.8E-03	3.9E+02	2.7E-04	10	0.208	7797	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.64%	0.0027
6.05	460	1.8E-03	3.7E+02	2.9E-04	16	0.460	6396	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.12%	0.0035
6.10	460	1.8E-03	3.7E+02	2.9E-04	16	0.460	6374	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.16%	0.0035
6.15	460	1.8E-03	3.7E+02	2.9E-04	16	0.461	6353	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.20%	0.0036
6.20	460	1.8E-03	3.9E+02	2.8E-04	10	0.210	7688	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.77%	0.0029
6.25	460	1.8E-03	3.9E+02	2.8E-04	10	0.210	7661	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.81%	0.0030
6.30	460	1.8E-03	3.7E+02	3.0E-04	16	0.462	6287	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.31%	0.0038
6.35	460	1.8E-03	3.7E+02	3.0E-04	16	0.463	6266	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.34%	0.0038
6.40	460	1.8E-03	3.9E+02	2.9E-04	10	0.211	7583	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.91%	0.0031
6.45	460	1.8E-03	3.9E+02	2.9E-04	10	0.212	7557	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.95%	0.0032
6.50	460	1.8E-03	3.7E+02	3.1E-04	16	0.464	6203	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.45%	0.0040
6.55	460	1.8E-03	3.7E+02	3.1E-04	16	0.464	6183	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.49%	0.0041
6.60	460	1.8E-03	3.7E+02	3.2E-04	16	0.465	6163	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.52%	0.0041
6.65	460	1.8E-03	3.9E+02	3.0E-04	10	0.214	7460	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.08%	0.0034
6.70	460	1.8E-03	3.9E+02	3.1E-04	10	0.214	7435	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.12%	0.0035
6.75	460	1.8E-03	3.7E+02	3.2E-04	16	0.466	6104	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.64%	0.0043
6.80	460	1.8E-03	3.7E+02	3.3E-04	16	0.466	6085	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.67%	0.0044
6.85	460	1.8E-03	3.7E+02	3.3E-04	16	0.467	6067	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.71%	0.0044
6.90	460	1.8E-03	3.7E+02	3.3E-04	16	0.467	6048	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.75%	0.0045
6.95	460	1.8E-03	3.7E+02	3.3E-04	16	0.468	6030	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.78%	0.0046
7.00	460	1.8E-03	3.7E+02	3.4E-04	16	0.468	6012	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.82%	0.0046
7.05	460	1.8E-03	3.9E+02	3.2E-04	10	0.217	7277	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.36%	0.0039
7.10	460	1.8E-03	3.7E+02	3.4E-04	16	0.469	5976	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.90%	0.0047
7.15	460	1.8E-03	3.7E+02	3.4E-04	16	0.469	5958	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.93%	0.0048
7.20	460	1.8E-03	3.7E+02	3.5E-04	16	0.469	5941	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.97%	0.0049
7.25	460	1.8E-03	3.7E+02	3.5E-04	16	0.470	5924	0.11%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.01%	0.0049
7.30	460	1.8E-03	3.7E+02	3.5E-04	16	0.470	5907	0.11%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.04%	0.0050
7.35	460	1.8E-03	3.9E+02	3.4E-04	10	0.219	7149	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.58%	0.0042
7.40	460	1.8E-03	3.9E+02	3.4E-04	10	0.220	7128	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.62%	0.0043
7.45	460	1.8E-03	3.9E+02	3.4E-04	10	0.220	7107	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.66%	0.0044
7.50	500	1.8E-03	4.4E+02	3.1E-04	16	0.472	5838	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.16%	0.0035
7.55	500	1.8E-03	4.6E+02	2.9E-04	10	0.221	7066	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.76%	0.0029
7.60	500	1.8E-03	4.4E+02	3.1E-04	16	0.472	5805	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.22%	0.0036
7.65	500	1.8E-03	4.4E+02	3.1E-04	16	0.473	5790	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.25%	0.0037
7.70	500	1.8E-03	4.4E+02	3.1E-04	16	0.473	5774	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.28%	0.0037
7.75	500	1.8E-03	4.4E+02	3.2E-04	16	0.474	5758	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.30%	0.0038
7.80	500	1.8E-03	4.4E+02	3.2E-04	16	0.474	5743	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.33%	0.0038
7.85	500	1.8E-03	4.6E+02	3.0E-04	10	0.223	6951	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.92%	0.0032
7.90	500	1.8E-03	4.6E+02	3.1E-04	10	0.223	6931	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.95%	0.0032
7.95	500	1.8E-03	4.6E+02	3.1E-04	10	0.224	6912	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.98%	0.0032
8.00	500	1.8E-03	4.6E+02	3.1E-04	10	0.224	6893	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.01%	0.0033
8.05	500	1.8E-03	4.6E+02	3.1E-04	10	0.225	6874	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.04%	0.0033
8.10	500	1.8E-03	4.4E+02	3.3E-04	16	0.476	5650	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.51%	0.0041
8.15	500	1.8E-03	4.4E+02	3.3E-04	16	0.476	5636	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.54%	0.0042
8.20	500	1.8E-03	4.4E+02	3.4E-04	16	0.477	5621	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.57%	0.0042
8.25	500	1.8E-03	4.4E+02	3.4E-04	16	0.477	5607	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.59%	0.0043
8.30	500	1.8E-03	4.4E+02	3.4E-04	16	0.477	5593	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.62%	0.0043

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W2

Data File: 13-52106_SP2W2-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Dat

Legend:
- Tailings Sands
- Tailings Sand-Slimes
- Tailings Slimes
- Interim Cover
- Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5613.10	Water surface elevation during CPT investigation (ft a
5607.57	Water surface elevation at t_0 (ft amsl)
5598.51	Water surface elevation at t_1 (ft amsl)
5593.51	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earth
7.51	Equiv. Number of Uniform Strain Cycles, N
5615.85	Ground Surface Elevation at time of CPT (ft amsl)
5625.87	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after plac
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
2.02	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1111.60	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5593.51	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5625.62	5625.37	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5623.62	5621.87	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5619.87	5617.87	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334	1.83	508	1.9E-03	4.8E+02	6.8E-05	11	0.153	12419	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######	5616.86	5615.85	2.02	0.050	101	0.556	0.505	0.00	0.00	0.556	0.505	2.75	508	1.6E-03	4.0E+02	1.2E-04	11	0.170	10466	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No
17.388	5598.46	9.6	0.196	9.2	57.7	25.02	2.05%	Slime Tailings	0.057	113.1	0.98	0.46	0.53	1
17.552	5598.30	8.9	0.209	8.4	74.2	32.14	2.35%	Slime Tailings	0.057	113.1	0.99	0.46	0.53	1
17.716	5598.13	9.1	0.199	8.7	67.5	29.25	2.19%	Slime Tailings	0.057	113.1	1.00	0.47	0.53	1
17.880	5597.97	9.1	0.170	8.7	60.5	26.22	1.88%	Slime Tailings	0.057	113.1	1.01	0.47	0.54	1
18.044	5597.81	9.4	0.142	9.0	57.5	24.92	1.52%	Sand-Slime Tailin	0.059	119.0	1.02	0.48	0.54	1
18.208	5597.64	8.7	0.209	8.3	57.7	25.02	2.41%	Slime Tailings	0.057	113.1	1.03	0.48	0.55	1
18.372	5597.48	10.0	0.260	9.5	72.0	31.20	2.61%	Slime Tailings	0.057	113.1	1.04	0.49	0.55	1
18.537	5597.31	10.6	0.320	10.3	54.3	23.51	3.02%	Slime Tailings	0.057	113.1	1.05	0.49	0.55	1
18.701	5597.15	12.3	0.297	12.1	37.1	16.09	2.42%	Slime Tailings	0.057	113.1	1.06	0.50	0.56	1
18.865	5596.99	17.2	0.199	17.1	20.4	8.85	1.16%	Sand-Slime Tailin	0.059	119.0	1.07	0.50	0.56	1
19.029	5596.82	16.8	0.219	16.7	20.1	8.71	1.31%	Sand-Slime Tailin	0.059	119.0	1.08	0.51	0.57	1
19.193	5596.66	15.5	0.212	15.4	19.4	8.42	1.37%	Sand-Slime Tailin	0.059	119.0	1.09	0.51	0.57	1
19.357	5596.49	11.9	0.188	11.8	28.4	12.32	1.58%	Sand-Slime Tailin	0.059	119.0	1.10	0.52	0.58	1
19.521	5596.33	10.5	0.213	10.3	42.0	18.18	2.02%	Slime Tailings	0.057	113.1	1.10	0.52	0.58	1
19.685	5596.17	10.7	0.236	10.3	60.5	26.21	2.21%	Slime Tailings	0.057	113.1	1.11	0.53	0.59	1
19.849	5596.00	13.4	0.216	13.1	40.2	17.42	1.62%	Sand-Slime Tailin	0.059	119.0	1.12	0.53	0.59	1
20.013	5595.84	12.8	0.185	12.6	40.5	17.54	1.44%	Sand-Slime Tailin	0.059	119.0	1.13	0.54	0.59	1
20.177	5595.67	14.7	0.185	14.4	48.7	21.12	1.26%	Sand-Slime Tailin	0.059	119.0	1.14	0.54	0.60	1
20.341	5595.51	13.5	0.185	13.4	28.8	12.46	1.37%	Sand-Slime Tailin	0.059	119.0	1.15	0.55	0.60	1
22.340	5593.51							Sand-Slime Tailin	0.059	119.0				

CPT Data Interpretations (cont.) / Conditions at t_1

Depth at time of CPT (ft)	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
17.388	1.47	13.529	188.05	16.33	16	2.29%	2.8	71%	1.54	0.00	1.54	1
17.552	1.46	12.319	171.23	15.09	15	2.65%	2.8	71%	1.55	0.01	1.54	1
17.716	1.45	12.622	175.44	15.37	15	2.46%	2.8	71%	1.56	0.01	1.54	1
17.880	1.45	12.545	174.38	15.20	15	2.11%	2.8	71%	1.57	0.02	1.55	1
18.044	1.44	12.921	179.60	15.61	15	1.70%	2.7	47%	1.58	0.02	1.55	1
18.208	1.43	11.845	164.64	14.35	14	2.74%	2.9	71%	1.58	0.03	1.56	1
18.372	1.42	13.491	187.53	16.41	16	2.91%	2.8	71%	1.59	0.03	1.56	1
18.537	1.41	14.484	201.33	17.38	17	3.35%	2.8	71%	1.60	0.04	1.57	1
18.701	1.40	16.910	235.04	20.02	20	2.64%	2.7	71%	1.61	0.04	1.57	1
18.865	1.37	23.404	325.31	27.38	29	1.23%	2.4	47%	1.62	0.05	1.57	1
19.029	1.36	22.707	315.63	26.57	28	1.39%	2.4	47%	1.63	0.05	1.58	1
19.193	1.36	20.954	291.26	24.53	25	1.47%	2.5	47%	1.64	0.06	1.58	1
19.357	1.37	16.059	223.22	18.93	19	1.74%	2.6	47%	1.65	0.06	1.59	1
19.521	1.36	13.972	194.20	16.64	16	2.26%	2.8	71%	1.66	0.07	1.59	1
19.685	1.35	13.907	193.31	16.75	16	2.47%	2.8	71%	1.67	0.07	1.60	1
19.849	1.34	17.596	244.59	20.83	21	1.77%	2.6	47%	1.68	0.08	1.60	1
20.013	1.34	16.808	233.63	19.91	20	1.58%	2.6	47%	1.69	0.08	1.61	1
20.177	1.32	18.997	264.05	22.53	23	1.37%	2.5	47%	1.70	0.09	1.61	1
20.341	1.32	17.608	244.76	20.73	20	1.49%	2.6	47%	1.71	0.09	1.62	1
22.340									1.83	0.12	1.70	1

Liquefaction Triggering Analyses — Idriss & Boulanger (2008)

Depth at time of CPT (ft)	Cyclic Stress Ratio r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Cyclic Resistance Ratio Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS
17.388	0.90	0.05	0.97	1.0	0.050	35.77	52.10	0.080	1.58
17.552	0.90	0.05	0.97	1.0	0.051	35.34	50.44	0.078	1.54
17.716	0.89	0.05	0.97	1.0	0.051	35.44	50.81	0.078	1.55
17.880	0.89	0.05	0.97	1.0	0.051	35.38	50.59	0.078	1.54
18.044	0.89	0.05	0.97	1.0	0.051	35.77	51.38	0.079	1.55
18.208	0.89	0.05	0.97	1.0	0.051	35.09	49.44	0.077	1.51
18.372	0.89	0.05	0.97	1.0	0.051	35.80	52.21	0.080	1.56
18.537	0.89	0.05	0.97	1.0	0.051	36.14	53.52	0.081	1.59
18.701	0.89	0.05	0.97	1.0	0.051	37.06	57.08	0.085	1.66
18.865	0.89	0.06	0.97	1.0	0.051	39.91	67.29	0.096	1.89
19.029	0.88	0.06	0.97	1.0	0.051	39.62	66.19	0.095	1.86
19.193	0.88	0.06	0.97	1.0	0.051	38.90	63.43	0.092	1.79
19.357	0.88	0.05	0.97	1.0	0.051	36.94	55.88	0.083	1.63
19.521	0.88	0.05	0.97	1.0	0.051	35.88	52.52	0.080	1.56
19.685	0.88	0.05	0.97	1.0	0.051	35.92	52.66	0.080	1.56
19.849	0.88	0.05	0.97	1.0	0.051	37.61	58.44	0.086	1.67
20.013	0.88	0.05	0.97	1.0	0.052	37.29	57.20	0.085	1.65
20.177	0.87	0.05	0.97	1.0	0.052	38.20	60.73	0.089	1.72
20.341	0.87	0.05	0.97	1.0	0.052	37.57	58.30	0.086	1.66

Liquefaction Triggering Analyses — Youd et al. (2001)

Depth at time of CPT (ft)	Cyclic Stress Ratio r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
17.388	0.94	0.23	0.80	1.10	1.0	0.037	4.41	72.07	0.115	4.56	3.07	2
17.552	0.94	0.22	0.80	1.10	1.0	0.038	4.99	75.30	0.120	4.70	3.12	2
17.716	0.94	0.23	0.80	1.10	1.0	0.038	4.77	73.31	0.117	4.53	3.04	2
17.880	0.93	0.23	0.80	1.10	1.0	0.038	4.50	68.48	0.110	4.22	2.88	2
18.044	0.93	0.23	0.80	1.10	1.0	0.038	4.03	62.94	0.103	3.92	2.74	2
18.208	0.93	0.22	0.80	1.10	1.0	0.038	5.27	75.69	0.120	4.53	3.02	2
18.372	0.93	0.23	0.80	1.09	1.0	0.038	4.95	81.19	0.130	4.83	3.20	2
18.537	0.93	0.24	0.80	1.09	1.0	0.039	5.08	88.30	0.144	5.31	3.45	2
18.701	0.93	0.26	0.80	1.09	1.0	0.039	4.13	82.75	0.133	4.84	3.25	2
18.865	0.93	0.30	0.80	1.09	1.0	0.039	2.32	63.52	0.104	3.75	2.82	2
19.029	0.93	0.30	0.80	1.09	1.0	0.039	2.50	66.55	0.107	3.83	2.85	2
19.193	0.93	0.29	0.80	1.08	1.0	0.039	2.72	66.83	0.108	3.80	2.80	2
19.357	0.93	0.25	0.80	1.08	1.0	0.039	3.56	67.47	0.109	3.79	2.71	2
19.521	0.93	0.24	0.80	1.08	1.0	0.040	4.40	73.27	0.117	4.03	2.79	2
19.685	0.93	0.24	0.80	1.08	1.0	0.040	4.57	76.54	0.122	4.17	2.86	2
19.849	0.93	0.26	0.80	1.08	1.0	0.040	3.36	70.06	0.112	3.80	2.74	2
20.013	0.93	0.26	0.80	1.08	1.0	0.040	3.31	65.95	0.107	3.58	2.61	2
20.177	0.93	0.27	0.80	1.08	1.0	0.040	2.84	63.94	0.104	3.47	2.59	2
20.341	0.93	0.26	0.80	1.07	1.0	0.040	3.15	65.23	0.106	3.49	2.58	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.347

Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
8.35	500	1.8E-03	4.4E+02	3.4E-04	16	0.478	5582	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.65%	0.0044
8.40	500	1.8E-03	4.4E+02	3.4E-04	16	0.478	5575	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.69%	0.0044
8.45	500	1.8E-03	4.4E+02	3.5E-04	16	0.478	5569	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.72%	0.0045
8.50	500	1.8E-03	4.4E+02	3.5E-04	16	0.478	5563	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.75%	0.0045
8.55	500	1.8E-03	4.6E+02	3.3E-04	10	0.227	6742	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.33%	0.0038
8.60	500	1.8E-03	4.4E+02	3.5E-04	16	0.479	5550	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.82%	0.0046
8.65	500	1.8E-03	4.4E+02	3.5E-04	16	0.479	5544	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.86%	0.0047
8.70	500	1.8E-03	4.4E+02	3.6E-04	16	0.479	5538	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.89%	0.0047
8.75	500	1.8E-03	4.4E+02	3.6E-04	16	0.479	5532	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.92%	0.0048
8.80	500	1.8E-03	4.6E+02	3.4E-04	10	0.228	6704	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.49%	0.0041
8.85	500	1.8E-03	4.6E+02	3.4E-04	10	0.228	6696	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.52%	0.0041
8.90	500	1.8E-03	4.6E+02	3.5E-04	10	0.228	6687	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.56%	0.0042
8.95	500	1.8E-03	4.6E+02	3.5E-04	10	0.229	6679	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.59%	0.0043
9.00	500	1.8E-03	4.4E+02	3.7E-04	16	0.480	5499	0.12%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.10%	0.0051
9.05	538	1.8E-03	5.1E+02	3.2E-04	16	0.480	5493	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.24%	0.0037
9.10	538	1.8E-03	5.3E+02	3.1E-04	10	0.229	6657	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.85%	0.0030
9.15	538	1.8E-03	5.3E+02	3.1E-04	10	0.229	6649	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.88%	0.0031
9.20	538	1.8E-03	5.3E+02	3.1E-04	10	0.229	6641	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.91%	0.0031
9.25	538	1.8E-03	5.3E+02	3.1E-04	10	0.230	6633	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.93%	0.0032
9.86	538	1.8E-03	5.3E+02	3.3E-04	10	0.233	6489	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.24%	0.0447

Extra layer added to analyze seismic settlement of tailings below the bottom of CPT investigation.

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W3

Data File:	13-52106_SP2W3-BSC-CPT
Location:	White Mesa 2013 CPT Investigation
	..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da
	Tailings Sands
	Tailings Sand-Slimes
	Tailings Slimes
	Interim Cover
	Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5613.80	Water surface elevation during CPT investigation (ft amsl)
5607.44	Water surface elevation at t_0 (ft amsl)
5597.74	Water surface elevation at t_1 (ft amsl)
5592.74	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ratio, r_α
0.47	Volumetric Strain Ratio for Site-Specific Design Ea
7.51	Equiv. Number of Uniform Strain Cycles, N

5615.72	Ground Surface Elevation at time of CPT (ft amsl)
5626.27	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after plac
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
2.55	Thickness of Random/Platform Fill on top of existing interim cover (ft)
1164.98	Additional Stress due to Final Cover Placement, $\Delta\sigma_c$ (psf)
5592.74	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5626.02	5625.77	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5624.02	5622.27	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5620.27	5618.27	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334	1.83	508	1.9E-03	4.8E+02	6.8E-05	11	0.153	12419	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######	5617	5615.72	2.55	0.050	101	0.582	0.518	0.00	0.00	0.582	0.518	2.83	508	1.6E-03	4.0E+02	1.3E-04	11	0.172	10354	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec — CPT Data Interpretations — Conditions at t_1 — Liquefaction Triggering Analyses (Idriss & Boulanger (2008); Youd et al. (2001)) — Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.363

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined)
0.164	5615.56	7.7	0.125	7.7	1.9	0.82	1.62%	Interim Cover
0.328	5615.39	34.3	0.207	34.2	7.6	3.28	0.60%	Interim Cover
0.492	5615.23	60.2	0.548	60.2	5.7	2.48	0.91%	Interim Cover
0.656	5615.06	93.8	1.118	93.8	6.5	2.81	1.19%	Interim Cover
0.820	5614.90	158.1	1.774	158.0	7.2	3.13	1.12%	Interim Cover
0.984	5614.74	233.5	2.580	233.4	9.6	4.17	1.11%	Interim Cover
1.148	5614.57	321.1	3.237	321.1	4.7	2.05	1.01%	Interim Cover
1.312	5614.41	348.1	3.834	348.0	7.5	3.25	1.10%	Interim Cover
1.476	5614.24	325.9	3.960	325.9	6.7	2.88	1.22%	Interim Cover
1.640	5614.08	280.6	3.998	280.6	6.9	3.01	1.42%	Interim Cover
1.804	5613.92	244.2	3.918	244.1	3.6	1.54	1.60%	Interim Cover
1.968	5613.75	208.3	4.496	208.3	3.0	1.30	2.16%	Interim Cover
2.133	5613.59	171.3	4.306	171.3	1.4	0.62	2.51%	Interim Cover
2.297	5613.42	146.4	3.625	146.4	0.5	0.21	2.48%	Interim Cover
2.461	5613.26	130.5	2.022	130.5	-0.0	-0.01	1.55%	Interim Cover
2.625	5613.10	117.5	1.895	117.5	0.5	0.22	1.61%	Interim Cover
2.789	5612.93	87.2	1.616	87.2	-0.2	-0.08	1.85%	Interim Cover
2.953	5612.77	56.6	1.213	56.6	-0.3	-0.11	2.14%	Interim Cover
3.117	5612.60	41.8	0.990	41.8	-0.7	-0.32	2.37%	Interim Cover
3.281	5612.44	29.4	0.781	29.4	-1.4	-0.59	2.66%	Sand-Slime Tailings
3.445	5612.28	24.9	0.524	24.9	-1.2	-0.53	2.10%	Sand-Slime Tailings
3.609	5612.11	21.4	0.387	21.4	-1.7	-0.72	1.81%	Sand-Slime Tailings
3.773	5611.95	13.1	0.327	13.2	-2.1	-0.91	2.49%	Slime Tailings
3.937	5611.78	9.9	0.171	10.0	-1.5	-0.64	1.72%	Sand-Slime Tailings
4.101	5611.62	9.9	0.106	9.9	1.7	0.74	1.07%	Sand-Slime Tailings
4.265	5611.45	13.3	0.031	13.3	3.7	1.60	0.23%	Sand-Slime Tailings
4.429	5611.29	10.7	0.042	10.7	2.1	0.90	0.39%	Sand-Slime Tailings
4.593	5611.13	8.5	0.048	8.4	6.1	2.62	0.57%	Sand-Slime Tailings
4.757	5610.96	7.9	0.031	7.8	13.0	5.65	0.39%	Sand-Slime Tailings
4.921	5610.80	7.2	0.093	7.1	20.3	8.78	1.30%	Slime Tailings
5.085	5610.63	7.1	0.130	7.0	25.9	11.21	1.82%	Slime Tailings
5.249	5610.47	8.4	0.108	8.2	23.7	10.28	1.29%	Sand-Slime Tailings
5.413	5610.31	18.2	0.125	18.1	15.6	6.76	0.69%	Sand-Slime Tailings
5.577	5610.14	20.7	0.144	20.7	2.2	0.94	0.69%	Sand-Slime Tailings
5.741	5609.98	20.9	0.185	20.9	1.2	0.52	0.89%	Sand-Slime Tailings
5.905	5609.81	17.0	0.216	17.0	-0.2	-0.07	1.27%	Sand-Slime Tailings
6.069	5609.65	16.4	0.222	16.4	0.0	0.01	1.35%	Sand-Slime Tailings
6.234	5609.49	12.5	0.167	12.5	0.5	0.23	1.33%	Sand-Slime Tailings
6.398	5609.32	11.4	0.156	11.4	5.1	2.22	1.37%	Sand-Slime Tailings
6.562	5609.16	8.9	0.092	8.8	14.8	6.41	1.03%	Sand-Slime Tailings
6.726	5608.99	7.1	0.054	7.0	16.9	7.31	0.76%	Sand-Slime Tailings
6.890	5608.83	6.9	0.094	6.8	23.9	10.34	1.36%	Slime Tailings
7.054	5608.67	6.6	0.021	6.4	33.6	14.56	0.32%	Sand-Slime Tailings
7.218	5608.50	8.6	0.044	8.4	29.9	12.94	0.51%	Sand-Slime Tailings
7.382	5608.34	6.9	0.052	6.7	30.0	13.02	0.75%	Sand-Slime Tailings
7.546	5608.17	6.5	0.057	6.3	35.9	15.54	0.88%	Slime Tailings
7.710	5608.01	7.0	0.066	6.9	29.2	12.65	0.94%	Sand-Slime Tailings
7.874	5607.85	6.7	0.068	6.5	36.4	15.76	1.02%	Slime Tailings
8.038	5607.68	7.0	0.101	6.8	40.5	17.55	1.44%	Slime Tailings
8.202	5607.52	7.2	0.053	7.0	32.9	14.27	0.74%	Sand-Slime Tailings
8.366	5607.35	8.3	0.060	8.1	33.6	14.56	0.72%	Sand-Slime Tailings
8.530	5607.19	8.4	0.039	8.2	29.3	12.71	0.47%	Sand-Slime Tailings
8.694	5607.03	9.0	0.046	8.9	16.0	6.93	0.51%	Sand-Slime Tailings
8.858	5606.86	8.9	0.043	8.8	19.3	8.37	0.48%	Sand-Slime Tailings
9.022	5606.70	9.0	0.081	8.9	11.3	4.91	0.90%	Sand-Slime Tailings
9.186	5606.53	10.5	0.074	10.5	12.7	5.50	0.70%	Sand-Slime Tailings
9.350	5606.37	8.8	0.087	8.8	6.6	2.84	0.98%	Sand-Slime Tailings
9.514	5606.21	6.8	0.122	6.7	23.8	10.30	1.78%	Slime Tailings
9.678	5606.04	8.3	0.124	8.0	40.2	17.44	1.50%	Slime Tailings
9.842	5605.88	13.0	0.032	12.8	32.9	14.24	0.25%	Sand-Slime Tailings
10.006	5605.71	14.0	0.141	13.9	7.1	3.09	1.01%	Sand-Slime Tailings
10.170	5605.55	8.3	0.114	8.2	6.4	2.78	1.38%	Sand-Slime Tailings
10.335	5605.39	8.7	0.102	8.7	10.1	4.39	1.17%	Sand-Slime Tailings
10.499	5605.22	23.1	0.120	23.1	9.6	4.17	0.52%	Sand-Slime Tailings
10.663	5605.06	24.0	0.124	23.9	8.7	3.75	0.52%	Sand-Slime Tailings
10.827	5604.89	25.3	0.175	25.3	8.6	3.72	0.69%	Sand-Slime Tailings
10.991	5604.73	28.0	0.202	28.0	8.4	3.62	0.72%	Sand-Slime Tailings
11.155	5604.57	24.5	0.216	24.4	7.8	3.38	0.88%	Sand-Slime Tailings
11.319	5604.40	20.2	0.227	20.2	7.1	3.09	1.12%	Sand-Slime Tailings
11.483	5604.24	17.7	0.281	17.6	7.2	3.11	1.59%	Sand-Slime Tailings
11.647	5604.07	17.7	0.326	17.7	8.6	3.74	1.84%	Sand-Slime Tailings
11.811	5603.91	20.4	0.539	20.3	13.1	5.69	2.65%	Sand-Slime Tailings
11.975	5603.75	17.7	0.579	17.6	13.2	5.71	3.27%	Slime Tailings
12.139	5603.58	11.5	0.499	11.4	15.5	6.73	4.33%	Slime Tailings
12.303	5603.42	10.9	0.321	10.7	30.3	13.15	2.94%	Slime Tailings
12.467	5603.25	10.3	0.339	10.0	56.2	24.35	3.28%	Slime Tailings
12.631	5603.09	8.7	0.195	8.6	16.5	7.14	2.25%	Slime Tailings
12.795	5602.92	9.5	0.203	9.3	29.1	12.59	2.13%	Slime Tailings
12.959	5602.76	8.1	0.206	7.9	33.3	14.44	2.53%	Slime Tailings
13.123	5602.60	7.2	0.183	6.9	46.1	19.99	2.54%	Slime Tailings
13.287	5602.43	10.7	0.106	10.4	37.6	16.29	0.99%	Sand-Slime Tailings
13.451	5602.27	16.7	0.102	16.7	10.8	4.70	0.61%	Sand-Slime Tailings
13.615	5602.10	17.2	0.121	17.1	10.8	4.69	0.70%	Sand-Slime Tailings
13.779	5601.94	17.2	0.165	17.1	13.8	5.99	0.96%	Sand-Slime Tailings
13.943	5601.78	17.7	0.203	17.6	15.3	6.65	1.15%	Sand-Slime Tailings
14.107	5601.61	19.0	0.286	18.9	16.8	7.30	1.50%	Sand-Slime Tailings
14.271	5601.45	18.8	0.300	18.7	17.6	7.62	1.59%	Sand-Slime Tailings
14.436	5601.28	21.0	0.318	20.9	18.2	7.88	1.51%	Sand-Slime Tailings
14.600	5601.12	18.5	0.163	18.5	9.1	3.93	0.88%	Sand-Slime Tailings
14.764	5600.96	15.4	0.117	15.4	3.3	1.43	0.76%	Sand-Slime Tailings
14.928	5600.79	12.2	0.162	12.2	9.3	4.03	1.32%	Sand-Slime Tailings
15.092	5600.63	11.5	0.194	11.3	27.6	11.96	1.69%	Sand-Slime Tailings
15.256	5600.46	10.0	0.206	9.9	14.5	6.29	2.06%	Slime Tailings
15.420	5600.30	8.6	0.137	8.4	31.8	13.77	1.60%	Slime Tailings
15.584	5600.14	9.3	0.108	9.1	29.9	12.95	1.16%	Sand-Slime Tailings
15.748	5599.97	8.4	0.114	8.2	29.4	12.75	1.36%	Sand-Slime Tailings
15.912	5599.81	7.3	0.150	7.0	43.6	18.89	2.07%	Slime Tailings
16.076	5599.64	6.8	0.155	6.5	59.5	25.76	2.27%	Slime Tailings
16.240	5599.48	6.4	0.150	6.0	55.9	24.23	2.36%	Slime Tailings
16.404	5599.32	6.2	0.155	5.8	62.4	27.06	2.49%	Slime Tailings
16.568	5599.15	6.4	0.156	6.0	61.6	26.67	2.43%	Slime Tailings
16.732	5598.99	6.5	0.127	6.1	59.1	25.59	1.96%	Slime Tailings
16.896	5598.82	6.4	0.116	6.1	51.0	22.11	1.81%	Slime Tailings
17.060	5598.66	5.5	0.121	5.1	60.9	26.40	2.22%	Slime Tailings
17.224	5598.50	5.3	0.143	4.9	60.8	26.34	2.71%	Slime Tailings

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W3

Data File: 13-52106_SP2W3-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Dat

Legend:
- Tailings Sands
- Tailings Sand-Slimes
- Tailings Slimes
- Interim Cover
- Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5613.80	Water surface elevation during CPT investigation (ft
5607.44	Water surface elevation at t_0 (ft amsl)
5597.74	Water surface elevation at t_1 (ft amsl)
5592.74	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ear
7.51	Equiv. Number of Uniform Strain Cycles, N

Value	Parameter
5615.72	Ground Surface Elevation at time of CPT (ft amsl)
5626.27	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after plac
3.50	Thickness of Water Storage/Rooting Zone Layer (ft)
4.00	Thickness of High Compaction Layer (ft)
2.55	Thickness of Random/Platform Fill on top of existing interim cover (ft)
1164.98	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5592.74	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5626.02	5625.77	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5624.02	5622.27	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5620.27	5618.27	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334	1.83	508	1.9E-03	4.8E+02	6.8E-05	11	0.153	12419	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######	5617	5615.72	2.55	0.050	101	0.582	0.518	0.00	0.00	0.582	0.518	2.83	508	1.6E-03	4.0E+02	1.3E-04	11	0.172	10354	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
17.388	5598.33	5.4	0.167	5.0	60.4	26.17	3.09%	Slime Tailings	0.057	113.1	0.99	0.48	0.51	1	1.51	7.567	105.17	9.45	9	3.79%	3.1	71%	1.57	0.00	1.57	0
17.552	5598.17	8.1	0.153	7.8	49.8	21.59	1.90%	Slime Tailings	0.057	113.1	1.00	0.49	0.51	1	1.50	11.622	161.55	14.04	14	2.16%	2.8	71%	1.58	0.00	1.58	0
17.716	5598.00	12.1	0.146	11.9	23.4	10.13	1.21%	Sand-Slime Tailin	0.059	119.0	1.01	0.49	0.52	1	1.49	17.713	246.21	20.82	21	1.32%	2.5	47%	1.59	0.00	1.59	0
17.880	5597.84	14.1	0.132	14.0	21.9	9.47	0.94%	Sand-Slime Tailin	0.059	119.0	1.02	0.50	0.52	1	1.46	20.417	283.79	23.94	25	1.01%	2.4	47%	1.60	0.00	1.60	0
18.044	5597.68	14.0	0.074	13.9	17.3	7.51	0.53%	Sand-Slime Tailin	0.059	119.0	1.03	0.50	0.53	1	1.45	20.197	280.74	23.64	25	0.57%	2.3	47%	1.61	0.00	1.61	1
18.208	5597.51	11.8	0.070	11.7	17.2	7.43	0.59%	Sand-Slime Tailin	0.059	119.0	1.04	0.51	0.53	1	1.46	16.985	236.10	19.91	20	0.65%	2.4	47%	1.62	0.01	1.62	1
18.372	5597.35	9.1	0.178	8.9	23.4	10.12	1.96%	Slime Tailings	0.057	113.1	1.05	0.51	0.54	1	1.45	12.930	179.72	15.26	15	2.22%	2.8	71%	1.63	0.01	1.62	1
18.537	5597.18	6.8	0.214	6.6	44.6	19.31	3.12%	Slime Tailings	0.057	113.1	1.06	0.52	0.54	1	1.44	9.455	131.43	11.45	11	3.70%	3.0	71%	1.64	0.02	1.62	1
18.701	5597.02	12.2	0.207	12.1	17.2	7.44	1.70%	Sand-Slime Tailin	0.059	119.0	1.07	0.52	0.55	1	1.43	17.226	239.45	20.19	20	1.87%	2.6	47%	1.65	0.02	1.63	1
18.865	5596.86	12.4	0.172	12.2	21.3	9.23	1.39%	Sand-Slime Tailin	0.059	119.0	1.08	0.53	0.55	1	1.42	17.382	241.62	20.41	21	1.52%	2.6	47%	1.66	0.03	1.63	1
19.029	5596.69	14.4	0.138	14.3	22.3	9.64	0.96%	Sand-Slime Tailin	0.059	119.0	1.09	0.53	0.55	1	1.40	20.001	278.01	23.46	24	1.04%	2.4	47%	1.67	0.03	1.64	1
19.193	5596.53	15.7	0.130	15.6	20.8	8.99	0.83%	Sand-Slime Tailin	0.059	119.0	1.10	0.54	0.56	1	1.39	21.538	299.38	25.22	26	0.89%	2.4	47%	1.68	0.04	1.64	1
19.357	5596.36	16.7	0.123	16.5	23.1	9.99	0.74%	Sand-Slime Tailin	0.059	119.0	1.11	0.54	0.56	1	1.37	22.650	314.83	26.54	28	0.79%	2.3	47%	1.69	0.04	1.65	1
19.521	5596.20	16.7	0.112	16.5	24.3	10.52	0.67%	Sand-Slime Tailin	0.059	119.0	1.12	0.55	0.57	1	1.36	22.519	313.02	26.39	27	0.72%	2.3	47%	1.70	0.05	1.65	1
19.685	5596.04	16.2	0.142	16.1	26.1	11.31	0.88%	Sand-Slime Tailin	0.059	119.0	1.13	0.55	0.57	1	1.36	21.815	303.23	25.59	26	0.94%	2.4	47%	1.71	0.05	1.66	1
19.849	5595.87	13.7	0.203	13.5	30.3	13.14	1.48%	Sand-Slime Tailin	0.059	119.0	1.14	0.56	0.58	1	1.36	18.424	256.09	21.70	22	1.62%	2.6	47%	1.72	0.06	1.66	1
20.013	5595.71	9.9	0.190	9.6	41.6	18.02	1.92%	Slime Tailings	0.057	113.1	1.15	0.56	0.58	1	1.36	13.071	181.68	15.59	15	2.18%	2.8	71%	1.73	0.06	1.67	1
20.177	5595.54	8.7	0.172	8.3	65.6	28.43	1.98%	Slime Tailings	0.057	113.1	1.16	0.57	0.59	1	1.35	11.187	155.51	13.64	13	2.28%	2.8	71%	1.74	0.07	1.67	1
20.341	5595.38	8.9	0.207	8.5	67.9	29.41	2.32%	Slime Tailings	0.057	113.1	1.16	0.57	0.59	1	1.34	11.394	158.38	13.90	13	2.67%	2.9	71%	1.75	0.07	1.67	1
20.505	5595.22	9.3	0.168	8.9	65.7	28.45	1.81%	Slime Tailings	0.057	113.1	1.17	0.58	0.59	1	1.34	11.840	164.57	14.39	14	2.08%	2.8	71%	1.76	0.08	1.68	1
20.669	5595.05	12.9	0.090	12.6	43.1	18.67	0.70%	Sand-Slime Tailin	0.059	119.0	1.18	0.58	0.60	1	1.33	16.762	232.99	19.88	20	0.77%	2.4	47%	1.77	0.08	1.68	1
20.833	5594.89	13.2	0.156	13.1	27.5	11.92	1.18%	Sand-Slime Tailin	0.059	119.0	1.19	0.59	0.60	1	1.32	17.242	239.67	20.29	20	1.30%	2.5	47%	1.78	0.09	1.69	1
20.997	5594.72	9.7	0.180	9.2	68.8	29.83	1.86%	Slime Tailings	0.057	113.1	1.20	0.60	0.61	1	1.31	12.134	168.66	14.75	14	2.13%	2.8	71%	1.79	0.09	1.69	1
21.161	5594.56	9.1	0.158	8.5	91.2	39.53	1.73%	Slime Tailings	0.057	113.1	1.21	0.60	0.61	1	1.31	11.155	155.05	13.82	13	2.00%	2.8	71%	1.79	0.10	1.70	1
21.325	5594.39	9.1	0.173	8.5	87.2	37.78	1.90%	Slime Tailings	0.057	113.1	1.22	0.61	0.62	1	1.30	11.096	154.23	13.71	13	2.20%	2.8	71%	1.80	0.10	1.70	1
21.489	5594.23	10.0	0.173	9.4	103.1	44.66	1.73%	Sand-Slime Tailin	0.059	119.0	1.23	0.61	0.62	1	1.29	12.116	168.41	15.04	14	1.97%	2.8	47%	1.81	0.11	1.70	1
21.653	5594.07	11.1	0.173	10.5	102.2	44.29	1.56%	Sand-Slime Tailin	0.059	119.0	1.24	0.62	0.63	1	1.28	13.420	186.53	16.54	16	1.76%	2.7	47%	1.82	0.11	1.71	1
22.980	5592.74							Sand-Slime Tailin	0.059	119.0													1.90	0.14	1.77	1

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	I&B r_d	I&B C_σ	I&B K_σ	I&B K_α	I&B CSR M=7.5, s'v=1atm	Δqc_{1n}	qc_{1n-cs}	I&B (CRR) M=7.5, s'v=1atm	I&B FoS	Youd r_d	D_r	f	Youd K_σ	Youd K_α	Youd CSR M=7.5, s'v=1atm	Kc	Youd qc_{1n-cs}	Youd (CRR) M=7.5, s'v=1atm	Youd FoS	Avg FoS	Liquefiable? 1=Yes 2=No
17.388	0.90	0.04	0.97	1.0	0.050	33.38	42.83	0.071	1.41	0.93	0.18	0.80	1.11	1.0	0.037	8.01	75.70	0.120	4.93	3.17	2
17.552	0.90	0.05	0.97	1.0	0.050	34.98	49.02	0.077	1.52	0.93	0.22	0.80	1.11	1.0	0.037	4.80	67.46	0.109	4.42	2.97	2
17.716	0.89	0.05	0.97	1.0	0.050	37.61	58.43	0.086	1.72	0.93	0.26	0.80	1.11	1.0	0.037	2.91	60.54	0.101	4.06	2.89	2
17.880	0.89	0.06	0.97	1.0	0.050	38.70	62.64	0.091	1.82	0.93	0.28	0.80	1.10	1.0	0.037	2.34	56.01	0.096	3.85	2.84	2
18.044	0.89	0.05	0.97	1.0	0.050	38.59	62.23	0.090	1.81	0.93	0.28	0.80	1.10	1.0	0.037	1.94	45.86	0.088	3.49	2.65	2
18.208	0.89	0.05	0.97	1.0	0.050	37.28	57.19	0.085	1.70	0.93	0.26	0.80	1.10	1.0	0.038	2.31	46.04	0.088	3.46	2.58	2
18.372	0.89	0.05	0.97	1.0	0.050	35.40	50.66	0.078	1.56	0.93	0.23	0.80	1.10	1.0	0.038	4.60	70.24	0.112	4.35	2.95	2
18.537	0.89	0.05	0.97	1.0	0.050	34.07	45.52	0.073	1.46	0.93	0.20	0.80	1.10	1.0	0.038	7.03	80.43	0.128	4.92	3.19	2
18.701	0.89	0.05	0.97	1.0	0.050	37.38	57.57	0.085	1.70	0.93	0.26	0.80	1.10	1.0	0.038	3.49	70.44	0.113	4.27	2.98	2
18.865	0.89	0.05	0.97	1.0	0.050	37.46	57.87	0.086	1.70	0.93	0.26	0.80	1.09	1.0	0.038	3.17	64.62	0.105	3.94	2.82	2
19.029	0.88	0.05	0.96	1.0	0.050	38.53	61.98	0.090	1.79	0.93	0.28	0.80	1.09	1.0	0.038	2.42	56.88	0.097	3.60	2.70	2
19.193	0.88	0.06	0.96	1.0	0.050	39.15	64.37	0.093	1.84	0.93	0.29	0.80	1.09	1.0	0.039	2.17	54.73	0.095	3.49	2.67	2
19.357	0.88	0.06	0.96	1.0	0.050	39.61	66.14	0.095	1.88	0.93	0.30	0.80	1.09	1.0	0.039	2.00	53.20	0.094	3.41	2.65	2
19.521	0.88	0.06	0.96	1.0	0.050	39.56	65.95	0.095	1.88	0.93	0.30	0.80	1.09	1.0	0.039	1.95	51.52	0.093	3.33	2.60	2
19.685	0.88	0.06	0.96	1.0	0.051	39.28	64.87	0.093	1.85	0.93	0.29	0.80	1.08	1.0	0.039	2.20	56.30	0.097	3.44	2.64	2
19.849	0.88	0.05	0.96	1.0	0.051	37.91	59.61	0.087	1.73	0.93	0.27	0.80	1.08	1.0	0.039	3.13	67.89	0.109	3.85	2.79	2
20.013	0.88	0.05	0.97	1.0	0.051	35.52	51.11	0.079	1.54	0.93	0.23	0.80	1.08	1.0	0.039	4.55	71.01	0.113	3.96	2.75	2
20.177	0.87	0.05	0.97	1.0	0.051	34.84	48.47	0.076	1.49	0.92	0.21	0.80	1.08	1.0	0.039	5.13	70.00	0.112	3.88	2.68	2
20.341	0.87	0.05	0.97	1.0	0.051	34.93	48.82	0.076	1.50	0.92	0.22	0.80	1.08	1.0	0.039	5.43	75.40	0.120	4.12	2.81	2
20.505	0.87	0.05	0.97	1.0	0.051	35.10	49.49	0.077	1.51	0.92	0.22	0.80	1.08	1.0	0.039	4.75	68.35	0.110	3.74	2.62	2
20.669	0.87	0.05	0.96	1.0	0.051	37.27	57.16	0.085	1.66	0.92	0.26	0.80	1.08	1.0	0.040	2.50	49.68	0.091	3.09	2.37	2
20.833	0.87	0.05	0.96	1.0	0.051	37.42	57.71	0.085	1.67	0.92	0.26	0.80	1.07	1.0	0.040	3.02	61.18	0.101	3.39	2.53	2
20.997	0.87	0.05	0.97	1.0	0.051	35.22	49.97	0.077	1.51	0.92	0.22	0.80	1.07	1.0	0.040	4.73	69.77	0.112	3.70	2.61	2
21.161	0.87	0.05	0.97	1.0	0.051	34.90	48.72	0.076	1.49	0.92	0.21	0.80	1.07	1.0	0.040	4.84	66.95	0.108	3.55	2.52	2
21.325	0.87	0.05	0.97	1.0	0.051	34.86	48.57	0.076	1.48	0.91	0.21	0.80	1.07	1.0	0.040	5.08	69.61	0.111	3.64	2.56	2
21.489	0.86	0.05	0.97	1.0	0.051	35.58	50.61	0.078	1.52	0.91	0.22	0.80	1.07	1.0	0.040	4.53	68.09	0.109	3.54	2.53	2
21.653	0.86	0.05	0.97	1.0	0.051	36.10	52.64	0.080	1.56	0.91	0.23	0.80	1.07	1.0	0.040	4.02	66.55	0.107	3.45	2.50	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.363

Depth at time of CPT (ft)	Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
17.388	8.52	500	1.8E-03	4.4E+02	3.5E-04	16	0.479	5525	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.77%	0.0045
17.552	8.57	500	1.8E-03	4.4E+02	3.5E-04	16	0.479	5512	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.79%	0.0046
17.716	8.62	500	1.8E-03	4.6E+02	3.4E-04	10	0.229	6670	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.37%	0.0039
17.880	8.67	500	1.8E-03	4.6E+02	3.4E-04	10	0.229	6653	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.40%	0.0039
18.044	8.72	500	1.8E-03	4.6E+02	3.4E-04	10	0.229	6640	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.43%	0.0040
18.208	8.77	500	1.8E-03	4.6E+02	3.4E-04	10	0.230	6632	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.46%	0.0040
18.372	8.82	500	1.8E-03	4.4E+02	3.6E-04	16	0.481	5461	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.96%	0.0049
18.537	8.87	500	1.8E-03	4.4E+02	3.6E-04	16	0.481	5455	0.11%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	2.99%	0.0049
18.701	8.92	500	1.8E-03	4.6E+02	3.4E-04	10	0.230	6610	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.56%	0.0042
18.865	8.97	500	1.8E-03	4.6E+02	3.5E-04	10	0.230	6603	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.59%	0.0043
19.029	9.02	500	1.8E-03	4.6E+02	3.5E-04	10	0.230	6595	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.63%	0.0043
19.193	9.07	500	1.8E-03	4.6E+02	3.5E-04	10	0.230	6587	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.66%	0.0044
19.357	9.12	500	1.8E-03	4.6E+02	3.6E-04	10	0.231	6579	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.69%	0.0044
19.521	9.17	500	1.8E-03	4.6E+02	3.6E-04	10	0.231	6572	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.73%	0.0045
19.685	9.22	538	1.8E-03	5.3E+02	3.1E-04	10	0.231	6564	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.91%	0.0031
19.849	9.27	538	1.8E-03	5.3E+02	3.1E-04	10	0.231	6556	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.94%	0.0032
20.013	9.32	538	1.8E-03	5.1E+02	3.3E-04	16	0.482	5399	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.38%	0.0039
20.177	9.37	538	1.8E-03	5.1E+02	3.3E-04	16	0.482	5394	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.41%	0.0039
20.341	9.42	538	1.8E-03	5.1E+02	3.3E-04	16	0.483	5388	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.43%	0.0040
20.505	9.47	538	1.8E-03	5.1E+02	3.4E-04	16	0.483	5383	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.46%	0.0040
20.669	9.52	538	1.8E-03	5.3E+02	3.2E-04	10	0.232	6522	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.06%	0.0034
20.833	9.57	538	1.8E-03	5.3E+02	3.2E-04	10	0.232	6514	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.09%	0.0034
20.997	9.62	538	1.8E-03	5.1E+02	3.4E-04	16	0.483	5365	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.54%	0.0042
21.161	9.67	538	1.8E-03	5.1E+02	3.4E-04	16	0.483	5360	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.57%	0.0042
21.325	9.72	538	1.8E-03	5.1E+02	3.5E-04	16	0.483	5354	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.60%	0.0043
21.489	9.77	538	1.8E-03	5.3E+02	3.3E-04	10	0.233	6487	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.19%	0.0036
21.653	9.82	538	1.8E-03	5.3E+02	3.3E-04	10	0.233	6480	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.22%	0.0036
22.980	10.22	538	1.8E-03	5.3E+02	3.5E-04	10	0.235	6391	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.43%	0.0322

Extra layer added to analyze seismic settlement of tailings below the bottom of CPT investigation.

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W4-C

Data File: 13-52106_SP2W4-C-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5611.20	Water surface elevation during CPT investigation (ft amsl)
5607.96	Water surface elevation at t_0 (ft amsl)
5593.50	Water surface elevation at t_1 (ft amsl)
5588.50	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earthq
7.51	Equiv. Number of Uniform Strain Cycles, N
5616.24	Ground Surface Elevation at time of CPT (ft amsl)
5626.19	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
1.95	Thickness of Random/Platform Fill on top of existing interim cover (ft)
1104.55	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5588.50	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max})	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	5626.19	5625.94	5625.69	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	5625.69	5623.94	5622.19	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	5622.19	5620.19	5618.19	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334	1.83	508	1.9E-03	4.8E+02	6.8E-05	11	0.153	12419	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	5618.19	5617.22	5616.24	1.95	0.050	101	0.552	0.503	0.00	0.00	0.552	0.503	2.74	508	1.6E-03	4.0E+02	1.2E-04	11	0.170	10482	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q	Normalized Friction Ratio, F (%)	Soil Behavior Type Index, Ic	FC %	Total Stress at t_1 (tsf)	Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
0.164	5616.08	20.1	0.057	20.0	8.1	3.50	0.28%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	34.068	473.55	39.67	2431	0.28%	0.7	51%	0.56	0.00	0.56	0
0.328	5615.91	44.3	0.080	44.3	3.0	1.28	0.18%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	75.242	1045.86	87.43	2679	0.18%	0.5	51%	0.57	0.00	0.57	0
0.492	5615.75	56.7	0.160	56.7	4.6	1.97	0.28%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	96.373	1339.58	111.99	2287	0.28%	0.7	51%	0.58	0.00	0.58	0
0.656	5615.58	59.2	0.227	59.2	1.6	0.69	0.38%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	100.708	1399.84	116.99	1792	0.38%	0.8	51%	0.59	0.00	0.59	0
0.820	5615.42	57.7	0.368	57.7	1.8	0.79	0.64%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	98.107	1363.69	113.97	1396	0.64%	1.1	51%	0.59	0.00	0.59	0
0.984	5615.26	76.8	0.959	76.8	3.0	1.30	1.25%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	130.509	1814.08	151.62	1548	1.25%	1.3	51%	0.60	0.00	0.60	0
1.148	5615.09	85.7	0.894	85.6	3.7	1.58	1.04%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	145.571	2023.44	169.12	1480	1.04%	1.3	51%	0.61	0.00	0.61	0
1.312	5614.93	82.5	0.999	82.4	17.4	7.54	1.21%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	140.046	1946.64	162.87	1247	1.21%	1.4	51%	0.62	0.00	0.62	0
1.476	5614.76	93.6	0.450	93.6	0.8	0.34	0.48%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	159.120	2211.77	184.82	1258	0.48%	1.0	51%	0.63	0.00	0.63	0
1.640	5614.60	40.2	0.533	40.2	-0.8	-0.35	1.33%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	68.306	949.45	79.32	485	1.33%	1.6	51%	0.63	0.00	0.63	0
1.804	5614.44	69.8	0.650	69.8	3.2	1.40	0.93%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	118.609	1648.67	137.80	767	0.93%	1.3	51%	0.64	0.00	0.64	0
1.968	5614.27	139.8	1.194	139.8	6.7	2.90	0.85%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	237.575	3302.29	276.01	1409	0.85%	1.2	51%	0.65	0.00	0.65	0
2.133	5614.11	222.3	2.152	222.2	6.7	2.90	0.97%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	377.791	5251.29	438.86	2069	0.97%	1.2	51%	0.66	0.00	0.66	0
2.297	5613.94	246.8	3.608	246.8	4.8	2.07	1.46%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	419.082	5825.24	486.80	2133	1.46%	1.4	51%	0.67	0.00	0.67	0
2.461	5613.78	219.5	4.267	219.4	6.7	2.90	1.94%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.67	365.913	5086.19	425.07	1770	1.95%	1.5	51%	0.68	0.00	0.68	0
2.625	5613.62	178.9	4.079	179.0	-0.1	-0.03	2.28%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.64	293.386	4078.06	340.75	1353	2.28%	1.6	51%	0.68	0.00	0.68	0
2.789	5613.45	149.3	2.666	149.3	0.3	0.12	1.79%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0	1.61	240.810	3347.26	279.69	1062	1.79%	1.5	51%	0.69	0.00	0.69	0
2.953	5613.29	132.8	2.041	132.8	-0.3	-0.15	1.54%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0	1.61	213.554	2968.40	248.03	892	1.54%	1.5	51%	0.70	0.00	0.70	0
3.117	5613.12	92.1	1.817	92.1	2.6	1.12	1.97%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0	1.70	156.604	2176.80	181.92	586	1.98%	1.7	51%	0.71	0.00	0.71	0
3.281	5612.96	80.8	1.379	80.8	2.1	0.89	1.71%	Sand Tailings	0.051	102.8	0.17	0.00	0.17	0	1.70	137.326	1908.83	159.52	487	1.71%	1.7	18%	0.72	0.00	0.72	0
3.445	5612.80	68.7	1.150	68.7	0.4	0.18	1.67%	Sand-Slime Tailings	0.047	93.3	0.17	0.00	0.17	0	1.70	116.722	1622.44	135.57	396	1.68%	1.7	47%	0.73	0.00	0.73	0
3.609	5612.63	56.4	0.959	56.4	-0.5	-0.20	1.70%	Sand-Slime Tailings	0.047	93.3	0.18	0.00	0.18	0	1.70	95.897	1332.97	111.37	311	1.71%	1.8	47%	0.73	0.00	0.73	0
3.773	5612.47	53.4	0.881	53.4	-0.6	-0.27	1.65%	Sand-Slime Tailings	0.047	93.3	0.19	0.00	0.19	0	1.70	90.797	1262.08	105.45	283	1.66%	1.8	47%	0.74	0.00	0.74	0
3.937	5612.30	48.2	0.768	48.2	-0.6	-0.27	1.59%	Sand-Slime Tailings	0.047	93.3	0.20	0.00	0.20	0	1.70	81.991	1139.67	95.22	245	1.60%	1.8	47%	0.75	0.00	0.75	0
4.101	5612.14	42.9	0.667	42.9	-0.7	-0.29	1.56%	Sand-Slime Tailings	0.047	93.3	0.20	0.00	0.20	0	1.70	72.879	1013.02	84.64	209	1.56%	1.8	47%	0.76	0.00	0.76	0
4.265	5611.97	37.5	0.582	37.5	-0.0	-0.01	1.55%	Sand-Slime Tailings	0.047	93.3	0.21	0.00	0.21	0	1.70	63.767	886.36	74.06	177	1.56%	1.9	47%	0.76	0.00	0.76	0
4.429	5611.81	34.9	0.521	35.0	-0.6	-0.25	1.49%	Sand-Slime Tailings	0.047	93.3	0.22	0.00	0.22	0	1.70	59.415	825.87	69.00	159	1.50%	1.9	47%	0.77	0.00	0.77	0
4.593	5611.65	33.0	0.469	33.0	-0.6	-0.26	1.42%	Sand-Slime Tailings	0.047	93.3	0.23	0.00	0.23	0	1.70	56.049	779.08	65.09	144	1.43%	1.9	47%	0.78	0.00	0.78	0
4.757	5611.48	30.9	0.492	30.9	-0.7	-0.32	1.59%	Sand-Slime Tailings	0.047	93.3	0.23	0.00	0.23	0	1.70	52.462	729.22	60.92	131	1.61%	2.0	47%	0.79	0.00	0.79	0
4.921	5611.32	29.7	0.432	29.7	-1.3	-0.55	1.45%	Sand-Slime Tailings	0.047	93.3	0.24	0.00	0.24	0	1.70	50.490	701.81	58.63	122	1.47%	2.0	47%	0.79	0.00	0.79	0
5.085	5611.15	26.8	0.410	26.8	-1.5	-0.67	1.53%	Sand-Slime Tailings	0.059	119.0	0.25	0.00	0.25	1	1.70	45.594	633.76	52.94	106	1.54%	2.0	47%	0.80	0.00	0.80	0
5.249	5610.99	24.8	0.386	24.8	-0.4	-0.16	1.56%	Sand-Slime Tailings	0.059	119.0	0.26	0.01	0.25	1	1.70	42.143	585.79	48.94	96	1.57%	2.1	47%	0.81	0.00	0.81	0
5.413	5610.83	26.0	0.371	26.0	-0.4	-0.17	1.43%	Sand-Slime Tailings	0.059	119.0	0.27	0.01	0.26	1	1.70	44.200	614.38	51.33	99	1.44%	2.0	47%	0.82	0.00	0.82	0
5.577	5610.66	24.7	0.321	24.7	-0.3	-0.13	1.30%	Sand-Slime Tailings	0.059	119.0	0.28	0.02	0.26	1	1.70	41.922	582.72	48.69	92	1.32%	2.0	47%	0.83	0.00	0.83	0
5.741	5610.50	27.7	0.310	27.7	-0.3	-0.13	1.12%	Sand-Slime Tailings	0.059	119.0	0.29	0.02	0.27	1	1.70	47.022	653.61	54.61	102	1.13%	1.9	47%	0.84	0.00	0.84	0
5.905	5610.33	28.1	0.321	28.1	-0.4	-0.16	1.14%	Sand-Slime Tailings	0.059	119.0	0.30	0.03	0.27	1	1.70	47.770	664.00	55.48	102	1.15%	1.9	47%	0.85	0.00	0.85	0
6.069	5610.17	23.8	0.368	23.8	-0.4	-0.17	1.54%	Sand-Slime Tailings	0.059	119.0	0.31	0.03	0.28	1	1.70	40.511	563.10	47.05	85	1.56%	2.1	47%	0.86	0.00	0.86	0
6.234	5610.01	18.4	0.319	18.4	-0.5	-0.20	1.73%	Sand-Slime Tailings	0.059	119.0	0.32	0.04	0.28	1	1.70	31.297	435.03	36.34	64	1.76%	2.2	47%	0.87	0.00	0.87	0
6.398	5609.84	20.4	0.332	20.5	-0.3	-0.14	1.62%	Sand-Slime Tailings	0.059	119.0	0.33	0.04	0.29	1	1.70	34.765	483.23	40.37	70	1.65%	2.2	47%	0.88	0.00	0.88	0
6.562	5609.68	17.3	0.407	17.3	-0.4	-0.16	2.35%	Sand-Slime Tailings	0.059	119.0	0.34	0.05	0.29	1	1.70	29.461	409.51	34.21	58	2.40%	2.3	47%	0.89	0.00	0.89	0
6.726	5609.51	11.3	0.330	11.4	-0.5	-0.20	2.91%	Slime Tailings	0.057	113.1	0.35	0.05	0.30	1	1.70	19.295	268.20	22.40	37	3.00%	2.5	71%	0.90	0.00	0.90	0
6.890	5609.35	13.4	0.217	13.4	1.7	0.72	1.62%	Sand-Slime Tailings	0.059	119.0	0.36	0.06	0.30	1	1.70	22.763	316.41	26.46	43	1.66%	2.3	47%	0.91	0.00	0.91	0
7.054	5609.19	20.5	0.195	20.5	1.9	0.83	0.95%	Sand-Slime Tailings	0.059	119.0	0.37	0.06	0.31	1	1.70	34.782	483.47	40.42	66	0.97%	2.0	47%	0.92	0.00	0.92	0
7.218	5609.02	20.5	0.217	20.5	0.3	0.14	1.06%	Sand-Slime Tailings	0.059	119.0	0.38	0.07	0.31	1	1.70	34.782	483.47	40.40	65	1.08%	2.1	47%	0.93	0.00	0.93	0
7.382	5608.86	18.7	0.284	18.7	-0.3	-0.14	1.52%	Sand-Slime Tailings	0.059	119.0	0.39	0.07	0.31	1	1.70	31.756	441.41	36.88	58	1.55%	2.2	47%	0.94	0.00	0.94	0
7.546	5608.69	13.6	0.275	13.6	-0.3	-0.14	2.03%	Sand-Slime Tailings	0.059	119.0	0.40	0.08	0.32	1	1.70	23.086	320.90	26.81	41	2.09%	2.4	47%	0.95	0.00	0.95	0
7.710	5608.53	17.2	0.252	17.2	0.6	0.24	1.46%	Sand-Slime Tailings	0.059	119.0	0.41	0.08	0.32	1	1.70	29.257	406.67	33.99	52	1.50%	2.2	47%	0.96	0.00	0.96	0
7.874	5608.37	19.5	0.259	19.5	0.3	0.14	1.33%	Sand-Slime Tailings	0.059	119.0	0.42	0.09	0.33	1	1.70	33.184	461.26	38.55	58	1.36%	2.2	47%	0.97	0.00	0.97	0
8.038	5608.20	17.5	0.270	17.5	-0.4	-0.19	1.54%	Sand-Slime Tailings	0.059	119.0	0.43	0.09	0.33	1	1.70	29.716	413.05	34.51	51	1.58%	2.3	47%	0.98	0.00	0.98	0
8.202	5608.04	20.8	0.275	20.8	-0.3	-0.15	1.32%	Sand-Slime Tailings	0.059	119.0	0.44	0.10	0.34	1	1.70	35.343	491.27	41.04	60	1.35%	2.2	47%	0.99	0.00	0.99	0
8.366	5607.87	29.7	0.344	29.7	-0.3	-0.13	1.16%	Sand-Slime Tailings	0.059	119.0	0.45	0.10	0.34	1	1.70	50.524	702.28	58.68	85	1.18%	2.0	47%	1.00	0.00	1.00	0
8.530	5607.71	27.7	0.473	27.7	-0.4	-0.17	1.71%	Sand-Slime Tailings	0.059	119.0	0.46	0.11	0.35	1	1.70	47.056	654.08	54.65	78	1.74%	2.1	47%	1.01	0.00	1.01	0
8.694	5607.55	17.5	0.350	17.5	-0.4	-0.18	2.00%	Sand-Slime Tailings	0.059	119.0	0.47	0.11	0.35	1	1.70	29.733	413.29	34.53	48	2.06%	2.4	47%	1.02	0.00	1.02	0
8.858	5607.38	14.1	0.266	14.1	0.3	0.13	1.88%	Sand-Slime Tailings	0.059	119.0	0.48	0.12	0.36	1	1.70	23.987	333.42	27.86	38	1.95%	2.4	47%	1.03	0.00	1.03	0
9.022	5607.22	12.6	0.246	12.4	27.0	11.71	1.96%	Sand-Slime Tailings	0.059	119.0	0.49	0.12	0.36	1	1.70	21.080	293.01	24.82	33	2.04%	2.5	47%	1.04	0.00	1.04	0
9.186	5607.05	14.1	0.209	14.0	21.8	9.43	1.48%	Sand-Slime Tailings	0.059	119.0	0.50	0.13	0.37	1	1.70	23.783	330.58	27.89	37	1.53%	2.4	47%	1.05	0.00	1.05	0
9.350	5606.89	11.2	0.245	11.2	5.5	2.40	2.18%	Slime Tailings	0.057	113.1	0.50	0.13	0.37	1	1.70	19.023	264.42	22.16	29	2.29%	2.6	71%	1.06	0.00	1.06	0
9.514	5606.73	8.4	0.166	8.3	7.5	3.23	1.98%	Slime Tailings	0.057	113.1	0.51	0.14	0.37	1	1.70	14.144	196.60	16.52	21	2.11%	2.6	71%	1.07	0.00	1.07	0
9.678	5606.56	9.2	0.101	9.1	11.5	4.97	1.10%	Sand-Slime Tailings	0.059	119.0	0.52	0.14	0.38	1	1.70	15.470	215.03	18.11	23	1.17%	2.5	47%	1.08	0.00	1.08	0
9.842	5606.40	8.9	0.136	8.8	15.6	6.76	1.53%	Sand-Slime Tailings	0.059	119.0	0.53	0.15	0.38	1	1.70	14.926	207.47	17.53	22	1.63%	2.6	47%	1.09	0.00	1.09	0
10.006	5606.23	7.4	0.138	7.3	21.3	9.25	1.87%	Slime Tailings	0.057	113.1	0.54	0.15	0.39	1	1.70	12.325	171.32	14.58	18	2.02%	2.7	71%	1.09	0.00	1.09	0
10.170	5606.07	10.2	0.164	10.2	-1.3	-0.56	1.60%	Sand-Slime Tailings	0.059	119.0	0.55	0.16	0.39	1	1.70	17.408	241.97	20.20	25	1.69%	2.5	47%	1.10	0.00	1.10	0
10.335	5605.91	11.2	0.177	11.1	9.8	4.26	1.58%	Sand-Slime Tailings	0.059	119.0	0.56	0.17	0.40	1	1.70	18.921	263.00	22.10	27	1.67%	2.5	47%	1.11	0.00	1.11	0
10.499	5605.74	10.6	0.158	10.5	14.1	6.11	1.49%	Sand-Slime Tailings	0.059	119.0	0.57	0.17	0.40	1	1.70	17.833	247.88	20.89	25	1.58%	2.5	47%	1.12	0.00	1.12	0
10.663	5605.58	11.5	0.125	11.4	10.9	4.70	1.09%	Sand-Slime Tailings	0.059	119.0	0.58	0.18	0.41	1	1.70	19.380	269.38	22.64	27	1.15%	2.4	47%	1.13	0.00	1.13	0
10.827	5605.41	11.2	0.137	11.1	7.2	3.12	1.22%	Sand-Slime Tailings	0.059	119.0	0.59	0.18	0.41	1	1.70	18.938	263.24	22.08	26	1.29%	2.5	47%	1.14	0.00	1.14	0
10.991	5605.25	11.3	0.125	11.2	15.6	6.77	1.11%	Sand-Slime Tailings	0.059	119.0	0.60	0.19	0.42	1	1.70	19.057	264.89	22.33	26	1.17%	2.4	47%	1.15	0.00	1.15	0
11.155	5605.09	12.7	0.188	12.6	14.5	6.28	1.48%	Sand-Slime Tailings	0.059	119.0	0.61	0.19	0.42	1	1.70	21.437	297.97	25.08	29	1.56%	2.5	47%	1.16	0.00	1.16	0
11.319	5604.92	10.6	0.193	10.5	12.0	5.18	1.82%	Sand-Slime Tailings	0.059	119.0	0.62	0.20	0.42	1	1.70	17.867	248.35	20.90	23	1.94%	2.6	47%	1.17	0.00	1.17	0
11.483	5604.76	10.1	0.128	10.0	15.4	6.66	1.27%	Sand-Slime Tailings	0.059	119.0	0.63	0.20	0.43	1	1.70	17.000	236.30	19.93	22	1.35%	2.5	47%	1.18	0.00	1.18	0
11.647	5604.59	9.6	0.155	9.5	10.4	4.52	1.62%	Sand-Slime Tailings	0.059	119.0	0.64	0.21	0.43	1	1.70	16.150	224.49	18.89	21	1.74%	2.6	47%	1.19	0.00	1.19	0
11.811	5604.43	7.6	0.132	7.4	26.7	11.58	1.74%	Slime Tailings	0.057	113.1	0.65	0.21	0.44	1	1.70	12.549	174.44	14.90	16	1.91%	2.7	71%	1.20	0.00	1.20	0
11.975	5604.27	7.8	0.081	7.7	21.2	9.18	1.04%	Sand-Slime Tailings	0.059	119.0	0.66	0.22	0.44	1	1.68	12.884	179.08	15.22	16	1.14%	2.6	47%	1.21	0.00	1.21	0
12.139	5604.10	8.6	0.080	8.5	21.2	9.20	0.93%	Sand-Slime Tailings	0.059	119.0	0.67	0.22	0.45	1	1.67	14.147	196.65	16.69	18	1.01%	2.5	47%	1.22	0.00	1.22	0
12.303	5603.94	7.4	0.144	7.2	28.9	12.53	1.95%	Slime Tailings	0.057	113.1	0.68	0.23	0.45	1	1.66	11.958	166.22	14.24	15	2.14%	2.8	71%	1.23	0.00	1.23	0
12.467	5603.77	6.6	0.098	6.4	31.0	13.42	1.49%	Slime Tailings	0.057	113.1	0.69	0.23	0.46	1	1.64	10.508	146.06	12.57	13	1.66%	2.8	71%	1.24	0.00	1.24	0
12.631	5603.61	10.5	0.114	10.4	20.4	8.82	1.08%	Sand-Slime Tailings	0.059	119.0	0.70	0.24	0.46	1	1.63	16.984	236.07	19.97	21	1.16%	2.5	47%	1.25	0.00	1.25	0
12.795	5603.44	13.7	0.097	13.6	15.2	6.59	0.71%	Sand-Slime Tailings	0.059	119.0	0.71	0.24	0.46	1	1.59	21.666	301.16	25.34	28	0.75%	2.3	47%	1.26	0.00	1.26	0
12.959	5603.28	16.5	0.105	16.4	9.8	4.23	0.64%	Sand-Slime Tailings	0.059	119.0	0.72	0.25	0.47	1	1.55	25.544	355.07	29.78	34	0.67%	2.2	47%	1.27	0.00	1.27	0
13.123	5603.12	21.7	0.122	21.7	9.2	4.00	0.56%	Sand-Slime Tailings	0.059	119.0	0.73	0.25	0.47	1	1.51	32.623	453.45	37.99	44	0.58%	2.1	47%	1.28	0.00	1.28	0
13.287	5602.95	18.8	0.157	18.7	5.8	2.52	0.84%	Sand-Slime Tailings	0.059	119.0	0.74	0.26	0.48	1	1.52	28.407	394.86	33.06	38	0.87%	2.2	47%	1.29	0.00	1.29	0
13.451	5602.79	19.3	0.227	19.2	9.2	4.00	1.18%	Sand-Slime Tailings	0.059	119.0	0.75	0.26	0.48	1	1.50	28.942	402.30	33.72	38	1.22%	2.3	47%	1.30	0.00	1.30	0
13.615	5602.62	15.8	0.262	15.7	7.7	3.33	1.66%	Sand-Slime Tailings	0.059	119.0	0.76	0.27	0.49	1	1.52	23.933	332.67	27.88	31	1.74%	2.5	47%	1.31	0.00	1.31	0
13.779	5602.46	12.7	0.218	12.6	16.1	6.99	1.72%	Sand-Slime Tailings	0.059	119.0	0.77	0.27	0.49	1	1.54	19.381	269.39	22.69	24	1.83%	2.6	47%	1.32	0.00	1.32	0
13.943	5602.30	10.1	0.175	9.9	22.6	9.81	1.74%	Sand-Slime Tailings	0.059	119.0	0.78	0.28	0.50	1	1.54	15.263	212.15	17.98	19	1.88%	2.7	47%	1.33	0.00	1.33	0
14.107	5602.13	9.1	0.134	8.8	44.4	19.24	1.48%	Sand-Slime Tailings	0.059	119.0	0.79	0.28	0.50	1	1.52	13.415	186.46	16.07	17	1.62%	2.7	47%	1.34	0.00	1.34	0
14.271	5601.97	13.3	0.135	13.2	23.4	10.14	1.01%	Sand-Slime Tailings	0.059	119.0	0.79	0.29	0.51	1	1.50	19.817	275.45	23.27	25	1.08%	2.4	47%	1.35	0.00	1.35	0
14.436	5601.80	11.8	0.101	11.7	21.6	9.38	0.86%	Sand-Slime Tailings	0.059	119.0	0.80	0.29	0.51	1	1.50	17.537	243.76	20.60	22	0.92%	2.4	47%	1.36	0.00	1.36	0
14.600	5601.64	11.3	0.117	11.2	20.4	8.83	1.03%	Sand-Slime Tailings	0.059	119.0	0.81	0.30	0.52	1	1.49	16.742	232.71	19.67	20	1.11%	2.5	47%	1.37	0.00	1.37	0
14.764	5601.48	10.3	0.048	10.1	26.4	11.43	0.47%	Sand-Slime Tailings	0.059	119.0	0.82	0.30	0.52	1	1.48	15.025	208.85	17.73	18	0.51%	2.4	47%	1.38	0.00	1.38	0
14.928	5601.31	10.3	0.125	10.2	18.1	7.85	1.21%	Sand-Slime Tailings	0.059	119.0	0.83	0.31	0.53	1	1.47	15.024	208.83	17.64	18	1.32%	2.6	47%	1.39	0.00	1.39	0
15.092	5601.15	9.7	0.124	9.5	36.6	15.86	1.28%	Sand-Slime Tailings	0.059	119.0	0.84	0.31	0.53	1	1.46	13.810	191.97	16.43	17	1.40%	2.6	47%	1.40	0.00	1.40	0
15.256	5600.98	10.1	0.123	10.0	14.9	6.47	1.22%	Sand-Slime Tailings	0.059	119.0	0.85	0.32	0.53	1	1.45	14.471	201.15	16.96	17	1.34%	2.6	47%	1.41	0.00	1.41	0
15.420	5600.82	8.8	0.119	8.6	32.5	14.09	1.36%	Sand-Slime Tailings	0.059	119.0	0.86	0.32	0.54	1	1.44	12.356	171.74	14.69	15	1.50%	2.7	47%	1.42	0.00	1.42	0
15.584	5600.66	9.0	0.124	8.6	54.7	23.71	1.38%	Sand-Slime Tailings	0.059	119.0	0.87	0.33	0.54	1	1.43	12.359	171.79	14.92	15	1.53%	2.7	47%	1.43	0.00	1.43	0
15.748	5600.49	9.1	0.139	8.8	60.7	26.31	1.52%	Sand-Slime Tailings	0.059	119.0	0.88	0.33	0.55	1	1.42	12.476	173.42	15.12	15	1.68%	2.7	47%	1.43	0.00	1.43	0
15.912	5600.33	8.8	0.135	8.4	58.5	25.37	1.54%	Sand-Slime Tailings	0.059	119.0	0.89	0.34	0.55	1	1.41	11.857	164.82	14.37	14	1.72%	2.7	47%	1.44	0.00	1.44	0
16.076	5600.16	8.0	0.083	7.6	54.0	23.40	1.04%	Sand-Slime Tailings	0.059	119.0	0.90	0.34	0.56	1	1.40	10.699	148.72	12.98	13	1.18%	2.7	47%	1.45	0.00	1.45	0
16.240	5600.00	7.9	0.083	7.6	49.3	21.36	1.05%	Sand-Slime Tailings	0.059	119.0	0.91	0.35	0.56	1	1.40	10.560	146.79	12.76	12	1.19%	2.7	47%	1.46	0.00	1.46	0
16.404	5599.84	7.2	0.093	6.8	64.6	27.99	1.29%	Slime Tailings	0.057	113.1	0.92	0.35	0.57	1	1.39	9.446	131.29	11.62	11	1.48%	2.8	71%	1.47	0.00	1.47	0
16.568	5599.67	7.6	0.134	7.3	52.4	22.70	1.75%	Slime Tailings	0.057	113.1	0.93	0.36	0.57	1	1.38	10.095	140.32	12.25	12	2.00%	2.8	71%	1.48	0.00	1.48	0
16.732	5599.51	6.9	0.131	6.6	54.4	23.55	1.89%	Slime Tailings	0.057	113.1	0.94	0.36	0.57	1	1.37	9.064	125.99	11.07	10	2.18%	2.9	71%	1.49	0.00	1.49	0
16.896	5599.34	8.8	0.147	8.5	39.7	17.21	1.67%	Slime Tailings	0.057	113.1	0.95	0.37	0.58	1	1.36	11.645	161.86	13.92	14	1.88%	2.8	71%	1.50	0.00	1.50	0
17.060	5599.18	7.0	0.190	6.8	39.7	17.19	2.72%	Slime Tailings	0.057	113.1	0.96	0.38	0.58	1	1.36	9.153	127.22	11.02	10	3.15%	3.0	71%	1.51	0.00	1.51	0
17.224	5599.02	6.5	0.176	6.2	52.9	22.94	2.70%	Slime Tailings	0.057	113.1	0.97	0.38	0.59	1	1.35	8.333	115.83	10.20	9	3.18%	3.0	71%	1.52	0.00	1.52	0

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	Idriss & Boulanger (2008) r_d	C_σ	K_σ	K_α	CSR $_{M=7.5, \sigma'v=1atm}$	Δq_{c1n}	q_{c1n-cs}	CRR $_{M=7.5, \sigma'v=1atm}$	FoS	Youd et al. (2001) r_d	D_r	f	K_σ	K_α	CSR $_{M=7.5}$	Kc	q_{c1n-cs}	(CRR) $_{M=7.5, \sigma'v=1atm}$	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
0.164	1.00	0.06	1.03	1.0	0.059	44.24	83.91	0.118	1.99	0.98	0.36	0.80	2.53	1.0	0.017	1.00	39.67	0.083	201.04	101.51	2
0.328	1.00	0.10	1.04	1.0	0.060	61.00	148.43	0.264	4.40	0.98	0.54	0.73	2.91	1.0	0.015	1.00	87.43	0.142	172.13	88.26	2
0.492	1.00	0.12	1.05	1.0	0.061	69.62	181.61	0.563	9.30	0.98	0.61	0.69	2.96	1.0	0.015	1.00	111.99	0.211	170.09	89.70	2
0.656	1.00	0.12	1.05	1.0	0.061	71.37	188.36	0.707	11.68	0.98	0.62	0.69	2.77	1.0	0.016	1.00	116.99	0.229	138.70	75.19	2
0.820	1.00	0.12	1.04	1.0	0.060	70.32	184.28	0.614	10.17	0.97	0.62	0.69	2.55	1.0	0.017	1.00	113.97	0.218	105.56	57.86	2
0.984	1.00	0.16	1.06	1.0	0.061	83.53	235.14	1.000	16.35	0.97	0.71	0.64	2.76	1.0	0.016	1.00	151.62	0.404	163.38	89.86	2
1.148	1.00	0.19	1.07	1.0	0.062	89.67	258.79	1.000	16.23	0.97	0.75	0.62	2.76	1.0	0.016	1.00	169.12	1.000	346.66	181.45	2
1.312	1.00	0.18	1.06	1.0	0.061	87.48	250.35	1.000	16.33	0.97	0.74	0.63	2.57	1.0	0.017	1.00	162.87	1.000	303.45	159.89	2
1.476	1.00	0.22	1.07	1.0	0.062	95.18	280.00	1.000	16.16	0.97	0.78	0.61	2.61	1.0	0.016	1.00	184.82	1.000	269.84	143.00	2
1.640	1.00	0.09	1.03	1.0	0.059	58.16	137.48	0.224	3.78	0.97	0.51	0.74	1.83	1.0	0.023	1.00	79.32	0.126	30.71	17.24	2
1.804	1.00	0.14	1.04	1.0	0.060	78.68	216.47	1.000	16.60	0.97	0.68	0.66	2.14	1.0	0.020	1.00	137.80	0.323	71.44	44.02	2
1.968	1.00	0.30	1.08	1.0	0.063	127.18	403.19	1.000	15.98	0.97	0.96	0.60	2.37	1.0	0.018	1.00	276.01	1.000	202.62	109.30	2
2.133	1.00	0.30	1.08	1.0	0.062	184.33	623.20	1.000	16.05	0.97	1.21	0.60	2.30	1.0	0.019	1.00	438.86	1.000	187.10	101.57	2
2.297	1.00	0.30	1.08	1.0	0.062	201.15	687.95	1.000	16.11	0.97	1.27	0.60	2.23	1.0	0.019	1.00	486.80	1.000	173.81	94.96	2
2.461	1.00	0.30	1.07	1.0	0.062	179.49	604.56	1.000	16.18	0.97	1.19	0.60	2.17	1.0	0.020	1.00	425.07	1.000	162.28	89.23	2
2.625	1.00	0.30	1.07	1.0	0.062	149.90	490.65	1.000	16.25	0.97	1.07	0.60	2.12	1.0	0.020	1.00	340.75	1.000	152.20	84.23	2
2.789	0.99	0.30	1.07	1.0	0.061	128.47	408.16	1.000	16.32	0.97	0.97	0.60	2.07	1.0	0.021	1.00	279.69	1.000	143.30	79.81	2
2.953	0.99	0.30	1.06	1.0	0.061	117.36	365.39	1.000	16.39	0.97	0.91	0.60	2.02	1.0	0.021	1.00	248.03	1.000	135.40	75.89	2
3.117	0.99	0.22	1.04	1.0	0.060	94.16	276.08	1.000	16.72	0.97	0.78	0.61	1.94	1.0	0.022	1.02	185.13	1.000	128.32	72.52	2
3.281	0.99	0.17	1.03	1.0	0.059	62.87	222.39	1.000	16.90	0.97	0.73	0.64	1.82	1.0	0.023	1.00	160.07	1.000	121.83	69.36	2
3.445	0.99	0.14	1.02	1.0	0.059	77.85	213.42	1.000	17.04	0.97	0.67	0.66	1.71	1.0	0.025	1.03	139.61	0.333	38.80	27.92	2
3.609	0.99	0.12	1.02	1.0	0.058	69.36	180.73	0.548	9.39	0.97	0.61	0.70	1.61	1.0	0.027	1.07	119.35	0.238	26.57	17.98	2
3.773	0.99	0.11	1.02	1.0	0.058	67.28	172.73	0.437	7.51	0.97	0.59	0.70	1.57	1.0	0.027	1.08	113.95	0.218	23.31	15.41	2
3.937	0.99	0.10	1.01	1.0	0.058	63.70	158.92	0.319	5.50	0.97	0.56	0.72	1.52	1.0	0.028	1.10	104.52	0.186	19.17	12.34	2
4.101	0.99	0.09	1.01	1.0	0.058	59.98	144.62	0.249	4.31	0.97	0.53	0.73	1.47	1.0	0.029	1.12	95.05	0.160	15.85	10.08	2
4.265	0.99	0.09	1.01	1.0	0.058	56.28	130.34	0.204	3.54	0.97	0.50	0.75	1.42	1.0	0.030	1.16	85.99	0.139	13.30	8.42	2
4.429	0.99	0.08	1.01	1.0	0.058	54.50	123.50	0.187	3.26	0.97	0.48	0.76	1.39	1.0	0.031	1.18	81.21	0.130	11.98	7.62	2
4.593	0.98	0.08	1.01	1.0	0.057	53.13	118.22	0.176	3.06	0.97	0.47	0.77	1.36	1.0	0.031	1.19	77.39	0.123	10.98	7.02	2
4.757	0.98	0.08	1.01	1.0	0.057	51.67	112.59	0.165	2.87	0.97	0.45	0.77	1.34	1.0	0.032	1.26	76.65	0.122	10.52	6.70	2
4.921	0.98	0.08	1.01	1.0	0.057	50.86	109.49	0.159	2.78	0.97	0.44	0.78	1.32	1.0	0.032	1.25	73.30	0.117	9.75	6.27	2
5.085	0.98	0.07	1.00	1.0	0.057	48.87	101.80	0.146	2.55	0.96	0.42	0.79	1.30	1.0	0.033	1.32	70.05	0.112	9.05	5.80	2
5.249	0.98	0.07	1.00	1.0	0.057	47.47	96.41	0.137	2.40	0.96	0.40	0.80	1.28	1.0	0.033	1.38	67.39	0.108	8.62	5.51	2
5.413	0.98	0.07	1.00	1.0	0.057	48.30	99.63	0.142	2.50	0.96	0.41	0.79	1.28	1.0	0.033	1.32	68.00	0.109	8.53	5.51	2
5.577	0.98	0.07	1.00	1.0	0.057	47.38	96.06	0.136	2.40	0.96	0.40	0.80	1.27	1.0	0.033	1.32	64.25	0.105	8.03	5.21	2
5.741	0.98	0.07	1.00	1.0	0.057	49.45	104.06	0.149	2.64	0.96	0.43	0.79	1.28	1.0	0.033	1.23	67.08	0.108	8.15	5.39	2
5.905	0.98	0.07	1.00	1.0	0.057	49.76	105.24	0.151	2.68	0.96	0.43	0.78	1.28	1.0	0.033	1.23	68.51	0.110	8.15	5.41	2
6.069	0.98	0.07	1.00	1.0	0.056	46.80	93.85	0.133	2.35	0.96	0.40	0.80	1.25	1.0	0.034	1.44	67.86	0.109	7.96	5.15	2
6.234	0.98	0.06	1.00	1.0	0.056	43.05	79.39	0.112	1.98	0.96	0.35	0.80	1.25	1.0	0.034	1.71	62.22	0.102	7.35	4.67	2
6.398	0.97	0.07	1.00	1.0	0.056	44.46	84.83	0.119	2.12	0.96	0.37	0.80	1.25	1.0	0.034	1.60	64.41	0.105	7.41	4.77	2
6.562	0.97	0.06	1.00	1.0	0.056	42.30	76.51	0.108	1.92	0.96	0.34	0.80	1.24	1.0	0.034	2.08	71.05	0.113	7.88	4.90	2
6.726	0.97	0.05	1.00	1.0	0.056	37.89	60.29	0.088	1.57	0.96	0.27	0.80	1.24	1.0	0.034	3.02	67.71	0.109	7.47	4.52	2
6.890	0.97	0.06	1.00	1.0	0.056	39.58	66.04	0.095	1.69	0.96	0.30	0.80	1.23	1.0	0.034	2.05	54.36	0.095	6.42	4.05	2
7.054	0.97	0.07	1.00	1.0	0.056	44.48	84.90	0.119	2.14	0.96	0.37	0.80	1.23	1.0	0.034	1.36	55.14	0.096	6.36	4.25	2
7.218	0.97	0.07	0.99	1.0	0.056	44.47	84.87	0.119	2.14	0.96	0.37	0.80	1.23	1.0	0.035	1.42	57.29	0.097	6.40	4.27	2
7.382	0.97	0.06	0.99	1.0	0.056	43.24	80.11	0.113	2.03	0.96	0.35	0.80	1.22	1.0	0.035	1.70	62.74	0.103	6.66	4.34	2
7.546	0.97	0.06	0.99	1.0	0.056	39.70	66.51	0.095	1.72	0.96	0.30	0.80	1.22	1.0	0.035	2.35	63.11	0.103	6.59	4.15	2
7.710	0.97	0.06	0.99	1.0	0.055	42.22	76.21	0.108	1.94	0.96	0.34	0.80	1.22	1.0	0.035	1.78	60.41	0.101	6.32	4.13	2
7.874	0.96	0.06	0.99	1.0	0.055	43.82	82.37	0.116	2.09	0.96	0.36	0.80	1.21	1.0	0.035	1.61	62.11	0.102	6.34	4.22	2
8.038	0.96	0.06	0.99	1.0	0.055	42.40	76.91	0.108	1.96	0.96	0.34	0.80	1.21	1.0	0.035	1.83	63.24	0.104	6.33	4.15	2
8.202	0.96	0.07	0.99	1.0	0.055	44.70	85.74	0.121	2.19	0.96	0.37	0.80	1.21	1.0	0.035	1.58	64.94	0.105	6.36	4.28	2
8.366	0.96	0.08	0.99	1.0	0.055	50.88	109.56	0.159	2.89	0.96	0.44	0.78	1.23	1.0	0.034	1.31	76.88	0.122	7.28	5.09	2
8.530	0.96	0.07	0.99	1.0	0.055	49.47	104.12	0.149	2.72	0.96	0.43	0.79	1.21	1.0	0.035	1.55	84.64	0.136	8.02	5.37	2
8.694	0.96	0.06	0.99	1.0	0.055	42.41	76.94	0.109	1.98	0.96	0.34	0.80	1.20	1.0	0.035	2.13	73.60	0.117	6.79	4.38	2
8.858	0.96	0.06	0.99	1.0	0.055	40.07	67.94	0.097	1.77	0.96	0.30	0.80	1.19	1.0	0.035	2.38	66.42	0.107	6.14	3.96	2
9.022	0.96	0.06	0.99	1.0	0.055	39.01	63.82	0.092	1.68	0.96	0.29	0.80	1.19	1.0	0.035	2.64	65.56	0.106	6.01	3.85	2
9.186	0.96	0.06	0.99	1.0	0.055	40.08	67.97	0.097	1.78	0.96	0.30	0.80	1.19	1.0	0.035	2.17	60.39	0.100	5.62	3.70	2
9.350	0.96	0.05	0.99	1.0	0.055	37.81	59.97	0.088	1.61	0.95	0.27	0.80	1.18	1.0	0.036	3.06	67.79	0.109	6.02	3.82	2
9.514	0.95	0.05	0.99	1.0	0.055	35.84	52.36	0.080	1.46	0.95	0.23	0.80	1.18	1.0	0.036	3.62	59.80	0.100	5.46	3.46	2
9.678	0.95	0.05	0.99	1.0	0.054	36.65	54.76	0.082	1.51	0.95	0.25	0.80	1.18	1.0	0.036	2.64	47.72	0.090	4.85	3.18	2
9.842	0.95	0.05	0.99	1.0	0.054	36.45	53.98	0.081	1.50	0.95	0.24	0.80	1.18	1.0	0.036	3.14	55.03	0.095	5.10	3.30	2
10.006	0.95	0.05	0.99	1.0	0.054	35.16	49.74	0.077	1.42	0.95	0.22	0.80	1.17	1.0	0.036	3.97	57.82	0.098	5.18	3.30	2
10.170	0.95	0.05	0.99	1.0	0.054	37.39	57.59	0.085	1.57	0.95	0.26	0.80	1.17	1.0	0.036	2.94	59.41	0.100	5.20	3.39	2
10.335	0.95	0.05	0.99	1.0	0.054	38.05	60.15	0.088	1.63	0.95	0.27	0.80	1.17	1.0	0.036	2.77	61.13	0.101	5.23	3.43	2
10.499	0.95	0.05	0.99	1.0	0.054	37.63	58.51	0.086	1.60	0.95	0.26	0.80	1.16	1.0	0.036	2.83	59.12	0.099	5.07	3.33	2
10.663	0.95	0.05	0.99	1.0	0.054	38.24	60.89	0.089	1.65	0.95	0.27	0.80	1.16	1.0	0.036	2.35	53.28	0.094	4.75	3.20	2
10.827	0.95	0.05	0.98	1.0	0.054	38.05	60.13	0.088	1.64	0.95	0.27	0.80	1.16	1.0	0.036	2.54	56.01	0.096	4.81	3.22	2
10.991	0.94	0.05	0.98	1.0	0.054	38.13	60.46	0.088	1.64	0.95	0.27	0.80	1.16	1.0	0.036	2.43	54.27	0.095	4.69	3.17	2
11.155	0.94	0.06	0.98	1.0	0.054	39.10	64.17	0.093	1.73	0.95	0.29	0.80	1.15	1.0	0.036	2.56	64.20	0.105	5.12	3.42	2
11.319	0.94	0.05	0.98	1.0	0.054	37.63	58.53	0.086	1.61	0.95	0.26	0.80	1.15	1.0	0.036	3.23	67.57	0.109	5.26	3.43	2
11.483	0.94	0.05	0.98	1.0	0.053	37.29	57.23	0.085	1.59	0.95	0.26	0.80	1.15	1.0	0.036	2.87	57.19	0.097	4.66	3.12	2
11.647	0.94	0.05	0.98	1.0	0.053	36.93	55.81	0.083	1.56	0.95	0.25	0.80	1.15	1.0	0.037	3.35	63.33	0.104	4.91	3.24	2
11.811	0.94	0.05	0.98	1.0	0.053	35.28	50.18	0.078	1.46	0.95	0.22	0.80	1.14	1.0	0.037	4.16	62.05	0.102	4.80	3.13	2
11.975	0.94	0.05	0.98	1.0	0.053	35.64	50.86	0.078	1.47	0.95	0.23	0.80	1.14	1.0	0.037	3.31	50.40	0.092	4.27	2.87	2
12.139	0.94	0.05	0.98	1.0	0.053	36.15	52.84	0.080	1.51	0.95	0.24	0.80	1.14	1.0	0.037	2.95	49.28	0.091	4.19	2.85	2
12.303	0.94	0.05	0.98	1.0	0.053	35.05	49.28	0.077	1.45	0.95	0.22	0.80	1.14	1.0	0.037	4.55	64.75	0.105	4.80	3.12	2
12.467	0.93	0.05	0.98	1.0	0.053	34.47	47.04	0.075	1.41	0.95	0.20	0.80	1.14	1.0	0.037	4.48	56.35	0.097	4.37	2.89	2
12.631	0.93	0.05	0.98	1.0	0.053	37.30	57.27	0.085	1.61	0.95	0.26	0.80	1.13	1.0	0.037	2.75	54.84	0.095	4.27	2.94	2
12.795	0.93	0.06	0.98	1.0	0.053	39.19	64.53	0.093	1.76	0.95	0.29	0.80	1.13	1.0	0.037	1.95	49.33	0.091	4.04	2.90	2
12.959	0.93	0.06	0.98	1.0	0.053	40.75	70.52	0.100	1.91	0.95	0.32	0.80	1.13	1.0	0.037	1.68	50.08	0.092	4.03	2.97	2
13.123	0.93	0.06	0.97	1.0	0.052	43.63	81.62	0.115	2.19	0.95	0.36	0.80	1.13	1.0	0.037	1.41	53.48	0.094	4.10	3.15	2
13.287	0.93	0.06	0.98	1.0	0.052	41.90	74.95	0.106	2.02	0.95	0.33	0.80	1.12	1.0	0.037	1.72	56.89	0.097	4.19	3.11	2
13.451	0.93	0.06	0.97	1.0	0.052	42.13	75.84	0.107	2.05	0.95	0.34	0.80	1.12	1.0	0.037	1.93	65.17	0.106	4.52	3.28	2
13.615	0.93	0.06	0.98	1.0	0.052	40.08	67.96	0.097	1.86	0.95	0.30	0.80	1.12	1.0	0.037	2.58	72.05	0.115	4.86	3.36	2
13.779	0.92	0.05	0.98	1.0	0.052	38.26	60.95	0.089	1.70	0.94	0.28	0.80	1.12	1.0	0.037	3.08	69.87	0.112	4.69	3.19	2
13.943	0.92	0.05	0.98	1.0	0.052	36.61	54.59	0.082	1.57	0.94	0.24	0.80	1.12	1.0	0.037	3.70	66.52	0.107	4.46	3.02	2
14.107	0.92	0.05	0.98	1.0	0.052	35.94	52.01	0.079	1.52	0.94	0.23	0.80	1.11	1.0	0.037	3.76	60.46	0.101	4.14	2.83	2
14.271	0.92	0.05	0.98	1.0	0.052	38.46	61.73	0.090	1.73	0.94	0.28	0.80	1.11	1.0	0.037	2.41	56.17	0.096	3.94	2.84	2
14.436	0.92	0.05	0.98	1.0	0.052	37.53	58.13	0.086	1.65	0.94	0.26	0.80	1.11	1.0	0.037	2.50	51.42	0.093	3.75	2.70	2
14.600	0.92	0.05	0.98	1.0	0.052	37.20	56.86	0.084	1.63	0.94	0.26	0.80	1.11	1.0	0.038	2.79	54.80	0.095	3.83	2.73	2
14.764	0.92	0.05	0.98	1.0	0.052	36.52	54.25	0.082	1.58	0.94	0.24	0.80	1.11	1.0	0.038	2.29	40.67	0.084	3.34	2.46	2
14.928	0.92	0.05	0.98	1.0	0.052	36.49	54.13	0.082	1.58	0.94	0.24	0.80	1.10	1.0	0.038	3.25	57.31	0.098	3.85	2.71	2
15.092	0.91	0.05	0.98	1.0	0.052	36.06	52.49	0.080	1.55	0.94	0.23	0.80	1.10	1.0	0.038	3.52	57.87	0.098	3.84	2.69	2
15.256	0.91	0.05	0.98	1.0	0.051	36.25	53.22	0.081	1.57	0.94	0.24	0.80	1.10	1.0	0.038	3.37	57.25	0.097	3.78	2.67	2
15.420	0.91	0.05	0.98	1.0	0.051	35.45	50.14	0.078	1.51	0.94	0.22	0.80	1.10	1.0	0.038	3.95	58.10	0.098	3.78	2.65	2
15.584	0.91	0.05	0.98	1.0	0.051	35.54	50.46	0.078	1.52	0.94	0.22	0.80	1.10	1.0	0.038	3.94	58.84	0.099	3.78	2.65	2
15.748	0.91	0.05	0.97	1.0	0.051	35.60	50.72	0.078	1.53	0.94	0.22	0.80	1.09	1.0	0.038	4.07	61.49	0.102	3.85	2.69	2
15.912	0.91	0.05	0.97	1.0	0.051	35.34	49.71	0.077	1.51	0.94	0.22	0.80	1.09	1.0	0.038	4.27	61.31	0.101	3.81	2.66	2
16.076	0.91	0.05	0.98	1.0	0.051	34.85	47.83	0.075	1.48	0.94	0.21	0.80	1.09	1.0	0.038	3.97	51.55	0.093	3.46	2.47	2
16.240	0.91	0.05	0.97	1.0	0.051	34.78	47.54	0.075	1.47	0.94	0.21	0.80	1.09	1.0	0.038	4.05	51.70	0.093	3.43	2.45	2
16.404	0.90	0.05	0.98	1.0	0.051	34.13	45.75	0.074	1.44	0.94	0.20	0.80	1.09	1.0	0.038	4.74	55.05	0.096	3.51	2.47	2
16.568	0.90	0.05	0.97	1.0	0.051	34.35	46.60	0.074	1.46	0.94	0.20	0.80	1.09	1.0	0.038	5.14	62.91	0.103	3.76	2.61	2
16.732	0.90	0.05	0.97	1.0	0.051	33.94	45.01	0.073	1.43	0.94	0.19	0.80	1.08	1.0	0.038	5.74	63.53	0.104	3.76	2.60	2
16.896	0.90	0.05	0.97	1.0	0.051	34.93	48.85	0.076	1.51	0.94	0.22	0.80	1.08	1.0	0.038	4.57	63.62	0.104	3.74	2.62	2
17.060	0.90	0.05	0.97	1.0	0.051	33.93	44.95	0.073	1.44	0.94	0.19	0.80	1.08	1.0	0.038	6.70	73.85	0.117	4.20	2.82	2
17.224	0.90	0.05	0.97	1.0	0.051	33.64	43.83	0.072	1.42	0.94	0.18	0.80	1.08	1.0	0.038	7.10	72.42	0.115	4.09	2.76	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.425

Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
3.08	594	1.6E-03	5.5E+02	9.9E-05	11	0.175	10022	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.13	594	1.6E-03	5.5E+02	1.0E-04	11	0.176	9961	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.18	594	1.6E-03	5.5E+02	1.0E-04	11	0.176	9902	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.23	594	1.6E-03	5.5E+02	1.0E-04	11	0.177	9844	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.28	594	1.6E-03	5.5E+02	1.0E-04	11	0.178	9786	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.33	594	1.6E-03	5.5E+02	1.1E-04	11	0.178	9730	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.38	594	1.6E-03	5.5E+02	1.1E-04	11	0.179	9676	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.43	594	1.6E-03	5.5E+02	1.1E-04	11	0.179	9622	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.48	594	1.6E-03	5.5E+02	1.1E-04	11	0.180	9569	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.53	594	1.6E-03	5.5E+02	1.1E-04	11	0.181	9517	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.58	594	1.6E-03	5.5E+02	1.1E-04	11	0.181	9466	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.63	594	1.6E-03	5.5E+02	1.2E-04	11	0.182	9416	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.68	594	1.6E-03	5.5E+02	1.2E-04	11	0.182	9367	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.73	594	1.6E-03	5.5E+02	1.2E-04	11	0.183	9318	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.78	594	1.6E-03	5.5E+02	1.2E-04	11	0.184	9271	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.83	594	1.6E-03	5.5E+02	1.2E-04	11	0.184	9224	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.88	594	1.6E-03	5.5E+02	1.2E-04	11	0.185	9179	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.93	594	1.6E-03	5.5E+02	1.2E-04	11	0.185	9133	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.98	495	1.6E-03	3.8E+02	1.8E-04	11	0.186	9089	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.03	495	1.6E-03	3.9E+02	1.8E-04	0	0.191	11691	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.03%	0.0000
4.08	495	1.4E-03	3.5E+02	2.0E-04	10	0.187	9244	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.59%	0.0010
4.13	495	1.4E-03	3.5E+02	2.0E-04	10	0.188	9204	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.62%	0.0010
4.18	495	1.4E-03	3.5E+02	2.0E-04	10	0.188	9165	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.66%	0.0011
4.23	495	1.4E-03	3.5E+02	2.1E-04	10	0.189	9126	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.70%	0.0011
4.28	495	1.4E-03	3.5E+02	2.1E-04	10	0.189	9087	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.73%	0.0012
4.33	495	1.4E-03	3.5E+02	2.1E-04	10	0.190	9050	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.77%	0.0013
4.38	495	1.4E-03	3.5E+02	2.1E-04	10	0.190	9012	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.80%	0.0013
4.43	495	1.4E-03	3.5E+02	2.1E-04	10	0.191	8975	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.83%	0.0014
4.48	495	1.4E-03	3.5E+02	2.2E-04	10	0.191	8939	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.87%	0.0014
4.53	495	1.4E-03	3.5E+02	2.2E-04	10	0.192	8903	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.90%	0.0015
4.58	495	1.8E-03	4.5E+02	1.7E-04	10	0.192	8858	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.63	495	1.8E-03	4.5E+02	1.8E-04	10	0.193	8814	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.68	495	1.8E-03	4.5E+02	1.8E-04	10	0.193	8771	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.73	495	1.8E-03	4.5E+02	1.8E-04	10	0.194	8728	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.78	495	1.8E-03	4.5E+02	1.8E-04	10	0.195	8686	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.83	495	1.8E-03	4.5E+02	1.8E-04	10	0.195	8645	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.02%	0.0000
4.88	495	1.8E-03	4.5E+02	1.9E-04	10	0.196	8604	0.03%	2.00	0.65	0.03%	0.001	0.34	0.079	0.765	0.12%	0.0002
4.93	495	1.8E-03	4.5E+02	1.9E-04	10	0.196	8564	0.03%	2.00	0.65	0.03%	0.001	0.34	0.079	0.765	0.18%	0.0003
4.98	495	1.8E-03	4.5E+02	1.9E-04	10	0.197	8524	0.03%	2.00	0.65	0.03%	0.002	0.34	0.079	0.765	0.24%	0.0004
5.03	495	1.8E-03	4.5E+02	1.9E-04	10	0.197	8486	0.03%	2.00	0.65	0.03%	0.002	0.34	0.079	0.765	0.29%	0.0005
5.08	495	1.8E-03	4.3E+02	2.0E-04	16	0.450	6952	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.78%	0.0013
5.13	495	1.8E-03	4.5E+02	2.0E-04	10	0.198	8412	0.03%	2.00	0.65	0.03%	0.002	0.34	0.079	0.765	0.37%	0.0006
5.18	495	1.8E-03	4.5E+02	2.0E-04	10	0.199	8375	0.03%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.41%	0.0007
5.23	495	1.8E-03	4.5E+02	2.0E-04	10	0.200	8338	0.03%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.45%	0.0007
5.28	495	1.8E-03	4.5E+02	2.0E-04	10	0.200	8302	0.04%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.49%	0.0008
5.33	495	1.8E-03	4.5E+02	2.0E-04	10	0.201	8266	0.04%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.53%	0.0009
5.38	495	1.8E-03	4.5E+02	2.1E-04	10	0.201	8232	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.56%	0.0009
5.43	495	1.8E-03	4.5E+02	2.1E-04	10	0.202	8197	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.60%	0.0010
5.48	495	1.8E-03	4.5E+02	2.1E-04	10	0.202	8163	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.63%	0.0010
5.53	495	1.8E-03	4.5E+02	2.1E-04	10	0.203	8130	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.66%	0.0011
5.58	495	1.8E-03	4.5E+02	2.2E-04	10	0.203	8097	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.70%	0.0011
5.63	495	1.8E-03	4.5E+02	2.2E-04	10	0.204	8064	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.73%	0.0012
5.68	495	1.8E-03	4.5E+02	2.2E-04	10	0.204	8032	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.76%	0.0012
5.73	495	1.8E-03	4.5E+02	2.2E-04	10	0.205	8000	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.79%	0.0013
5.78	495	1.8E-03	4.5E+02	2.2E-04	10	0.205	7969	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.82%	0.0014
5.83	495	1.8E-03	4.5E+02	2.3E-04	10	0.206	7938	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.85%	0.0014
5.88	460	1.8E-03	3.7E+02	2.8E-04	16	0.458	6510	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.95%	0.0032
5.93	460	1.8E-03	3.7E+02	2.8E-04	16	0.458	6487	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.98%	0.0033
5.98	460	1.8E-03	3.9E+02	2.7E-04	10	0.207	7851	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.57%	0.0026
6.03	460	1.8E-03	3.9E+02	2.7E-04	10	0.208	7821	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.61%	0.0026
6.08	460	1.8E-03	3.7E+02	2.9E-04	16	0.460	6416	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.09%	0.0034
6.13	460	1.8E-03	3.9E+02	2.8E-04	10	0.208	7765	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.67%	0.0027
6.18	460	1.8E-03	3.9E+02	2.8E-04	10	0.209	7737	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.71%	0.0028
6.23	460	1.8E-03	3.9E+02	2.8E-04	10	0.209	7709	0.07%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.74%	0.0029
6.28	460	1.8E-03	3.9E+02	2.8E-04	10	0.210	7681	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.78%	0.0029
6.33	460	1.8E-03	3.9E+02	2.9E-04	10	0.210	7654	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.82%	0.0030
6.38	460	1.8E-03	3.9E+02	2.9E-04	10	0.211	7627	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.85%	0.0030
6.43	460	1.8E-03	3.9E+02	2.9E-04	10	0.211	7601	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.89%	0.0031
6.48	460	1.8E-03	3.9E+02	2.9E-04	10	0.212	7574	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.92%	0.0032
6.53	460	1.8E-03	3.9E+02	2.9E-04	10	0.212	7548	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.96%	0.0032
6.58	460	1.8E-03	3.9E+02	3.0E-04	10	0.213	7523	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.99%	0.0033
6.63	460	1.8E-03	3.7E+02	3.2E-04	16	0.464	6175	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.50%	0.0041
6.68	460	1.8E-03	3.9E+02	3.0E-04	10	0.213	7473	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.06%	0.0034
6.73	460	1.8E-03	3.9E+02	3.0E-04	10	0.214	7449	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.10%	0.0034
6.78	460	1.8E-03	3.7E+02	3.2E-04	16	0.466	6115	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.61%	0.0043
6.83	460	1.8E-03	3.7E+02	3.3E-04	16	0.466	6096	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.65%	0.0043
6.88	460	1.8E-03	3.9E+02	3.1E-04	10	0.215	7378	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.20%	0.0036
6.93	460	1.8E-03	3.9E+02	3.1E-04	10	0.215	7354	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.24%	0.0037
6.98	460	1.8E-03	3.9E+02	3.2E-04	10	0.216	7331	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.28%	0.0037
7.03	460	1.8E-03	3.9E+02	3.2E-04	10	0.216	7308	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.31%	0.0038
7.08	460	1.8E-03	3.9E+02	3.2E-04	10	0.217	7285	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.35%	0.0039
7.13	460	1.8E-03	3.9E+02	3.2E-04	10	0.217	7262	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.39%	0.0039
7.18	460	1.8E-03	3.9E+02	3.3E-04	10	0.218	7239	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.43%	0.0040
7.23	460	1.8E-03	3.9E+02	3.3E-04	10	0.218	7217	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.46%	0.0040
7.28	460	1.8E-03	3.9E+02	3.3E-04	10	0.218	7195	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.50%	0.0041
7.33	460	1.8E-03	3.9E+02	3.3E-04	10	0.219	7173	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.54%	0.0042
7.38	460	1.8E-03	3.9E+02	3.4E-04	10	0.219	7152	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.58%	0.0042
7.43	460	1.8E-03	3.9E+02	3.4E-04	10	0.220	7130	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.61%	0.0043
7.48	500	1.8E-03	4.6E+02	2.9E-04	10	0.220	7109	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.71%	0.0028
7.53	500	1.8E-03	4.6E+02	2.9E-04	10	0.220	7088	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.73%	0.0028
7.58	500	1.8E-03	4.6E+02	2.9E-04	10	0.221	7067	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.76%	0.0029
7.63	500	1.8E-03	4.6E+02	2.9E-04	10	0.221	7047	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.79%	0.0029
7.68	500	1.8E-03	4.6E+02	3.0E-04	10	0.222	7027	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.82%	0.0030
7.73	500	1.8E-03	4.6E+02	3.0E-04	10	0.222	7006	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.84%	0.0030
7.78	500	1.8E-03	4.6E+02	3.0E-04	10	0.222	6987	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.87%	0.0031
7.83	500	1.8E-03	4.6E+02	3.0E-04	10	0.223	6967	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.90%	0.0031
7.88	500	1.8E-03	4.6E+02	3.0E-04	10	0.223	6947	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.93%	0.0032
7.93	500	1.8E-03	4.6E+02	3.1E-04	10	0.223	6928	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.96%	0.0032
7.98	500	1.8E-03	4.6E+02	3.1E-04	10	0.224	6909	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.99%	0.0033
8.03	500	1.8E-03	4.4E+02	3.3E-04	16	0.475	5678	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.45%	0.0040
8.08	500	1.8E-03	4.4E+02	3.3E-04	16	0.476	5663	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.48%	0.0041
8.13	500	1.8E-03	4.4E+02	3.3E-04	16	0.476	5649	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.51%	0.0041
8.18	500	1.8E-03	4.4E+02	3.3E-04	16	0.476	5634	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.54%	0.0042
8.23	500	1.8E-03	4.4E+02	3.4E-04	16	0.477	5620	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.57%	0.0042
8.28	500	1.8E-03	4.4E+02	3.4E-04	16	0.477	5606	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.60%	0.0043

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W4-C

Data File: 13-52106_SP2W4-C-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)

Parameter	Value
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69

Youd, et al (2001)

Parameter	Value
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Description
5611.20	Water surface elevation during CPT investigation (ft a
5607.96	Water surface elevation at t_0 (ft amsl)
5593.50	Water surface elevation at t_1 (ft amsl)
5588.50	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ratio, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earth
7.51	Equiv. Number of Uniform Strain Cycles, N
5616.24	Ground Surface Elevation at time of CPT (ft amsl)
5626.19	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
1.95	Thickness of Random/Platform Fill on top of existing interim cover (ft)
1104.55	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5588.50	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	5626.19	5625.94	5625.69	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	5625.69	5623.94	5622.19	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	5622.19	5620.19	5618.19	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334	1.83	508	1.9E-03	4.8E+02	6.8E-05	11	0.153	12419	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	5618.19	5617.22	5616.24	1.95	0.050	101	0.552	0.503	0.00	0.00	0.552	0.503	2.74	508	1.6E-03	4.0E+02	1.2E-04	11	0.170	10482	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
17.388	5598.85	7.9	0.164	7.7	33.1	14.33	2.07%	Slime Tailings	0.057	113.1	0.98	0.39	0.59	1	1.34	10.339	143.72	12.33	12	2.36%	2.9	71%	1.53	0.00	1.53	0
17.552	5598.69	11.4	0.123	11.3	9.0	3.89	1.08%	Sand-Slime Tailin	0.059	119.0	0.99	0.39	0.60	1	1.33	15.075	209.54	17.60	17	1.19%	2.6	47%	1.54	0.00	1.54	0
17.716	5598.52	11.9	0.100	11.9	9.2	3.97	0.84%	Sand-Slime Tailin	0.059	119.0	1.00	0.40	0.60	1	1.32	15.752	218.95	18.38	18	0.91%	2.5	47%	1.55	0.00	1.55	0
17.880	5598.36	13.3	0.080	13.2	10.8	4.68	0.60%	Sand-Slime Tailin	0.059	119.0	1.01	0.40	0.61	1	1.32	17.409	241.99	20.32	20	0.65%	2.4	47%	1.56	0.00	1.56	0
18.044	5598.20	11.4	0.112	11.3	11.6	5.01	0.98%	Sand-Slime Tailin	0.059	119.0	1.02	0.41	0.61	1	1.31	14.805	205.79	17.31	17	1.08%	2.6	47%	1.57	0.00	1.57	0
18.208	5598.03	9.8	0.153	9.6	32.4	14.04	1.56%	Sand-Slime Tailin	0.059	119.0	1.03	0.41	0.61	1	1.30	12.479	173.46	14.80	14	1.75%	2.7	47%	1.58	0.00	1.58	0
18.372	5597.87	8.7	0.140	8.4	48.2	20.90	1.61%	Slime Tailings	0.057	113.1	1.03	0.42	0.62	1	1.29	10.848	150.78	13.05	12	1.83%	2.8	71%	1.59	0.00	1.59	0
18.537	5597.70	13.2	0.140	13.0	34.0	14.71	1.06%	Sand-Slime Tailin	0.059	119.0	1.04	0.42	0.62	1	1.29	16.691	232.01	19.70	19	1.15%	2.5	47%	1.60	0.00	1.60	0
18.701	5597.54	16.6	0.192	16.5	16.7	7.23	1.15%	Sand-Slime Tailin	0.059	119.0	1.05	0.43	0.63	1	1.27	21.007	292.00	24.55	25	1.23%	2.5	47%	1.61	0.00	1.61	0
18.865	5597.38	18.6	0.304	18.5	20.3	8.79	1.64%	Sand-Slime Tailin	0.059	119.0	1.06	0.43	0.63	1	1.26	23.192	322.37	27.12	28	1.74%	2.5	47%	1.62	0.00	1.62	0
19.029	5597.21	12.1	0.344	12.0	21.5	9.30	2.85%	Slime Tailings	0.057	113.1	1.07	0.44	0.64	1	1.27	15.124	210.23	17.76	17	3.12%	2.8	71%	1.63	0.00	1.63	0
19.193	5597.05	10.5	0.228	10.4	14.6	6.31	2.17%	Slime Tailings	0.057	113.1	1.08	0.44	0.64	1	1.26	13.121	182.38	15.37	15	2.42%	2.8	71%	1.63	0.00	1.63	0
19.357	5596.88	14.9	0.247	14.8	23.9	10.36	1.66%	Sand-Slime Tailin	0.059	119.0	1.09	0.45	0.65	1	1.25	18.446	256.39	21.64	21	1.79%	2.6	47%	1.64	0.00	1.64	0
19.521	5596.72	13.9	0.205	13.8	21.2	9.20	1.47%	Sand-Slime Tailin	0.059	119.0	1.10	0.45	0.65	1	1.25	17.183	238.84	20.15	20	1.60%	2.6	47%	1.65	0.00	1.65	0
19.685	5596.56	13.2	0.218	13.1	22.9	9.93	1.65%	Sand-Slime Tailin	0.059	119.0	1.11	0.46	0.66	1	1.24	16.221	225.47	19.05	19	1.80%	2.7	47%	1.66	0.00	1.66	0
19.849	5596.39	13.5	0.200	13.2	37.2	16.11	1.49%	Sand-Slime Tailin	0.059	119.0	1.12	0.46	0.66	1	1.23	16.280	226.29	19.24	19	1.62%	2.6	47%	1.67	0.00	1.67	0
20.013	5596.23	12.3	0.225	12.1	40.5	17.56	1.82%	Sand-Slime Tailin	0.059	119.0	1.13	0.47	0.66	1	1.22	14.794	205.64	17.54	17	2.01%	2.7	47%	1.68	0.00	1.68	0
20.177	5596.06	11.2	0.272	11.1	13.6	5.88	2.44%	Slime Tailings	0.057	113.1	1.14	0.47	0.67	1	1.22	13.492	187.53	15.79	15	2.72%	2.8	71%	1.69	0.00	1.69	0
20.341	5595.90	8.2	0.252	7.9	49.1	21.27	3.08%	Slime Tailings	0.057	113.1	1.15	0.48	0.67	1	1.21	9.557	132.85	11.53	10	3.58%	3.0	71%	1.70	0.00	1.70	0
20.505	5595.74	9.4	0.193	9.0	75.9	32.90	2.05%	Slime Tailings	0.057	113.1	1.16	0.48	0.68	1	1.21	10.815	150.33	13.23	12	2.33%	2.9	71%	1.71	0.00	1.71	0
20.669	5595.57	9.3	0.202	9.0	52.0	22.51	2.18%	Slime Tailings	0.057	113.1	1.17	0.49	0.68	1	1.20	10.763	149.61	12.95	12	2.49%	2.9	71%	1.72	0.00	1.72	0
20.833	5595.41	8.3	0.219	7.8	73.7	31.95	2.64%	Slime Tailings	0.057	113.1	1.18	0.49	0.69	1	1.20	9.349	129.95	11.50	10	3.08%	3.0	71%	1.73	0.00	1.73	0
20.997	5595.24	12.0	0.180	11.6	62.5	27.06	1.50%	Sand-Slime Tailin	0.059	119.0	1.19	0.50	0.69	1	1.19	13.843	192.42	16.62	16	1.66%	2.7	47%	1.74	0.00	1.74	0
21.161	5595.08	19.0	0.205	19.0	5.5	2.37	1.08%	Sand-Slime Tailin	0.059	119.0	1.20	0.50	0.69	1	1.17	22.300	309.97	25.95	26	1.15%	2.4	47%	1.75	0.00	1.75	0
21.325	5594.91	17.5	0.316	17.4	19.7	8.54	1.80%	Sand-Slime Tailin	0.059	119.0	1.21	0.51	0.70	1	1.17	20.385	283.36	23.84	23	1.94%	2.6	47%	1.76	0.00	1.76	0
21.489	5594.75	17.3	0.420	17.1	33.3	14.41	2.43%	Sand-Slime Tailin	0.059	119.0	1.22	0.51	0.70	1	1.17	19.921	276.90	23.42	23	2.62%	2.7	47%	1.77	0.00	1.77	0
21.653	5594.59	15.7	0.502	15.4	48.2	20.90	3.21%	Slime Tailings	0.057	113.1	1.23	0.52	0.71	1	1.17	17.885	248.60	21.18	20	3.48%	2.8	71%	1.78	0.00	1.78	0
21.817	5594.42	15.8	0.368	15.7	17.6	7.63	2.33%	Sand-Slime Tailin	0.059	119.0	1.24	0.52	0.71	1	1.16	18.175	252.63	21.26	20	2.53%	2.7	47%	1.79	0.00	1.79	0
21.981	5594.26	15.2	0.338	15.1	19.9	8.62	2.23%	Sand-Slime Tailin	0.059	119.0	1.25	0.53	0.72	1	1.15	17.362	241.33	20.33	19	2.43%	2.7	47%	1.80	0.00	1.80	0
22.145	5594.09	12.0	0.255	11.8	32.8	14.22	2.12%	Slime Tailings	0.057	113.1	1.25	0.53	0.72	1	1.15	13.551	188.36	16.01	15	2.37%	2.8	71%	1.81	0.00	1.81	0
22.309	5593.93	8.6	0.140	8.2	71.6	31.03	1.62%	Slime Tailings	0.057	113.1	1.26	0.54	0.73	1	1.14	9.341	129.83	11.44	10	1.90%	2.9	71%	1.82	0.00	1.82	0
22.473	5593.77	9.5	0.099	9.0	82.5	35.75	1.04%	Sand-Slime Tailin	0.059	119.0	1.27	0.54	0.73	1	1.14	10.238	142.31	12.57	11	1.20%	2.7	47%	1.83	0.00	1.83	0
22.638	5593.60	10.4	0.096	9.8	94.2	40.81	0.93%	Sand-Slime Tailin	0.059	119.0	1.28	0.55	0.73	1	1.13	11.059	153.72	13.62	12	1.06%	2.7	47%	1.84	0.00	1.84	0
22.802	5593.44	9.9	0.099	9.3	99.2	43.00	1.00%	Sand-Slime Tailin	0.059	119.0	1.29	0.55	0.74	1	1.13	10.431	144.98	12.92	12	1.15%	2.7	47%	1.85	0.00	1.84	1
22.966	5593.27	10.2	0.107	9.5	106.1	45.99	1.05%	Sand-Slime Tailin	0.059	119.0	1.30	0.56	0.74	1	1.12	10.660	148.17	13.24	12	1.21%	2.7	47%	1.86	0.01	1.85	1
23.130	5593.11	10.7	0.153	10.0	111.1	48.14	1.44%	Sand-Slime Tailin	0.059	119.0	1.31	0.56	0.75	1	1.12	11.110	154.43	13.80	12	1.64%	2.8	47%	1.87	0.01	1.85	1
23.294	5592.95	12.8	0.177	12.1	112.8	48.88	1.39%	Sand-Slime Tailin	0.059	119.0	1.32	0.57	0.75	1	1.11	13.388	186.09	16.46	15	1.55%	2.7	47%	1.88	0.02	1.86	1
23.458	5592.78	14.7	0.172	14.3	63.4	27.46	1.17%	Sand-Slime Tailin	0.059	119.0	1.33	0.57	0.76	1	1.10	15.787	219.45	18.84	18	1.29%	2.6	47%	1.88	0.02	1.86	1
23.622	5592.62	13.1	0.169	12.7	73.0	31.63	1.29%	Sand-Slime Tailin	0.059	119.0	1.34	0.58	0.76	1	1.10	13.909	193.34	16.74	15	1.44%	2.7	47%	1.89	0.03	1.87	1
23.786	5592.45	13.9	0.141	13.4	84.0	36.41	1.02%	Sand-Slime Tailin	0.059	119.0	1.35	0.58	0.77	1	1.09	14.609	203.07	17.63	16	1.13%	2.6	47%	1.90	0.03	1.87	1
23.950	5592.29	12.4	0.180	12.0	69.1	29.93	1.45%	Sand-Slime Tailin	0.059	119.0	1.36	0.59	0.77	1	1.09	13.081	181.83	15.74	14	1.62%	2.7	47%	1.91	0.04	1.88	1
24.114	5592.13	12.8	0.188	11.8	149.2	64.65	1.47%	Sand-Slime Tailin	0.059	119.0	1.37	0.60	0.78	1	1.08	12.814	178.11	16.06	15	1.65%	2.7	47%	1.92	0.04	1.88	1
24.278	5591.96	13.0	0.159	12.1	152.5	66.07	1.22%	Sand-Slime Tailin	0.059	119.0	1.38	0.60	0.78	1	1.08	13.024	181.04	16.32	15	1.37%	2.7	47%	1.93	0.05	1.89	1
24.442	5591.80	13.9	0.175	13.0	152.5	66.07	1.26%	Sand-Slime Tailin	0.059	119.0	1.39	0.61	0.79	1	1.07	13.931	193.64	17.37	16	1.40%	2.6	47%	1.94	0.05	1.89	1
24.606	5591.63	14.2	0.192	13.3	152.9	66.26	1.35%	Sand-Slime Tailin	0.059	119.0	1.40	0.61	0.79	1	1.07	14.198	197.35	17.68	16	1.50%	2.7	47%	1.95	0.06	1.89	1
24.770	5591.47	13.7	0.186	12.8	151.0	65.42	1.36%	Sand-Slime Tailin	0.059	119.0	1.41	0.62	0.80	1	1.06	13.601	189.06	16.96	15	1.51%	2.7	47%	1.96	0.06	1.90	1
24.934	5591.31	12.8	0.197	12.0	120.3	52.12	1.54%	Sand-Slime Tailin	0.059	119.0	1.42	0.62	0.80	1	1.06	12.734	177.01	15.71	14	1.74%	2.7	47%	1.97	0.07	1.90	1
25.098	5591.14	11.7	0.209	10.9	127.8	55.38	1.79%	Sand-Slime Tailin	0.059	119.0	1.43	0.63	0.80	1	1.05	11.464	159.35	14.29	13	2.04%	2.8	47%	1.98	0.07	1.91	1
25.262	5590.98	11.2	0.195	10.6	97.8	42.36	1.74%	Sand-Slime Tailin	0.059	119.0	1.44	0.63	0.81	1	1.05	11.150	154.99	13.69	12	1.99%	2.8	47%	1.99	0.08	1.91	1
25.426	5590.81	11.4	0.160	10.8	101.4	43.94	1.41%	Sand-Slime Tailin	0.059	119.0	1.45	0.64	0.81	1	1.05	11.236	156.18	13.82	12	1.61%	2.8	47%	2.00	0.08	1.92	1
25.590	5590.65	11.2	0.149	10.6	105.8	45.83	1.33%	Sand-Slime Tailin	0.059	119.0	1.46	0.64	0.82	1	1.04	10.978	152.60	13.55	12	1.53%	2.8	47%	2.01	0.09	1.92	1
25.754	5590.49	11.6	0.159	11.1	86.4	37.44	1.37%	Sand-Slime Tailin	0.059	119.0	1.47	0.65	0.82	1	1.04	11.458	159.27	13.96	12	1.57%	2.8	47%	2.02	0.09	1.93	1
25.918	5590.32	11.7	0.182	11.0	108.2	46.89	1.56%	Sand-Slime Tailin	0.059	119.0	1.48	0.65	0.83	1	1.03	11.356	157.85	14.00	12	1.78%	2.8	47%	2.03	0.10	1.93	1
26.082	5590.16	11.7	0.204	11.1	102.1	44.24	1.74%	Sand-Slime Tailin	0.059	119.0	1.49	0.66	0.83	1	1.03	11.368	158.02	13.96	12	2.00%	2.8	47%	2.04	0.10	1.94	1
26.246	5589.99	11.8	0.197	11.1	100.4	43.51	1.67%	Sand-Slime Tailin	0.059	119.0	1.50	0.66	0.84	1	1.02	11.391	158.33	13.97	12	1.92%	2.8	47%	2.05	0.11	1.94	1
26.410	5589.83	11.4	0.197	10.8	88.6	38.40	1.73%	Sand-Slime Tailin	0.059	119.0	1.51	0.67	0.84	1	1.02	11.016	153.12	13.45	12	2.00%	2.8	47%	2.06	0.11	1.95	1
26.574	5589.67	10.5	0.197	10.0	88.3	38.26	1.87%	Sand-Slime Tailin	0.059	119.0	1.52	0.67	0.85	1	1.01	10.127	140.77	12.41	11	2.18%	2.9	47%	2.07	0.12	1.95	1
27.740	5588.50							Sand-Slime Tailin	0.059	119.0													2.14	0.14	2.00	1

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	I&B (2008) r_d	C_σ	K_σ	K_α	CSR M=7.5, σ'v=1atm	Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, σ'v=1atm	FoS	Youd (2001) r_d	D_r	f	K_σ	K_α	CSR M=7.5, σ'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, σ'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
17.388	0.90	0.05	0.97	1.0	0.050	34.38	46.71	0.074	1.47	0.94	0.20	0.80	1.08	1.0	0.038	5.52	68.04	0.109	3.85	2.66	2
17.552	0.90	0.05	0.97	1.0	0.050	36.47	54.07	0.082	1.62	0.94	0.24	0.80	1.08	1.0	0.038	3.19	56.15	0.096	3.38	2.50	2
17.716	0.89	0.05	0.97	1.0	0.050	36.75	55.13	0.083	1.65	0.94	0.25	0.80	1.07	1.0	0.038	2.79	51.35	0.093	3.22	2.43	2
17.880	0.89	0.05	0.97	1.0	0.050	37.43	57.75	0.085	1.71	0.94	0.26	0.80	1.07	1.0	0.038	2.30	46.76	0.089	3.07	2.39	2
18.044	0.89	0.05	0.97	1.0	0.050	36.37	53.68	0.081	1.62	0.93	0.24	0.80	1.07	1.0	0.038	3.13	54.15	0.095	3.25	2.43	2
18.208	0.89	0.05	0.97	1.0	0.050	35.49	50.29	0.078	1.56	0.93	0.22	0.80	1.07	1.0	0.039	4.29	63.44	0.104	3.53	2.54	2
18.372	0.89	0.05	0.97	1.0	0.050	34.63	47.68	0.075	1.51	0.93	0.21	0.80	1.07	1.0	0.039	4.81	62.72	0.103	3.48	2.49	2
18.537	0.89	0.05	0.97	1.0	0.050	37.21	56.91	0.085	1.70	0.93	0.26	0.80	1.07	1.0	0.039	2.92	57.59	0.098	3.28	2.49	2
18.701	0.89	0.06	0.97	1.0	0.049	38.91	63.46	0.092	1.85	0.93	0.29	0.80	1.07	1.0	0.039	2.55	62.56	0.103	3.42	2.64	2
18.865	0.89	0.06	0.96	1.0	0.049	39.81	66.93	0.096	1.94	0.93	0.30	0.80	1.06	1.0	0.039	2.76	74.88	0.119	3.94	2.94	2
19.029	0.88	0.05	0.97	1.0	0.049	36.27	54.04	0.081	1.65	0.93	0.24	0.80	1.06	1.0	0.039	4.91	87.26	0.142	4.66	3.15	2
19.193	0.88	0.05	0.97	1.0	0.049	35.44	50.81	0.078	1.58	0.93	0.23	0.80	1.06	1.0	0.039	4.83	74.31	0.118	3.86	2.72	2
19.357	0.88	0.05	0.97	1.0	0.049	37.89	59.53	0.087	1.78	0.93	0.27	0.80	1.06	1.0	0.039	3.31	71.69	0.114	3.71	2.74	2
19.521	0.88	0.05	0.97	1.0	0.049	37.37	57.52	0.085	1.73	0.93	0.26	0.80	1.06	1.0	0.039	3.32	66.95	0.108	3.48	2.61	2
19.685	0.88	0.05	0.97	1.0	0.049	36.98	56.03	0.084	1.70	0.93	0.25	0.80	1.06	1.0	0.039	3.65	69.51	0.111	3.56	2.63	2
19.849	0.88	0.05	0.97	1.0	0.049	37.05	56.29	0.084	1.71	0.93	0.25	0.80	1.05	1.0	0.039	3.47	66.72	0.108	3.42	2.57	2
20.013	0.88	0.05	0.97	1.0	0.049	36.45	54.00	0.081	1.66	0.93	0.24	0.80	1.05	1.0	0.039	4.08	71.55	0.114	3.60	2.63	2
20.177	0.87	0.05	0.97	1.0	0.049	35.59	51.38	0.079	1.61	0.93	0.23	0.80	1.05	1.0	0.039	5.03	79.45	0.127	3.98	2.80	2
20.341	0.87	0.05	0.97	1.0	0.049	34.10	45.64	0.073	1.50	0.93	0.20	0.80	1.05	1.0	0.039	7.03	81.06	0.130	4.05	2.78	2
20.505	0.87	0.05	0.97	1.0	0.049	34.69	47.92	0.076	1.55	0.93	0.21	0.80	1.05	1.0	0.039	5.35	70.73	0.113	3.52	2.53	2
20.669	0.87	0.05	0.97	1.0	0.049	34.60	47.55	0.075	1.54	0.92	0.21	0.80	1.05	1.0	0.039	5.58	72.33	0.115	3.57	2.56	2
20.833	0.87	0.05	0.97	1.0	0.049	34.09	45.59	0.073	1.51	0.92	0.20	0.80	1.05	1.0	0.039	6.64	76.37	0.121	3.75	2.63	2
20.997	0.87	0.05	0.96	1.0	0.048	36.13	52.75	0.080	1.66	0.92	0.24	0.80	1.05	1.0	0.039	3.93	65.36	0.106	3.25	2.45	2
21.161	0.87	0.06	0.96	1.0	0.048	39.40	65.35	0.094	1.95	0.92	0.29	0.80	1.04	1.0	0.039	2.42	62.89	0.103	3.15	2.55	2
21.325	0.87	0.05	0.96	1.0	0.048	38.66	62.51	0.091	1.89	0.92	0.28	0.80	1.04	1.0	0.039	3.25	77.41	0.123	3.74	2.81	2
21.489	0.86	0.05	0.96	1.0	0.048	38.51	61.93	0.090	1.88	0.92	0.28	0.80	1.04	1.0	0.039	3.80	88.94	0.145	4.40	3.14	2
21.653	0.86	0.05	0.96	1.0	0.048	37.46	58.64	0.086	1.80	0.92	0.27	0.80	1.04	1.0	0.039	4.68	99.17	0.171	5.14	3.47	2
21.817	0.86	0.05	0.96	1.0	0.048	37.76	59.01	0.087	1.81	0.92	0.27	0.80	1.04	1.0	0.039	4.01	85.19	0.137	4.12	2.96	2
21.981	0.86	0.05	0.96	1.0	0.048	37.43	57.76	0.085	1.79	0.91	0.26	0.80	1.04	1.0	0.039	4.06	82.51	0.132	3.94	2.86	2
22.145	0.86	0.05	0.96	1.0	0.048	35.66	51.68	0.079	1.65	0.91	0.23	0.80	1.04	1.0	0.039	4.75	76.11	0.121	3.59	2.62	2
22.309	0.86	0.05	0.96	1.0	0.048	34.07	45.51	0.073	1.53	0.91	0.20	0.80	1.03	1.0	0.039	5.55	63.50	0.104	3.07	2.30	2
22.473	0.86	0.05	0.96	1.0	0.048	34.71	47.28	0.075	1.57	0.91	0.20	0.80	1.03	1.0	0.039	4.33	54.47	0.095	2.79	2.18	2
22.638	0.85	0.05	0.96	1.0	0.048	35.08	48.70	0.076	1.60	0.91	0.21	0.80	1.03	1.0	0.039	3.88	52.88	0.094	2.74	2.17	2
22.802	0.85	0.05	0.96	1.0	0.048	34.83	47.76	0.075	1.58	0.91	0.21	0.80	1.03	1.0	0.039	4.18	54.08	0.095	2.75	2.17	2
22.966	0.85	0.05	0.96	1.0	0.048	34.95	48.19	0.076	1.59	0.91	0.21	0.80	1.03	1.0	0.039	4.18	55.34	0.096	2.76	2.18	2
23.130	0.85	0.05	0.96	1.0	0.048	35.14	48.94	0.076	1.60	0.90	0.21	0.80	1.03	1.0	0.039	4.56	63.00	0.103	2.96	2.28	2
23.294	0.85	0.05	0.96	1.0	0.048	36.07	52.53	0.080	1.68	0.90	0.23	0.80	1.03	1.0	0.039	3.91	64.31	0.105	2.98	2.33	2
23.458	0.85	0.05	0.96	1.0	0.048	36.91	55.75	0.083	1.75	0.90	0.25	0.80	1.03	1.0	0.039	3.27	61.70	0.102	2.87	2.31	2
23.622	0.85	0.05	0.96	1.0	0.048	36.17	52.91	0.080	1.68	0.90	0.23	0.80	1.03	1.0	0.039	3.75	62.77	0.103	2.89	2.28	2
23.786	0.85	0.05	0.96	1.0	0.048	36.49	54.12	0.082	1.71	0.90	0.24	0.80	1.02	1.0	0.039	3.27	57.67	0.098	2.72	2.21	2
23.950	0.84	0.05	0.96	1.0	0.048	35.82	51.56	0.079	1.65	0.90	0.23	0.80	1.02	1.0	0.040	4.14	65.19	0.106	2.92	2.29	2
24.114	0.84	0.05	0.96	1.0	0.048	35.93	51.99	0.079	1.66	0.90	0.23	0.80	1.02	1.0	0.040	4.11	66.05	0.107	2.93	2.29	2
24.278	0.84	0.05	0.96	1.0	0.048	36.03	52.34	0.080	1.67	0.90	0.23	0.80	1.02	1.0	0.040	3.76	61.39	0.102	2.76	2.21	2
24.442	0.84	0.05	0.96	1.0	0.048	36.39	53.76	0.081	1.69	0.89	0.24	0.80	1.02	1.0	0.040	3.62	62.94	0.103	2.79	2.24	2
24.606	0.84	0.05	0.96	1.0	0.048	36.50	54.18	0.082	1.70	0.89	0.24	0.80	1.02	1.0	0.040	3.68	65.11	0.106	2.84	2.27	2
24.770	0.84	0.05	0.96	1.0	0.048	36.25	53.21	0.081	1.68	0.89	0.24	0.80	1.02	1.0	0.040	3.82	64.78	0.105	2.81	2.24	2
24.934	0.84	0.05	0.96	1.0	0.048	35.81	51.53	0.079	1.64	0.89	0.23	0.80	1.01	1.0	0.040	4.29	67.41	0.108	2.87	2.26	2
25.098	0.83	0.05	0.96	1.0	0.048	35.31	49.61	0.077	1.60	0.89	0.22	0.80	1.01	1.0	0.040	4.93	70.46	0.113	2.96	2.28	2
25.262	0.83	0.05	0.96	1.0	0.048	35.10	48.80	0.076	1.58	0.89	0.21	0.80	1.01	1.0	0.040	5.04	69.04	0.111	2.89	2.24	2
25.426	0.83	0.05	0.96	1.0	0.048	35.15	48.97	0.077	1.59	0.89	0.21	0.80	1.01	1.0	0.040	4.60	63.56	0.104	2.70	2.14	2
25.590	0.83	0.05	0.96	1.0	0.048	35.05	48.60	0.076	1.58	0.88	0.21	0.80	1.01	1.0	0.040	4.58	62.02	0.102	2.63	2.11	2
25.754	0.83	0.05	0.96	1.0	0.048	35.20	49.15	0.077	1.59	0.88	0.22	0.80	1.01	1.0	0.040	4.53	63.18	0.103	2.65	2.12	2
25.918	0.83	0.05	0.96	1.0	0.048	35.21	49.21	0.077	1.59	0.88	0.22	0.80	1.01	1.0	0.041	4.76	66.63	0.108	2.74	2.16	2
26.082	0.83	0.05	0.96	1.0	0.048	35.20	49.16	0.077	1.59	0.88	0.22	0.80	1.01	1.0	0.041	5.00	69.81	0.112	2.82	2.20	2
26.246	0.82	0.05	0.96	1.0	0.048	35.20	49.18	0.077	1.58	0.88	0.22	0.80	1.00	1.0	0.041	4.92	68.75	0.110	2.77	2.18	2
26.410	0.82	0.05	0.96	1.0	0.048	35.02	48.47	0.076	1.57	0.88	0.21	0.80	1.00	1.0	0.041	5.15	69.27	0.111	2.77	2.17	2
26.574	0.82	0.05	0.96	1.0	0.048	34.65	47.07	0.075	1.54	0.88	0.20	0.80	1.00	1.0	0.041	5.67	70.40	0.112	2.79	2.16	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.425

Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
8.33	500	1.8E-03	4.4E+02	3.4E-04	16	0.477	5592	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.62%	0.0043
8.38	500	1.8E-03	4.6E+02	3.2E-04	10	0.227	6768	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.20%	0.0036
8.43	500	1.8E-03	4.6E+02	3.3E-04	10	0.227	6750	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.23%	0.0037
8.48	500	1.8E-03	4.6E+02	3.3E-04	10	0.227	6732	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.26%	0.0037
8.53	500	1.8E-03	4.6E+02	3.3E-04	10	0.228	6715	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.29%	0.0038
8.58	500	1.8E-03	4.6E+02	3.3E-04	10	0.228	6698	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.32%	0.0038
8.63	500	1.8E-03	4.4E+02	3.5E-04	16	0.480	5507	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.81%	0.0046
8.68	500	1.8E-03	4.6E+02	3.4E-04	10	0.229	6664	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.38%	0.0039
8.73	500	1.8E-03	4.6E+02	3.4E-04	10	0.229	6648	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.41%	0.0039
8.78	500	1.8E-03	4.6E+02	3.4E-04	10	0.230	6631	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.43%	0.0040
8.83	500	1.8E-03	4.4E+02	3.6E-04	16	0.481	5453	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.93%	0.0048
8.88	500	1.8E-03	4.4E+02	3.6E-04	16	0.481	5440	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.96%	0.0048
8.93	500	1.8E-03	4.6E+02	3.5E-04	10	0.231	6583	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.52%	0.0041
8.98	500	1.8E-03	4.6E+02	3.5E-04	10	0.231	6567	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.55%	0.0042
9.03	538	1.8E-03	5.3E+02	3.0E-04	10	0.231	6551	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.77%	0.0029
9.08	538	1.8E-03	5.3E+02	3.1E-04	10	0.232	6535	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.80%	0.0029
9.13	538	1.8E-03	5.3E+02	3.1E-04	10	0.232	6520	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.82%	0.0030
9.18	538	1.8E-03	5.1E+02	3.2E-04	16	0.483	5363	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.25%	0.0037
9.23	538	1.8E-03	5.1E+02	3.3E-04	16	0.484	5351	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.27%	0.0037
9.28	538	1.8E-03	5.1E+02	3.3E-04	16	0.484	5339	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.30%	0.0038
9.33	538	1.8E-03	5.1E+02	3.3E-04	16	0.484	5327	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.32%	0.0038
9.38	538	1.8E-03	5.1E+02	3.3E-04	16	0.485	5315	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.34%	0.0038
9.43	538	1.8E-03	5.3E+02	3.2E-04	10	0.234	6432	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.95%	0.0032
9.48	538	1.8E-03	5.3E+02	3.2E-04	10	0.234	6417	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.98%	0.0032
9.53	538	1.8E-03	5.3E+02	3.2E-04	10	0.235	6402	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.00%	0.0033
9.58	538	1.8E-03	5.3E+02	3.2E-04	10	0.235	6387	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.02%	0.0033
9.63	538	1.8E-03	5.1E+02	3.4E-04	16	0.486	5255	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.46%	0.0040
9.68	538	1.8E-03	5.3E+02	3.3E-04	10	0.236	6359	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.07%	0.0034
9.73	538	1.8E-03	5.3E+02	3.3E-04	10	0.236	6345	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.09%	0.0034
9.78	538	1.8E-03	5.1E+02	3.5E-04	16	0.487	5221	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.53%	0.0042
9.83	538	1.8E-03	5.1E+02	3.5E-04	16	0.487	5210	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.55%	0.0042
9.88	538	1.8E-03	5.3E+02	3.3E-04	10	0.237	6304	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.16%	0.0035
9.93	538	1.8E-03	5.3E+02	3.3E-04	10	0.237	6290	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.18%	0.0036
9.98	538	1.8E-03	5.3E+02	3.4E-04	10	0.237	6279	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.20%	0.0036
10.03	538	1.8E-03	5.3E+02	3.4E-04	10	0.237	6272	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.23%	0.0037
10.08	538	1.8E-03	5.3E+02	3.4E-04	10	0.238	6266	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.26%	0.0037
10.13	538	1.8E-03	5.3E+02	3.4E-04	10	0.238	6259	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.28%	0.0037
10.18	538	1.8E-03	5.3E+02	3.4E-04	10	0.238	6253	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.31%	0.0038
10.23	538	1.8E-03	5.3E+02	3.5E-04	10	0.238	6246	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.34%	0.0038
10.28	538	1.8E-03	5.3E+02	3.5E-04	10	0.238	6240	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.36%	0.0039
10.33	538	1.8E-03	5.3E+02	3.5E-04	10	0.238	6233	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.39%	0.0039
10.38	538	1.8E-03	5.3E+02	3.5E-04	10	0.239	6227	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.42%	0.0040
10.43	538	1.8E-03	5.3E+02	3.5E-04	10	0.239	6221	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.45%	0.0040
10.48	538	1.8E-03	5.3E+02	3.5E-04	10	0.239	6214	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.47%	0.0041
10.53	538	1.8E-03	5.3E+02	3.6E-04	10	0.239	6208	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.50%	0.0041
10.58	594	1.8E-03	6.5E+02	2.9E-04	10	0.239	6202	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.52%	0.0025
10.63	594	1.8E-03	6.5E+02	3.0E-04	10	0.239	6195	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.54%	0.0025
10.68	594	1.8E-03	6.5E+02	3.0E-04	10	0.239	6189	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.56%	0.0026
10.73	594	1.8E-03	6.5E+02	3.0E-04	10	0.240	6183	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.58%	0.0026
10.78	594	1.8E-03	6.5E+02	3.0E-04	10	0.240	6177	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.60%	0.0026
10.83	594	1.8E-03	6.5E+02	3.0E-04	10	0.240	6171	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.62%	0.0027
10.88	594	1.8E-03	6.5E+02	3.0E-04	10	0.240	6164	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.64%	0.0027
10.93	594	1.8E-03	6.5E+02	3.0E-04	10	0.240	6158	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.66%	0.0027
10.98	594	1.8E-03	6.5E+02	3.1E-04	10	0.240	6152	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.68%	0.0028
11.03	594	1.8E-03	6.5E+02	3.1E-04	10	0.240	6146	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.70%	0.0028
11.08	594	1.8E-03	6.5E+02	3.1E-04	10	0.241	6140	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.72%	0.0028
11.13	594	1.8E-03	6.5E+02	3.1E-04	10	0.241	6134	0.07%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.74%	0.0029
11.49	594	1.8E-03	6.5E+02	3.2E-04	10	0.242	6068	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.87%	0.0218

Extra layer added to analyze seismic settlement of tailings below the bottom of CPT investigation.

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W5-C

Data File: 13-52106_SP2W5-C-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Dat

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69

Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5604.20	Water surface elevation during CPT investigation (ft amsl)
5604.20	Water surface elevation at t_0 (ft amsl)
5589.01	Water surface elevation at t_1 (ft amsl)
5584.01	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Eart
7.51	Equiv. Number of Uniform Strain Cycles, N
5615.86	Ground Surface Elevation at time of CPT (ft amsl)
5626.28	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after plac
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
2.42	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1151.89	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5584.01	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5626.03	5625.78	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5624.03	5622.28	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5620.28	5618.28	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334	1.83	508	1.9E-03	4.8E+02	6.8E-05	11	0.153	12419	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######	5617.07	5615.86	2.42	0.050	101	0.576	0.515	0.00	0.00	0.576	0.515	2.81	508	1.6E-03	4.0E+02	1.2E-04	11	0.171	10381	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %
0.164	5615.70	4.8	0.029	4.8	1.1	0.49	0.60%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	8.143	113.19	9.47	580	0.61%	1.2	51%
0.328	5615.53	11.7	0.170	11.6	8.2	3.56	1.46%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	19.737	274.34	23.02	705	1.46%	1.5	51%
0.492	5615.37	34.1	0.408	34.1	8.9	3.84	1.20%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	57.885	804.60	67.34	1375	1.20%	1.3	51%
0.656	5615.20	51.6	0.661	51.6	1.4	0.59	1.28%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	87.686	1218.84	101.86	1560	1.28%	1.4	51%
0.820	5615.04	73.2	1.112	73.1	6.6	2.84	1.52%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	124.304	1727.83	144.45	1770	1.52%	1.4	51%
0.984	5614.88	89.2	1.392	89.2	-0.9	-0.37	1.56%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	151.606	2107.32	176.07	1798	1.56%	1.4	51%
1.148	5614.71	116.0	1.613	115.8	37.9	16.43	1.39%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	196.792	2735.41	229.03	2005	1.39%	1.4	51%
1.312	5614.55	135.8	1.481	135.7	12.6	5.44	1.09%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	230.724	3207.06	268.13	2054	1.09%	1.3	51%

Conditions at t_1 / Liquefaction Triggering Analyses – Idriss & Boulanger (2008)

Depth at time of CPT (ft)	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS
0.164	0.58	0.00	0.58	0	1.00	0.04	1.02	1.0	0.059	33.64	43.12	0.071	1.21
0.328	0.59	0.00	0.59	0	1.00	0.05	1.02	1.0	0.059	38.40	61.43	0.089	1.52
0.492	0.60	0.00	0.60	0	1.00	0.08	1.03	1.0	0.060	53.95	121.29	0.182	3.06
0.656	0.61	0.00	0.61	0	1.00	0.11	1.04	1.0	0.060	66.07	167.92	0.388	6.46
0.820	0.62	0.00	0.62	0	1.00	0.15	1.05	1.0	0.061	81.01	225.47	1.000	16.46
0.984	0.63	0.00	0.63	0	1.00	0.20	1.07	1.0	0.062	92.11	268.18	1.000	16.24
1.148	0.63	0.00	0.63	0	1.00	0.30	1.09	1.0	0.063	110.69	339.72	1.000	15.84
1.312	0.64	0.00	0.64	0	1.00	0.30	1.09	1.0	0.063	124.41	392.54	1.000	15.90

Youd et al. (2001)

Depth at time of CPT (ft)	r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
0.164	0.98	0.18	0.80	2.53	1.0	0.017	1.00	9.47	0.058	4.26	2.74	2
0.328	0.97	0.28	0.80	2.20	1.0	0.019	1.00	23.02	0.069	4.34	2.93	2
0.492	0.97	0.47	0.76	2.32	1.0	0.019	1.00	67.34	0.108	6.40	4.73	2
0.656	0.97	0.58	0.71	2.59	1.0	0.017	1.00	101.86	0.178	11.62	9.04	2
0.820	0.97	0.69	0.65	2.87	1.0	0.015	1.00	144.45	0.360	23.84	20.15	2
0.984	0.97	0.77	0.62	2.98	1.0	0.014	1.00	176.07	1.000	62.26	39.25	2
1.148	0.97	0.87	0.60	2.95	1.0	0.015	1.00	229.03	1.000	54.71	35.28	2
1.312	0.97	0.95	0.60	2.79	1.0	0.015	1.00	268.13	1.000	65.11	40.50	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.494

Depth at time of CPT (ft)	Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
0.164	3.23	594	1.6E-03	5.5E+02	1.0E-04	11	0.177	9851	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
0.328	3.28	594	1.6E-03	5.5E+02	1.0E-04	11	0.178	9794	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
0.492	3.33	594	1.6E-03	5.5E+02	1.1E-04	11	0.178	9738	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
0.656	3.38	594	1.6E-03	5.5E+02	1.1E-04	11	0.179	9683	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
0.820	3.43	594	1.6E-03	5.5E+02	1.1E-04	11	0.179	9629	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
0.984	3.48	594	1.6E-03	5.5E+02	1.1E-04	11	0.180	9576	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
1.148	3.53	594	1.6E-03	5.5E+02	1.1E-04	11	0.181	9524	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
1.312	3.58	594	1.6E-03	5.5E+02	1.1E-04	11	0.181	9473	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W5-C

Data File: 13-52106_SP2W5-C-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)
Max. Horiz. Acceleration, Amax/g: 0.15
Earthquake Moment Magnitude, M: 5.5
Magnitude Scaling Factor, MSF: 1.69

Youd, et al (2001)
Max. Horiz. Acceleration, Amax/g: 0.15
Earthquake Moment Magnitude, M: 5.5
Magnitude Scaling Factor, MSF: 2.21

5604.20 Water surface elevation during CPT investigation (ft amsl)
5604.20 Water surface elevation at t_0 (ft amsl)
5589.01 Water surface elevation at t_1 (ft amsl)
5584.01 Water surface elevation at t_2 (ft amsl)
1.44 Scaling Factor for stress ratio, r_m
0.47 Volumetric Strain Ratio for Site-Specific Design Earthquake
7.51 Equiv. Number of Uniform Strain Cycles, N

5615.86 Ground Surface Elevation at time of CPT (ft amsl)
5626.28 Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50 Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50 Thickness of Water Storage/Rooting Zone (ft)
4.00 Thickness of High Compaction Layer (ft)
2.42 Thickness of Random/Platform Fill on top of existing interim cover (ft)
1151.89 Additional Stress due to Final Cover Placement, $\Delta\sigma_{vc}$ (psf)
5584.01 Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5626.03	5625.78	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5624.03	5622.28	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5620.28	5618.28	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334	1.83	508	1.9E-03	4.8E+02	6.8E-05	11	0.153	12419	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######	5617.07	5615.86	2.42	0.050	101	0.576	0.515	0.00	0.00	0.576	0.515	2.81	508	1.6E-03	4.0E+02	1.2E-04	11	0.171	10381	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil. Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil. Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
17.388	5598.47	19.1	0.394	19.0	18.5	8.03	2.06%	Sand-Slime Tailings	0.059	119.0	0.90	0.18	0.73	1	1.14	21.615	300.45	25.26	25	2.16%	2.6	47%	1.48	0.00	1.48	0
17.552	5598.31	15.7	0.311	15.6	23.1	10.01	1.98%	Sand-Slime Tailings	0.059	119.0	0.91	0.18	0.73	1	1.14	17.686	245.84	20.73	20	2.10%	2.7	47%	1.49	0.00	1.49	0
17.716	5598.14	13.9	0.260	13.8	26.1	11.33	1.86%	Sand-Slime Tailings	0.059	119.0	0.92	0.19	0.73	1	1.13	15.596	216.78	18.33	18	2.00%	2.7	47%	1.50	0.00	1.50	0
17.880	5597.98	18.8	0.179	18.5	52.4	22.70	0.95%	Sand-Slime Tailings	0.059	119.0	0.93	0.19	0.74	1	1.12	20.761	288.58	24.54	24	1.00%	2.4	47%	1.51	0.00	1.51	0
18.044	5597.82	39.1	0.438	39.0	24.3	10.53	1.12%	Sand-Slime Tailings	0.059	119.0	0.94	0.20	0.74	1	1.10	42.754	594.28	49.85	51	1.15%	2.2	47%	1.52	0.00	1.52	0
18.208	5597.65	18.6	0.428	18.6	11.8	5.10	2.30%	Sand-Slime Tailings	0.059	119.0	0.95	0.20	0.75	1	1.11	20.630	286.76	24.06	24	2.42%	2.6	47%	1.53	0.00	1.53	0
18.372	5597.49	12.8	0.269	12.7	14.8	6.43	2.10%	Sand-Slime Tailings	0.059	119.0	0.96	0.21	0.75	1	1.11	14.096	195.93	16.49	16	2.27%	2.8	47%	1.54	0.00	1.54	0
18.537	5597.32	17.7	0.255	17.5	38.1	16.51	1.44%	Sand-Slime Tailings	0.059	119.0	0.97	0.21	0.76	1	1.10	19.280	267.99	22.70	22	1.52%	2.5	47%	1.55	0.00	1.55	0
18.701	5597.16	15.7	0.298	15.5	35.1	15.21	1.90%	Sand-Slime Tailings	0.059	119.0	0.98	0.22	0.76	1	1.10	17.040	236.85	20.07	19	2.02%	2.7	47%	1.56	0.00	1.56	0
18.865	5597.00	16.1	0.307	15.8	50.1	21.72	1.90%	Sand-Slime Tailings	0.059	119.0	0.99	0.22	0.77	1	1.09	17.309	240.60	20.50	20	2.03%	2.7	47%	1.57	0.00	1.57	0
19.029	5596.83	26.6	0.234	26.5	23.1	10.00	0.88%	Sand-Slime Tailings	0.059	119.0	1.00	0.23	0.77	1	1.08	28.588	397.38	33.38	33	0.91%	2.3	47%	1.58	0.00	1.58	0
19.193	5596.67	29.7	0.205	29.7	9.5	4.12	0.69%	Sand-Slime Tailings	0.059	119.0	1.01	0.24	0.78	1	1.07	31.852	442.74	37.07	37	0.71%	2.2	47%	1.59	0.00	1.59	0
19.357	5596.50	31.2	0.166	31.2	6.0	2.60	0.53%	Sand-Slime Tailings	0.059	119.0	1.02	0.24	0.78	1	1.07	33.332	463.32	38.76	39	0.55%	2.1	47%	1.60	0.00	1.60	0
19.521	5596.34	30.6	0.174	30.6	5.8	2.51	0.57%	Sand-Slime Tailings	0.059	119.0	1.03	0.25	0.79	1	1.06	32.529	452.15	37.83	38	0.59%	2.1	47%	1.61	0.00	1.61	0
19.685	5596.18	30.2	0.251	30.2	5.6	2.43	0.83%	Sand-Slime Tailings	0.059	119.0	1.04	0.25	0.79	1	1.06	32.002	444.83	37.21	37	0.86%	2.2	47%	1.62	0.00	1.62	0
19.849	5596.01	25.2	0.236	25.2	6.5	2.83	0.93%	Sand-Slime Tailings	0.059	119.0	1.05	0.26	0.80	1	1.06	26.686	370.94	31.04	30	0.98%	2.3	47%	1.63	0.00	1.63	0
20.013	5595.85	19.0	0.220	19.0	7.3	3.16	1.16%	Sand-Slime Tailings	0.059	119.0	1.06	0.26	0.80	1	1.06	20.060	278.83	23.35	22	1.23%	2.5	47%	1.64	0.00	1.64	0
20.177	5595.68	29.6	0.210	29.5	8.7	3.79	0.71%	Sand-Slime Tailings	0.059	119.0	1.07	0.27	0.80	1	1.05	30.959	430.33	36.02	35	0.74%	2.2	47%	1.65	0.00	1.65	0
20.341	5595.52	30.3	0.241	30.2	8.7	3.77	0.80%	Sand-Slime Tailings	0.059	119.0	1.08	0.27	0.81	1	1.04	31.560	438.68	36.72	36	0.83%	2.2	47%	1.66	0.00	1.66	0
20.505	5595.36	30.4	0.302	30.3	9.5	4.11	0.99%	Sand-Slime Tailings	0.059	119.0	1.09	0.28	0.81	1	1.04	31.508	437.97	36.67	36	1.03%	2.3	47%	1.67	0.00	1.67	0
20.669	5595.19	31.3	0.368	31.3	10.8	4.68	1.17%	Sand-Slime Tailings	0.059	119.0	1.10	0.28	0.82	1	1.04	32.371	449.96	37.68	37	1.22%	2.3	47%	1.68	0.00	1.68	0
20.833	5595.03	30.5	0.484	30.4	10.9	4.74	1.59%	Sand-Slime Tailings	0.059	119.0	1.11	0.29	0.82	1	1.03	31.396	436.41	36.55	36	1.65%	2.4	47%	1.69	0.00	1.69	0
20.997	5594.86	26.1	0.582	26.0	10.9	4.74	2.23%	Sand-Slime Tailings	0.059	119.0	1.12	0.29	0.83	1	1.03	26.780	372.24	31.18	30	2.33%	2.5	47%	1.69	0.00	1.69	0
21.161	5594.70	20.1	0.593	20.1	11.7	5.06	2.95%	Slime Tailings	0.057	113.1	1.13	0.30	0.83	1	1.03	20.583	286.10	23.99	23	3.12%	2.7	71%	1.70	0.00	1.70	0
21.325	5594.53	18.4	0.531	18.3	20.6	8.93	2.89%	Slime Tailings	0.057	113.1	1.14	0.30	0.84	1	1.02	18.692	259.82	21.86	21	3.08%	2.7	71%	1.71	0.00	1.71	0
21.489	5594.37	17.0	0.447	16.8	29.0	12.56	2.63%	Slime Tailings	0.057	113.1	1.15	0.31	0.84	1	1.02	17.124	238.03	20.10	19	2.82%	2.8	71%	1.72	0.00	1.72	0
21.653	5594.21	14.2	0.424	14.0	29.7	12.89	2.99%	Slime Tailings	0.057	113.1	1.16	0.31	0.84	1	1.02	14.215	197.59	16.73	15	3.25%	2.9	71%	1.73	0.00	1.73	0
21.817	5594.04	16.9	0.422	16.5	68.7	29.77	2.50%	Slime Tailings	0.057	113.1	1.17	0.32	0.85	1	1.01	16.669	231.70	19.86	19	2.68%	2.8	71%	1.74	0.00	1.74	0
21.981	5593.88	21.8	0.335	21.7	23.7	10.26	1.54%	Sand-Slime Tailings	0.059	119.0	1.18	0.32	0.85	1	1.01	21.800	303.01	25.49	24	1.62%	2.5	47%	1.75	0.00	1.75	0
22.145	5593.71	21.8	0.428	21.7	22.3	9.65	1.96%	Sand-Slime Tailings	0.059	119.0	1.18	0.33	0.86	1	1.00	21.771	302.62	25.45	24	2.07%	2.6	47%	1.76	0.00	1.76	0
22.309	5593.55	17.7	0.439	17.6	19.7	8.53	2.48%	Sand-Slime Tailings	0.059	119.0	1.19	0.33	0.86	1	1.00	17.547	243.90	20.52	19	2.66%	2.7	47%	1.77	0.00	1.77	0
22.473	5593.39	16.8	0.471	16.6	34.2	14.81	2.80%	Slime Tailings	0.057	113.1	1.20	0.34	0.87	1	0.99	16.546	229.99	19.46	18	3.01%	2.8	71%	1.78	0.00	1.78	0
22.638	5593.22	19.3	0.376	19.1	34.2	14.81	1.95%	Sand-Slime Tailings	0.059	119.0	1.21	0.34	0.87	1	0.99	18.876	262.38	22.17	21	2.08%	2.6	47%	1.79	0.00	1.79	0
22.802	5593.06	15.1	0.327	14.7	65.1	28.22	2.17%	Sand-Slime Tailings	0.059	119.0	1.22	0.35	0.88	1	0.99	14.455	200.93	17.25	16	2.36%	2.8	47%	1.80	0.00	1.80	0
22.966	5592.89	12.6	0.218	11.9	111.5	48.31	1.73%	Sand-Slime Tailings	0.059	119.0	1.23	0.35	0.88	1	0.98	11.703	162.67	14.39	13	1.92%	2.8	47%	1.81	0.00	1.81	0
23.130	5592.73	12.0	0.226	11.4	106.7	46.22	1.88%	Sand-Slime Tailings	0.059	119.0	1.24	0.36	0.89	1	0.98	11.107	154.39	13.66	12	2.10%	2.8	47%	1.82	0.00	1.82	0
23.294	5592.57	14.5	0.334	13.6	154.3	66.85	2.30%	Sand-Slime Tailings	0.059	119.0	1.25	0.36	0.89	1	0.97	13.235	183.97	16.46	15	2.51%	2.8	47%	1.83	0.00	1.83	0
23.458	5592.40	17.3	0.173	16.5	120.2	52.09	1.00%	Sand-Slime Tailings	0.059	119.0	1.26	0.37	0.89	1	0.97	16.025	222.75	19.46	18	1.08%	2.5	47%	1.84	0.00	1.84	0
23.622	5592.24	26.9	0.267	26.6	51.3	22.22	0.99%	Sand-Slime Tailings	0.059	119.0	1.27	0.37	0.90	1	0.97	25.759	358.04	30.28	29	1.04%	2.4	47%	1.85	0.00	1.85	0
23.786	5592.07	18.3	0.357	17.9	69.4	30.09	1.95%	Sand-Slime Tailings	0.059	119.0	1.28	0.38	0.90	1	0.96	17.187	238.90	20.45	19	2.10%	2.7	47%	1.86	0.00	1.86	0
23.950	5591.91	13.8	0.283	13.3	90.4	39.18	2.05%	Sand-Slime Tailings	0.059	119.0	1.29	0.38	0.91	1	0.96	12.716	176.76	15.40	14	2.26%	2.8	47%	1.87	0.00	1.87	0
24.114	5591.75	10.3	0.189	10.0	60.4	26.18	1.83%	Sand-Slime Tailings	0.059	119.0	1.30	0.39	0.91	1	0.96	9.514	132.24	11.47	10	2.09%	2.9	47%	1.88	0.00	1.88	0
24.278	5591.58	10.0	0.219	9.3	112.2	48.61	2.19%	Slime Tailings	0.057	113.1	1.31	0.39	0.92	1	0.95	8.871	123.30	11.08	9	2.51%	3.0	71%	1.89	0.00	1.89	0
24.442	5591.42	14.0	0.326	13.2	122.0	52.86	2.33%	Slime Tailings	0.057	113.1	1.32	0.40	0.92	1	0.95	12.529	174.15	15.39	14	2.58%	2.8	71%	1.90	0.00	1.90	0
24.606	5591.25	14.1	0.236	13.7	63.7	27.60	1.67%	Sand-Slime Tailings	0.059	119.0	1.33	0.40	0.93	1	0.94	12.962	180.17	15.49	14	1.85%	2.8	47%	1.91	0.00	1.91	0
24.770	5591.09	23.3	0.448	22.8	72.8	31.55	1.92%	Sand-Slime Tailings	0.059	119.0	1.34	0.41	0.93	1	0.94	21.533	299.31	25.51	24	2.04%	2.6	47%	1.92	0.00	1.92	0
24.934	5590.93	29.6	0.313	29.2	58.1	25.19	1.06%	Sand-Slime Tailings	0.059	119.0	1.35	0.41	0.94	1	0.94	27.544	382.86	32.39	30	1.11%	2.4	47%	1.93	0.00	1.93	0
25.098	5590.76	38.5	0.429	38.5	11.6	5.02	1.11%	Sand-Slime Tailings	0.059	119.0	1.36	0.42	0.94	1	0.94	36.269	504.14	42.20	40	1.15%	2.3	47%	1.94	0.00	1.94	0
25.262	5590.60	30.5	0.493	30.4	9.2	3.99	1.62%	Sand-Slime Tailings	0.059	119.0	1.37	0.42	0.94	1	0.94	28.493	396.05	33.16	31	1.69%	2.5	47%	1.94	0.00	1.94	0
25.426	5590.43	25.9	0.457	25.8	10.7	4.64	1.77%	Sand-Slime Tailings	0.059	119.0	1.38	0.43	0.95	1	0.93	23.999	333.59	27.95	26	1.87%	2.5	47%	1.95	0.00	1.95	0
25.590	5590.27	23.2	0.409	23.0	38.5	16.67	1.76%	Sand-Slime Tailings	0.059	119.0	1.39	0.43	0.95	1	0.93	21.279	295.77	24.97	23	1.87%	2.6	47%	1.96	0.00	1.96	0
25.754	5590.11	23.9	0.457	23.6	50.5	21.90	1.91%	Sand-Slime Tailings	0.059	119.0	1.40	0.44	0.96	1	0.92	21.735	302.12	25.58	23	2.03%	2.6	47%	1.97	0.00	1.97	0
25.918	5589.94	23.4	0.409	22.9	85.5	37.03	1.75%	Sand-Slime Tailings	0.059	119.0	1.41	0.44	0.96	1	0.92	21.004	291.95	24.96	23	1.86%	2.6	47%	1.98	0.00	1.98	0
26.082	5589.78	26.8	0.466	26.4	63.1	27.33	1.74%	Sand-Slime Tailings	0.059	119.0	1.42	0.45	0.97	1	0.92	24.200	336.38	28.53	26	1.84%	2.5	47%	1.99	0.00	1.99	0
26.246	5589.61	24.8	0.467	24.4	58.0	25.13	1.89%	Sand-Slime Tailings	0.059	119.0	1.43	0.46	0.97	1	0.91	22.278	309.67	26.26	24	2.00%	2.6	47%	2.00	0.00	2.00	0
26.410	5589.45	27.9	0.443	27.7	46.7	20.25	1.59%	Sand-Slime Tailings	0.059	119.0	1.44	0.46	0.98	1	0.91	25.216	350.50	29.60	27	1.67%	2.5	47%	2.01	0.00	2.01	0
26.574	5589.29	21.4	0.459	21.2	34.8	15.06	2.15%	Sand-Slime Tailings	0.059	119.0	1.45	0.47	0.98	1	0.90	19.114	265.68	22.43	20	2.30%	2.7	47%	2.02	0.00	2.02	0
26.739	5589.12	22.9	0.449	22.4	91.9	39.81	1.96%	Sand-Slime Tailings	0.059	119.0	1.46	0.47	0.99	1	0.90	20.162	280.25	24.02	22	2.09%	2.6	47%	2.03	0.00	2.03	0
26.903	5588.96	23.7	0.369	23.3	57.9	25.11	1.56%	Sand-Slime Tailings	0.059	119.0	1.47	0.48	0.99	1	0.90	20.966	291.42	24.73	22	1.66%	2.6	47%	2.04	0.00	2.04	1
27.067	5588.79	17.9	0.322	17.4	76.8	33.26	1.80%	Sand-Slime Tailings	0.059	119.0	1.48	0.48	1.00	1	0.89	15.524	215.78	18.53	16	1.96%	2.7	47%	2.05	0.01	2.05	1
27.231	5588.63	17.2	0.221	16.6	101.5	44.00	1.29%	Sand-Slime Tailings	0.059	119.0	1.49	0.49	1.00	1	0.89	14.729	204.74	17.76	16	1.41%	2.7	47%	2.06	0.01	2.05	1
27.395	5588.47	17.3	0.221	16.7	96.1	41.66	1.28%	Sand-Slime Tailings	0.059	119.0	1.50	0.49	1.00	1	0.89	14.791	205.60	17.80	16	1.40%	2.7	47%	2.07	0.02	2.05	1
27.559	5588.30	17.1	0.300	16.3	130.8	56.69	1.75%	Sand-Slime Tailings	0.059	119.0	1.51	0.50	1.01	1	0.88	14.394	200.07	17.55	15	1.92%	2.7	47%	2.08	0.02	2.06	1
27.723	5588.14	24.2	0.427	23.2	165.1	71.55	1.76%	Sand-Slime Tailings	0.059	119.0	1.52	0.50	1.01	1	0.88	20.498	284.93	24.87	22	1.88%	2.6	47%	2.09	0.03	2.06	1
27.887	5587.97	31.6	0.511	31.4	40.1	17.37	1.62%	Sand-Slime Tailings	0.059	119.0	1.53	0.51	1.02	1	0.89	27.813	386.60	32.56	30	1.70%	2.5	47%	2.10	0.03	2.07	1
28.051	5587.81	29.9	0.506	29.4	77.3	33.50	1.69%	Sand-Slime Tailings	0.059	119.0	1.53	0.51	1.02	1	0.88	25.927	360.38	30.61	28	1.79%	2.5	47%	2.11	0.04	2.07	1
28.215	5587.65	34.1	0.485	33.8	56.5	24.47	1.42%	Sand-Slime Tailings	0.059	119.0	1.54	0.52	1.03	1	0.88	29.829	414.63	35.01	32	1.49%	2.4	47%	2.12	0.04	2.08	1
28.379	5587.48	23.6	0.376	23.3	54.2	23.50	1.59%	Sand-Slime Tailings	0.059	119.0	1.55	0.52	1.03	1	0.87	20.248	281.45	23.86	21	1.71%	2.6	47%	2.13	0.05	2.08	1
28.543	5587.32	20.0	0.587	19.3	110.3	47.80	2.94%	Slime Tailings	0.057	113.1	1.56	0.53	1.04	1	0.86	16.699	232.11	20.09	18	3.18%	2.8	71%	2.14	0.05	2.09	1
28.707	5587.15	20.3	0.625	19.3	175.0	75.82	3.07%	Slime Tailings	0.057	113.1	1.57	0.53	1.04	1	0.86	16.595	230.67	20.37	18	3.33%	2.8	71%	2.15	0.06	2.09	1
28.871	5586.99	70.9	0.744	70.3	91.2	39.52	1.05%	Sand Tailings	0.062	123.5	1.58	0.54	1.05	1	0.90	63.004	875.75	73.77	66	1.07%	2.1	18%	2.16	0.06	2.10	1
29.035	5586.82	72.6	0.686	72.2	66.2	28.68	0.94%	Sand Tailings	0.062	123.5	1.59	0.54	1.05	1	0.89	64.601	897.96	75.46	68	0.97%	2.0	18%	2.17	0.07	2.10	1
29.199	5586.66	79.5	1.181	79.4	15.5	6.72	1.49%	Sand Tailings	0.062	123.5	1.60	0.55	1.06	1	0.90	71.104	988.34	82.68	74	1.52%	2.1	18%	2.18	0.07	2.11	1
29.363	5586.50	113.4	1.549	113.4	8.3	3.58	1.37%	Sand Tailings	0.062	123.5	1.61	0.55	1.06	1	0.91	103.022	1432.01	119.71	105	1.39%	2.0	18%	2.19	0.08	2.11	1
29.527	5586.33	133.5	2.246	133.4	9.1	3.95	1.68%	Sand Tailings	0.062	123.5	1.62	0.56	1.07	1	0.91	122.058	1696.61	141.82	124	1.70%	2.0	18%	2.20	0.08	2.12	1
29.691	5586.17	134.1	3.012	134.1	-0.7	-0.28	2.25%	Sand-Slime Tailings	0.059	119.0	1.63	0.56	1.07	1	0.91	122.449	1702.04	142.21	124	2.27%	2.1	47%	2.21	0.09	2.12	1
29.855	5586.00	114.2	2.896	114.0	26.4	11.45	2.54%	Sand-Slime Tailings	0.059	119.0	1.64	0.57	1.08	1	0.90	102.984	1431.48	119.78	105	2.57%	2.2	47%	2.22	0.09	2.13	1
30.019	5585.84	179.1	2.896	178.1	160.2	69.40	1.62%	Sand Tailings	0.062	123.5	1.65	0.57	1.08	1	0.93	164.913	2292.29	192.61	164	1.63%	1.9	18%	2.23	0.10	2.13	1
30.183	5585.68	217.4	2.896	217.3	26.4	11.43	1.33%	Sand Tailings	0.062	123.5	1.66	0.58	1.09	1	0.94	203.425	2827.61	236.45	199	1.34%	1.8	18%	2.24	0.10	2.14	1
31.850	5584.01							Sand Tailings	0.062	123.5													2.34	0.13	2.21	1

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	Idriss & Boulanger (2008) r_d	C_σ	K_σ	K_α	CSR M=7.5, σ'v=1atm	Δq_{c1n}	q_{c1n-cs}	(CRR) M=7.5, σ'v=1atm	FoS	Youd et al. (2001) r_d	D_r	f	K_σ	K_α	CSR M=7.5, σ'v=1atm	Kc	q_{c1n-cs}	(CRR) M=7.5, σ'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
17.388	0.90	0.06	0.97	1.0	0.050	39.16	64.42	0.093	1.85	0.94	0.29	0.80	1.03	1.0	0.040	3.26	82.40	0.132	3.80	2.82	2
17.552	0.90	0.05	0.97	1.0	0.050	37.57	58.30	0.086	1.71	0.93	0.26	0.80	1.03	1.0	0.040	3.70	76.68	0.122	3.49	2.60	2
17.716	0.89	0.05	0.97	1.0	0.050	36.73	55.06	0.083	1.64	0.93	0.25	0.80	1.03	1.0	0.040	3.94	72.19	0.115	3.27	2.46	2
17.880	0.89	0.06	0.97	1.0	0.050	38.91	63.45	0.092	1.83	0.93	0.29	0.80	1.03	1.0	0.040	2.38	58.47	0.099	2.79	2.31	2
18.044	0.89	0.07	0.96	1.0	0.049	47.78	97.63	0.139	2.80	0.93	0.41	0.80	1.03	1.0	0.040	1.61	80.28	0.128	3.60	3.20	2
18.208	0.89	0.06	0.97	1.0	0.050	38.74	62.79	0.091	1.83	0.93	0.28	0.80	1.03	1.0	0.040	3.58	86.19	0.140	3.90	2.86	2
18.372	0.89	0.05	0.97	1.0	0.050	36.09	52.58	0.080	1.60	0.93	0.23	0.80	1.03	1.0	0.040	4.51	74.42	0.118	3.29	2.45	2
18.537	0.89	0.05	0.97	1.0	0.050	38.26	60.96	0.089	1.79	0.93	0.28	0.80	1.03	1.0	0.040	3.02	68.48	0.110	3.03	2.41	2
18.701	0.89	0.05	0.97	1.0	0.050	37.34	57.41	0.085	1.71	0.93	0.26	0.80	1.03	1.0	0.040	3.74	75.13	0.119	3.28	2.50	2
18.865	0.89	0.05	0.97	1.0	0.050	37.49	57.99	0.086	1.73	0.93	0.26	0.80	1.02	1.0	0.040	3.70	75.79	0.120	3.29	2.51	2
19.029	0.88	0.06	0.96	1.0	0.049	42.01	75.39	0.106	2.16	0.93	0.33	0.80	1.02	1.0	0.040	1.88	62.88	0.103	2.80	2.48	2
19.193	0.88	0.06	0.96	1.0	0.049	43.30	80.37	0.113	2.31	0.93	0.35	0.80	1.02	1.0	0.040	1.63	60.40	0.100	2.71	2.51	2
19.357	0.88	0.06	0.96	1.0	0.049	43.90	82.66	0.116	2.38	0.93	0.36	0.80	1.02	1.0	0.040	1.48	57.35	0.098	2.62	2.50	2
19.521	0.88	0.06	0.96	1.0	0.049	43.57	81.39	0.115	2.34	0.93	0.36	0.80	1.02	1.0	0.040	1.53	57.77	0.098	2.62	2.48	2
19.685	0.88	0.06	0.96	1.0	0.049	43.35	80.56	0.113	2.32	0.93	0.35	0.80	1.02	1.0	0.040	1.73	64.49	0.105	2.79	2.56	2
19.849	0.88	0.06	0.96	1.0	0.049	41.19	72.23	0.102	2.10	0.93	0.32	0.80	1.02	1.0	0.040	2.03	63.17	0.103	2.74	2.42	2
20.013	0.88	0.05	0.96	1.0	0.049	38.49	61.85	0.090	1.84	0.93	0.28	0.80	1.01	1.0	0.040	2.72	63.54	0.104	2.74	2.29	2
20.177	0.87	0.06	0.96	1.0	0.049	42.94	78.96	0.111	2.29	0.93	0.35	0.80	1.01	1.0	0.040	1.68	60.65	0.101	2.64	2.47	2
20.341	0.87	0.06	0.96	1.0	0.048	43.18	79.90	0.112	2.32	0.92	0.35	0.80	1.01	1.0	0.040	1.73	63.52	0.104	2.71	2.52	2
20.505	0.87	0.06	0.96	1.0	0.048	43.16	79.83	0.112	2.33	0.92	0.35	0.80	1.01	1.0	0.040	1.88	68.85	0.110	2.87	2.60	2
20.669	0.87	0.06	0.96	1.0	0.048	43.52	81.19	0.114	2.37	0.92	0.35	0.80	1.01	1.0	0.040	1.97	74.32	0.118	3.06	2.72	2
20.833	0.87	0.06	0.96	1.0	0.048	43.12	79.67	0.112	2.33	0.92	0.35	0.80	1.01	1.0	0.040	2.30	83.89	0.135	3.48	2.90	2
20.997	0.87	0.06	0.96	1.0	0.048	41.24	72.42	0.103	2.13	0.92	0.32	0.80	1.01	1.0	0.040	3.01	93.89	0.157	4.03	3.08	2
21.161	0.87	0.06	0.96	1.0	0.048	38.44	62.44	0.091	1.88	0.92	0.28	0.80	1.01	1.0	0.040	4.14	99.39	0.171	4.39	3.13	2
21.325	0.87	0.05	0.96	1.0	0.048	37.70	59.56	0.087	1.81	0.92	0.27	0.80	1.01	1.0	0.040	4.37	95.63	0.161	4.12	2.96	2
21.489	0.86	0.05	0.96	1.0	0.048	37.09	57.19	0.085	1.76	0.91	0.26	0.80	1.00	1.0	0.040	4.44	89.28	0.146	3.72	2.74	2
21.653	0.86	0.05	0.96	1.0	0.048	35.91	52.64	0.080	1.66	0.91	0.24	0.80	1.00	1.0	0.040	5.36	89.70	0.147	3.73	2.70	2
21.817	0.86	0.05	0.96	1.0	0.048	37.01	56.87	0.084	1.76	0.91	0.26	0.80	1.00	1.0	0.040	4.38	86.93	0.141	3.56	2.66	2
21.981	0.86	0.06	0.96	1.0	0.048	39.24	64.73	0.093	1.95	0.91	0.29	0.80	1.00	1.0	0.040	2.93	74.56	0.119	2.98	2.47	2
22.145	0.86	0.06	0.96	1.0	0.048	39.23	64.67	0.093	1.95	0.91	0.29	0.80	1.00	1.0	0.040	3.28	83.48	0.134	3.36	2.66	2
22.309	0.86	0.05	0.96	1.0	0.048	37.50	58.02	0.086	1.80	0.91	0.26	0.80	1.00	1.0	0.040	4.28	87.80	0.143	3.57	2.68	2
22.473	0.86	0.05	0.96	1.0	0.048	36.87	56.33	0.084	1.76	0.91	0.25	0.80	1.00	1.0	0.040	4.70	91.53	0.151	3.76	2.76	2
22.638	0.85	0.05	0.96	1.0	0.047	38.08	60.25	0.088	1.86	0.90	0.27	0.80	1.00	1.0	0.040	3.63	80.39	0.128	3.18	2.52	2
22.802	0.85	0.05	0.96	1.0	0.047	36.35	53.61	0.081	1.71	0.90	0.24	0.80	1.00	1.0	0.040	4.57	78.92	0.126	3.10	2.40	2
22.966	0.85	0.05	0.96	1.0	0.047	35.35	49.73	0.077	1.63	0.90	0.22	0.80	1.00	1.0	0.040	4.76	68.44	0.110	2.70	2.16	2
23.130	0.85	0.05	0.96	1.0	0.047	35.09	48.75	0.076	1.61	0.90	0.21	0.80	0.99	1.0	0.040	5.13	70.08	0.112	2.74	2.18	2
23.294	0.85	0.05	0.96	1.0	0.047	36.08	52.54	0.080	1.69	0.90	0.23	0.80	0.99	1.0	0.040	4.87	80.16	0.128	3.12	2.41	2
23.458	0.85	0.05	0.96	1.0	0.047	37.13	56.58	0.084	1.79	0.90	0.25	0.80	0.99	1.0	0.040	3.02	58.77	0.099	2.40	2.10	2
23.622	0.85	0.06	0.95	1.0	0.047	40.92	71.20	0.101	2.16	0.90	0.32	0.80	0.99	1.0	0.040	2.17	65.84	0.107	2.58	2.37	2
23.786	0.85	0.05	0.96	1.0	0.047	37.47	57.92	0.086	1.83	0.90	0.26	0.80	0.99	1.0	0.040	3.87	79.22	0.126	3.05	2.44	2
23.950	0.84	0.05	0.96	1.0	0.047	35.70	51.10	0.079	1.67	0.89	0.23	0.80	0.99	1.0	0.040	4.89	75.23	0.120	2.88	2.27	2
24.114	0.84	0.05	0.96	1.0	0.047	34.32	45.79	0.074	1.57	0.89	0.20	0.80	0.99	1.0	0.040	5.85	67.03	0.108	2.59	2.08	2
24.278	0.84	0.05	0.96	1.0	0.047	33.95	45.02	0.073	1.55	0.89	0.19	0.80	0.99	1.0	0.040	6.45	71.42	0.114	2.72	2.14	2
24.442	0.84	0.05	0.96	1.0	0.047	35.45	50.84	0.078	1.68	0.89	0.23	0.80	0.99	1.0	0.040	5.19	79.86	0.127	3.03	2.36	2
24.606	0.84	0.05	0.96	1.0	0.047	35.73	51.22	0.079	1.69	0.89	0.23	0.80	0.99	1.0	0.040	4.48	69.42	0.111	2.64	2.16	2
24.770	0.84	0.06	0.96	1.0	0.046	39.25	64.75	0.093	2.02	0.89	0.29	0.80	0.98	1.0	0.040	3.30	84.25	0.136	3.21	2.61	2
24.934	0.84	0.06	0.95	1.0	0.046	41.66	74.05	0.105	2.28	0.89	0.33	0.80	0.98	1.0	0.040	2.15	69.61	0.111	2.62	2.45	2
25.098	0.83	0.07	0.95	1.0	0.046	45.10	87.31	0.123	2.69	0.88	0.38	0.80	0.98	1.0	0.040	1.86	78.30	0.125	2.93	2.81	2
25.262	0.83	0.06	0.95	1.0	0.046	41.93	75.08	0.106	2.32	0.88	0.33	0.80	0.98	1.0	0.040	2.55	84.46	0.136	3.18	2.75	2
25.426	0.83	0.06	0.95	1.0	0.046	40.10	68.05	0.097	2.12	0.88	0.31	0.80	0.98	1.0	0.040	2.99	83.54	0.134	3.13	2.63	2
25.590	0.83	0.06	0.95	1.0	0.046	39.06	64.03	0.092	2.02	0.88	0.29	0.80	0.98	1.0	0.040	3.23	80.75	0.129	3.00	2.51	2
25.754	0.83	0.06	0.95	1.0	0.046	39.27	64.86	0.093	2.04	0.88	0.29	0.80	0.98	1.0	0.040	3.31	84.64	0.136	3.16	2.60	2
25.918	0.83	0.06	0.95	1.0	0.046	39.06	64.02	0.092	2.03	0.88	0.29	0.80	0.98	1.0	0.040	3.23	80.65	0.129	2.97	2.50	2
26.082	0.83	0.06	0.95	1.0	0.045	40.31	68.83	0.098	2.16	0.88	0.31	0.80	0.98	1.0	0.040	2.94	83.82	0.135	3.10	2.63	2
26.246	0.82	0.06	0.95	1.0	0.045	39.51	65.77	0.094	2.08	0.88	0.30	0.80	0.98	1.0	0.040	3.24	84.96	0.137	3.14	2.61	2
26.410	0.82	0.06	0.95	1.0	0.045	40.68	70.28	0.100	2.21	0.87	0.31	0.80	0.98	1.0	0.040	2.75	81.34	0.130	2.97	2.59	2
26.574	0.82	0.05	0.95	1.0	0.045	38.17	60.59	0.089	1.95	0.87	0.27	0.80	0.97	1.0	0.040	3.85	86.38	0.140	3.19	2.57	2
26.739	0.82	0.06	0.95	1.0	0.045	38.72	62.74	0.091	2.01	0.87	0.28	0.80	0.97	1.0	0.039	3.52	84.47	0.136	3.09	2.55	2
26.903	0.82	0.06	0.95	1.0	0.045	38.97	63.70	0.092	2.04	0.87	0.29	0.80	0.97	1.0	0.039	3.10	76.78	0.122	2.76	2.40	2
27.067	0.82	0.05	0.96	1.0	0.045	36.80	55.33	0.083	1.83	0.87	0.25	0.80	0.97	1.0	0.040	4.10	75.99	0.121	2.72	2.27	2
27.231	0.82	0.05	0.96	1.0	0.045	36.53	54.29	0.082	1.80	0.87	0.24	0.80	0.97	1.0	0.040	3.67	65.24	0.106	2.37	2.08	2
27.395	0.82	0.05	0.96	1.0	0.045	36.54	54.34	0.082	1.80	0.87	0.24	0.80	0.97	1.0	0.040	3.66	65.18	0.106	2.35	2.08	2
27.559	0.81	0.05	0.96	1.0	0.045	36.46	54.01	0.081	1.79	0.86	0.24	0.80	0.97	1.0	0.040	4.23	74.31	0.118	2.61	2.20	2
27.723	0.81	0.06	0.95	1.0	0.045	39.02	63.89	0.092	2.04	0.86	0.29	0.80	0.97	1.0	0.040	3.29	81.72	0.131	2.88	2.46	2
27.887	0.81	0.06	0.95	1.0	0.045	41.72	74.28	0.105	2.33	0.86	0.33	0.80	0.97	1.0	0.040	2.62	85.37	0.138	3.02	2.67	2
28.051	0.81	0.06	0.95	1.0	0.045	41.04	71.64	0.102	2.25	0.86	0.32	0.80	0.97	1.0	0.040	2.80	85.63	0.138	3.01	2.63	2
28.215	0.81	0.06	0.95	1.0	0.045	42.58	77.59	0.109	2.43	0.86	0.34	0.80	0.97	1.0	0.040	2.36	82.64	0.132	2.87	2.65	2
28.379	0.81	0.05	0.95	1.0	0.045	38.67	62.53	0.091	2.00	0.86	0.28	0.80	0.96	1.0	0.040	3.25	77.44	0.123	2.65	2.33	2
28.543	0.81	0.05	0.95	1.0	0.046	37.08	57.17	0.085	1.86	0.86	0.26	0.80	0.96	1.0	0.040	4.87	97.86	0.167	3.58	2.72	2
28.707	0.80	0.05	0.95	1.0	0.046	37.18	57.55	0.085	1.87	0.86	0.26	0.80	0.96	1.0	0.040	4.93	100.50	0.174	3.72	2.80	2
28.871	0.80	0.09	0.92	1.0	0.044	40.95	114.71	0.169	3.83	0.85	0.50	0.75	0.95	1.0	0.041	1.40	103.45	0.183	3.88	3.85	2
29.035	0.80	0.09	0.92	1.0	0.044	41.38	116.84	0.173	3.92	0.85	0.50	0.75	0.95	1.0	0.041	1.35	101.77	0.178	3.76	3.84	2
29.199	0.80	0.09	0.92	1.0	0.044	43.23	125.91	0.193	4.40	0.85	0.52	0.74	0.95	1.0	0.041	1.51	124.72	0.260	5.46	4.93	2
29.363	0.80	0.12	0.89	1.0	0.043	52.69	172.40	0.433	10.18	0.85	0.63	0.68	0.94	1.0	0.042	1.28	153.66	0.417	8.71	9.44	2
29.527	0.80	0.15	0.87	1.0	0.041	58.35	200.17	1.000	24.11	0.85	0.69	0.66	0.93	1.0	0.042	1.30	184.56	1.000	20.76	22.43	2
29.691	0.80	0.15	0.87	1.0	0.041	80.18	222.39	1.000	24.12	0.85	0.69	0.66	0.93	1.0	0.042	1.44	205.32	1.000	20.66	22.39	2
29.855	0.79	0.12	0.89	1.0	0.043	72.31	192.09	0.813	19.11	0.85	0.63	0.68	0.93	1.0	0.042	1.62	194.57	1.000	20.55	19.83	2
30.019	0.79	0.24	0.78	1.0	0.037	71.33	263.94	1.000	26.69	0.84	0.80	0.60	0.91	1.0	0.043	1.19	229.76	1.000	20.45	23.57	2
30.183	0.79	0.30	0.73	1.0	0.035	82.54	318.98	1.000	28.64	0.84	0.89	0.60	0.91	1.0	0.043	1.10	259.26	1.000	20.34	24.49	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.494

Depth at t_1, z_1 (ft)	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
8.48	500	1.8E-03	4.6E+02	3.1E-04	10	0.224	6877	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.03%	0.0033
8.53	500	1.8E-03	4.6E+02	3.1E-04	10	0.225	6859	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.06%	0.0034
8.58	500	1.8E-03	4.6E+02	3.2E-04	10	0.225	6840	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.09%	0.0034
8.63	500	1.8E-03	4.6E+02	3.2E-04	10	0.226	6822	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.12%	0.0035
8.68	500	1.8E-03	4.6E+02	3.2E-04	10	0.226	6804	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.15%	0.0035
8.73	500	1.8E-03	4.6E+02	3.2E-04	10	0.226	6785	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.18%	0.0036
8.78	500	1.8E-03	4.6E+02	3.2E-04	10	0.227	6768	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.20%	0.0036
8.83	500	1.8E-03	4.6E+02	3.3E-04	10	0.227	6750	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.23%	0.0037
8.88	500	1.8E-03	4.6E+02	3.3E-04	10	0.227	6732	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.26%	0.0037
8.93	500	1.8E-03	4.6E+02	3.3E-04	10	0.228	6715	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.29%	0.0038
8.98	500	1.8E-03	4.6E+02	3.3E-04	10	0.228	6698	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.32%	0.0038
9.03	500	1.8E-03	4.6E+02	3.4E-04	10	0.229	6681	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.35%	0.0039
9.08	500	1.8E-03	4.6E+02	3.4E-04	10	0.229	6664	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.38%	0.0039
9.13	500	1.8E-03	4.6E+02	3.4E-04	10	0.229	6647	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.41%	0.0039
9.18	538	1.8E-03	5.3E+02	2.9E-04	10	0.230	6630	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.66%	0.0027
9.23	538	1.8E-03	5.3E+02	3.0E-04	10	0.230	6614	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.69%	0.0028
9.28	538	1.8E-03	5.3E+02	3.0E-04	10	0.230	6597	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.71%	0.0028
9.33	538	1.8E-03	5.3E+02	3.0E-04	10	0.231	6581	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.73%	0.0028
9.38	538	1.8E-03	5.3E+02	3.0E-04	10	0.231	6565	0.07%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.76%	0.0029
9.43	538	1.8E-03	5.3E+02	3.0E-04	10	0.231	6549	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.78%	0.0029
9.48	538	1.8E-03	5.3E+02	3.1E-04	10	0.232	6533	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.80%	0.0030
9.53	538	1.8E-03	5.3E+02	3.1E-04	10	0.232	6517	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.82%	0.0030
9.58	538	1.8E-03	5.3E+02	3.1E-04	10	0.232	6502	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.85%	0.0030
9.63	538	1.8E-03	5.1E+02	3.3E-04	16	0.484	5348	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.28%	0.0037
9.68	538	1.8E-03	5.1E+02	3.3E-04	16	0.484	5336	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.30%	0.0038
9.73	538	1.8E-03	5.1E+02	3.3E-04	16	0.484	5325	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.32%	0.0038
9.78	538	1.8E-03	5.1E+02	3.3E-04	16	0.485	5313	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.35%	0.0038
9.83	538	1.8E-03	5.1E+02	3.3E-04	16	0.485	5301	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.37%	0.0039
9.88	538	1.8E-03	5.3E+02	3.2E-04	10	0.234	6415	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.98%	0.0032
9.93	538	1.8E-03	5.3E+02	3.2E-04	10	0.235	6400	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.00%	0.0033
9.98	538	1.8E-03	5.3E+02	3.2E-04	10	0.235	6385	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.02%	0.0033
10.03	538	1.8E-03	5.1E+02	3.4E-04	16	0.486	5254	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.46%	0.0040
10.08	538	1.8E-03	5.3E+02	3.3E-04	10	0.236	6357	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.07%	0.0034
10.13	538	1.8E-03	5.3E+02	3.3E-04	10	0.236	6343	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.09%	0.0034
10.18	538	1.8E-03	5.3E+02	3.3E-04	10	0.236	6328	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.12%	0.0035
10.23	538	1.8E-03	5.3E+02	3.3E-04	10	0.237	6314	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.14%	0.0035
10.28	538	1.8E-03	5.3E+02	3.3E-04	10	0.237	6300	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.16%	0.0035
10.33	538	1.8E-03	5.3E+02	3.4E-04	10	0.237	6286	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.19%	0.0036
10.38	538	1.8E-03	5.3E+02	3.4E-04	10	0.237	6273	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.21%	0.0036
10.43	538	1.8E-03	5.3E+02	3.4E-04	10	0.238	6259	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.23%	0.0037
10.48	538	1.8E-03	5.3E+02	3.4E-04	10	0.238	6245	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.26%	0.0037
10.53	538	1.8E-03	5.3E+02	3.4E-04	10	0.238	6232	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.28%	0.0037
10.58	538	1.8E-03	5.1E+02	3.6E-04	16	0.490	5129	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.73%	0.0045
10.63	538	1.8E-03	5.1E+02	3.6E-04	16	0.490	5119	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.75%	0.0045
10.68	538	1.8E-03	5.3E+02	3.5E-04	10	0.239	6193	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.35%	0.0039
10.73	594	1.8E-03	6.5E+02	2.9E-04	10	0.240	6180	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.42%	0.0023
10.78	594	1.8E-03	6.5E+02	2.9E-04	10	0.240	6167	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.43%	0.0024
10.83	594	1.8E-03	6.5E+02	2.9E-04	10	0.240	6154	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.45%	0.0024
10.88	594	1.8E-03	6.5E+02	2.9E-04	10	0.241	6141	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.47%	0.0024
10.93	594	1.8E-03	6.5E+02	2.9E-04	10	0.241	6129	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.49%	0.0024
10.98	594	1.8E-03	6.5E+02	2.9E-04	10	0.241	6116	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.50%	0.0025
11.03	594	1.8E-03	6.5E+02	3.0E-04	10	0.241	6104	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.52%	0.0025
11.08	594	1.8E-03	6.5E+02	3.0E-04	10	0.242	6091	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.54%	0.0025
11.13	594	1.8E-03	6.5E+02	3.0E-04	10	0.242	6079	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.56%	0.0026
11.18	594	1.8E-03	6.5E+02	3.0E-04	10	0.242	6066	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.57%	0.0026
11.23	594	1.8E-03	6.5E+02	3.0E-04	10	0.243	6054	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.59%	0.0026
11.28	594	1.8E-03	6.5E+02	3.0E-04	10	0.243	6042	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.61%	0.0026
11.33	594	1.8E-03	6.5E+02	3.0E-04	10	0.243	6030	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.63%	0.0027
11.38	594	1.8E-03	6.5E+02	3.1E-04	10	0.244	6020	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.64%	0.0027
11.43	594	1.8E-03	6.5E+02	3.1E-04	10	0.244	6014	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.66%	0.0027
11.48	594	1.8E-03	6.5E+02	3.1E-04	10	0.244	6009	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.68%	0.0028
11.53	594	1.8E-03	6.5E+02	3.1E-04	10	0.244	6003	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.70%	0.0028
11.58	594	1.8E-03	6.5E+02	3.1E-04	10	0.244	5997	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.72%	0.0028
11.63	594	1.8E-03	6.5E+02	3.1E-04	10	0.244	5992	0.07%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.74%	0.0029
11.68	594	1.8E-03	6.5E+02	3.1E-04	10	0.244	5986	0.07%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.76%	0.0029
11.73	594	1.8E-03	6.5E+02	3.2E-04	10	0.245	5981	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.78%	0.0029
11.78	594	1.8E-03	6.5E+02	3.2E-04	10	0.245	5975	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.80%	0.0029
11.83	594	1.8E-03	6.5E+02	3.2E-04	10	0.245	5970	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.82%	0.0030
11.88	594	1.8E-03	6.2E+02	3.4E-04	16	0.496	4922	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.21%	0.0036
11.93	594	1.8E-03	6.2E+02	3.4E-04	16	0.496	4918	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.23%	0.0037
11.98	594	1.9E-03	6.8E+02	3.1E-04	0	0.244	7534	0.09%	5.00	1.00	0.03%	0.003	0.34	0.079	0.765	0.45%	0.0007
12.03	594	1.9E-03	6.8E+02	3.1E-04	0	0.245	7527	0.09%	5.00	1.00	0.03%	0.003	0.34	0.079	0.765	0.46%	0.0007
12.08	594	1.9E-03	6.8E+02	3.1E-04	0	0.245	7519	0.09%	5.00	1.00	0.03%	0.003	0.34	0.079	0.765	0.46%	0.0008
12.13	594	1.9E-03	6.8E+02	3.2E-04	0	0.245	7512	0.09%	5.00	1.00	0.03%	0.003	0.34	0.079	0.765	0.47%	0.0008
12.18	594	1.9E-03	6.8E+02	3.2E-04	0	0.245	7505	0.09%	5.00	1.00	0.03%	0.003	0.34	0.079	0.765	0.48%	0.0008
12.23	594	1.8E-03	6.5E+02	3.3E-04	10	0.246	5925	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.97%	0.0032
12.28	594	1.8E-03	6.5E+02	3.3E-04	10	0.246	5920	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.99%	0.0033
12.33	594	1.9E-03	6.8E+02	3.2E-04	0	0.245	7484	0.10%	5.00	1.00	0.03%	0.003	0.34	0.079	0.765	0.50%	0.0008
12.38	594	1.9E-03	6.8E+02	3.2E-04	0	0.245	7477	0.10%	5.00	1.00	0.03%	0.003	0.34	0.079	0.765	0.51%	0.0008
12.88	594	1.9E-03	6.8E+02	3.4E-04	0	0.247	7369	0.11%	5.00	1.00	0.03%	0.004	0.34	0.079	0.765	0.59%	0.0099

Extra layer added to analyze seismic settlement of tailings below the bottom of CPT investigation.

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W6-S

Data File: 13-52106_SP2W6-S-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)
- Max. Horiz. Acceleration, Amax/g: 0.15
- Earthquake Moment Magnitude, M: 5.5
- Magnitude Scaling Factor, MSF: 1.69

Youd, et al (2001)
- Max. Horiz. Acceleration, Amax/g: 0.15
- Earthquake Moment Magnitude, M: 5.5
- Magnitude Scaling Factor, MSF: 2.21

Value	Parameter
5604.40	Water surface elevation during CPT investigation (ft amsl)
5604.40	Water surface elevation at t_1 (ft amsl)
5588.59	Water surface elevation at t_2 (ft amsl)
5583.59	Water surface elevation at t_3 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ear
7.51	Equiv. Number of Uniform Strain Cycles, N
5615.85	Ground Surface Elevation at time of CPT (ft amsl)
5625.41	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
1.56	Thickness of Random/Platform Fill on top of existing interim cover (ft)
1065.26	Additional Stress due to Final Cover Placement, $\Delta\sigma_{vc}$ (psf)
5583.59	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max})	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, $\varepsilon_{c,15}$ (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5625.16	5624.91	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5623.16	5621.41	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5619.41	5617.41	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334	1.83	508	1.9E-03	4.8E+02	6.8E-05	11	0.153	12419	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######	5616.63	5615.85	1.56	0.050	101	0.533	0.493	0.00	0.00	0.533	0.493	2.68	508	1.6E-03	4.0E+02	1.2E-04	11	0.169	10568	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1 / Liquefaction Triggering Analyses – Idriss & Boulanger (2008)

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q	Normalized Friction Ratio, F (%)	Soil Behavior Type Index, Ic	FC %	Total Stress at t_1 (tsf)	Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	r_d	C_σ	K_σ	K_α	CSR M=7.5, σ'=1atm	Δq_{c1n}	q_{c1n-cs}	CRR M=7.5, σ'=1atm	FoS
0.164	5615.69	6.5	0.020	6.5	1.2	0.51	0.31%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	11.067	153.83	12.87	788	0.31%	0.9	51%	0.54	0.00	0.54	0	1.00	0.05	1.02	1.0	0.059	34.84	47.70	0.075	1.27
0.328	5615.52	22.2	0.060	22.2	2.8	1.22	0.27%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	37.723	524.35	43.85	1343	0.27%	0.7	51%	0.55	0.00	0.55	0	1.00	0.07	1.03	1.0	0.060	45.71	89.56	0.126	2.12
0.492	5615.36	34.7	0.122	34.7	1.7	0.75	0.35%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	58.973	819.72	68.51	1399	0.35%	0.8	51%	0.56	0.00	0.56	0	1.00	0.08	1.04	1.0	0.060	54.36	122.88	0.186	3.10
0.656	5615.19	54.7	0.219	54.6	1.9	0.81	0.40%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	92.888	1291.14	107.91	1653	0.40%	0.9	51%	0.57	0.00	0.57	0	1.00	0.11	1.05	1.0	0.061	68.19	176.10	0.478	7.90
0.820	5615.03	83.1	0.349	83.1	2.0	0.85	0.42%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	141.202	1962.71	164.02	2010	0.42%	0.9	51%	0.57	0.00	0.57	0	1.00	0.18	1.07	1.0	0.062	87.88	251.90	1.000	16.11
0.984	5614.87	94.0	0.544	94.0	2.0	0.85	0.58%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	159.715	2220.04	185.52	1895	0.58%	1.0	51%	0.58	0.00	0.58	0	1.00	0.22	1.09	1.0	0.063	95.43	280.95	1.000	15.90
1.148	5614.70	94.8	0.470	94.8	2.0	0.87	0.50%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	161.126	2239.65	187.16	1638	0.50%	1.0	51%	0.59	0.00	0.59	0	1.00	0.23	1.09	1.0	0.063	96.00	283.16	1.000	15.93
1.312	5614.54	92.2	0.392	92.2	1.8	0.77	0.43%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	156.689	2177.98	182.01	1394	0.43%	0.9	51%	0.60	0.00	0.60	0	1.00	0.22	1.08	1.0	0.062	94.19	276.20	1.000	16.04
1.476	5614.37	90.8	0.315	90.8	0.7	0.29	0.35%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	154.309	2144.90	179.23	1220	0.35%	0.9	51%	0.61	0.00	0.61	0	1.00	0.21	1.07	1.0	0.062	93.22	272.45	1.000	16.12
1.640	5614.21	85.8	0.359	85.8	4.3	1.87	0.42%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	145.843	2027.22	169.44	1038	0.42%	1.0	51%	0.62	0.00	0.62	0	1.00	0.19	1.06	1.0	0.062	89.78	259.22	1.000	16.26
1.804	5614.05	83.8	0.375	83.8	2.0	0.86	0.45%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	142.375	1979.01	165.38	921	0.45%	1.0	51%	0.62	0.00	0.62	0	1.00	0.18	1.06	1.0	0.061	88.36	253.74	1.000	16.33
1.968	5613.88	76.6	0.445	76.6	1.8	0.79	0.58%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	130.135	1808.88	151.17	771	0.58%	1.1	51%	0.63	0.00	0.63	0	1.00	0.16	1.05	1.0	0.061	83.37	234.54	1.000	16.49
2.133	5613.72	61.3	0.546	61.3	1.1	0.47	0.89%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	104.159	1447.81	120.99	570	0.89%	1.4	51%	0.64	0.00	0.64	0	1.00	0.13	1.04	1.0	0.060	72.78	193.77	0.869	14.52
2.297	5613.55	64.2	0.470	64.2	1.8	0.79	0.73%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	109.123	1516.81	126.76	554	0.73%	1.3	51%	0.65	0.00	0.65	0	1.00	0.13	1.04	1.0	0.060	74.81	201.57	1.000	16.72
2.461	5613.39	68.7	0.730	68.7	2.8	1.20	1.06%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	116.807	1623.62	135.70	554	1.06%	1.4	51%	0.66	0.00	0.66	0	1.00	0.14	1.04	1.0	0.060	77.94	213.64	1.000	16.72
2.625	5613.23	191.6	1.300	191.6	4.3	1.85	0.68%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.70	314.125	4366.34	364.89	1449	0.68%	1.1	51%	0.66	0.00	0.66	0	1.00	0.30	1.08	1.0	0.062	#####	523.26	1.000	16.12
2.789	5613.06	241.3	3.362	241.3	3.2	1.37	1.39%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0	1.61	389.250	5410.57	452.13	1717	1.39%	1.4	51%	0.67	0.00	0.67	0	0.99	0.30	1.07	1.0	0.062	#####	641.11	1.000	16.19
2.953	5612.90	265.3	5.646	265.3	4.3	1.85	2.13%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0	1.59	421.663	5861.12	489.79	1783	2.13%	1.6	51%	0.68	0.00	0.68	0	0.99	0.30	1.07	1.0	0.061	#####	691.99	1.000	16.26
3.117	5612.73	238.5	7.457	238.5	2.5	1.06	3.13%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0	1.57	373.653	5193.78	434.00	1518	3.13%	1.7	51%	0.69	0.00	0.69	0	0.99	0.30	1.07	1.0	0.061	#####	616.63	1.000	16.33
3.281	5612.57	217.3	7.057	217.3	1.3	0.58	3.25%	Sand-Slime Tailings	0.047	93.3	0.16	0.00	0.16	0	1.55	336.251	4673.89	390.55	1319	3.25%	1.8	47%	0.70	0.00	0.70	0	0.99	0.30	1.06	1.0	0.061	#####	557.62	1.000	16.40
3.445	5612.41	217.9	6.621	217.9	0.9	0.38	3.04%	Sand-Slime Tailings	0.047	93.3	0.17	0.00	0.17	0	1.53	333.101	4630.11	386.93	1264	3.04%	1.7	47%	0.71	0.00	0.71	0	0.99	0.30	1.06	1.0	0.061	#####	552.87	1.000	16.46
3.609	5612.24	256.0	7.793	256.0	1.4	0.59	3.04%	Sand-Slime Tailings	0.047	93.3	0.18	0.00	0.18	0	1.51	386.904	5377.97	449.38	1422	3.05%	1.7	47%	0.71	0.00	0.71	0	0.99	0.30	1.06	1.0	0.061	#####	637.29	1.000	16.53
3.773	5612.08	314.1	8.489	314.1	6.9	2.98	2.70%	Sand Tailings	0.051	102.8	0.19	0.00	0.19	0	1.49	469.029	6519.50	544.82	1667	2.70%	1.7	18%	0.72	0.00	0.72	0	0.99	0.30	1.05	1.0	0.060	#####	706.20	1.000	16.60
3.937	5611.91	227.8	8.106	227.7	12.0	5.18	3.56%	Sand-Slime Tailings	0.047	93.3	0.20	0.00	0.20	0	1.48	336.474	4676.99	390.92	1161	3.56%	1.8	47%	0.73	0.00	0.73	0	0.99	0.30	1.05	1.0	0.060	#####	558.33	1.000	16.66
4.101	5611.75	218.4	6.483	218.4	6.5	2.83	2.97%	Sand-Slime Tailings	0.047	93.3	0.20	0.00	0.20	0	1.46	319.444	4440.28	371.08	1072	2.97%	1.7	47%	0.74	0.00	0.74	0	0.99	0.30	1.05	1.0	0.060	#####	531.53	1.000	16.73
4.265	5611.58	214.9	5.761	214.9	3.0	1.32	2.68%	Sand-Slime Tailings	0.047	93.3	0.21	0.00	0.21	0	1.45	311.252	4326.41	361.53	1016	2.68%	1.7	47%	0.74	0.00	0.74	0	0.99	0.30	1.04	1.0	0.059	#####	518.63	1.000	16.79
4.429	5611.42	175.0	4.480	175.0	2.3	0.98	2.56%	Sand-Slime Tailings	0.047	93.3	0.22	0.00	0.22	0	1.44	251.142	3490.88	291.71	798	2.56%	1.7	47%	0.75	0.00	0.75	0	0.99	0.30	1.04	1.0	0.059	#####	424.32	1.000	16.86
4.593	5611.26	150.8	3.824	150.8	1.6	0.68	2.54%	Sand-Slime Tailings	0.047	93.3	0.23	0.00	0.23	0	1.43	215.630	2997.26	250.46	665	2.54%	1.7	47%	0.76	0.00	0.76	0	0.98	0.30	1.04	1.0	0.059	#####	368.60	1.000	16.93
4.757	5611.09	121.0	2.453	121.0	1.6	0.71	2.03%	Sand Tailings	0.051	102.8	0.24	0.00	0.24	0	1.50	181.995	2529.74	211.39	514	2.03%	1.7	18%	0.77	0.00	0.77	0	0.98	0.30	1.03	1.0	0.059	76.13	287.53	1.000	17.00
4.921	5610.93	111.4	1.755	111.4	0.9	0.40	1.57%	Sand Tailings	0.051	102.8	0.24	0.00	0.24	0	1.52	169.758	2359.64	197.17	457	1.58%	1.6	18%	0.78	0.00	0.78	0	0.98	0.25	1.03	1.0	0.059	72.50	269.67	1.000	17.14
5.085	5610.76	105.9	2.102	105.9	0.1	0.06	1.99%	Sand Tailings	0.051	102.8	0.25	0.00	0.25	0	1.53	161.916	2250.64	188.06	419	1.99%	1.7	18%	0.78	0.00	0.78	0	0.98	0.23	1.02	1.0	0.058	70.17	258.22	1.000	17.25
5.249	5610.60	102.9	2.378	102.9	-1.0	-0.44	2.31%	Sand-Slime Tailings	0.047	93.3	0.26	0.00	0.26	0	1.53	157.250	2185.78	182.63	396	2.32%	1.8	47%	0.79	0.00	0.79	0	0.98	0.22	1.02	1.0	0.058	94.35	276.98	1.000	17.32
5.413	5610.44	102.4	2.370	102.4	-0.5	-0.23	2.31%	Sand-Slime Tailings	0.047	93.3	0.27	0.00	0.27	0	1.52	155.399	2160.05	180.48	382	2.32%	1.8	47%	0.80	0.00	0.80	0	0.98	0.21	1.02	1.0	0.058	93.60	274.08	1.000	17.38
5.577	5610.27	101.3	2.366	101.3	-0.4	-0.15	2.34%	Sand-Slime Tailings	0.047	93.3	0.27	0.00	0.27	0	1.51	152.916	2125.53	177.60	368	2.34%	1.8	47%	0.81	0.00	0.81	0	0.98	0.21	1.01	1.0	0.057	92.59	270.19	1.000	17.44
5.741	5610.11	96.2	2.597	96.2	-1.0	-0.43	2.70%	Sand-Slime Tailings	0.047	93.3	0.28	0.00	0.28	0	1.52	145.768	2026.18	169.29	339	2.71%	1.9	47%	0.81	0.00	0.81	0	0.98	0.19	1.01	1.0	0.057	89.67	258.96	1.000	17.50
5.905	5609.94	86.9	2.414	86.9	-0.9	-0.40	2.78%	Sand-Slime Tailings	0.047	93.3	0.29	0.00	0.29	0	1.54	133.514	1855.84	155.06	298	2.79%	1.9	47%	0.82	0.00	0.82	0	0.98	0.17	1.01	1.0	0.057	84.68	239.74	1.000	17.57
6.069	5609.78	80.9	2.523	80.9	-1.0	-0.43	3.12%	Sand-Slime Tailings	0.047	93.3	0.30	0.00	0.30	0	1.55	125.130	1739.31	145.32	271	3.13%	2.0	47%	0.83	0.00	0.83	0	0.98	0.15	1.01	1.0	0.057	81.27	226.59	1.000	17.62
6.234	5609.62	79.6	2.316	79.6	-1.1	-0.49	2.91%	Sand-Slime Tailings	0.047	93.3	0.31	0.00	0.31	0	1.54	122.573	1703.76	142.35	260	2.92%	2.0	47%	0.84	0.00	0.84	0	0.98	0.15	1.00	1.0	0.057	80.23	222.57	1.000	17.67
6.398	5609.45	76.6	2.134	76.6	-0.2	-0.10	2.79%	Sand-Slime Tailings	0.047	93.3	0.31	0.00	0.31	0	1.54	117.783	1637.19	136.80	244	2.80%	2.0	47%	0.85	0.00	0.85	0	0.97	0.14	1.00	1.0	0.056	78.28	215.07	1.000	17.71
6.562	5609.29	57.1	1.783	57.1	-0.1	-0.03	3.12%	Sand-Slime Tailings	0.047	93.3	0.32	0.00	0.32	0	1.61	91.966	1278.33	106.81	177	3.14%	2.1	47%	0.85	0.00	0.85	0	0.97	0.11	1.00	1.0	0.056	67.76	174.57	0.459	8.14
6.726	5609.12	51.8	1.588	51.8	-0.1	-0.03	3.07%	Sand-Slime Tailings	0.047	93.3	0.33	0.00	0.33	0	1.62	84.096	1168.93	97.67	157	3.09%	2.1	47%	0.86	0.00	0.86	0	0.97	0.10	1.00	1.0	0.056	64.56	162.23	0.341	6.07
6.890	5608.96	49.7	1.224	49.7	-0.8	-0.33	2.46%	Sand-Slime Tailings	0.047	93.3	0.34	0.00	0.34	0	1.62	80.549	1119.63	93.54	147	2.48%	2.1	47%	0.87	0.00	0.87	0	0.97	0.10	1.00	1.0	0.056	63.20	156.74	0.305	5.45
7.054	5608.80	56.3	1.510	56.4	-0.3	-0.13	2.68%	Sand-Slime Tailings	0.047	93.3	0.34	0.00	0.34	0	1.57	88.530	1230.57	102.82	163	2.70%	2.1	47%	0.88	0.00	0.88	0	0.97	0.11	1.00	1.0	0.056	66.36	169.18	0.399	7.14
7.218	5608.63	68.1	2.477	68.1	7.0	3.01	3.64%	Slime Tailings	0.041	82.7	0.35	0.00	0.35	0	1.51	102.716	1427.76	119.37	193	3.66%	2.1	71%	0.88	0.00	0.88	0	0.97	0.12	1.00	1.0	0.056	71.66	191.03	0.781	13.98
7.382	5608.47	66.2	2.994	66.2	1.5	0.65	4.52%	Slime Tailings	0.041	82.7	0.36	0.00	0.36	0	1.51	99.683	1385.59	115.79	184	4.55%	2.2	71%	0.89	0.00	0.89	0	0.97	0.12	1.00	1.0	0.056	70.41	186.20	0.655	11.75
7.546	5608.30	143.2	1.935	143.2	2.8	1.21	1.35%	Sand Tailings	0.051	102.8	0.37	0.00	0.37	0	1.30	186.431	2591.40	216.56	391	1.35%	1.6	18%	0.90	0.00	0.90	0	0.97	0.30	0.99	1.0	0.055	77.45	294.01	1.000	18.12
7.710	5608.14	161.7	1.640	161.7	-0.1	-0.04	1.01%	Sand Tailings	0.051	102.8	0.37	0.00	0.37	0	1.27	204.599	2843.92	237.63	431	1.02%	1.5	18%	0.91	0.00	0.91	0	0.97	0.30	0.98	1.0	0.055	82.84	320.47	1.000	18.19
7.874	5607.98	86.8	1.774	86.8	4.1	1.79	2.04%	Sand-Slime Tailings	0.047	93.3	0.38	0.00	0.38	0	1.40	121.855	1693.79	141.57	226	2.05%	1.9	47%	0.91	0.00	0.91	0	0.96	0.15	0.99	1.0	0.055	79.95	221.52	1.000	18.09
8.038	5607.81	50.5	1.194	50.5	1.7	0.75	2.36%	Sand-Slime Tailings	0.047	93.3	0.39	0.00	0.39	0	1.52	76.535	1063.84	88.91	129	2.38%	2.1	47%	0.92	0.00	0.92	0	0.96	0.10	0.99	1.0	0.055	61.48	150.39	0.273	4.93
8.202	5607.65	34.7	0.878	34.7	0.9	0.37	2.53%	Sand-Slime Tailings	0.047	93.3	0.40	0.00	0.40	0	1.58	54.878	762.80	63.75	86	2.56%	2.2	47%	0.93	0.00	0.93	0	0.96	0.08	0.99	1.0	0.055	52.66	116.41	0.172	3.11
8.366	5607.48	25.8	0.664	25.8	0.5	0.20	2.58%	Sand-Slime Tailings	0.047	93.3	0.40	0.00	0.40	0	1.63	41.903	582.45	48.67	63	2.62%	2.3	47%	0.94	0.00	0.94	0	0.96	0.07	0.99	1.0	0.055	47.37	96.05	0.136	2.46
8.530	5607.32	31.8	0.573	31.8	2.8	1.21	1.80%	Sand-Slime Tailings	0.047	93.3	0.41	0.00	0.41	0	1.57	49.800	692.22	57.87	76	1.83%	2.2	47%	0.95	0.00	0.95	0	0.96	0.08	0.99	1.0	0.055	50.60	108.47	0.157	2.85
8.694	5607.16	34.8	0.413	34.8	2.3	1.01	1.19%	Sand-Slime Tailings	0.047	93.3	0.42	0.00	0.42	0	1.54	53.460	743.09	62.12	82	1.20%	2.0	47%	0.95	0.00	0.95	0	0.96	0.08	0.99	1.0	0.055	52.09	114.20	0.168	3.05
8.858	5606.99	33.7	0.343	33.7	0.9	0.37	1.02%	Sand-Slime Tailings	0.047	93.3	0.43	0.00	0.43	0	1.53	51.481	715.59	59.80	78	1.03%	2.0	47%	0.96	0.00	0.96	0	0.96	0.08	0.99	1.0	0.055	51.27	111.08	0.162	2.95
9.022	5606.83	29.3	0.358	29.3	0.1	0.05	1.22%	Sand-Slime Tailings	0.047	93.3	0.44	0.00	0.44	0	1.54	44.964	624.99	52.22	66	1.24%	2.1	47%	0.97	0.00	0.97	0	0.96	0.07	0.99	1.0	0.055	48.62	100.84	0.144	2.62
9.186	5606.66	20.9	0.342	20.9	-0.3	-0.13	1.64%	Sand-Slime Tailings	0.047	93.3	0.44	0.00	0.44	0	1.58	32.960	458.14	38.28	46	1.67%	2.3	47%	0.98	0.00	0.98	0	0.96	0.06	0.99	1.0	0.055	43.73	82.00	0.115	2.10
9.350	5606.50	12.6	0.327	12.6	-0.6	-0.25	2.59%	Slime Tailings	0.041	82.7	0.45	0.00	0.45	0	1.64	20.679	287.43	24.01	27	2.69%	2.6	71%	0.98	0.00	0.98	0	0.96	0.06	0.99	1.0	0.055	38.45	62.46	0.091	1.65
9.514	5606.34	12.0	0.251	12.0	-0.7	-0.29	2.10%	Slime Tailings	0.041	82.7	0.46	0.00	0.46	0	1.63	19.500	271.05	22.64	25	2.18%	2.6	71%	0.99	0.00	0.99	0	0.95	0.05	0.99	1.0	0.055	37.97	60.61	0.089	1.62
9.678	5606.17	14.1	0.216	14.1	-0.6	-0.26	1.53%	Sand-Slime Tailings	0.047	93.3	0.46	0.00	0.46	0	1.59	22.445	311.98	26.06	29	1.58%	2.5	47%	1.00	0.00	1.00	0	0.95	0.06	0.99	1.0	0.055	39.44	65.50	0.094	1.72
9.842	5606.01	23.2	0.158	23.2	-0.3	-0.12	0.68%	Sand-Slime Tailings	0.047	93.3	0.47	0.00	0.47	0	1.50	34.822	484.03	40.44	48	0.70%	2.1	47%	1.00	0.00	1.00	0	0.95	0.07	0.99	1.0	0.054	44.48	84.93	0.120	2.19
10.006	5605.84	22.6	0.274	22.6	-0.3	-0.12	1.21%	Sand-Slime Tailings	0.047	93.3	0.48	0.00	0.48	0	1.49	33.696	468.37	39.13	46	1.24%	2.2	47%	1.01	0.00	1.01	0	0.95	0.06	0.99	1.0	0.054	44.03	83.16	0.117	2.15
10.170	5605.68	11.1	0.368	11.1	-0.5	-0.23	3.32%	Slime Tailings	0.041	82.7	0.49	0.00	0.49	0	1.56	17.349	241.15	20.14	22	3.47%	2.8	71%	1.02	0.00	1.02	0	0.95	0.05	0.99	1.0	0.054	37.10	57.25	0.085	1.56
10.335	5605.52	10.3	0.383	10.3	0.3	0.12	3.73%	Slime Tailings	0.041	82.7	0.49	0.00	0.49	0	1.55	15.894	220.93	18.46	20	3.91%	2.8	71%	1.03	0.00	1.03	0	0.95	0.05	0.99	1.0	0.054	36.52	54.98	0.082	1.52
10.499	5605.35	8.6	0.299	8.6	1.8	0.79	3.46%	Slime Tailings	0.041	82.7	0.50	0.00	0.50	0	1.53	13.186	183.29	15.34	16	3.68%	2.9	71%	1.03	0.00	1.03	0	0.95	0.05	0.99	1.0	0.054	35.43	50.76	0.078	1.44
10.663	5605.19	11.2	0.222	11.2	2.1	0.91	1.98%	Slime Tailings	0.041	82.7	0.51	0.00	0.51	0	1.51	16.923	235.23	19.68	21	2.08%	2.6	71%	1.04	0.00	1.04	0	0.95	0.05	0.99	1.0	0.054	36.94	56.62	0.084	1.55
10.827	5605.02	22.3	0.182	22.3	1.3	0.55	0.82%	Sand-Slime Tailings	0.047	93.3	0.51	0.00	0.51	0	1.43	31.828	442.41	36.98	42	0.84%	2.2	47%	1.05	0.00	1.05	0	0.95	0.06	0.99	1.0	0.054	43.27	80.25	0.113	2.09
10.991	5604.86	26.2	0.185	26.2	0.6	0.25	0.71%	Sand-Slime Tailings	0.047	93.3	0.52	0.00	0.52	0	1.40	36.562	508.21	42.47	49	0.72%	2.1	47%	1.05	0.00	1.05	0	0.94	0.07	0.99	1.0	0.054	45.20	87.67	0.123	2.29
11.155	5604.70	24.7	0.273	24.7	0.3	0.14	1.10%	Sand-Slime Tailings	0.047	93.3	0.53	0.00	0.53	0	1.39	34.382	477.91	39.94	46	1.13%	2.2	47%	1.06	0.00	1.06	0	0.94	0.06	0.99	1.0	0.054	44.31	84.24	0.119	2.20
11.319	5604.53	17.5	0.349	17.5	-0.1	-0.05	1.99%	Sand-Slime Tailings	0.047	93.3	0.54	0.00	0.54	0	1.41	24.763	344.20	28.76	32	2.06%	2.5	47%	1.07	0.00	1.07	0	0.94	0.06	0.99	1.0	0.054	40.39	69.15	0.099	1.83
11.483	5604.37	12.5	0.390	12.5	-0.2	-0.07	3.12%	Slime Tailings	0.057	113.1	0.55	0.00	0.55	1	1.43	17.845	248.04	20.72	22	3.27%	2.7	71%	1.08	0.00	1.08	0	0.94	0.05	0.99	1.0	0.054	37.30	58.03	0.086	1.59
11.647	5604.20	12.1	0.339	12.1	2.0	0.88	2.79%	Slime Tailings	0.057	113.1	0.56	0.01	0.55	1	1.42	17.214	239.27	20.01	21	2.93%	2.7	71%	1.09	0.00	1.09	0	0.94	0.05	0.99	1.0	0.054	37.06	57.07	0.085	1.58
11.811	5604.04	10.7	0.328	10.7	10.4	4.49	3.06%	Slime Tailings	0.057	113.1	0.57	0.01	0.55	1	1.41	15.051	209.21	17.59	18	3.23%	2.8	71%	1.10	0.00	1.10	0	0.94	0.05	0.99	1.0	0.054	36.21	53.80	0.081	1.52
11.975	5603.88	17.0	0.353	16.9	18.5	8.03	2.08%	Sand-Slime Tailings	0.059	119.0	0.57	0.02	0.56	1	1.38	23.239	323.02	27.18	29	2.15%	2.5	47%	1.11	0.00	1.11	0	0.94	0.06	0.99	1.0	0.053	39.83	67.01	0.096	1.80
12.139	5603.71	12.2	0.338	12.1	8.3	3.58	2.77%	Slime Tailings	0.057	113.1	0.58	0.02	0.56	1	1.39	16.931	235.34	19.75	21	2.91%	2.7	71%	1.12	0.00	1.12	0	0.94	0.05	0.99	1.0	0.053	36.96	56.71	0.084	1.58
12.303	5603.55	8.8	0.266	8.8	6.5	2.80	3.02%	Slime Tailings	0.057	113.1	0.59	0.03	0.57	1	1.39	12.161	169.03	14.19	14	3.24%	2.9	71%	1.13	0.00	1.13	0	0.94	0.05	0.99	1.0	0.053	35.03	49.22	0.077	1.44
12.467	5603.38	5.7	0.163	5.7	9.4	4.08	2.86%	Slime Tailings	0.057	113.1	0.60	0.03	0.57	1	1.38	7.790	108.28	9.14	9	3.19%	3.1	71%	1.14	0.00	1.14	0	0.93	0.04	0.99	1.0	0.053	33.27	42.41	0.071	1.32
12.631	5603.22	6.7	0.119	6.6	17.7	7.65	1.77%	Slime Tailings	0.057	113.1	0.61	0.04	0.58	1	1.37	9.089	126.34	10.73	11	1.94%	2.9	71%	1.14	0.00	1.14	0	0.93	0.05	0.99	1.0	0.053	33.82	44.56	0.072	1.36
12.795	5603.05	9.3	0.181	9.2	25.8	11.18	1.94%	Slime Tailings	0.057	113.1	0.62	0.04	0.58	1	1.36	12.514	173.95	14.79	15	2.08%	2.8	71%	1.15	0.00	1.15	0	0.93	0.05	0.99	1.0	0.053	35.24	50.03	0.078	1.46
12.959	5602.89	8.3	0.182	8.2	18.0	7.82	2.18%	Slime Tailings	0.057	113.1	0.63	0.05	0.58	1	1.36	11.157	155.08	13.13	13	2.36%	2.8	71%	1.16	0.00	1.16	0	0.93	0.05	0.99	1.0	0.053	34.66	47.80	0.075	1.42
13.123	5602.73	6.3	0.181	6.2	22.2	9.60	2.85%	Slime Tailings	0.057	113.1	0.64	0.05	0.59	1	1.35	8.372	116.37	9.94	10	3.17%	3.0	71%	1.17	0.00	1.17	0	0.93	0.05	0.99	1.0	0.053	33.55	43.49	0.072	1.35
13.287	5602.56	5.9	0.160	5.6	56.5	24.47	2.70%	Slime Tailings	0.057	113.1	0.65	0.06	0.59	1	1.34	7.468	103.80	9.22	9	3.03%	3.0	71%	1.18	0.00	1.18	0	0.93	0.04	0.99	1.0	0.053	33.30	42.52	0.071	1.34
13.451	5602.40	5.0	0.142	4.6	62.6	27.11	2.87%	Slime Tailings	0.057	113.1	0.66	0.06	0.60	1	1.33	6.080	84.51	7.67	7	3.31%	3.1	71%	1.19	0.00	1.19	0	0.93	0.04	0.99	1.0	0.053	32.76	40.42	0.069	1.31
13.615	5602.23	4.7	0.156	4.3	65.6	28.41	3.34%	Slime Tailings	0.057	113.1	0.67	0.07	0.60	1	1.33	5.649	78.52	7.19	7	3.90%	3.2	71%	1.20	0.00	1.20	0	0.93	0.04	0.99	1.0	0.053	32.59	39.78	0.068	1.30
13.779	5602.07	5.0	0.155	4.5	70.8	30.68	3.12%	Slime Tailings	0.057	113.1	0.68	0.07	0.60	1	1.32	5.962	82.87	7.60	7	3.62%	3.2	71%	1.21	0.00	1.21	0	0.92	0.04	0.99	1.0	0.053	32.73	40.34	0.069	1.31
13.943	5601.91	5.3	0.171	4.9	65.5	28.40	3.21%	Slime Tailings	0.057	113.1	0.69	0.08	0.61	1	1.31	6.441	89.54	8.10	8	3.69%	3.1	71%	1.22	0.00	1.22	0	0.92	0.04	0.98	1.0	0.053	32.91	41.01	0.069	1.32
14.107	5601.74	5.7	0.161	5.3	66.6	28.87	2.81%	Slime Tailings	0.057	113.1	0.70	0.08	0.61	1	1.30	6.929	96.32	8.68	8	3.20%	3.1	71%	1.23	0.00	1.23	0	0.92	0.04	0.98	1.0	0.052	33.11	41.79	0.070	1.34
14.271	5601.58	6.2	0.224	5.8	64.0	27.75	3.64%	Slime Tailings	0.057	113.1	0.70	0.09	0.62	1	1.30	7.477	103.93	9.29	9	4.11%	3.1	71%	1.24	0.00	1.24	0	0.92	0.04	0.98	1.0	0.052	33.32	42.61	0.071	1.35
14.436	5601.41	6.8	0.221	6.7	27.2	11.78	3.24%	Slime Tailings	0.057	113.1	0.71	0.09	0.62	1	1.29	8.600	119.54	10.24	10	3.61%	3.0	71%	1.25	0.00	1.25	0	0.92	0.05	0.98	1.0	0.052	33.65	43.90	0.072	1.38
14.600	5601.25	12.2	0.194	12.0	33.9	14.70	1.58%	Sand-Slime Tailings	0.059	119.0	0.72	0.10	0.63	1	1.28	15.444	214.67	18.25	18	1.68%	2.6	47%	1.26	0.00	1.26	0	0.92	0.05	0.98	1.0	0.052	36.70	54.96	0.082	1.58
14.764	5601.09	17.1	0.255	17.0	12.7	5.52	1.49%	Sand-Slime Tailings	0.059	119.0	0.73	0.10	0.63	1	1.27	21.529	299.25	25.12	26	1.56%	2.5	47%	1.27	0.00	1.27	0	0.92	0.06	0.98	1.0	0.052	39.11	64.23	0.093	1.79
14.928	5600.92	15.7	0.220	15.7	4.6	1.99	1.40%	Sand-Slime Tailings	0.059	119.0	0.74	0.11	0.63	1	1.26	19.827	275.59	23.07	24	1.47%	2.5	47%	1.28	0.00	1.28	0	0.92	0.05	0.98	1.0	0.052	38.39	61.46	0.089	1.73
15.092	5600.76	10.8	0.225	10.8	8.1	3.49	2.08%	Slime Tailings	0.057	113.1	0.75	0.11	0.64	1	1.26	13.623	189.36	15.90	16	2.23%	2.8	71%	1.29	0.00	1.29	0	0.91	0.05	0.98	1.0	0.052	35.62	51.52	0.079	1.52
15.256	5600.59	23.2	0.308	23.2	2.0	0.87	1.33%	Sand-Slime Tailings	0.059	119.0	0.76	0.12	0.64	1	1.23	28.564	397.04	33.19	35	1.37%	2.4	47%	1.29	0.00	1.29	0	0.91	0.06	0.98	1.0	0.051	41.94	75.14	0.106	2.06
15.420	5600.43	16.2	0.412	16.2	0.7	0.28	2.55%	Slime Tailings	0.057	113.1	0.77	0.12	0.65	1	1.24	20.096	279.34	23.35	24	2.68%	2.7	71%	1.30	0.00	1.30	0	0.91	0.05	0.98	1.0	0.052	38.22	61.56	0.090	1.74
15.584	5600.27	12.6	0.274	12.6	2.6	1.12	2.17%	Slime Tailings	0.057	113.1	0.78	0.13	0.65	1	1.24	15.661	217.69	18.21	18	2.32%	2.7	71%	1.31	0.00	1.31	0	0.91	0.05	0.98	1.0	0.052	36.43	54.64	0.082	1.59
15.748	5600.10	10.3	0.241	10.2	8.8	3.82	2.34%	Slime Tailings	0.057	113.1	0.79	0.13	0.66	1	1.24	12.652	175.86	14.77	14	2.54%	2.8	71%	1.32	0.00	1.32	0	0.91	0.05	0.98	1.0	0.051	35.23	50.01	0.077	1.51
15.912	5599.94	9.3	0.182	8.8	77.2	33.43	1.96%	Slime Tailings	0.057	113.1	0.80	0.14	0.66	1	1.23	10.854	150.88	13.30	13	2.14%	2.8	71%	1.33	0.00	1.33	0	0.91	0.05	0.98	1.0	0.051	34.72	48.01	0.076	1.47
16.076	5599.77	9.1	0.171	8.6	82.6	35.81	1.87%	Slime Tailings	0.057	113.1	0.81	0.14	0.66	1	1.22	10.569	146.90	13.01	13	2.05%	2.8	71%	1.34	0.00	1.34	0	0.91	0.05	0.98	1.0	0.051	34.62	47.63	0.075	1.47
16.240	5599.61	10.3	0.119	9.8	84.2	36.48	1.15%	Sand-Slime Tailings	0.059	119.0	0.82	0.15	0.67	1	1.22	11.912	165.58	14.58	14	1.25%	2.7	47%	1.35	0.00	1.35	0	0.91	0.05	0.98	1.0	0.051	35.41	49.99	0.077	1.51
16.404	5599.45	10.7	0.142	10.3	64.6	28.00	1.33%	Sand-Slime Tailings	0.059	119.0	0.83	0.15	0.67	1	1.21	12.466	173.27	15.05	15	1.44%	2.7	47%	1.36	0.00	1.36	0	0.90	0.05	0.98	1.0	0.051	35.58	50.62	0.078	1.53
16.568	5599.28	9.7	0.148	9.1	90.7	39.29	1.52%	Sand-Slime Tailings	0.059	119.0	0.84	0.16	0.68	1	1.20	11.013	153.08	13.58	13	1.67%	2.8	47%	1.37	0.00	1.37	0	0.90	0.05	0.98	1.0	0.051	35.07	48.65	0.076	1.49
16.732	5599.12	11.2	0.142	10.7	72.9	31.59	1.27%	Sand-Slime Tailings	0.059	119.0	0.85	0.16	0.68	1	1.20	12.872	178.92	15.58	15	1.37%	2.7	47%	1.38	0.00	1.38	0	0.90	0.05	0.98	1.0	0.051	35.77	51.35	0.079	1.55
16.896	5598.95	11.8	0.171	11.3	78.1	33.86	1.45%	Sand-Slime Tailings	0.059	119.0	0.86	0.17	0.69	1	1.19	13.484	187.43	16.34	16	1.56%	2.7	47%	1.39	0.00	1.39	0	0.90	0.05	0.98	1.0	0.051	36.03	52.37	0.080	1.57
17.060	5598.79	12.0	0.161	11.4	83.5	36.17	1.35%	Sand-Slime Tailings	0.059	119.0	0.87	0.18	0.69	1	1.19	13.567	188.59	16.48	16	1.45%	2.7	47%	1.40	0.00	1.40	0	0.90	0.05	0.98	1.0	0.051	36.08	52.56	0.080	1.58
17.224	5598.63	12.8	0.164	12.3	73.7	31.95	1.28%	Sand-Slime Tailings	0.059	119.0	0.88	0.18	0.70	1	1.18	14.547	202.20	17.53	17	1.38%	2.6	47%	1.41	0.00	1.41	0	0.90	0.05	0.97	1.0	0.051	36.45	53.97	0.081	1.61

Liquefaction Triggering Analyses – Youd et al. (2001) / Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.481

Depth at time of CPT (ft)	r_d	D_r	f	K_σ	K_α	CSR M=7.5, σ'=1atm	Kc	q_{c1n-cs}	CRR M=7.5, σ'=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, $\varepsilon_{c,15}$ (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation on (ft)
0.164	0.98	0.21	0.80	2.53	1.0	0.017	1.00	12.87	0.061	3.63	2.45	2	2.96	594	1.6E-03	5.5E+02	9.6E-05	11	0.173	10172	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
0.328	0.98	0.38	0.80	2.20	1.0	0.020	1.00	43.85	0.087	4.59	3.35	2	3.01	594	1.6E-03	5.5E+02	9.7E-05	11	0.174	10108	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
0.492	0.98	0.48	0.76	2.33	1.0	0.018	1.00	68.51	0.110	5.44	4.27	2	3.06	594	1.6E-03	5.5E+02	9.8E-05	11	0.175	10045	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
0.656	0.98	0.60	0.70	2.66	1.0	0.016	1.00	107.91	0.197	119.17	63.53	2	3.11	594	1.6E-03	5.5E+02	1.0E-04	11	0.175	9984	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
0.820	0.98	0.74	0.63	3.07	1.0	0.014	1.00	164.02	1.000	484.49	250.30	2	3.16	594	1.6E-03	5.5E+02	1.0E-04	11	0.176	9924	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
0.984	0.98	0.79	0.61	3.07	1.0	0.014	1.00	185.52	1.000	403.90	209.90	2	3.21	594	1.6E-03	5.5E+02	1.0E-04	11	0.177	9865	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
1.148	0.98	0.79	0.61	2.91	1.0	0.015	1.00	187.16	1.000	346.34	181.13	2	3.26	594	1.6E-03	5.5E+02	1.0E-04	11	0.177	9808	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
1.312	0.97	0.78	0.61	2.72	1.0	0.016	1.00	182.01	1.000	303.16	159.60	2	3.31	594	1.6E-03	5.5E+02	1.1E-04	11	0.178	9751	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
1.476	0.97	0.77	0.61	2.58	1.0	0.017	1.00	179.23	1.000	269.58	142.85	2	3.36	594	1.6E-03	5.5E+02	1.1E-04	11	0.179	9696	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
1.640	0.97	0.75	0.62	2.41	1.0	0.018	1.00	169.44	1.000	242.72	129.49	2	3.41	594	1.6E-03	5.5E+02	1.1E-04	11	0.179	9642	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
1.804	0.97	0.74	0.63	2.30	1.0	0.019	1.00	165.38	1.000	220.74	118.54	2	3.46	594	1.6E-03	5.5E+02	1.1E-04	11	0.180	9589	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
1.968	0.97	0.71	0.65	2.15	1.0	0.020	1.00	151.17	0.401	81.22	48.86	2	3.51	594	1.6E-03	5.5E+02	1.1E-04	11	0.180	9536	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.133	0.97	0.64	0.68	1.94	1.0	0.022	1.00	120.99	0.245	45.74	30.13	2	3.56	594	1.6E-03	5.5E+02	1.1E-04	11	0.181	9485	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.297	0.97	0.65	0.67	1.92	1.0	0.022	1.00	126.76	0.269	46.79	31.75	2	3.61	594	1.6E-03	5.5E+02	1.1E-04	11	0.182	9435	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.461	0.97	0.67	0.66	1.92	1.0	0.022	1.00	135.70	0.312	50.65	33.68	2	3.66	594	1.6E-03	5.5E+02	1.2E-04	11	0.182	9385	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.625	0.97	1.10	0.60	2.12	1.0	0.020	1.00	364.89	1.000	152.06	84.09	2	3.71	594	1.6E-03	5.5E+02	1.2E-04	11	0.183	9337	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.789	0.97	1.23	0.60	2.07	1.0	0.021	1.00	452.13	1.000	143.17	79.68	2	3.76	594	1.6E-03	5.5E+02	1.2E-04	11	0.183	9289	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.953	0.97	1.28	0.60	2.02	1.0	0.021	1.00	489.79	1.000	135.27	75.77	2	3.81	594	1.6E-03	5.5E+02	1.2E-04	11	0.184	9242	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.117	0.97	1.20	0.60	1.98	1.0	0.022	1.06	461.98	1.000	128.20	72.27	2	3.86	495	1.6E-03	3.8E+02	1.8E-04	11	0.185	9196	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.281	0.97	1.14	0.60	1.94	1.0	0.022	1.08	423.01	1.000	122.29	69.34	2	3.91	495	1.4E-03	3.5E+02	1.9E-04	10	0.185	9397	0.03%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.44%	0.0007
3.445	0.97	1.14	0.60	1.90	1.0	0.022	1.07	412.59	1.000	116.91	66.68	2	3.96	495	1.4E-03	3.5E+02	1.9E-04	10	0.186	9355	0.03%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.48%	0.0008
3.609	0.97	1.22	0.60	1.87	1.0	0.023	1.06	476.39	1.000	111.98	64.25	2	4.01	495	1.6E-03	3.9E+02	2.0E-04	10	0.187	9313	0.04%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.52%	0.0009
3.773	0.97	1.35	0.60	1.84	1.0	0.023	1.02	554.48	1.000	107.01	61.80	2	4.06	495	1.6E-03	3.9E+02	1.8E-04	0	0.191	11669	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.03%	0.0000
3.937	0.97	1.14	0.60	1.81	1.0	0.024	1.12	437.65	1.000	102.87	59.77	2	4.11	495	1.4E-03	3.5E+02	2.0E-04	10	0.188	9227	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.60%	0.0010
4.101	0.97	1.11	0.60	1.78	1.0	0.024	1.07	397.43	1.000	99.05	57.89	2	4.16	495	1.4E-03	3.5E+02	2.0E-04	10	0.188	9187	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.64%	0.0011
4.265	0.97	1.10	0.60	1.75	1.0	0.024	1.05	380.28	1.000	95.50	56.15	2	4.21	495	1.4E-03	3.5E+02	2.0E-04	10	0.189	9148	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.68%	0.0011
4.429	0.97	0.99	0.60	1.73	1.0	0.025	1.05	307.64	1.000	92.20	54.53	2	4.26	495	1.4E-03	3.5E+02	2.1E-04	10	0.189	9109	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.71%	0.0012
4.593	0.97	0.91	0.60	1.71	1.0	0.025	1.07	268.21	1.000	89.12	53.02	2	4.31	495	1.4E-03	3.5E+02	2.1E-04	10	0.190	9071	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.75%	0.0012
4.757	0.97	0.84	0.60	1.68	1.0	0.025	1.04	220.27	1.000	85.96	51.48	2	4.36	495	1.6E-03	3.9E+02	1.9E-04	0	0.194	11373	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.05%	0.0001
4.921	0.97	0.81	0.60	1.66	1.0	0.026	1.00	197.17	1.000	83.01	50.08	2	4.41	495	1.6E-03	3.9E+02	1.9E-04	0	0.194	11322	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.05%	0.0001
5.085	0.97	0.79	0.60	1.63	1.0	0.026	1.06	200.17	1.000	80.26	48.75	2	4.46	495	1.6E-03	3.9E+02	2.0E-04	0	0.195	11272	0.05%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.05%	0.0001
5.249	0.97	0.78	0.61	1.60	1.0	0.027	1.11	203.34	1.000	77.93	47.62	2	4.51	495	1.4E-03	3.5E+02	2.2E-04	10	0.192	8913	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.89%	0.0015
5.413	0.97	0.78	0.61	1.57	1.0	0.027	1.12	202.03	1.000	75.73	46.55	2	4.56	495	1.4E-03	3.5E+02	2.2E-04	10	0.192	8877	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.93%	0.0015
5.577	0.96	0.77	0.62	1.55	1.0	0.027	1.13	200.40	1.000	73.65	45.54	2	4.61	495	1.4E-03	3.5E+02	2.2E-04	10	0.193	8842	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.96%	0.0016
5.741	0.96	0.75	0.62	1.52	1.0	0.028	1.19	201.39	1.000	71.68	44.59	2	4.66	495	1.4E-03	3.5E+02	2.2E-04	10	0.193	8808	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.99%	0.0016
5.905	0.96	0.72	0.64	1.48	1.0	0.029	1.23	190.57	1.000	69.82	43.69	2	4.71	495	1.4E-03	3.5E+02	2.3E-04	10	0.193	8774	0.05%	2.00	0.65	0.03%	0.007	0.34	0.079	0.765	1.02%	0.0017
6.069	0.96	0.70	0.65	1.45	1.0	0.029	1.31	189.90	1.000	68.05	42.84	2	4.76	495	1.4E-03	3.5E+02	2.3E-04	10	0.194	8740	0.05%	2.00	0.65	0.03%	0.007	0.34	0.079	0.765	1.06%	0.0017
6.234	0.96	0.69	0.66	1.43	1.0	0.030	1.29	182.97	1.000	66.38	42.02	2	4.81	495	1.4E-03	3.5E+02	2.3E-04	10	0.194	8707	0.05%	2.00	0.65	0.03%	0.007	0.34	0.079	0.765	1.09%	0.0017
6.398	0.96	0.68	0.66	1.41	1.0	0.030	1.28	175.75	1.000	64.78	41.25	2	4.86	495	1.4E-03	3.5E+02	2.3E-04	10	0.194	8674	0.05%	2.00	0.65	0.03%	0.007	0.34	0.079	0.765	1.12%	0.0018
6.562	0.96	0.60	0.70	1.34	1.0	0.031	1.47	156.93	0.439	27.80	17.97	2	4.91	495	1.4E-03	3.5E+02	2.4E-04	10	0.195	8642	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.15%	0.0019
6.726	0.96	0.57	0.71	1.32	1.0	0.032	1.52	148.18	0.383	23.65	14.86	2	4.96	495	1.4E-03	3.5E+02	2.4E-04	10	0.196	8610	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.18%	0.0019
6.890	0.96	0.56	0.72	1.30	1.0	0.033	1.41	131.92	0.294	17.74	11.59	2	5.01	495	1.4E-03	3.5E+02	2.4E-04	10	0.196	8578	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.22%	0.0020
7.054	0.96	0.59	0.71	1.29	1.0	0.032	1.41	145.16	0.365	21.55	14.34	2	5.06	495	1.4E-03	3.5E+02	2.4E-04	10	0.197	8547	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.25%	0.0020
7.218	0.96	0.63	0.68	1.33	1.0	0.031	1.58	182.80	1.000	57.98	35.98	2	5.11	495	1.3E-03	3.1E+02	2.7E-04	16	0.448	7010	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.09%	0.0034
7.382	0.96	0.62	0.69	1.31	1.0	0.032	1.75	202.06	1.000	56.91	34.33	2	5.16	495	1.3E-03	3.1E+02	2.8E-04	16	0.449	6988	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.12%	0.0035
7.546	0.96	0.85	0.60	1.41	1.0	0.030	1.00	216.56	1.000	55.62	36.87	2	5.21	495	1.6E-03	3.9E+02	2.2E-04	0	0.201	10663	0.06%	2.20	1.00	0.03%	0.001	0.34	0.079	0.765	0.10%	0.0002
7.710	0.96	0.89	0.60	1.40	1.0	0.030	1.00	237.63	1.000	54.38	36.29	2	5.26	495	1.6E-03	3.9E+02	2.3E-04	0	0.201	10622	0.06%	2.20	1.00	0.03%	0.001	0.34	0.079	0.765	0.10%	0.0002
7.874	0.96	0.69	0.66	1.32	1.0	0.032	1.18	167.67	1.000	53.32	35.70	2	5.31	495	1.4E-03	3.5E+02	2.5E-04	10	0.199	8398	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.40%	0.0023
8.038	0.96	0.54	0.73	1.24	1.0	0.034	1.45	128.98	0.280	14.62	9.78	2	5.36	495	1.4E-03	3.5E+02	2.5E-04	10	0.199	8369	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.44%	0.0024
8.202	0.96	0.46	0.77	1.20	1.0	0.035	1.76	112.27	0.212	10.86	6.98	2	5.41	495	1.4E-03	3.5E+02	2.6E-04	10	0.200	8340	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.47%	0.0024
8.366	0.96	0.40	0.80	1.16	1.0	0.036	2.09	101.59	0.178	8.94	5.70	2	5.46	495	1.4E-03	3.5E+02	2.6E-04	10	0.200	8312	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.50%	0.0025
8.530	0.96	0.44	0.78	1.18	1.0	0.036	1.60	92.72	0.154	7.62	5.23	2	5.51	495	1.4E-03	3.5E+02	2.6E-04	10	0.200	8284	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.53%	0.0025
8.694	0.96	0.46	0.77	1.18	1.0	0.036	1.34	83.09	0.133	6.48	4.76	2	5.56	495	1.4E-03	3.5E+02	2.6E-04	10	0.201	8256	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.56%	0.0026
8.858	0.96	0.45	0.78	1.17	1.0	0.036	1.30	77.98	0.124	5.92	4.43	2	5.61	495	1.4E-03	3.5E+02	2.6E-04	10	0.201	8229	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.59%	0.0026
9.022	0.96	0.42	0.79	1.15	1.0	0.037	1.47	76.82	0.122	5.73	4.18	2	5.66	495	1.4E-03	3.5E+02	2.7E-04	10	0.202	8202	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.62%	0.0027
9.186	0.96	0.36	0.80	1.14	1.0	0.037	1.99	76.07	0.121	5.57	3.84	2	5.71	495	1.4E-03	3.5E+02	2.7E-04	10	0.202	8175	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.66%	0.0027
9.350	0.96	0.28	0.80	1.14	1.0	0.037	3.47	83.20	0.134	6.07	3.86	2	5.76	460	1.3E-03	2.7E+02	3.5E-04	16	0.454	6709	0.14%	2.00	0.65	0.03%	0.024	0.34	0.079	0.765	3.68%	0.0060
9.514	0.96	0.27	0.80	1.14	1.0	0.037	3.27	74.01	0.118	5.27	3.44	2	5.81	460	1.3E-03	2.7E+02	3.6E-04	16	0.455	6690	0.14%	2.00	0.65	0.03%	0.024	0.34	0.079	0.765	3.73%	0.0061
9.678	0.96	0.29	0.80	1.13	1.0	0.037	2.54	66.27	0.107	4.72	3.22	2	5.86	460	1.4E-03	3.1E+02	3.2E-04	10	0.203	8103	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.63%	0.0043
9.842	0.95	0.37	0.80	1.13	1.0	0.037	1.42	57.38	0.098	4.23	3.21	2	5.91	460	1.4E-03	3.1E+02	3.2E-04	10	0.203	8077	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.67%	0.0044
10.006	0.95	0.36	0.80	1.12	1.0	0.037	1.75	68.53	0.110	4.69	3.42	2	5.96	460	1.4E-03	3.1E+02	3.2E-04	10	0.204	8052	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.71%	0.0044
10.170	0.95	0.26	0.80	1.12	1.0	0.038	4.49	90.38	0.149	6.26	3.91	2	6.01	460	1.3E-03	2.7E+02	3.7E-04	16	0.456	6609	0.15%	2.00	0.65	0.03%	0.026	0.34	0.079	0.765	3.94%	0.0065
10.335	0.95	0.25	0.80	1.12	1.0	0.038	5.04	92.99	0.155	6.43	3.97	2	6.06	460	1.3E-03	2.7E+02	3.7E-04	16	0.456	6591	0.16%	2.00	0.65	0.03%	0.026	0.34	0.079	0.765	3.98%	0.0065
10.499	0.95	0.23	0.80	1.11	1.0	0.038	5.50	84.30	0.136	5.56	3.50	2	6.11	460	1.3E-03	2.7E+02	3.7E-04	16	0.457	6573	0.16%	2.00	0.65	0.03%	0.026	0.34	0.079	0.765	4.03%	0.0066
10.663	0.95	0.26	0.80	1.11	1.0	0.038	3.58	70.44	0.113	4.55	3.05	2	6.16	460	1.3E-03	2.7E+02	3.7E-04	16	0.457	6555	0.16%	2.00	0.65	0.03%	0.027	0.34	0.079	0.765	4.08%	0.0067
10.827	0.95	0.35	0.80	1.11	1.0	0.038	1.59	58.90	0.099	3.95	3.02	2	6.21	460	1.4E-03	3.1E+02	3.3E-04	10	0.206	7940	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.91%	0.0048
10.991	0.95	0.38	0.80	1.11	1.0	0.038	1.42	60.27	0.100	3.94	3.12	2	6.26	460	1.4E-03	3.1E+02	3.4E-04	10	0.206	7916	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.95%	0.0048
11.155	0.95	0.36	0.80	1.10	1.0	0.038	1.70	67.83	0.109	4.22	3.21	2	6.31	460	1.4E-03	3.1E+02	3.4E-04	10	0.206	7892	0.11%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.00%	0.0049
11.319	0.95	0.31	0.80	1.10	1.0	0.038	2.75	79.07	0.126	4.81	3.32	2	6.36	460	1.4E-03	3.1E+02	3.4E-04	10	0.207	7868	0.11%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.04%	0.0050
11.483	0.95	0.26	0.80	1.10	1.0	0.038	4.35	90.07	0.148	5.57	3.58	2	6.41	460	1.8E-03	3.7E+02	2.8E-04	16	0.459	6454	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.03%	0.0033
11.647	0.95	0.26	0.80	1.09	1.0	0.038	4.22	84.43	0.136	5.08	3.33	2	6.46	460	1.8E-03	3.7E+02	2.9E-04	16	0.459	6432	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.07%	0.0034
11.811	0.95	0.24	0.80	1.09	1.0	0.038	4.81	84.62	0.136	5.06	3.29	2	6.51	460	1.8E-03	3.7E+02	2.9E-04	16	0.460	6409	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.10%	0.0035
11.975	0.95	0.30	0.80	1.09	1.0	0.038	2.95	80.09	0.128	4.70	3.25	2	6.56	460	1.8E-03	3.9E+02	2.8E-04	10	0.209	7757	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.69%	0.0028
12.139	0.95	0.26	0.80	1.09	1.0	0.038	4.26	84.15	0.135	4.95	3.26	2	6.61	460	1.8E-03	3.7E+02	2.9E-04	16	0.461	6364	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.18%	0.0036
12.303	0.95	0.22	0.80	1.09	1.0	0.038	5.55	78.80	0.126	4.56	3.00	2	6.66	460	1.8E-03	3.7E+02	3.0E-04	16	0.461	6342	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.21%	0.0036
12.467	0.95	0.17	0.80	1.09	1.0	0.039	7.34	67.12	0.108	3.90	2.61	2	6.71	460	1.8E-03	3.7E+02	3.0E-04	16	0.462	6321	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.25%	0.0037
12.631	0.95	0.19	0.80	1.08	1.0	0.039	5.42	58.12	0.098	3.52	2.44	2	6.76	460	1.8E-03	3.7E+02	3.0E-04	16	0.462	6300	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.28%	0.0037
12.795	0.95	0.22	0.80	1.08	1.0	0.039	4.45	65.88	0.107	3.79	2.63	2	6.81	460	1.8E-03	3.7E+02	3.0E-04	16	0.462	6279	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.32%	0.0038
12.959	0.95	0.21	0.80	1.08	1.0	0.039	5.12	67.20	0.108	3.82	2.62	2	6.86	460	1.8E-03	3.7E+02	3.1E-04	16	0.463	6258	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.35%	0.0039
13.123	0.95	0.18	0.80	1.08	1.0	0.039	6.98	69.37	0.111	3.90	2.62	2	6.91	460	1.8E-03	3.7E+02	3.1E-04	16	0.463	6238	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.39%	0.0039
13.287	0.95	0.18	0.80	1.08	1.0	0.039	7.21	66.51	0.107	3.74	2.54	2	6.96	460	1.8E-03	3.7E+02	3.1E-04	16	0.464	6217	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.43%	0.0040
13.451	0.95	0.16	0.80	1.08	1.0	0.039	8.42	64.56	0.105	3.64	2.47	2	7.01	460	1.8E-03	3.7E+02	3.1E-04	16	0.464	6197	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.46%	0.0040
13.615	0.95	0.15	0.80	1.07	1.0	0.039	9.34	67.15	0.108	3.72	2.51	2	7.06	460	1.8E-03	3.7E+02	3.1E-04	16	0.464	6178	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.50%	0.0041
13.779	0.95	0.16	0.80	1.07	1.0	0.039	8.78	66.76	0.108	3.68	2.49	2	7.11	460	1.8E-03	3.7E+02	3.2E-04	16	0.465	6158	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.53%	0.0042
13.943	0.95	0.16	0.80	1.07	1.0	0.039	8.51	68.96	0.111	3.75	2.54	2	7.16	460	1.8E-03	3.7E+02	3.2E-04	16	0.465	6139	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.57%	0.0042
14.107	0.94	0.17	0.80	1.07	1.0	0.039	7.72	67.00	0.108	3.64	2.49	2	7.21	460	1.8E-03	3.7E+02	3.2E-04	16	0.466	6120	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.61%	0.0043
14.271	0.94	0.18	0.80	1.07	1.0	0.039	8.17	75.85	0.121	4.04	2.70	2	7.26	460	1.8E-03	3.7E+02	3.2E-04	16	0.466	6101	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.64%	0.0043
14.436	0.94	0.18	0.80	1.07	1.0	0.039	7.30	74.79	0.119	3.96	2.67	2	7.31	460	1.8E-03	3.7E+02	3.3E-04	16	0.466	6082	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.68%	0.0044
14.600	0.94	0.25	0.80	1.07	1.0	0.039	3.56	64.99	0.106	3.49	2.54	2	7.36	500	1.8E-03	4.6E+02	2.7E-04	10	0.215	7361	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.39%	0.0023
14.764	0.94	0.29	0.80	1.06	1.0	0.039	2.74	68.85	0.110	3.63	2.71	2	7.41	500	1.8E-03	4.6E+02	2.7E-04	10	0.216	7338	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.42%	0.0023
14.928	0.94	0.28	0.80	1.06	1.0	0.039	2.84	65.58	0.106	3.47	2.60	2	7.46	500	1.8E-03	4.6E+02	2.7E-04	10	0.216	7314	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.45%	0.0024
15.092	0.94	0.23	0.80	1.06	1.0	0.039	4.46	70.87	0.113	3.67	2.60	2	7.51	500	1.8E-03	4.4E+02	2.9E-04	16	0.468	6006	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.89%	0.0031
15.256	0.94	0.33	0.80	1.06	1.0	0.039	2.14	71.16	0.114	3.66	2.86	2	7.56	500	1.8E-03	4.6E+02	2.7E-04	10	0.217	7270	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.50%	0.0025
15.420	0.94	0.28	0.80	1.06	1.0	0.039	3.75	87.44	0.142	4.55	3.15	2	7.61	500	1.8E-03	4.4E+02	2.9E-04	16	0.469	5970	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.95%	0.0032
15.584	0.94	0.25	0.80	1.06	1.0	0.039	4.15	75.50	0.120	3.82	2.71	2	7.66	500	1.8E-03	4.4E+02	2.9E-04	16	0.469	5953	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.97%	0.0032
15.748	0.94	0.22	0.80	1.06	1.0	0.039	4.99	73.70	0.117	3.71	2.61	2	7.71	500	1.8E-03	4.4E+02	2.9E-04	16	0.470	5935	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.00%	0.0033
15.912	0.94	0.21	0.80	1.05	1.0	0.039	4.99	66.36	0.107	3.37	2.42	2	7.76	500	1.8E-03	4.4E+02	3.0E-04	16	0.470	5918	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.03%	0.0033
16.076	0.94	0.21	0.80	1.05	1.0	0.039	4.99	64.85	0.105	3.29	2.38	2	7.81	500	1.8E-03	4.4E+02	3.0E-04	16	0.470	5901	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.06%	0.0034
16.240	0.94	0.22	0.80	1.05	1.0	0.039	3.76	54.85	0.095	2.96	2.24	2	7.86	500	1.8E-03	4.6E+02	2.9E-04	10	0.219	7143	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.66%	0.0027
16.404	0.94	0.22	0.80	1.05	1.0	0.039	3.89	58.50	0.099	3.04	2.29	2	7.91	500	1.8E-03	4.6E+02	2.9E-04	10	0.220	7121	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.69%	0.0028
16.568	0.94	0.21	0.80	1.05	1.0	0.039	4.46	60.55	0.101	3.09	2.29	2	7.96	500	1.8E-03	4.6E+02	2.9E-04	10	0.220	7100	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.72%	0.0028
16.732	0.94	0.23	0.80	1.05	1.0	0.040	3.73	58.07	0.098	2.99	2.27	2	8.01	500	1.8E-03	4.6E+02	2.9E-04	10	0.221	7080	0.07%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.74%	0.0029
16.896	0.94	0.23	0.80	1.05	1.0	0.040	3.80	62.13	0.102	3.10	2.33	2	8.06	500	1.8E-03	4.6E+02	2.9E-04	10	0.221	7059	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.77%	0.0029
17.060	0.94	0.23	0.80	1.04	1.0	0.040	3.67	60.46	0.101	3.02	2.30	2	8.11	500	1.8E-03	4.6E+02	3.0E-04	10	0.221	7038	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.80%	0.0030
17.224	0.94	0.24	0.80	1.04	1.0	0.040	3.44	60.21	0.100	3.00	2.30	2	8.16	500	1.8E-03	4.6E+02	3.0E-04	10	0.222	7018	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.83%	0.0030

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W6-S

Data File: 13-52106_SP2W6-S-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3 Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5604.40	Water surface elevation during CPT investigation (ft amsl)
5604.40	Water surface elevation at t_0 (ft amsl)
5588.59	Water surface elevation at t_1 (ft amsl)
5583.59	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ratio, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ear
7.51	Equiv. Number of Uniform Strain Cycles, N
5615.85	Ground Surface Elevation at time of CPT (ft amsl)
5625.41	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
1.56	Thickness of Random/Platform Fill on top of existing interim cover (ft)
1065.26	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5583.59	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5625.16	5624.91	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5623.16	5621.41	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5619.41	5617.41	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334	1.83	508	1.9E-03	4.6E+02	6.8E-05	11	0.153	12419	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######	5616.63	5615.85	1.56	0.050	101	0.533	0.493	0.00	0.00	0.533	0.493	2.68	508	1.6E-03	4.0E+02	1.2E-04	11	0.169	10568	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
17.388	5598.46	10.4	0.217	9.9	73.6	31.89	2.09%	Slime Tailings	0.057	113.1	0.89	0.19	0.70	1	1.17	11.637	161.76	14.14	14	2.29%	2.8	71%	1.42	0.00	1.42	0
17.552	5598.30	9.6	0.305	9.0	98.4	42.63	3.19%	Slime Tailings	0.057	113.1	0.90	0.19	0.71	1	1.17	10.462	145.41	12.98	12	3.52%	3.0	71%	1.43	0.00	1.43	0
17.716	5598.13	12.3	0.378	11.6	110.0	47.65	3.07%	Slime Tailings	0.057	113.1	0.90	0.20	0.71	1	1.16	13.532	188.09	16.64	16	3.31%	2.9	71%	1.44	0.00	1.44	0
17.880	5597.97	15.9	0.393	15.5	61.9	26.81	2.47%	Slime Tailings	0.057	113.1	0.91	0.20	0.71	1	1.16	17.966	249.73	21.39	21	2.62%	2.7	71%	1.45	0.00	1.45	0
18.044	5597.81	13.0	0.378	12.5	74.4	32.24	2.91%	Slime Tailings	0.057	113.1	0.92	0.21	0.72	1	1.15	14.435	200.65	17.39	17	3.13%	2.8	71%	1.46	0.00	1.46	0
18.208	5597.64	15.2	0.346	14.8	53.4	23.14	2.28%	Sand-Slime Tailings	0.059	119.0	0.93	0.21	0.72	1	1.15	17.001	236.31	20.19	20	2.43%	2.7	47%	1.47	0.00	1.47	0
18.372	5597.48	20.1	0.278	20.0	22.1	9.56	1.38%	Sand-Slime Tailings	0.059	119.0	0.94	0.22	0.73	1	1.13	22.670	315.11	26.51	26	1.45%	2.5	47%	1.48	0.00	1.48	0
18.537	5597.31	25.1	0.274	25.1	0.0	0.00	1.09%	Sand-Slime Tailings	0.059	119.0	0.95	0.22	0.73	1	1.12	28.232	392.43	32.79	33	1.13%	2.3	47%	1.49	0.00	1.49	0
18.701	5597.15	25.6	0.284	25.6	-1.5	-0.63	1.11%	Sand-Slime Tailings	0.059	119.0	0.96	0.23	0.74	1	1.12	28.599	397.53	33.20	33	1.15%	2.3	47%	1.50	0.00	1.50	0
18.865	5596.99	26.1	0.274	26.0	4.6	1.98	1.05%	Sand-Slime Tailings	0.059	119.0	0.97	0.23	0.74	1	1.11	28.952	402.43	33.66	34	1.09%	2.3	47%	1.50	0.00	1.50	0
19.029	5596.82	26.3	0.324	26.2	6.9	2.99	1.23%	Sand-Slime Tailings	0.059	119.0	0.98	0.24	0.75	1	1.11	29.032	403.54	33.77	34	1.28%	2.4	47%	1.51	0.00	1.51	0
19.193	5596.66	19.7	0.359	19.6	11.6	5.03	1.82%	Sand-Slime Tailings	0.059	119.0	0.99	0.24	0.75	1	1.11	21.744	302.25	25.35	25	1.92%	2.6	47%	1.52	0.00	1.52	0
19.357	5596.49	17.3	0.409	17.2	10.2	4.42	2.36%	Sand-Slime Tailings	0.059	119.0	1.00	0.25	0.75	1	1.11	19.087	265.31	22.25	22	2.51%	2.7	47%	1.53	0.00	1.53	0
19.521	5596.33	21.7	0.317	21.6	11.8	5.13	1.46%	Sand-Slime Tailings	0.059	119.0	1.01	0.25	0.76	1	1.10	23.745	330.06	27.67	27	1.53%	2.5	47%	1.54	0.00	1.54	0
19.685	5596.17	22.7	0.488	22.7	9.2	3.99	2.15%	Sand-Slime Tailings	0.059	119.0	1.02	0.26	0.76	1	1.09	24.734	343.80	28.80	28	2.25%	2.6	47%	1.55	0.00	1.55	0
19.849	5596.00	19.2	0.558	19.2	4.8	2.06	2.91%	Slime Tailings	0.057	113.1	1.03	0.26	0.77	1	1.09	20.883	290.27	24.29	24	3.07%	2.7	71%	1.56	0.00	1.56	0
20.013	5595.84	17.8	0.580	17.8	9.9	4.27	3.26%	Slime Tailings	0.057	113.1	1.04	0.27	0.77	1	1.09	19.301	268.29	22.49	22	3.46%	2.8	71%	1.57	0.00	1.57	0
20.177	5595.67	16.5	0.428	16.5	3.3	1.42	2.59%	Slime Tailings	0.057	113.1	1.05	0.27	0.78	1	1.08	17.865	248.32	20.77	20	2.77%	2.7	71%	1.58	0.00	1.58	0
20.341	5595.51	16.1	0.364	15.8	46.6	20.19	2.26%	Sand-Slime Tailings	0.059	119.0	1.06	0.28	0.78	1	1.08	17.027	236.67	20.14	19	2.42%	2.7	47%	1.59	0.00	1.59	0
20.505	5595.35	17.0	0.387	16.6	69.6	30.17	2.27%	Sand-Slime Tailings	0.059	119.0	1.07	0.28	0.79	1	1.07	17.836	247.93	21.26	20	2.42%	2.7	47%	1.60	0.00	1.60	0
20.669	5595.18	17.8	0.559	17.1	110.3	47.80	3.15%	Slime Tailings	0.057	113.1	1.08	0.29	0.79	1	1.07	18.247	253.63	22.05	21	3.35%	2.8	71%	1.61	0.00	1.61	0
20.833	5595.02	20.8	0.452	20.2	105.5	45.73	2.17%	Sand-Slime Tailings	0.059	119.0	1.09	0.29	0.79	1	1.06	21.444	298.07	25.72	25	2.29%	2.6	47%	1.62	0.00	1.62	0
20.997	5594.85	32.5	0.419	32.2	39.9	17.27	1.29%	Sand-Slime Tailings	0.059	119.0	1.10	0.30	0.80	1	1.05	33.912	471.38	39.69	39	1.33%	2.3	47%	1.63	0.00	1.63	0
21.161	5594.69	30.5	0.438	30.5	-5.4	-2.35	1.44%	Sand-Slime Tailings	0.059	119.0	1.11	0.30	0.80	1	1.05	32.002	444.83	37.13	37	1.49%	2.4	47%	1.64	0.00	1.64	0
21.325	5594.52	26.6	0.429	26.6	10.9	4.71	1.61%	Sand-Slime Tailings	0.059	119.0	1.12	0.31	0.81	1	1.05	27.780	386.14	32.35	32	1.68%	2.4	47%	1.65	0.00	1.65	0
21.489	5594.36	31.3	0.445	31.2	10.5	4.56	1.42%	Sand-Slime Tailings	0.059	119.0	1.13	0.31	0.81	1	1.04	32.472	451.36	37.79	37	1.48%	2.4	47%	1.66	0.00	1.66	0
21.653	5594.20	33.9	0.558	33.9	8.4	3.65	1.64%	Sand-Slime Tailings	0.059	119.0	1.14	0.32	0.82	1	1.04	35.087	487.71	40.81	40	1.70%	2.4	47%	1.67	0.00	1.67	0
21.817	5594.03	28.7	0.579	28.7	11.6	5.03	2.01%	Sand-Slime Tailings	0.059	119.0	1.15	0.32	0.82	1	1.03	29.609	411.56	34.48	34	2.10%	2.5	47%	1.68	0.00	1.68	0
21.981	5593.87	32.2	0.577	32.1	12.6	5.46	1.79%	Sand-Slime Tailings	0.059	119.0	1.16	0.33	0.83	1	1.03	33.006	458.78	38.43	38	1.86%	2.4	47%	1.69	0.00	1.69	0
22.145	5593.70	31.5	0.519	31.4	11.5	4.97	1.65%	Sand-Slime Tailings	0.059	119.0	1.17	0.33	0.83	1	1.02	32.168	447.13	37.45	36	1.71%	2.4	47%	1.70	0.00	1.70	0
22.309	5593.54	38.3	0.405	38.2	9.8	4.23	1.06%	Sand-Slime Tailings	0.059	119.0	1.18	0.34	0.84	1	1.02	38.964	541.60	45.33	44	1.09%	2.2	47%	1.71	0.00	1.71	0
22.473	5593.38	36.9	0.465	36.9	8.3	3.58	1.26%	Sand-Slime Tailings	0.059	119.0	1.18	0.34	0.84	1	1.02	37.469	520.81	43.58	43	1.30%	2.3	47%	1.72	0.00	1.72	0
22.638	5593.21	38.4	0.519	38.4	9.0	3.91	1.35%	Sand-Slime Tailings	0.059	119.0	1.19	0.35	0.85	1	1.01	38.805	539.39	45.14	44	1.39%	2.3	47%	1.73	0.00	1.73	0
22.802	5593.05	41.4	0.519	41.3	10.3	4.46	1.25%	Sand-Slime Tailings	0.059	119.0	1.20	0.35	0.85	1	1.01	41.633	578.70	48.43	47	1.29%	2.2	47%	1.74	0.00	1.74	0
22.966	5592.88	42.6	0.493	42.5	9.8	4.23	1.16%	Sand-Slime Tailings	0.059	119.0	1.21	0.36	0.85	1	1.00	42.702	593.55	49.67	48	1.19%	2.2	47%	1.75	0.00	1.75	0
23.130	5592.72	41.6	0.532	41.6	11.5	4.97	1.28%	Sand-Slime Tailings	0.059	119.0	1.22	0.36	0.86	1	1.00	41.593	578.15	48.39	47	1.32%	2.2	47%	1.76	0.00	1.76	0
23.294	5592.56	42.3	0.534	42.2	13.1	5.66	1.26%	Sand-Slime Tailings	0.059	119.0	1.23	0.37	0.86	1	1.00	42.088	585.03	48.98	47	1.30%	2.2	47%	1.77	0.00	1.77	0
23.458	5592.39	47.2	0.593	47.2	13.5	5.86	1.26%	Sand-Slime Tailings	0.059	119.0	1.24	0.37	0.87	1	0.99	46.893	651.82	54.56	53	1.29%	2.2	47%	1.78	0.00	1.78	0
23.622	5592.23	49.1	0.674	49.0	13.7	5.94	1.37%	Sand-Slime Tailings	0.059	119.0	1.25	0.38	0.87	1	0.99	48.576	675.21	56.52	55	1.41%	2.2	47%	1.79	0.00	1.79	0
23.786	5592.06	47.0	0.774	46.9	14.2	6.14	1.65%	Sand-Slime Tailings	0.059	119.0	1.26	0.38	0.88	1	0.99	46.335	644.06	53.92	52	1.69%	2.3	47%	1.80	0.00	1.80	0
23.950	5591.90	41.4	0.772	41.4	13.6	5.88	1.86%	Sand-Slime Tailings	0.059	119.0	1.27	0.39	0.88	1	0.98	40.695	565.65	47.36	46	1.92%	2.4	47%	1.81	0.00	1.81	0
24.114	5591.74	41.1	0.727	41.0	13.4	5.82	1.77%	Sand-Slime Tailings	0.059	119.0	1.28	0.40	0.89	1	0.98	40.240	559.34	46.83	45	1.82%	2.3	47%	1.82	0.00	1.82	0
24.278	5591.57	37.0	0.661	36.9	13.4	5.82	1.79%	Sand-Slime Tailings	0.059	119.0	1.29	0.40	0.89	1	0.98	36.033	500.86	41.95	40	1.85%	2.4	47%	1.82	0.00	1.82	0
24.442	5591.41	32.5	0.603	32.4	13.5	5.86	1.85%	Sand-Slime Tailings	0.059	119.0	1.30	0.41	0.90	1	0.97	31.538	438.38	36.73	35	1.93%	2.4	47%	1.83	0.00	1.83	0
24.606	5591.24	31.6	0.528	31.5	13.5	5.86	1.67%	Sand-Slime Tailings	0.059	119.0	1.31	0.41	0.90	1	0.97	30.546	424.59	35.57	34	1.74%	2.4	47%	1.84	0.00	1.84	0
24.770	5591.08	31.6	0.507	31.5	15.0	6.51	1.60%	Sand-Slime Tailings	0.059	119.0	1.32	0.42	0.91	1	0.97	30.436	423.06	35.45	33	1.67%	2.4	47%	1.85	0.00	1.85	0
24.934	5590.92	32.8	0.414	32.7	16.5	7.16	1.26%	Sand-Slime Tailings	0.059	119.0	1.33	0.42	0.91	1	0.96	31.433	436.92	36.62	35	1.32%	2.4	47%	1.86	0.00	1.86	0
25.098	5590.75	34.3	0.437	34.2	17.3	7.49	1.27%	Sand-Slime Tailings	0.059	119.0	1.34	0.43	0.92	1	0.96	32.804	455.97	38.22	36	1.33%	2.3	47%	1.87	0.00	1.87	0
25.262	5590.59	36.0	0.512	35.9	14.2	6.17	1.42%	Sand-Slime Tailings	0.059	119.0	1.35	0.43	0.92	1	0.96	34.352	477.49	40.00	38	1.48%	2.3	47%	1.88	0.00	1.88	0
25.426	5590.42	41.3	0.688	41.2	15.1	6.55	1.67%	Sand-Slime Tailings	0.059	119.0	1.36	0.44	0.92	1	0.95	39.342	546.86	45.80	43	1.72%	2.3	47%	1.89	0.00	1.89	0
25.590	5590.26	34.2	0.767	34.1	15.3	6.63	2.24%	Sand-Slime Tailings	0.059	119.0	1.37	0.44	0.93	1	0.95	32.336	449.47	37.66	35	2.34%	2.5	47%	1.90	0.00	1.90	0
25.754	5590.10	26.7	0.796	26.6	16.0	6.92	2.98%	Slime Tailings	0.057	113.1	1.38	0.45	0.93	1	0.94	25.105	348.96	29.27	27	3.14%	2.7	71%	1.91	0.00	1.91	0
25.918	5589.93	29.3	0.592	29.2	15.0	6.51	2.02%	Sand-Slime Tailings	0.059	119.0	1.39	0.45	0.94	1	0.94	27.443	381.46	31.98	30	2.12%	2.5	47%	1.92	0.00	1.92	0
26.082	5589.77	35.4	0.454	35.3	14.3	6.19	1.28%	Sand-Slime Tailings	0.059	119.0	1.40	0.46	0.94	1	0.94	33.177	461.16	38.63	36	1.34%	2.3	47%	1.93	0.00	1.93	0
26.246	5589.60	36.2	0.371	36.2	3.2	1.39	1.02%	Sand-Slime Tailings	0.059	119.0	1.41	0.46	0.95	1	0.94	33.911	471.36	39.41	37	1.07%	2.3	47%	1.94	0.00	1.94	0
26.410	5589.44	36.1	0.419	36.1	4.6	1.98	1.16%	Sand-Slime Tailings	0.059	119.0	1.42	0.47	0.95	1	0.93	33.729	468.84	39.21	36	1.21%	2.3	47%	1.95	0.00	1.95	0
26.574	5589.28	33.9	0.531	33.8	12.8	5.56	1.57%	Sand-Slime Tailings	0.059	119.0	1.43	0.47	0.96	1	0.93	31.447	437.12	36.61	34	1.63%	2.4	47%	1.96	0.00	1.96	0
26.739	5589.11	36.3	0.568	36.2	16.5	7.16	1.57%	Sand-Slime Tailings	0.059	119.0	1.44	0.48	0.96	1	0.93	33.570	466.63	39.10	36	1.63%	2.4	47%	1.97	0.00	1.97	0
26.903	5588.95	38.8	0.595	38.7	16.5	7.16	1.53%	Sand-Slime Tailings	0.059	119.0	1.45	0.48	0.97	1	0.93	35.865	498.52	41.77	39	1.59%	2.4	47%	1.98	0.00	1.98	0
27.067	5588.78	39.4	0.647	39.3	18.0	7.81	1.64%	Sand-Slime Tailings	0.059	119.0	1.46	0.49	0.97	1	0.92	36.285	504.36	42.26	39	1.70%	2.4	47%	1.99	0.00	1.99	0
27.231	5588.62	40.3	0.712	40.2	20.4	8.83	1.77%	Sand-Slime Tailings	0.059	119.0	1.47	0.49	0.98	1	0.92	37.005	514.36	43.11	40	1.83%	2.4	47%	2.00	0.00	2.00	0
27.395	5588.46	41.4	0.723	41.3	21.0	9.12	1.75%	Sand-Slime Tailings	0.059	119.0	1.48	0.50	0.98	1	0.92	37.919	527.07	44.18	41	1.81%	2.4	47%	2.01	0.00	2.01	1
27.559	5588.29	42.9	0.670	42.8	19.2	8.30	1.56%	Sand-Slime Tailings	0.059	119.0	1.49	0.50	0.98	1	0.92	39.157	544.29	45.61	42	1.62%	2.3	47%	2.02	0.01	2.01	1
27.723	5588.13	42.3	0.619	42.2	18.1	7.86	1.46%	Sand-Slime Tailings	0.059	119.0	1.50	0.51	0.99	1	0.91	38.500	535.15	44.84	41	1.52%	2.3	47%	2.03	0.01	2.01	1
27.887	5587.96	42.4	0.626	42.2	20.2	8.77	1.48%	Sand-Slime Tailings	0.059	119.0	1.51	0.51	0.99	1	0.91	38.435	534.24	44.77	41	1.53%	2.3	47%	2.04	0.02	2.02	1
28.051	5587.80	39.8	0.634	39.7	20.9	9.07	1.59%	Sand-Slime Tailings	0.059	119.0	1.52	0.52	1.00	1	0.91	35.941	499.57	41.88	38	1.66%	2.4	47%	2.05	0.02	2.02	1
28.215	5587.64	43.4	0.590	43.3	19.6	8.48	1.36%	Sand-Slime Tailings	0.059	119.0	1.53	0.52	1.00	1	0.90	39.142	544.07	45.59	42	1.41%	2.3	47%	2.06	0.03	2.03	1
28.379	5587.47	44.3	0.552	44.2	15.3	6.61	1.25%	Sand-Slime Tailings	0.059	119.0	1.54	0.53	1.01	1	0.90	39.911	554.76	46.45	42	1.29%	2.3	47%	2.07	0.03	2.03	1
28.543	5587.31	44.6	0.539	44.5	16.5	7.16	1.21%	Sand-Slime Tailings	0.059	119.0	1.55	0.53	1.01	1	0.90	40.085	557.18	46.66	43	1.25%	2.3	47%	2.08	0.04	2.04	1
28.707	5587.14	45.4	0.570	45.2	18.3	7.93	1.26%	Sand-Slime Tailings	0.059	119.0	1.56	0.54	1.02	1	0.90	40.610	564.48	47.29	43	1.30%	2.3	47%	2.09	0.05	2.04	1
28.871	5586.98	47.7	0.530	47.6	19.4	8.39	1.11%	Sand Tailings	0.062	123.5	1.57	0.54	1.02	1	0.90	42.658	592.95	49.67	45	1.15%	2.2	18%	2.10	0.05	2.05	1
29.035	5586.81	50.3	0.530	50.2	19.4	8.42	1.05%	Sand Tailings	0.062	123.5	1.58	0.55	1.03	1	0.89	44.933	624.57	52.31	47	1.09%	2.2	18%	2.11	0.06	2.05	1
29.199	5586.65	52.6	0.530	52.4	18.7	8.10	1.01%	Sand Tailings	0.062	123.5	1.59	0.55	1.03	1	0.89	46.851	651.23	54.54	49	1.04%	2.2	18%	2.12	0.06	2.06	1
32.260	5583.59							Sand Tailings	0.062	123.5													2.31	0.11	2.20	1

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	I&B (2008) r_d	I&B C_σ	I&B K_σ	I&B K_α	I&B CSR M=7.5, s'v=1atm	I&B Δqc_{1n}	I&B qc_{1n-cs}	I&B (CRR) M=7.5, s'v=1atm	I&B FoS	Youd (2001) r_d	Youd D_r	Youd f	Youd K_σ	Youd K_α	Youd CSR M=7.5, s'v=1atm	Youd Kc	Youd qc_{1n-cs}	Youd (CRR) M=7.5, s'v=1atm	Youd FoS	Avg FoS	Liquefiable? 1=Yes 2=No
17.388	0.90	0.05	0.98	1.0	0.051	35.01	49.16	0.077	1.52	0.94	0.22	0.80	1.04	1.0	0.040	4.98	70.37	0.112	3.34	2.43	2
17.552	0.90	0.05	0.98	1.0	0.051	34.61	47.59	0.075	1.49	0.94	0.21	0.80	1.04	1.0	0.040	6.35	82.50	0.132	3.91	2.70	2
17.716	0.89	0.05	0.97	1.0	0.050	35.88	52.53	0.080	1.59	0.94	0.24	0.80	1.04	1.0	0.040	5.27	87.75	0.143	4.20	2.89	2
17.880	0.89	0.05	0.97	1.0	0.050	37.54	58.92	0.087	1.73	0.94	0.27	0.80	1.04	1.0	0.040	4.01	85.65	0.138	4.05	2.89	2
18.044	0.89	0.05	0.97	1.0	0.050	36.14	53.53	0.081	1.61	0.94	0.24	0.80	1.04	1.0	0.040	5.00	87.01	0.141	4.11	2.86	2
18.208	0.89	0.05	0.97	1.0	0.050	37.38	57.57	0.085	1.70	0.94	0.26	0.80	1.04	1.0	0.040	4.03	81.33	0.130	3.76	2.73	2
18.372	0.89	0.06	0.97	1.0	0.050	39.60	66.11	0.095	1.90	0.93	0.30	0.80	1.03	1.0	0.040	2.63	69.61	0.111	3.20	2.55	2
18.537	0.89	0.06	0.97	1.0	0.050	41.80	74.59	0.105	2.12	0.93	0.33	0.80	1.03	1.0	0.040	2.05	67.17	0.108	3.09	2.61	2
18.701	0.89	0.06	0.97	1.0	0.050	41.95	75.15	0.106	2.14	0.93	0.33	0.80	1.03	1.0	0.040	2.05	68.05	0.109	3.10	2.62	2
18.865	0.89	0.06	0.97	1.0	0.049	42.11	75.77	0.107	2.16	0.93	0.33	0.80	1.03	1.0	0.040	1.99	66.98	0.108	3.05	2.61	2
19.029	0.88	0.06	0.97	1.0	0.049	42.15	75.92	0.107	2.17	0.93	0.34	0.80	1.03	1.0	0.040	2.12	71.66	0.114	3.21	2.69	2
19.193	0.88	0.06	0.97	1.0	0.049	39.19	64.54	0.093	1.88	0.93	0.29	0.80	1.03	1.0	0.040	3.10	78.57	0.125	3.49	2.69	2
19.357	0.88	0.05	0.97	1.0	0.049	38.11	60.36	0.088	1.79	0.93	0.27	0.80	1.03	1.0	0.040	3.85	85.76	0.139	3.85	2.82	2
19.521	0.88	0.06	0.97	1.0	0.049	40.01	67.68	0.097	1.97	0.93	0.30	0.80	1.03	1.0	0.040	2.63	72.87	0.116	3.20	2.58	2
19.685	0.88	0.06	0.97	1.0	0.049	40.40	69.20	0.099	2.01	0.93	0.31	0.80	1.02	1.0	0.040	3.07	88.53	0.145	3.96	2.99	2
19.849	0.88	0.06	0.97	1.0	0.049	38.55	62.84	0.091	1.86	0.93	0.28	0.80	1.02	1.0	0.040	4.03	97.81	0.167	4.56	3.21	2
20.013	0.88	0.05	0.97	1.0	0.049	37.92	60.42	0.088	1.80	0.93	0.27	0.80	1.02	1.0	0.040	4.49	101.07	0.176	4.78	3.29	2
20.177	0.87	0.05	0.97	1.0	0.049	37.32	58.10	0.086	1.75	0.93	0.26	0.80	1.02	1.0	0.040	4.25	88.39	0.144	3.90	2.82	2
20.341	0.87	0.05	0.97	1.0	0.049	37.36	57.50	0.085	1.74	0.93	0.26	0.80	1.02	1.0	0.040	4.08	82.25	0.132	3.54	2.64	2
20.505	0.87	0.05	0.97	1.0	0.049	37.76	59.02	0.087	1.78	0.93	0.27	0.80	1.02	1.0	0.040	3.94	83.73	0.135	3.60	2.69	2
20.669	0.87	0.05	0.97	1.0	0.049	37.77	59.81	0.088	1.80	0.93	0.27	0.80	1.02	1.0	0.040	4.50	99.19	0.171	4.55	3.18	2
20.833	0.87	0.06	0.96	1.0	0.048	39.32	65.04	0.094	1.93	0.93	0.29	0.80	1.02	1.0	0.040	3.37	86.69	0.141	3.73	2.83	2
20.997	0.87	0.06	0.96	1.0	0.048	44.22	83.91	0.118	2.45	0.93	0.36	0.80	1.01	1.0	0.040	1.98	78.44	0.125	3.30	2.88	2
21.161	0.87	0.06	0.96	1.0	0.048	43.32	80.45	0.113	2.36	0.92	0.35	0.80	1.01	1.0	0.040	2.16	80.34	0.128	3.37	2.86	2
21.325	0.87	0.06	0.96	1.0	0.048	41.65	73.99	0.105	2.18	0.92	0.33	0.80	1.01	1.0	0.040	2.50	80.95	0.129	3.39	2.78	2
21.489	0.86	0.06	0.96	1.0	0.048	43.56	81.35	0.114	2.39	0.92	0.35	0.80	1.01	1.0	0.040	2.13	80.68	0.129	3.36	2.87	2
21.653	0.86	0.07	0.96	1.0	0.048	44.62	85.43	0.120	2.52	0.92	0.37	0.80	1.01	1.0	0.040	2.17	88.64	0.145	3.76	3.14	2
21.817	0.86	0.06	0.96	1.0	0.048	42.39	76.87	0.108	2.27	0.92	0.34	0.80	1.01	1.0	0.040	2.68	92.26	0.153	3.96	3.11	2
21.981	0.86	0.06	0.96	1.0	0.048	43.78	82.21	0.116	2.43	0.92	0.36	0.80	1.01	1.0	0.040	2.36	90.58	0.149	3.84	3.13	2
22.145	0.86	0.06	0.96	1.0	0.048	43.43	80.88	0.114	2.40	0.92	0.35	0.80	1.01	1.0	0.040	2.31	86.41	0.140	3.59	2.99	2
22.309	0.86	0.07	0.95	1.0	0.047	46.20	91.53	0.129	2.73	0.91	0.39	0.80	1.01	1.0	0.040	1.70	77.22	0.123	3.14	2.93	2
22.473	0.86	0.07	0.95	1.0	0.047	45.59	89.16	0.126	2.66	0.91	0.38	0.80	1.00	1.0	0.040	1.87	81.40	0.130	3.31	2.99	2
22.638	0.85	0.07	0.95	1.0	0.047	46.13	91.27	0.129	2.74	0.91	0.39	0.80	1.00	1.0	0.040	1.89	85.12	0.137	3.48	3.11	2
22.802	0.85	0.07	0.95	1.0	0.047	47.29	95.72	0.136	2.89	0.91	0.40	0.80	1.00	1.0	0.040	1.76	85.15	0.137	3.47	3.18	2
22.966	0.85	0.07	0.95	1.0	0.047	47.72	97.39	0.138	2.96	0.91	0.41	0.80	1.00	1.0	0.040	1.68	83.56	0.134	3.37	3.16	2
23.130	0.85	0.07	0.95	1.0	0.047	47.27	95.66	0.136	2.90	0.91	0.40	0.80	1.00	1.0	0.040	1.78	85.96	0.139	3.48	3.19	2
23.294	0.85	0.07	0.95	1.0	0.047	47.48	96.46	0.137	2.93	0.91	0.40	0.80	1.00	1.0	0.040	1.76	86.10	0.139	3.47	3.20	2
23.458	0.85	0.07	0.95	1.0	0.046	49.44	104.00	0.149	3.22	0.91	0.43	0.79	1.00	1.0	0.040	1.66	90.30	0.148	3.69	3.45	2
23.622	0.85	0.08	0.95	1.0	0.046	50.12	106.64	0.154	3.32	0.90	0.43	0.78	1.00	1.0	0.040	1.68	95.21	0.160	3.96	3.64	2
23.786	0.85	0.07	0.95	1.0	0.046	49.21	103.13	0.148	3.20	0.90	0.42	0.79	1.00	1.0	0.040	1.87	100.76	0.175	4.31	3.76	2
23.950	0.84	0.07	0.95	1.0	0.046	46.91	94.27	0.133	2.88	0.90	0.40	0.80	1.00	1.0	0.040	2.14	101.19	0.176	4.33	3.61	2
24.114	0.84	0.07	0.95	1.0	0.046	46.73	93.56	0.132	2.86	0.90	0.40	0.80	0.99	1.0	0.040	2.10	98.40	0.169	4.12	3.49	2
24.278	0.84	0.07	0.95	1.0	0.046	45.01	86.96	0.122	2.65	0.90	0.37	0.80	0.99	1.0	0.040	2.26	94.94	0.160	3.89	3.27	2
24.442	0.84	0.06	0.95	1.0	0.046	43.18	79.91	0.113	2.43	0.90	0.35	0.80	0.99	1.0	0.040	2.51	92.27	0.153	3.71	3.07	2
24.606	0.84	0.06	0.95	1.0	0.046	42.78	78.35	0.110	2.39	0.90	0.34	0.80	0.99	1.0	0.040	2.44	86.95	0.141	3.41	2.90	2
24.770	0.84	0.06	0.95	1.0	0.046	42.74	78.19	0.110	2.39	0.89	0.34	0.80	0.99	1.0	0.040	2.41	85.32	0.138	3.32	2.85	2
24.934	0.84	0.06	0.95	1.0	0.046	43.15	79.77	0.112	2.44	0.89	0.35	0.80	0.99	1.0	0.040	2.12	77.71	0.124	2.97	2.71	2
25.098	0.83	0.06	0.95	1.0	0.046	43.71	81.93	0.115	2.51	0.89	0.36	0.80	0.99	1.0	0.040	2.07	79.27	0.126	3.02	2.77	2
25.262	0.83	0.06	0.95	1.0	0.046	44.33	84.32	0.119	2.60	0.89	0.37	0.80	0.99	1.0	0.040	2.12	84.60	0.136	3.25	2.92	2
25.426	0.83	0.07	0.95	1.0	0.045	46.36	92.16	0.130	2.86	0.89	0.39	0.80	0.99	1.0	0.040	2.09	95.76	0.162	3.84	3.35	2
25.590	0.83	0.06	0.95	1.0	0.046	43.51	81.17	0.114	2.51	0.89	0.35	0.80	0.98	1.0	0.040	2.74	103.10	0.182	4.31	3.41	2
25.754	0.83	0.06	0.95	1.0	0.046	40.28	69.55	0.099	2.17	0.89	0.31	0.80	0.98	1.0	0.040	3.74	109.38	0.202	4.76	3.46	2
25.918	0.83	0.06	0.95	1.0	0.046	41.52	73.49	0.104	2.28	0.89	0.33	0.80	0.98	1.0	0.040	2.90	92.83	0.154	3.63	2.96	2
26.082	0.83	0.06	0.95	1.0	0.045	43.85	82.48	0.116	2.56	0.88	0.36	0.80	0.98	1.0	0.040	2.08	80.35	0.128	3.01	2.78	2
26.246	0.82	0.06	0.95	1.0	0.045	44.12	83.53	0.118	2.60	0.88	0.36	0.80	0.98	1.0	0.040	1.88	73.99	0.118	2.75	2.67	2
26.410	0.82	0.06	0.95	1.0	0.045	44.05	83.26	0.117	2.60	0.88	0.36	0.80	0.98	1.0	0.040	1.98	77.62	0.123	2.87	2.74	2
26.574	0.82	0.06	0.95	1.0	0.045	43.14	79.75	0.112	2.49	0.88	0.35	0.80	0.98	1.0	0.040	2.36	86.38	0.140	3.25	2.87	2
26.739	0.82	0.06	0.95	1.0	0.045	44.01	83.12	0.117	2.60	0.88	0.36	0.80	0.98	1.0	0.040	2.26	88.48	0.144	3.34	2.97	2
26.903	0.82	0.07	0.95	1.0	0.045	44.95	86.72	0.122	2.73	0.88	0.37	0.80	0.98	1.0	0.040	2.15	89.86	0.147	3.40	3.06	2
27.067	0.82	0.07	0.94	1.0	0.045	45.12	87.39	0.123	2.76	0.88	0.38	0.80	0.98	1.0	0.040	2.21	93.25	0.155	3.57	3.16	2
27.231	0.82	0.07	0.94	1.0	0.045	45.42	88.54	0.125	2.80	0.87	0.38	0.80	0.98	1.0	0.040	2.26	97.33	0.166	3.80	3.30	2
27.395	0.82	0.07	0.94	1.0	0.045	45.80	89.98	0.127	2.85	0.87	0.38	0.80	0.97	1.0	0.040	2.21	97.80	0.167	3.80	3.33	2
27.559	0.81	0.07	0.94	1.0	0.045	46.30	91.90	0.130	2.91	0.87	0.39	0.80	0.97	1.0	0.040	2.07	94.21	0.158	3.57	3.24	2
27.723	0.81	0.07	0.94	1.0	0.045	46.03	90.86	0.128	2.88	0.87	0.39	0.80	0.97	1.0	0.040	2.03	90.98	0.150	3.38	3.13	2
27.887	0.81	0.07	0.94	1.0	0.045	46.00	90.78	0.128	2.87	0.87	0.39	0.80	0.97	1.0	0.040	2.04	91.41	0.151	3.38	3.13	2
28.051	0.81	0.07	0.94	1.0	0.045	44.99	86.87	0.122	2.74	0.87	0.37	0.80	0.97	1.0	0.040	2.20	92.24	0.153	3.41	3.07	2
28.215	0.81	0.07	0.94	1.0	0.045	46.29	91.88	0.130	2.91	0.87	0.39	0.80	0.97	1.0	0.040	1.95	89.01	0.146	3.22	3.07	2
28.379	0.81	0.07	0.94	1.0	0.045	46.59	93.05	0.132	2.95	0.87	0.39	0.80	0.97	1.0	0.040	1.86	86.56	0.140	3.09	3.02	2
28.543	0.81	0.07	0.94	1.0	0.045	46.67	93.33	0.132	2.95	0.86	0.39	0.80	0.97	1.0	0.040	1.84	85.72	0.139	3.04	3.00	2
28.707	0.80	0.07	0.94	1.0	0.045	46.89	94.17	0.133	2.98	0.86	0.40	0.80	0.97	1.0	0.040	1.85	87.70	0.143	3.11	3.05	2
28.871	0.80	0.07	0.94	1.0	0.045	34.79	84.46	0.119	2.66	0.86	0.41	0.80	0.97	1.0	0.040	1.72	85.44	0.138	2.99	2.83	2
29.035	0.80	0.07	0.94	1.0	0.045	35.46	87.78	0.124	2.77	0.86	0.42	0.79	0.96	1.0	0.040	1.64	85.89	0.139	2.99	2.88	2
29.199	0.80	0.07	0.94	1.0	0.045	36.03	90.57	0.128	2.87	0.86	0.43	0.79	0.96	1.0	0.041	1.58	86.40	0.140	3.00	2.93	2
32.260																					

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.481

Depth at time of CPT (ft)	Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
17.388	8.21	500	1.8E-03	4.4E+02	3.2E-04	16	0.473	5767	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.29%	0.0038
17.552	8.26	500	1.8E-03	4.4E+02	3.2E-04	16	0.474	5751	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.32%	0.0038
17.716	8.31	500	1.8E-03	4.4E+02	3.2E-04	16	0.474	5736	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.35%	0.0038
17.880	8.36	500	1.8E-03	4.4E+02	3.2E-04	16	0.474	5721	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.37%	0.0039
18.044	8.41	500	1.8E-03	4.4E+02	3.2E-04	16	0.475	5706	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.40%	0.0039
18.208	8.46	500	1.8E-03	4.6E+02	3.1E-04	10	0.224	6905	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.99%	0.0033
18.372	8.51	500	1.8E-03	4.6E+02	3.1E-04	10	0.224	6886	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.02%	0.0033
18.537	8.56	500	1.8E-03	4.6E+02	3.1E-04	10	0.225	6868	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.05%	0.0034
18.701	8.61	500	1.8E-03	4.6E+02	3.2E-04	10	0.225	6849	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.08%	0.0034
18.865	8.66	500	1.8E-03	4.6E+02	3.2E-04	10	0.225	6831	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.10%	0.0035
19.029	8.71	500	1.8E-03	4.6E+02	3.2E-04	10	0.226	6812	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.13%	0.0035
19.193	8.76	500	1.8E-03	4.6E+02	3.2E-04	10	0.226	6794	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.16%	0.0035
19.357	8.81	500	1.8E-03	4.6E+02	3.2E-04	10	0.227	6776	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.19%	0.0036
19.521	8.86	500	1.8E-03	4.6E+02	3.3E-04	10	0.227	6758	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.22%	0.0036
19.685	8.91	538	1.8E-03	5.3E+02	2.8E-04	10	0.227	6741	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.52%	0.0025
19.849	8.96	538	1.8E-03	5.1E+02	3.0E-04	16	0.479	5542	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.93%	0.0032
20.013	9.01	538	1.8E-03	5.1E+02	3.0E-04	16	0.479	5528	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.96%	0.0032
20.177	9.06	538	1.8E-03	5.1E+02	3.0E-04	16	0.479	5515	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.98%	0.0032
20.341	9.11	538	1.8E-03	5.3E+02	2.9E-04	10	0.229	6674	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.60%	0.0026
20.505	9.16	538	1.8E-03	5.3E+02	2.9E-04	10	0.229	6657	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.63%	0.0027
20.669	9.21	538	1.8E-03	5.1E+02	3.1E-04	16	0.480	5474	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.05%	0.0034
20.833	9.26	538	1.8E-03	5.3E+02	3.0E-04	10	0.230	6625	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.67%	0.0027
20.997	9.31	538	1.8E-03	5.3E+02	3.0E-04	10	0.230	6608	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.69%	0.0028
21.161	9.36	538	1.8E-03	5.3E+02	3.0E-04	10	0.230	6592	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.72%	0.0028
21.325	9.41	538	1.8E-03	5.3E+02	3.0E-04	10	0.231	6576	0.07%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.74%	0.0029
21.489	9.46	538	1.8E-03	5.3E+02	3.0E-04	10	0.231	6560	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.76%	0.0029
21.653	9.51	538	1.8E-03	5.3E+02	3.0E-04	10	0.231	6544	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.79%	0.0029
21.817	9.56	538	1.8E-03	5.3E+02	3.1E-04	10	0.232	6528	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.81%	0.0030
21.981	9.61	538	1.8E-03	5.3E+02	3.1E-04	10	0.232	6512	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.83%	0.0030
22.145	9.66	538	1.8E-03	5.3E+02	3.1E-04	10	0.232	6497	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.85%	0.0030
22.309	9.71	538	1.8E-03	5.3E+02	3.1E-04	10	0.233	6481	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.88%	0.0031
22.473	9.76	538	1.8E-03	5.3E+02	3.1E-04	10	0.233	6466	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.90%	0.0031
22.638	9.81	538	1.8E-03	5.3E+02	3.1E-04	10	0.233	6451	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.92%	0.0032
22.802	9.86	538	1.8E-03	5.3E+02	3.2E-04	10	0.234	6436	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.95%	0.0032
22.966	9.91	538	1.8E-03	5.3E+02	3.2E-04	10	0.234	6421	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.97%	0.0032
23.130	9.96	538	1.8E-03	5.3E+02	3.2E-04	10	0.234	6406	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.99%	0.0033
23.294	10.01	538	1.8E-03	5.3E+02	3.2E-04	10	0.235	6391	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.01%	0.0033
23.458	10.06	538	1.8E-03	5.3E+02	3.2E-04	10	0.235	6377	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.04%	0.0033
23.622	10.11	538	1.8E-03	5.3E+02	3.3E-04	10	0.235	6362	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.06%	0.0034
23.786	10.16	538	1.8E-03	5.3E+02	3.3E-04	10	0.236	6348	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.08%	0.0034
23.950	10.21	538	1.8E-03	5.3E+02	3.3E-04	10	0.236	6334	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.11%	0.0035
24.114	10.26	538	1.8E-03	5.3E+02	3.3E-04	10	0.236	6320	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.13%	0.0035
24.278	10.31	538	1.8E-03	5.3E+02	3.3E-04	10	0.237	6306	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.15%	0.0035
24.442	10.36	538	1.8E-03	5.3E+02	3.3E-04	10	0.237	6292	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.18%	0.0036
24.606	10.41	538	1.8E-03	5.3E+02	3.4E-04	10	0.237	6278	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.20%	0.0036
24.770	10.46	594	1.8E-03	6.5E+02	2.8E-04	10	0.238	6264	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.31%	0.0021
24.934	10.51	594	1.8E-03	6.5E+02	2.8E-04	10	0.238	6251	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.33%	0.0022
25.098	10.56	594	1.8E-03	6.5E+02	2.8E-04	10	0.238	6237	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.34%	0.0022
25.262	10.61	594	1.8E-03	6.5E+02	2.8E-04	10	0.239	6224	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.36%	0.0022
25.426	10.66	594	1.8E-03	6.5E+02	2.8E-04	10	0.239	6210	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.38%	0.0023
25.590	10.71	594	1.8E-03	6.5E+02	2.8E-04	10	0.239	6197	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.40%	0.0023
25.754	10.76	594	1.8E-03	6.2E+02	3.0E-04	16	0.490	5101	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.77%	0.0029
25.918	10.81	594	1.8E-03	6.5E+02	2.9E-04	10	0.240	6172	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.43%	0.0023
26.082	10.86	594	1.8E-03	6.5E+02	2.9E-04	10	0.240	6159	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.45%	0.0024
26.246	10.91	594	1.8E-03	6.5E+02	2.9E-04	10	0.240	6146	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.46%	0.0024
26.410	10.96	594	1.8E-03	6.5E+02	2.9E-04	10	0.241	6133	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.48%	0.0024
26.574	11.01	594	1.8E-03	6.5E+02	2.9E-04	10	0.241	6120	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.50%	0.0025
26.739	11.06	594	1.8E-03	6.5E+02	2.9E-04	10	0.241	6108	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.52%	0.0025
26.903	11.11	594	1.8E-03	6.5E+02	3.0E-04	10	0.242	6095	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.53%	0.0025
27.067	11.16	594	1.8E-03	6.5E+02	3.0E-04	10	0.242	6083	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.55%	0.0025
27.231	11.21	594	1.8E-03	6.5E+02	3.0E-04	10	0.242	6071	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.57%	0.0026
27.395	11.26	594	1.8E-03	6.5E+02	3.0E-04	10	0.242	6064	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.59%	0.0026
27.559	11.31	594	1.8E-03	6.5E+02	3.0E-04	10	0.243	6058	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.61%	0.0026
27.723	11.36	594	1.8E-03	6.5E+02	3.0E-04	10	0.243	6052	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.62%	0.0027
27.887	11.41	594	1.8E-03	6.5E+02	3.1E-04	10	0.243	6046	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.64%	0.0027
28.051	11.46	594	1.8E-03	6.5E+02	3.1E-04	10	0.243	6040	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.66%	0.0027
28.215	11.51	594	1.8E-03	6.5E+02	3.1E-04	10	0.243	6035	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.68%	0.0028
28.379	11.56	594	1.8E-03	6.5E+02	3.1E-04	10	0.243	6029	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.70%	0.0028
28.543	11.61	594	1.8E-03	6.5E+02	3.1E-04	10	0.243	6023	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.72%	0.0028
28.707	11.66	594	1.8E-03	6.5E+02	3.1E-04	10	0.244	6018	0.07%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.74%	0.0029
28.871	11.71	594	1.9E-03	6.8E+02	3.0E-04	0	0.243	7606	0.08%	5.00	1.00	0.03%	0.003	0.34	0.079	0.765	0.41%	0.0007
29.035	11.76	594	1.9E-03	6.8E+02	3.0E-04	0	0.243	7598	0.08%	5.00	1.00	0.03%	0.003	0.34	0.079	0.765	0.41%	0.0007
29.199	11.81	594	1.9E-03	6.8E+02	3.1E-04	0	0.243	7591	0.09%	5.00	1.00	0.03%	0.003	0.34	0.079	0.765	0.42%	0.0007
32.260	12.75	594	1.9E-03	6.8E+02	3.3E-04	0	0.247	7387	0.10%	5.00	1.00	0.03%	0.004	0.34	0.079	0.765	0.56%	0.0172

Extra layer added to analyze seismic settlement of tailings below the bottom of CPT investigation.

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W7-C

Data File: 13-52106_SP2W7-C-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Tailings Sands
Tailings Sand-Slimes
Tailings Slimes
Interim Cover
Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5613.10	Water surface elevation during CPT investigation (ft amsl)
5611.32	Water surface elevation at t_0 (ft amsl)
5595.40	Water surface elevation at t_1 (ft amsl)
5590.40	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ratio, r_N
0.47	Volumetric Strain Ratio for Site-Specific Design Ear
7.51	Equiv. Number of Uniform Strain Cycles, N
5619.60	Ground Surface Elevation at time of CPT (ft amsl)
5626.65	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
-0.95	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
812.44	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5590.40	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5626.4	5626.15	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5624.4	5622.65	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5620.65	5618.65	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334	1.83	508	1.9E-03	4.8E+02	6.8E-05	11	0.153	12419	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######	5619.13	5619.60	-0.95	0.050	101	0.406	0.430	0.00	0.00	0.406	0.430	2.29	508	1.6E-03	4.0E+02	1.0E-04	11	0.164	11187	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

Conditions at t_1 / Liquefaction Triggering Analyses (Idriss & Boulanger (2008); Youd et al. (2001))

Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
0.41	0.00	0.41	0	1.00	0.09	1.06	1.0	0.061	56.16	129.78	0.202	3.29	0.98	0.50	0.75	3.16	1.0	0.014	1.00	73.63	0.117	281.58	142.44	2
0.42	0.00	0.42	0	1.00	0.10	1.07	1.0	0.062	64.50	161.90	0.339	5.46	0.98	0.57	0.72	3.08	1.0	0.014	1.00	97.40	0.166	199.54	102.50	2
0.43	0.00	0.43	0	1.00	0.12	1.08	1.0	0.063	71.31	188.12	0.701	11.18	0.98	0.62	0.69	3.02	1.0	0.014	1.00	116.80	0.228	183.03	97.10	2
0.44	0.00	0.44	0	1.00	0.13	1.09	1.0	0.063	74.56	200.64	1.000	15.90	0.98	0.65	0.68	2.88	1.0	0.015	1.00	126.08	0.266	160.29	88.10	2
0.45	0.00	0.45	0	1.00	0.13	1.09	1.0	0.063	75.54	204.40	1.000	15.91	0.98	0.66	0.67	2.71	1.0	0.016	1.00	128.86	0.279	134.37	75.14	2
0.46	0.00	0.46	0	1.00	0.15	1.10	1.0	0.063	81.61	227.75	1.000	15.75	0.98	0.70	0.65	2.71	1.0	0.016	1.00	146.15	0.370	148.67	82.21	2
0.46	0.00	0.46	0	1.00	0.15	1.09	1.0	0.063	79.16	218.31	1.000	15.87	0.98	0.68	0.66	2.51	1.0	0.017	1.00	139.16	0.331	113.82	64.85	2
0.47	0.00	0.47	0	1.00	0.16	1.10	1.0	0.063	83.00	233.11	1.000	15.78	0.98	0.71	0.65	2.48	1.0	0.017	1.00	150.11	0.395	118.90	67.34	2
0.48	0.00	0.48	0	1.00	0.15	1.09	1.0	0.063	79.61	220.05	1.000	15.93	0.98	0.68	0.66	2.31	1.0	0.019	1.00	140.44	0.338	90.47	53.20	2
0.49	0.00	0.49	0	1.00	0.14	1.08	1.0	0.062	78.31	215.08	1.000	16.00	0.98	0.68	0.66	2.21	1.0	0.020	1.00	136.76	0.318	76.70	46.35	2
0.50	0.00	0.50	0	1.00	0.14	1.08	1.0	0.062	77.35	211.35	1.000	16.07	0.98	0.67	0.67	2.12	1.0	0.020	1.00	134.00	0.304	66.66	41.36	2
0.51	0.00	0.51	0	1.00	0.13	1.07	1.0	0.062	73.50	196.56	0.977	15.83	0.98	0.64	0.68	2.00	1.0	0.022	1.00	123.05	0.253	50.97	33.40	2
0.51	0.00	0.51	0	1.00	0.12	1.06	1.0	0.061	70.50	184.98	0.628	10.25	0.98	0.62	0.69	1.90	1.0	0.023	1.00	114.49	0.220	40.80	25.53	2
0.52	0.00	0.52	0	1.00	0.12	1.06	1.0	0.061	69.75	182.12	0.572	9.37	0.98	0.61	0.69	1.85	1.0	0.023	1.00	112.36	0.212	36.58	22.98	2
0.53	0.00	0.53	0	1.00	0.12	1.06	1.0	0.061	71.11	187.36	0.682	11.18	0.98	0.62	0.69	1.83	1.0	0.024	1.00	116.24	0.226	36.44	23.81	2
0.54	0.00	0.54	0	1.00	0.14	1.07	1.0	0.061	77.12	210.47	1.000	16.31	0.98	0.67	0.67	1.87	1.0	0.023	1.00	133.35	0.301	45.43	30.87	2
0.55	0.00	0.55	0	0.99	0.14	1.06	1.0	0.061	77.64	212.47	1.000	16.34	0.98	0.67	0.66	1.84	1.0	0.023	1.00	134.83	0.308	43.82	30.08	2
0.55	0.00	0.55	0	0.99	0.15	1.07	1.0	0.061	80.50	223.49	1.000	16.32	0.98	0.69	0.65	1.83	1.0	0.023	1.00	142.99	0.352	47.32	31.82	2
0.56	0.00	0.56	0	0.99	0.14	1.06	1.0	0.061	77.14	210.55	1.000	16.45	0.98	0.67	0.67	1.76	1.0	0.024	1.00	133.41	0.301	38.34	27.39	2
0.57	0.00	0.57	0	0.99	0.18	1.07	1.0	0.062	86.62	247.20	1.000	16.26	0.98	0.73	0.63	1.83	1.0	0.023	1.12	179.35	1.000	121.56	68.91	2
0.58	0.00	0.58	0	0.99	0.17	1.07	1.0	0.061	85.68	243.58	1.000	16.34	0.98	0.73	0.64	1.79	1.0	0.024	1.07	169.42	1.000	116.20	66.27	2
0.59	0.00	0.59	0	0.99	0.14	1.05	1.0	0.060	75.90	205.93	1.000	16.60	0.98	0.66	0.67	1.67	1.0	0.026	1.18	152.78	0.412	45.82	31.21	2
0.59	0.00	0.59	0	0.99	0.11	1.04	1.0	0.059	65.48	165.80	0.369	6.21	0.97	0.58	0.71	1.55	1.0	0.028	1.28	128.71	0.278	29.73	17.97	2
0.60	0.00	0.60	0	0.99	0.12	1.04	1.0	0.060	69.27	180.40	0.542	9.11	0.97	0.61	0.70	1.57	1.0	0.027	1.17	129.62	0.283	29.01	19.06	2
0.61	0.00	0.61	0	0.99	0.13	1.04	1.0	0.060	73.86	198.05	1.000	16.77	0.97	0.64	0.68	1.59	1.0	0.027	1.08	133.72	0.302	29.89	23.33	2
0.62	0.00	0.62	0	0.99	0.12	1.04	1.0	0.059	71.20	187.81	0.693	11.68	0.97	0.62	0.69	1.55	1.0	0.028	1.16	134.72	0.307	29.29	20.48	2
0.62	0.00	0.62	0	0.99	0.11	1.04	1.0	0.059	67.66	174.16	0.453	7.68	0.97	0.60	0.70	1.51	1.0	0.029	1.25	133.61	0.302	27.76	17.72	2
0.63	0.00	0.63	0	0.98	0.11	1.03	1.0	0.059	66.34	169.10	0.399	6.77	0.97	0.59	0.71	1.48	1.0	0.029	1.35	139.13	0.330	29.37	18.07	2
0.64	0.00	0.64	0	0.98	0.11	1.03	1.0	0.059	65.10	164.31	0.357	6.09	0.97	0.58	0.71	1.46	1.0	0.029	1.44	142.65	0.350	30.10	18.09	2
0.65	0.00	0.65	0	0.98	0.12	1.03	1.0	0.059	69.55	181.45	0.560	9.54	0.97	0.61	0.69	1.48	1.0	0.029	1.32	147.75	0.380	31.66	20.60	2
0.65	0.00	0.65	0	0.98	0.09	1.03	1.0	0.058	59.18	141.50	0.238	4.08	0.97	0.52	0.74	1.38	1.0	0.031	1.32	109.07	0.201	16.21	10.15	2
0.66	0.00	0.66	0	0.98	0.11	1.03	1.0	0.058	66.65	170.29	0.410	7.03	0.97	0.59	0.71	1.43	1.0	0.030	1.21	125.85	0.265	20.81	13.92	2
0.67	0.00	0.67	0	0.98	0.07	1.02	1.0	0.058	45.06	87.13	0.123	2.13	0.97	0.37	0.80	1.27	1.0	0.034	1.87	78.68	0.125	9.54	5.84	2
0.68	0.00	0.68	0	0.98	0.07	1.02	1.0	0.058	45.66	89.46	0.126	2.19	0.97	0.38	0.80	1.26	1.0	0.034	1.79	78.56	0.125	9.26	5.73	2
0.69	0.00	0.69	0	0.98	0.06	1.01	1.0	0.057	42.80	78.42	0.110	1.93	0.97	0.34	0.80	1.25	1.0	0.034	1.86	66.20	0.107	7.71	4.82	2
0.69	0.00	0.69	0	0.98	0.05	1.01	1.0	0.057	35.36	50.52	0.078	1.37	0.97	0.22	0.80	1.25	1.0	0.034	4.65	70.38	0.112	7.91	4.64	2
0.70	0.00	0.70	0	0.98	0.05	1.01	1.0	0.057	37.49	57.98	0.086	1.50	0.97	0.26	0.80	1.24	1.0	0.034	2.14	43.82	0.087	5.93	3.72	2
0.71	0.00	0.71	0	0.98	0.05	1.01	1.0	0.057	38.23	60.83	0.089	1.56	0.97	0.27	0.80	1.23	1.0	0.035	2.37	53.60	0.094	6.31	3.93	2
0.72	0.00	0.72	0	0.97	0.06	1.01	1.0	0.057	39.80	66.87	0.096	1.68	0.97	0.30	0.80	1.23	1.0	0.035	1.89	51.26	0.093	6.03	3.86	2
0.73	0.00	0.73	0	0.97	0.05	1.01	1.0	0.057	38.65	62.44	0.091	1.60	0.97	0.28	0.80	1.22	1.0	0.035	2.14	50.97	0.092	5.87	3.73	2
0.73	0.00	0.73	0	0.97	0.06	1.01	1.0	0.057	39.30	64.97	0.094	1.65	0.97	0.29	0.80	1.22	1.0	0.035	1.98	50.86	0.092	5.79	3.72	2
0.74	0.00	0.74	0	0.97	0.06	1.01	1.0	0.057	39.08	64.10	0.093	1.63	0.97	0.29	0.80	1.21	1.0	0.035	1.89	47.20	0.089	5.53	3.58	2
0.75	0.00	0.75	0	0.97	0.06	1.01	1.0	0.057	42.04	75.51	0.107	1.89	0.97	0.33	0.80	1.21	1.0	0.035	1.49	49.82	0.091	5.58	3.74	2
0.76	0.00	0.76	0	0.97	0.06	1.01	1.0	0.056	44.27	84.12	0.118	2.10	0.97	0.36	0.80	1.21	1.0	0.035	1.33	53.04	0.094	5.65	3.87	2
0.77	0.00	0.77	0	0.97	0.06	1.01	1.0	0.056	44.04	83.22	0.117	2.08	0.97	0.36	0.80	1.20	1.0	0.035	1.55	60.90	0.101	6.00	4.04	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.347

Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
2.20	594	1.6E-03	5.5E+02	7.3E-05	11	0.162	11360	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.25	594	1.6E-03	5.5E+02	7.5E-05	11	0.163	11268	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.30	594	1.6E-03	5.5E+02	7.6E-05	11	0.164	11177	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.35	594	1.6E-03	5.5E+02	7.8E-05	11	0.164	11090	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.40	594	1.6E-03	5.5E+02	7.9E-05	11	0.165	11004	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.45	594	1.6E-03	5.5E+02	8.1E-05	11	0.166	10921	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.50	594	1.6E-03	5.5E+02	8.2E-05	11	0.167	10840	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.55	594	1.6E-03	5.5E+02	8.3E-05	11	0.168	10761	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.60	594	1.6E-03	5.5E+02	8.5E-05	11	0.168	10683	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.65	594	1.6E-03	5.5E+02	8.6E-05	11	0.169	10608	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.70	594	1.6E-03	5.5E+02	8.8E-05	11	0.170	10535	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.75	594	1.6E-03	5.5E+02	8.9E-05	11	0.170	10463	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.80	594	1.6E-03	5.5E+02	9.1E-05	11	0.171	10392	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.85	594	1.6E-03	5.5E+02	9.2E-05	11	0.172	10324	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.90	594	1.6E-03	5.5E+02	9.4E-05	11	0.173	10257	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.95	594	1.6E-03	5.5E+02	9.5E-05	11	0.173	10191	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.00	594	1.6E-03	5.5E+02	9.7E-05	11	0.174	10127	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.05	594	1.6E-03	5.5E+02	9.8E-05	11	0.175	10064	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.10	495	1.6E-03	3.8E+02	1.4E-04	11	0.175	10002	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.15	495	1.4E-03	3.5E+02	1.6E-04	10	0.176	10210	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.20	495	1.4E-03	3.5E+02	1.6E-04	10	0.177	10153	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.25	495	1.4E-03	3.5E+02	1.6E-04	10	0.177	10098	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.30	495	1.4E-03	3.5E+02	1.6E-04	10	0.178	10044	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.35	495	1.4E-03	3.5E+02	1.7E-04	10	0.179	9991	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.40	495	1.4E-03	3.5E+02	1.7E-04	10	0.179	9939	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.45	495	1.4E-03	3.5E+02	1.7E-04	10	0.180	9887	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.50	495	1.4E-03	3.5E+02	1.7E-04	10	0.180	9837	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.55	495	1.4E-03	3.5E+02	1.7E-04	10	0.181	9787	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.60	495	1.4E-03	3.5E+02	1.8E-04	10	0.181	9739	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.65	495	1.4E-03	3.5E+02	1.8E-04	10	0.182	9691	0.03%	2.00	0.65	0.03%	0.001	0.34	0.079	0.765	0.09%	0.0002
3.70	495	1.4E-03	3.5E+02	1.8E-04	10	0.183	9644	0.03%	2.00	0.65	0.03%	0.001	0.34	0.079	0.765	0.17%	0.0003
3.75	495	1.4E-03	3.5E+02	1.8E-04	10	0.183	9597	0.03%	2.00	0.65	0.03%	0.001	0.34	0.079	0.765	0.23%	0.0004
3.80	495	1.4E-03	3.5E+02	1.8E-04	10	0.184	9552	0.03%	2.00	0.65	0.03%	0.002	0.34	0.079	0.765	0.28%	0.0005
3.85	495	1.4E-03	3.5E+02	1.9E-04	10	0.184	9507	0.03%	2.00	0.65	0.03%	0.002	0.34	0.079	0.765	0.33%	0.0005
3.90	495	1.4E-03	3.5E+02	1.9E-04	10	0.185	9463	0.03%	2.00	0.65	0.03%	0.002	0.34	0.079	0.765	0.38%	0.0006
3.95	495	1.3E-03	3.1E+02	2.1E-04	16	0.438	7751	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.18%	0.0019
4.00	495	1.4E-03	3.5E+02	1.9E-04	10	0.186	9382	0.03%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.46%	0.0008
4.05	495	1.4E-03	3.5E+02	1.9E-04	10	0.186	9339	0.04%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.50%	0.0008
4.10	495	1.4E-03	3.5E+02	2.0E-04	10	0.187	9298	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.54%	0.0009
4.15	495	1.8E-03	4.5E+02	1.6E-04	10	0.187	9246	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.20	495	1.8E-03	4.5E+02	1.6E-04	10	0.188	9195	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.25	495	1.8E-03	4.5E+02	1.6E-04	10	0.189	9144	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.30	495	1.8E-03	4.5E+02	1.6E-04	10	0.189	9095	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.35	495	1.8E-03	4.5E+02	1.6E-04	10	0.190	9047	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.40	495	1.8E-03	4.5E+02	1.7E-04	10	0.190	8999	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W7-C

Data File: 13-52106_SP2W7-C-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5613.10	Water surface elevation during CPT investigation (ft amsl)
5611.32	Water surface elevation at t_0 (ft amsl)
5595.40	Water surface elevation at t_1 (ft amsl)
5590.40	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ratio, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ear
7.51	Equiv. Number of Uniform Strain Cycles, N
5619.60	Ground Surface Elevation at time of CPT (ft amsl)
5626.65	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pl
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
-0.95	Thickness of Random/Platform Fill on top of existing interim cover (ft)
812.44	Additional Stress due to Final Cover Placement, $\Delta\sigma_{vc}$ (psf)
5590.40	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_2, z_i	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, $\varepsilon_{c,15}$ (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5626.4	5626.15	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5624.4	5622.65	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5620.65	5618.65	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334	1.83	508	1.9E-03	4.8E+02	6.8E-05	11	0.153	12419	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Random/Platform Fill Layer	######	5619.13	5619.60	-0.95	0.050	100	0.406	0.430	0.00	0.00	0.406	0.430	2.29	508	1.6E-03	4.0E+02	1.0E-04	11	0.164	11187	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q	Normalized Friction Ratio, F, (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
17.388	5602.21	14.6	0.394	14.5	24.8	10.76	2.69%	Slime Tailings	0.057	113.1	0.96	0.34	0.62	1	1.29	18.673	259.56	21.92	22	2.88%	2.7	71%	1.37	0.00	1.37	0
17.552	5602.05	10.6	0.341	10.5	16.3	7.05	3.20%	Slime Tailings	0.057	113.1	0.97	0.34	0.62	1	1.28	13.540	188.21	15.88	15	3.53%	2.9	71%	1.38	0.00	1.38	0
17.716	5601.88	11.2	0.288	10.8	64.1	27.78	2.57%	Slime Tailings	0.057	113.1	0.98	0.35	0.63	1	1.28	13.790	191.68	16.61	16	2.82%	2.8	71%	1.39	0.00	1.39	0
17.880	5601.72	12.9	0.210	12.7	33.7	14.62	1.63%	Sand-Slime Tailin	0.059	119.0	0.99	0.36	0.63	1	1.27	16.138	224.31	19.05	19	1.76%	2.6	47%	1.40	0.00	1.40	0
18.044	5601.56	10.5	0.231	10.2	41.6	18.04	2.20%	Slime Tailings	0.057	113.1	1.00	0.36	0.64	1	1.26	12.920	179.59	15.39	15	2.44%	2.8	71%	1.40	0.00	1.40	0
18.208	5601.39	9.1	0.184	8.6	70.9	30.71	2.03%	Slime Tailings	0.057	113.1	1.01	0.37	0.64	1	1.26	10.855	150.88	13.25	13	2.28%	2.8	71%	1.41	0.00	1.41	0
18.372	5601.23	10.2	0.118	9.8	69.3	30.03	1.16%	Sand-Slime Tailin	0.059	119.0	1.02	0.37	0.65	1	1.25	12.220	169.85	14.82	14	1.28%	2.7	47%	1.42	0.00	1.42	0
18.537	5601.06	10.3	0.159	9.8	81.3	35.24	1.55%	Sand-Slime Tailin	0.059	119.0	1.03	0.38	0.65	1	1.24	12.152	168.91	14.85	14	1.72%	2.7	47%	1.43	0.00	1.43	0
18.701	5600.90	12.1	0.167	11.4	113.1	49.03	1.38%	Sand-Slime Tailin	0.059	119.0	1.04	0.38	0.66	1	1.24	14.138	196.51	17.43	17	1.50%	2.6	47%	1.44	0.00	1.44	0
18.865	5600.74	14.0	0.166	13.5	77.6	33.64	1.19%	Sand-Slime Tailin	0.059	119.0	1.05	0.39	0.66	1	1.23	16.569	230.31	19.94	20	1.29%	2.6	47%	1.45	0.00	1.45	0
19.029	5600.57	13.9	0.222	13.5	75.7	32.80	1.59%	Sand-Slime Tailin	0.059	119.0	1.06	0.39	0.67	1	1.22	16.479	229.06	19.81	19	1.72%	2.6	47%	1.46	0.00	1.46	0
19.193	5600.41	14.2	0.182	13.9	41.6	18.02	1.28%	Sand-Slime Tailin	0.059	119.0	1.07	0.40	0.67	1	1.22	16.937	235.42	20.04	20	1.39%	2.6	47%	1.47	0.00	1.47	0
19.357	5600.24	12.2	0.148	11.8	73.0	31.64	1.21%	Sand-Slime Tailin	0.059	119.0	1.08	0.40	0.67	1	1.21	14.220	197.65	17.16	16	1.33%	2.6	47%	1.48	0.00	1.48	0
19.521	5600.08	10.5	0.113	9.8	106.9	46.30	1.08%	Sand-Slime Tailin	0.059	119.0	1.09	0.40	0.68	1	1.20	11.845	164.64	14.69	14	1.20%	2.7	47%	1.49	0.00	1.49	0
19.685	5599.92	10.6	0.200	9.8	131.7	57.08	1.89%	Slime Tailings	0.057	113.1	1.09	0.41	0.68	1	1.20	11.716	162.86	14.75	14	2.10%	2.8	71%	1.50	0.00	1.50	0
19.849	5599.75	36.3	0.300	35.3	156.8	67.96	0.83%	Sand Tailings	0.062	123.5	1.10	0.42	0.69	1	1.15	40.813	567.29	48.71	51	0.85%	2.1	18%	1.51	0.00	1.51	0
20.013	5599.59	33.0	0.456	32.9	14.8	6.43	1.38%	Sand-Slime Tailin	0.059	119.0	1.11	0.42	0.69	1	1.15	37.997	528.16	44.26	46	1.43%	2.3	47%	1.52	0.00	1.52	0
20.177	5599.42	18.7	0.520	18.6	13.8	5.96	2.78%	Slime Tailings	0.057	113.1	1.12	0.43	0.70	1	1.17	21.803	303.07	25.44	25	2.96%	2.7	71%	1.53	0.00	1.53	0
20.341	5599.26	13.7	0.464	13.5	40.0	17.35	3.39%	Slime Tailings	0.057	113.1	1.13	0.43	0.70	1	1.17	15.789	219.47	18.68	18	3.69%	2.8	71%	1.54	0.00	1.54	0
20.505	5599.10	11.5	0.373	11.1	62.3	27.01	3.25%	Slime Tailings	0.057	113.1	1.14	0.44	0.71	1	1.17	12.959	180.13	15.58	15	3.61%	2.9	71%	1.55	0.00	1.55	0
20.669	5598.93	12.4	0.338	11.7	107.6	46.62	2.73%	Slime Tailings	0.057	113.1	1.15	0.44	0.71	1	1.16	13.644	189.65	16.75	16	3.00%	2.8	71%	1.56	0.00	1.56	0
20.833	5598.77	13.3	0.244	12.9	67.9	29.44	1.84%	Sand-Slime Tailin	0.059	119.0	1.16	0.45	0.71	1	1.16	14.894	207.02	17.87	17	2.01%	2.7	47%	1.57	0.00	1.57	0
20.997	5598.60	15.3	0.235	15.0	45.2	19.60	1.54%	Sand-Slime Tailin	0.059	119.0	1.17	0.45	0.72	1	1.15	17.248	239.75	20.41	20	1.67%	2.6	47%	1.58	0.00	1.58	0
21.161	5598.44	18.4	0.276	18.0	52.8	22.87	1.50%	Sand-Slime Tailin	0.059	119.0	1.18	0.46	0.72	1	1.14	20.588	286.17	24.35	24	1.61%	2.5	47%	1.59	0.00	1.59	0
21.325	5598.27	17.9	0.231	17.7	21.2	9.20	1.29%	Sand-Slime Tailin	0.059	119.0	1.19	0.46	0.73	1	1.14	20.141	279.96	23.57	23	1.39%	2.5	47%	1.60	0.00	1.60	0
21.489	5598.11	12.3	0.171	12.1	31.8	13.76	1.39%	Sand-Slime Tailin	0.059	119.0	1.20	0.47	0.73	1	1.13	13.736	190.93	16.21	15	1.54%	2.7	47%	1.61	0.00	1.61	0
21.653	5597.95	9.4	0.173	9.0	70.1	30.36	1.84%	Slime Tailings	0.057	113.1	1.21	0.47	0.74	1	1.13	10.141	140.96	12.35	11	2.11%	2.9	71%	1.62	0.00	1.62	0
21.817	5597.78	10.2	0.308	9.6	109.8	47.60	3.01%	Slime Tailings	0.057	113.1	1.22	0.48	0.74	1	1.12	10.748	149.40	13.38	12	3.41%	3.0	71%	1.63	0.00	1.63	0
21.981	5597.62	16.3	0.494	15.9	55.4	24.01	3.04%	Slime Tailings	0.057	113.1	1.23	0.48	0.75	1	1.12	17.829	247.82	21.16	20	3.28%	2.8	71%	1.63	0.00	1.63	0
22.145	5597.45	14.7	0.580	14.5	37.9	16.40	3.94%	Slime Tailings	0.057	113.1	1.24	0.49	0.75	1	1.11	16.127	224.17	19.04	18	4.31%	2.9	71%	1.64	0.00	1.64	0
22.309	5597.29	15.8	0.533	15.5	43.5	18.86	3.38%	Slime Tailings	0.057	113.1	1.25	0.49	0.75	1	1.11	17.189	238.93	20.31	19	3.67%	2.8	71%	1.65	0.00	1.65	0
22.473	5597.13	14.0	0.457	13.9	15.6	6.74	3.26%	Slime Tailings	0.057	113.1	1.26	0.50	0.76	1	1.10	15.381	213.79	17.99	17	3.58%	2.9	71%	1.66	0.00	1.66	0
22.638	5596.96	22.3	0.455	22.1	22.5	9.75	2.04%	Sand-Slime Tailin	0.059	119.0	1.27	0.50	0.76	1	1.09	24.213	336.55	28.30	28	2.17%	2.6	47%	1.67	0.00	1.67	0
22.802	5596.80	17.6	0.383	17.4	21.7	9.38	2.18%	Sand-Slime Tailin	0.059	119.0	1.28	0.51	0.77	1	1.09	19.057	264.90	22.31	21	2.35%	2.7	47%	1.68	0.00	1.68	0
22.966	5596.63	11.2	0.327	10.7	70.0	30.33	2.93%	Slime Tailings	0.057	113.1	1.28	0.51	0.77	1	1.09	11.705	162.70	14.15	13	3.31%	2.9	71%	1.69	0.00	1.69	0
23.130	5596.47	11.9	0.236	11.3	90.3	39.11	1.99%	Sand-Slime Tailin	0.059	119.0	1.29	0.52	0.78	1	1.08	12.269	170.54	14.96	14	2.23%	2.8	47%	1.70	0.00	1.70	0
23.294	5596.31	13.5	0.214	12.9	103.9	45.01	1.59%	Sand-Slime Tailin	0.059	119.0	1.30	0.52	0.78	1	1.08	13.874	192.85	16.93	16	1.75%	2.7	47%	1.71	0.00	1.71	0
23.458	5596.14	12.3	0.222	11.8	82.8	35.86	1.80%	Sand-Slime Tailin	0.059	119.0	1.31	0.53	0.79	1	1.07	12.714	176.73	15.41	14	2.01%	2.8	47%	1.72	0.00	1.72	0
23.622	5595.98	10.7	0.234	10.1	92.5	40.09	2.19%	Slime Tailings	0.057	113.1	1.32	0.53	0.79	1	1.07	10.821	150.41	13.29	12	2.50%	2.9	71%	1.73	0.00	1.73	0
23.786	5595.81	17.2	0.313	16.6	101.1	43.81	1.82%	Sand-Slime Tailin	0.059	119.0	1.33	0.54	0.79	1	1.07	17.630	245.06	21.26	20	1.98%	2.6	47%	1.74	0.00	1.74	0
23.950	5595.65	18.0	0.305	17.9	11.3	4.88	1.70%	Sand-Slime Tailin	0.059	119.0	1.34	0.54	0.80	1	1.06	18.952	263.44	22.10	21	1.84%	2.6	47%	1.75	0.00	1.75	0
24.114	5595.49	13.6	0.288	13.4	40.7	17.64	2.12%	Sand-Slime Tailin	0.059	119.0	1.35	0.55	0.80	1	1.06	14.105	196.06	16.69	15	2.35%	2.8	47%	1.76	0.00	1.76	0
24.278	5595.32	19.1	0.356	18.5	95.5	41.38	1.87%	Sand-Slime Tailin	0.059	119.0	1.36	0.55	0.81	1	1.05	19.383	269.43	23.24	22	2.01%	2.6	47%	1.77	0.00	1.77	1
24.442	5595.16	19.8	0.406	19.6	24.9	10.80	2.05%	Sand-Slime Tailin	0.059	119.0	1.37	0.56	0.81	1	1.05	20.495	284.88	23.99	23	2.21%	2.6	47%	1.78	0.01	1.77	1
24.606	5594.99	17.4	0.456	17.3	12.2	5.27	2.62%	Slime Tailings	0.057	113.1	1.38	0.56	0.82	1	1.04	18.050	250.89	21.06	20	2.85%	2.7	71%	1.79	0.01	1.78	1
24.770	5594.83	12.0	0.315	11.9	21.2	9.17	2.62%	Slime Tailings	0.057	113.1	1.39	0.57	0.82	1	1.04	12.353	171.70	14.51	13	2.96%	2.9	71%	1.80	0.02	1.78	1
24.934	5594.67	10.2	0.249	9.9	49.0	21.21	2.45%	Slime Tailings	0.057	113.1	1.40	0.58	0.83	1	1.03	10.195	141.71	12.21	11	2.84%	3.0	71%	1.81	0.02	1.78	1
25.098	5594.50	10.1	0.244	9.6	79.6	34.51	2.41%	Slime Tailings	0.057	113.1	1.41	0.58	0.83	1	1.03	9.897	137.57	12.09	10	2.81%	3.0	71%	1.82	0.03	1.79	1
25.262	5594.34	14.2	0.261	14.1	10.4	4.50	1.84%	Sand-Slime Tailin	0.059	119.0	1.42	0.59	0.83	1	1.03	14.489	201.40	16.91	15	2.04%	2.7	47%	1.83	0.03	1.79	1
25.426	5594.17	14.1	0.415	13.8	52.2	22.60	2.93%	Slime Tailings	0.057	113.1	1.43	0.59	0.84	1	1.02	14.116	196.21	16.78	15	3.26%	2.9	71%	1.83	0.04	1.80	1
25.590	5594.01	15.1	0.371	15.0	20.2	8.75	2.46%	Slime Tailings	0.057	113.1	1.44	0.60	0.84	1	1.02	15.231	211.72	17.84	16	2.72%	2.8	71%	1.84	0.04	1.80	1
25.754	5593.85	12.5	0.387	12.0	70.3	30.45	3.10%	Slime Tailings	0.057	113.1	1.45	0.60	0.85	1	1.01	12.203	169.62	14.69	13	3.51%	2.9	71%	1.85	0.05	1.80	1
25.918	5593.68	15.4	0.224	15.0	51.8	22.46	1.46%	Sand-Slime Tailin	0.059	119.0	1.46	0.61	0.85	1	1.01	15.169	210.85	18.00	16	1.61%	2.7	47%	1.86	0.05	1.81	1
26.082	5593.52	20.6	0.226	20.5	15.0	6.51	1.10%	Sand-Slime Tailin	0.059	119.0	1.47	0.61	0.86	1	1.00	20.609	286.46	24.05	22	1.18%	2.5	47%	1.87	0.06	1.81	1
26.246	5593.35	17.9	0.228	17.7	30.6	13.24	1.27%	Sand-Slime Tailin	0.059	119.0	1.48	0.62	0.86	1	1.00	17.733	246.48	20.82	19	1.39%	2.6	47%	1.88	0.06	1.82	1
26.410	5593.19	13.3	0.303	13.1	41.9	18.16	2.27%	Slime Tailings	0.057	113.1	1.49	0.62	0.86	1	1.00	13.030	181.12	15.44	14	2.56%	2.8	71%	1.89	0.07	1.82	1
26.574	5593.03	12.3	0.204	11.9	75.2	32.58	1.65%	Sand-Slime Tailin	0.059	119.0	1.50	0.63	0.87	1	0.99	11.774	163.66	14.22	12	1.88%	2.8	47%	1.90	0.07	1.83	1
26.739	5592.86	21.0	0.154	20.8	25.1	10.86	0.73%	Sand-Slime Tailin	0.059	119.0	1.51	0.63	0.87	1	0.99	20.610	286.48	24.12	22	0.79%	2.4	47%	1.91	0.08	1.83	1
26.903	5592.70	21.7	0.157	21.6	16.6	7.20	0.72%	Sand-Slime Tailin	0.059	119.0	1.51	0.64	0.88	1	0.99	21.287	295.89	24.84	23	0.78%	2.4	47%	1.92	0.08	1.84	1
27.067	5592.53	21.5	0.222	21.4	21.0	9.11	1.03%	Sand-Slime Tailin	0.059	119.0	1.52	0.64	0.88	1	0.98	20.946	291.15	24.48	23	1.11%	2.5	47%	1.93	0.09	1.84	1
27.231	5592.37	20.3	0.256	20.2	23.1	10.02	1.26%	Sand-Slime Tailin	0.059	119.0	1.53	0.65	0.89	1	0.98	19.734	274.30	23.08	21	1.36%	2.5	47%	1.94	0.09	1.85	1
27.395	5592.21	26.5	0.406	26.3	23.6	10.23	1.53%	Sand-Slime Tailin	0.059	119.0	1.54	0.65	0.89	1	0.97	25.657	356.63	29.97	28	1.63%	2.5	47%	1.95	0.10	1.85	1
27.559	5592.04	19.7	0.516	19.6	24.8	10.73	2.61%	Sand-Slime Tailin	0.059	119.0	1.55	0.66	0.90	1	0.97	18.972	263.71	22.21	20	2.84%	2.7	47%	1.96	0.10	1.86	1
27.723	5591.88	15.4	0.486	15.2	25.6	11.08	3.16%	Slime Tailings	0.057	113.1	1.56	0.66	0.90	1	0.97	14.708	204.44	17.26	15	3.51%	2.9	71%	1.97	0.11	1.86	1
27.887	5591.71	13.0	0.486	12.8	45.1	19.56	3.73%	Slime Tailings	0.057	113.1	1.57	0.67	0.91	1	0.96	12.270	170.56	14.57	13	4.24%	3.0	71%	1.98	0.12	1.86	1
28.051	5591.55	11.8	0.486	11.3	75.6	32.75	4.13%	Slime Tailings	0.057	113.1	1.58	0.67	0.91	1	0.96	10.818	150.37	13.09	11	4.77%	3.1	71%	1.99	0.12	1.87	1
29.200	5590.40							Slime Tailings	0.057	113.1													2.05	0.14	1.91	1

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	I&B r_d	C_σ	K_σ	K_α	CSR M=7.5, σ'=1atm	Δq_{c1n}	$q_{c1n\text{-}cs}$	(CRR) M=7.5, σ'=1atm	FoS	Youd r_d	D_r	f	K_σ	K_α	CSR M=7.5, σ'=1atm	Kc	$q_{c1n\text{-}cs}$	(CRR) M=7.5, σ'=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
17.388	0.90	0.05	0.98	1.0	0.051	37.72	59.64	0.087	1.73	0.94	0.27	0.80	1.07	1.0	0.039	4.07	89.16	0.146	4.87	3.30	2
17.552	0.90	0.05	0.98	1.0	0.051	35.62	51.49	0.079	1.56	0.94	0.23	0.80	1.07	1.0	0.039	5.55	88.16	0.144	4.76	3.16	2
17.716	0.89	0.05	0.98	1.0	0.050	35.87	52.48	0.080	1.58	0.94	0.24	0.80	1.06	1.0	0.039	4.87	80.89	0.129	4.26	2.92	2
17.880	0.89	0.05	0.97	1.0	0.050	36.98	56.04	0.084	1.66	0.94	0.25	0.80	1.06	1.0	0.039	3.58	68.22	0.110	3.58	2.62	2
18.044	0.89	0.05	0.98	1.0	0.050	35.45	50.83	0.078	1.56	0.94	0.23	0.80	1.06	1.0	0.039	4.82	74.13	0.118	3.83	2.69	2
18.208	0.89	0.05	0.98	1.0	0.050	34.70	47.96	0.076	1.50	0.94	0.21	0.80	1.06	1.0	0.039	5.21	69.03	0.111	3.57	2.54	2
18.372	0.89	0.05	0.98	1.0	0.050	35.50	50.32	0.078	1.55	0.94	0.22	0.80	1.06	1.0	0.039	3.79	56.22	0.097	3.10	2.32	2
18.537	0.89	0.05	0.98	1.0	0.050	35.51	50.36	0.078	1.55	0.94	0.22	0.80	1.06	1.0	0.039	4.27	63.40	0.104	3.31	2.43	2
18.701	0.89	0.05	0.97	1.0	0.050	36.42	53.85	0.081	1.63	0.94	0.24	0.80	1.06	1.0	0.039	3.59	62.60	0.103	3.26	2.44	2
18.865	0.89	0.05	0.97	1.0	0.050	37.29	57.23	0.085	1.70	0.94	0.26	0.80	1.05	1.0	0.039	3.05	60.77	0.101	3.17	2.44	2
19.029	0.88	0.05	0.97	1.0	0.050	37.25	57.06	0.085	1.70	0.94	0.26	0.80	1.05	1.0	0.039	3.48	68.88	0.110	3.45	2.58	2
19.193	0.88	0.05	0.97	1.0	0.050	37.33	57.37	0.085	1.71	0.94	0.26	0.80	1.05	1.0	0.039	3.14	62.99	0.103	3.21	2.46	2
19.357	0.88	0.05	0.97	1.0	0.050	36.32	53.47	0.081	1.63	0.94	0.24	0.80	1.05	1.0	0.039	3.47	59.53	0.100	3.07	2.35	2
19.521	0.88	0.05	0.97	1.0	0.050	35.45	50.14	0.078	1.57	0.94	0.22	0.80	1.05	1.0	0.039	3.75	55.14	0.096	2.93	2.25	2
19.685	0.88	0.05	0.97	1.0	0.049	35.22	49.98	0.077	1.57	0.94	0.22	0.80	1.05	1.0	0.039	4.71	69.55	0.111	3.39	2.48	2
19.849	0.88	0.07	0.96	1.0	0.049	34.54	83.26	0.117	2.40	0.94	0.40	0.80	1.05	1.0	0.040	1.46	71.18	0.114	3.44	2.92	2
20.013	0.88	0.07	0.96	1.0	0.049	45.82	90.08	0.127	2.61	0.94	0.38	0.80	1.05	1.0	0.040	1.86	82.24	0.132	3.96	3.29	2
20.177	0.87	0.06	0.97	1.0	0.049	38.95	64.39	0.093	1.90	0.94	0.29	0.80	1.04	1.0	0.040	3.80	96.63	0.164	4.90	3.40	2
20.341	0.87	0.05	0.97	1.0	0.049	36.59	55.27	0.083	1.69	0.94	0.25	0.80	1.04	1.0	0.040	5.20	97.17	0.165	4.92	3.30	2
20.505	0.87	0.05	0.97	1.0	0.049	35.51	51.09	0.079	1.60	0.94	0.23	0.80	1.04	1.0	0.040	5.80	90.30	0.148	4.39	3.00	2
20.669	0.87	0.05	0.97	1.0	0.049	35.92	52.68	0.080	1.63	0.94	0.24	0.80	1.04	1.0	0.040	5.09	85.21	0.138	4.05	2.84	2
20.833	0.87	0.05	0.97	1.0	0.049	36.57	54.44	0.082	1.68	0.94	0.24	0.80	1.04	1.0	0.040	4.06	72.57	0.116	3.38	2.53	2
20.997	0.87	0.05	0.97	1.0	0.049	37.46	57.87	0.086	1.76	0.93	0.26	0.80	1.04	1.0	0.040	3.40	69.41	0.111	3.23	2.49	2
21.161	0.87	0.06	0.97	1.0	0.048	38.84	63.19	0.091	1.89	0.93	0.28	0.80	1.04	1.0	0.040	2.94	71.66	0.114	3.30	2.59	2
21.325	0.87	0.05	0.97	1.0	0.048	38.57	62.13	0.090	1.87	0.93	0.28	0.80	1.03	1.0	0.040	2.83	66.67	0.108	3.09	2.48	2
21.489	0.86	0.05	0.97	1.0	0.048	35.99	52.20	0.080	1.65	0.93	0.23	0.80	1.03	1.0	0.040	3.91	63.32	0.104	2.96	2.30	2
21.653	0.86	0.05	0.97	1.0	0.048	34.39	46.74	0.074	1.54	0.93	0.20	0.80	1.03	1.0	0.040	5.44	67.21	0.108	3.07	2.31	2
21.817	0.86	0.05	0.97	1.0	0.048	34.75	48.13	0.076	1.57	0.93	0.21	0.80	1.03	1.0	0.040	6.30	84.34	0.136	3.84	2.70	2
21.981	0.86	0.05	0.97	1.0	0.048	37.46	58.61	0.086	1.80	0.93	0.27	0.80	1.03	1.0	0.040	4.58	96.83	0.164	4.62	3.21	2
22.145	0.86	0.05	0.97	1.0	0.048	36.72	55.75	0.083	1.74	0.93	0.25	0.80	1.03	1.0	0.040	5.59	106.43	0.192	5.37	3.55	2
22.309	0.86	0.05	0.97	1.0	0.048	37.16	57.48	0.085	1.78	0.93	0.26	0.80	1.03	1.0	0.040	4.97	100.99	0.176	4.89	3.33	2
22.473	0.86	0.05	0.97	1.0	0.048	36.35	54.34	0.082	1.71	0.93	0.24	0.80	1.03	1.0	0.040	5.32	95.70	0.162	4.47	3.09	2
22.638	0.85	0.06	0.96	1.0	0.048	40.23	68.53	0.098	2.06	0.93	0.31	0.80	1.02	1.0	0.040	3.07	87.01	0.141	3.89	2.97	2
22.802	0.85	0.05	0.96	1.0	0.048	38.12	60.43	0.088	1.86	0.93	0.27	0.80	1.02	1.0	0.040	3.78	84.25	0.136	3.71	2.78	2
22.966	0.85	0.05	0.97	1.0	0.048	35.01	49.16	0.077	1.61	0.93	0.22	0.80	1.02	1.0	0.040	6.03	85.32	0.138	3.75	2.68	2
23.130	0.85	0.05	0.97	1.0	0.048	35.55	50.51	0.078	1.64	0.93	0.22	0.80	1.02	1.0	0.040	4.90	73.26	0.117	3.16	2.40	2
23.294	0.85	0.05	0.97	1.0	0.047	36.24	53.17	0.081	1.70	0.93	0.24	0.80	1.02	1.0	0.040	4.04	68.45	0.110	2.96	2.33	2
23.458	0.85	0.05	0.97	1.0	0.047	35.71	51.12	0.079	1.66	0.93	0.23	0.80	1.02	1.0	0.040	4.60	70.84	0.113	3.04	2.35	2
23.622	0.85	0.05	0.97	1.0	0.047	34.71	48.00	0.076	1.60	0.92	0.21	0.80	1.02	1.0	0.040	5.61	74.52	0.118	3.17	2.38	2
23.786	0.85	0.05	0.96	1.0	0.047	37.76	59.01	0.087	1.84	0.92	0.27	0.80	1.02	1.0	0.040	3.63	77.06	0.123	3.27	2.56	2
23.950	0.84	0.05	0.96	1.0	0.047	38.05	60.15	0.088	1.88	0.92	0.27	0.80	1.02	1.0	0.040	3.41	75.45	0.120	3.18	2.53	2
24.114	0.84	0.05	0.96	1.0	0.047	36.16	52.85	0.080	1.71	0.92	0.24	0.80	1.01	1.0	0.040	4.66	77.81	0.124	3.27	2.49	2
24.278	0.84	0.05	0.96	1.0	0.047	38.45	61.69	0.090	1.92	0.92	0.28	0.80	1.01	1.0	0.040	3.44	79.99	0.128	3.35	2.63	2
24.442	0.84	0.06	0.96	1.0	0.047	38.72	62.71	0.091	1.94	0.92	0.28	0.80	1.01	1.0	0.040	3.52	84.43	0.136	3.55	2.74	2
24.606	0.84	0.05	0.96	1.0	0.047	37.42	58.48	0.086	1.84	0.92	0.26	0.80	1.01	1.0	0.040	4.35	91.61	0.151	3.92	2.88	2
24.770	0.84	0.05	0.96	1.0	0.047	35.14	49.65	0.077	1.64	0.92	0.22	0.80	1.01	1.0	0.040	5.71	82.84	0.133	3.42	2.53	2
24.934	0.84	0.05	0.97	1.0	0.047	34.34	46.55	0.074	1.57	0.91	0.20	0.80	1.01	1.0	0.040	6.33	77.25	0.123	3.14	2.36	2
25.098	0.83	0.05	0.97	1.0	0.047	34.30	46.39	0.074	1.57	0.91	0.20	0.80	1.01	1.0	0.041	6.34	76.70	0.122	3.10	2.33	2
25.262	0.83	0.05	0.96	1.0	0.047	36.23	53.14	0.081	1.71	0.91	0.24	0.80	1.01	1.0	0.041	4.37	73.93	0.118	2.97	2.34	2
25.426	0.83	0.05	0.96	1.0	0.047	35.93	52.71	0.080	1.70	0.91	0.24	0.80	1.01	1.0	0.041	5.42	91.00	0.150	3.76	2.73	2
25.590	0.83	0.05	0.96	1.0	0.047	36.30	54.14	0.082	1.73	0.91	0.24	0.80	1.00	1.0	0.041	4.79	85.43	0.138	3.44	2.58	2
25.754	0.83	0.05	0.96	1.0	0.047	35.20	49.89	0.077	1.63	0.91	0.22	0.80	1.00	1.0	0.041	6.13	90.06	0.148	3.67	2.65	2
25.918	0.83	0.05	0.96	1.0	0.047	36.61	54.61	0.082	1.73	0.91	0.24	0.80	1.00	1.0	0.041	3.79	68.14	0.109	2.69	2.21	2
26.082	0.83	0.06	0.96	1.0	0.047	38.73	62.78	0.091	1.92	0.90	0.28	0.80	1.00	1.0	0.041	2.68	64.55	0.105	2.57	2.25	2
26.246	0.82	0.05	0.96	1.0	0.047	37.60	58.42	0.086	1.82	0.90	0.26	0.80	1.00	1.0	0.041	3.20	66.52	0.107	2.61	2.21	2
26.410	0.82	0.05	0.96	1.0	0.048	35.46	50.90	0.078	1.65	0.90	0.23	0.80	1.00	1.0	0.041	5.18	79.94	0.128	3.08	2.36	2
26.574	0.82	0.05	0.96	1.0	0.048	35.29	49.50	0.077	1.62	0.90	0.22	0.80	1.00	1.0	0.041	4.83	68.70	0.110	2.64	2.13	2
26.739	0.82	0.06	0.96	1.0	0.047	38.76	62.88	0.091	1.92	0.90	0.28	0.80	1.00	1.0	0.041	2.30	55.56	0.096	2.29	2.10	2
26.903	0.82	0.06	0.96	1.0	0.047	39.01	63.86	0.092	1.94	0.90	0.29	0.80	1.00	1.0	0.042	2.24	55.75	0.096	2.28	2.11	2
27.067	0.82	0.06	0.96	1.0	0.047	38.89	63.36	0.092	1.93	0.90	0.29	0.80	0.99	1.0	0.042	2.60	63.68	0.104	2.45	2.19	2
27.231	0.82	0.05	0.96	1.0	0.048	38.40	61.48	0.090	1.88	0.90	0.28	0.80	0.99	1.0	0.042	2.95	68.20	0.110	2.56	2.22	2
27.395	0.82	0.06	0.96	1.0	0.047	40.81	70.78	0.101	2.12	0.89	0.32	0.80	0.99	1.0	0.042	2.66	79.84	0.127	2.96	2.54	2
27.559	0.81	0.05	0.96	1.0	0.048	38.09	60.30	0.088	1.85	0.89	0.27	0.80	0.99	1.0	0.042	4.26	94.50	0.158	3.66	2.76	2
27.723	0.81	0.05	0.96	1.0	0.048	36.10	53.36	0.081	1.69	0.89	0.24	0.80	0.99	1.0	0.042	5.57	96.13	0.163	3.73	2.71	2
27.887	0.81	0.05	0.96	1.0	0.048	35.16	49.73	0.077	1.61	0.89	0.22	0.80	0.99	1.0	0.042	6.77	98.65	0.169	3.87	2.74	2
28.051	0.81	0.05	0.96	1.0	0.048	34.65	47.74	0.075	1.57	0.89	0.21	0.80	0.99	1.0	0.042	7.64	100.00	0.173	3.93	2.75	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.347

Depth at t_2, z_i m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, $\varepsilon_{c,15}$ (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
7.45	500	1.8E-03	4.4E+02	3.0E-04	16	0.471	5856	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.13%	0.0035
7.50	500	1.8E-03	4.4E+02	3.1E-04	16	0.472	5840	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.16%	0.0035
7.55	500	1.8E-03	4.4E+02	3.1E-04	16	0.472	5824	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.19%	0.0036
7.60	500	1.8E-03	4.6E+02	2.9E-04	10	0.221	7049	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.79%	0.0029
7.65	500	1.8E-03	4.4E+02	3.1E-04	16	0.473	5791	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.25%	0.0037
7.70	500	1.8E-03	4.4E+02	3.1E-04	16	0.473	5775	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.27%	0.0037
7.75	500	1.8E-03	4.6E+02	3.0E-04	10	0.222	6990	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.87%	0.0031
7.80	500	1.8E-03	4.6E+02	3.0E-04	10	0.223	6970	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.90%	0.0031
7.85	500	1.8E-03	4.6E+02	3.0E-04	10	0.223	6951	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.92%	0.0032
7.90	500	1.8E-03	4.6E+02	3.1E-04	10	0.223	6931	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.95%	0.0032
7.95	500	1.8E-03	4.6E+02	3.1E-04	10	0.224	6912	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.98%	0.0032
8.00	500	1.8E-03	4.6E+02	3.1E-04	10	0.224	6893	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.01%	0.0033
8.05	500	1.8E-03	4.6E+02	3.1E-04	10	0.225	6874	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.04%	0.0033
8.10	500	1.8E-03	4.6E+02	3.1E-04	10	0.225	6856	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.07%	0.0034
8.15	538	1.8E-03	5.1E+02	2.9E-04	16	0.476	5635	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.78%	0.0029
8.20	538	1.9E-03	5.5E+02	2.7E-04	0	0.227	8615	0.07%	2.20	1.00	0.03%	0.001	0.34	0.079	0.765	0.13%	0.0002
8.25	538	1.8E-03	5.3E+02	2.8E-04	10	0.226	6801	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.44%	0.0024
8.30	538	1.8E-03	5.1E+02	2.9E-04	16	0.478	5590	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.85%	0.0030
8.35	538	1.8E-03	5.1E+02	3.0E-04	16	0.478	5577	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.88%	0.0031
8.40	538	1.8E-03	5.1E+02	3.0E-04	16	0.478	5563	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.90%	0.0031
8.45	538	1.8E-03	5.1E+02	3.0E-04	16	0.479	5549	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.92%	0.0032
8.50	538	1.8E-03	5.3E+02	2.9E-04	10	0.228	6716	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.55%	0.0025
8.55	538	1.8E-03	5.3E+02	2.9E-04	10	0.228	6698	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.57%	0.0026
8.60	538	1.8E-03	5.3E+02	2.9E-04	10	0.228	6681	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.60%	0.0026
8.65	538	1.8E-03	5.3E+02	2.9E-04	10	0.229	6664	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.62%	0.0027
8.70	538	1.8E-03	5.3E+02	2.9E-04	10	0.229	6648	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.64%	0.0027
8.75	538	1.8E-03	5.1E+02	3.1E-04	16	0.481	5466	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.06%	0.0034
8.80	538	1.8E-03	5.1E+02	3.1E-04	16	0.481	5454	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.08%	0.0034
8.85	538	1.8E-03	5.1E+02	3.1E-04	16	0.481	5441	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.11%	0.0035
8.90	538	1.8E-03	5.1E+02	3.2E-04	16	0.482	5428	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.13%	0.0035
8.95	538	1.8E-03	5.1E+02	3.2E-04	16	0.482	5416	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.15%	0.0035
9.00	538	1.8E-03	5.1E+02	3.2E-04	16	0.482	5403	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.17%	0.0036
9.05	538	1.8E-03	5.3E+02	3.0E-04	10	0.232	6538	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.79%	0.0029
9.10	538	1.8E-03	5.3E+02	3.1E-04	10	0.232	6523	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.82%	0.0030
9.15	538	1.8E-03	5.1E+02	3.2E-04	16	0.483	5365	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.25%	0.0037
9.20	538	1.8E-03	5.3E+02	3.1E-04	10	0.233	6492	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.86%	0.0031
9.25	538	1.8E-03	5.3E+02	3.1E-04	10	0.233	6477	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.88%	0.0031
9.30	538	1.8E-03	5.3E+02	3.1E-04	10	0.233	6462	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.91%	0.0031
9.35	538	1.8E-03	5.1E+02	3.3E-04	16	0.485	5316	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.34%	0.0038
9.40	538	1.8E-03	5.3E+02	3.2E-04	10	0.234	6432	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.95%	0.0032
9.45	538	1.8E-03	5.3E+02	3.2E-04	10	0.234	6417	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.97%	0.0032
9.50	538	1.8E-03	5.3E+02	3.2E-04	10	0.235	6403	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.00%	0.0033
9.55	538	1.8E-03	5.3E+02	3.2E-04	10	0.235	6392	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.02%	0.0033
9.60	538	1.8E-03	5.3E+02	3.2E-04	10	0.235	6385	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.05%	0.0034
9.65	538	1.8E-03	5.1E+02	3.4E-04	16	0.486	5260	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.49%	0.0041
9.70	594	1.8E-03	6.2E+02	2.8E-04	16	0.486	5254	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.56%	0.0026
9.75	594	1.8E-03	6.2E+02	2.8E-04	16	0.486	5249	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.58%	0.0026
9.80	594	1.8E-03	6.2E+02	2.9E-04	16	0.486	5244	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.60%	0.0026
9.85	594	1.8E-03	6.5E+02	2.7E-04	10	0.236	6353	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.27%	0.0021
9.90	594	1.8E-03	6.2E+02	2.9E-04	16	0.487	5234	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.64%	0.0027
9.95	594	1.8E-03	6.2E+02	2.9E-04	16	0.487	5229	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.66%	0.0027
10.00	594	1.8E-03	6.2E+02	2.9E-04	16	0.487	5224	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.68%	0.0028
10.05	594	1.8E-03	6.5E+02	2.8E-04	10	0.236	6328	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.34%	0.0022
10.10	594	1.8E-03	6.5E+02	2.8E-04	10	0.236	6321	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.36%	0.0022
10.15	594	1.8E-03	6.5E+02	2.8E-04	10	0.237	6315	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.38%	0.0023
10.20	594	1.8E-03	6.2E+02	3.0E-04	16	0.488	5203	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.76%	0.0029
10.25	594	1.8E-03	6.5E+02	2.8E-04	10	0.237	6302	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.42%	0.0023
10.30	594	1.8E-03	6.5E+02	2.9E-04	10	0.237	6295	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.44%	0.0024
10.35	594	1.8E-03	6.5E+02	2.9E-04	10	0.237	6289	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.46%	0.0024
10.40	594	1.8E-03	6.5E+02	2.9E-04	10	0.237	6282	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.48%	0.0024
10.45	594	1.8E-03	6.5E+02	2.9E-04	10	0.237	6276	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.50%	0.0025
10.50	594	1.8E-03	6.5E+02	2.9E-04	10	0.238	6269	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.52%	0.0025
10.55	594	1.8E-03	6.5E+02	2.9E-04	10	0.238	6263	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.54%	0.0025
10.60	594	1.8E-03	6.2E+02	3.1E-04	16	0.489	5160	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.93%	0.0032
10.65	594	1.8E-03	6.2E+02	3.1E-04	16	0.489	5156	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.95%	0.0032
10.70	594	1.8E-03	6.2E+02	3.1E-04	16	0.489	5151	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.97%	0.0032
11.05	594	1.8E-03	6.2E+02	3.2E-04	16	0.490	5098	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.10%	0.0241

Extra layer added to analyze seismic settlement of tailings below the bottom of CPT investigation.

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2E1

Data File: 13-52106_SP2E1-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Dat

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5613.10	Water surface elevation during CPT investigation (ft a
5611.67	Water surface elevation at t_0 (ft amsl)
5595.46	Water surface elevation at t_1 (ft amsl)
5590.46	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earth
7.51	Equiv. Number of Uniform Strain Cycles, N
5619.95	Ground Surface Elevation at time of CPT (ft amsl)
5630.46	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after place
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
2.51	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1160.95	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5590.46	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5630.21	5629.96	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5628.21	5626.46	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5624.46	5622.46	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334	1.83	508	1.9E-03	4.8E+02	6.8E-05	11	0.153	12419	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######	5621.21	5619.95	2.51	0.050	101	0.580	0.517	0.00	0.00	0.580	0.517	2.82	508	1.6E-03	4.0E+02	1.2E-04	11	0.171	10362	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
0.164	5619.79	13.5	0.057	13.5	-0.0	-0.01	0.42%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	22.933	318.77	26.63	1632	0.42%	0.9	51%	0.59	0.00	0.59	0
0.328	5619.62	36.9	0.160	36.9	0.1	0.05	0.43%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	62.713	871.71	72.84	2232	0.43%	0.9	51%	0.60	0.00	0.60	0
0.492	5619.46	45.5	0.725	45.5	0.2	0.09	1.59%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	77.333	1074.93	89.82	1834	1.59%	1.4	51%	0.61	0.00	0.61	0
0.656	5619.29	78.6	0.721	78.6	0.4	0.19	0.92%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	133.671	1858.03	155.26	2379	0.92%	1.2	51%	0.61	0.00	0.61	0
0.820	5619.13	133.5	1.017	133.5	1.1	0.48	0.76%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	226.865	3153.42	263.50	3230	0.76%	1.1	51%	0.62	0.00	0.62	0
0.984	5618.97	159.6	1.857	159.6	1.1	0.48	1.16%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	271.388	3772.29	315.21	3220	1.16%	1.3	51%	0.63	0.00	0.63	0
1.148	5618.80	202.0	1.570	202.0	1.5	0.66	0.78%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	343.332	4772.31	398.78	3491	0.78%	1.1	51%	0.64	0.00	0.64	0
1.312	5618.64	282.1	2.962	282.1	2.0	0.85	1.05%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	479.536	6665.55	556.98	4267	1.05%	1.3	51%	0.65	0.00	0.65	0
1.476	5618.47	258.6	3.915	258.6	2.8	1.19	1.51%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	439.552	6109.77	510.55	3477	1.51%	1.4	51%	0.65	0.00	0.65	0
1.640	5618.31	203.5	4.263	203.5	3.0	1.31	2.09%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	345.933	4808.47	401.82	2462	2.10%	1.5	51%	0.66	0.00	0.66	0
1.804	5618.15	196.8	3.157	196.7	3.4	1.46	1.60%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	334.441	4648.73	388.47	2164	1.61%	1.4	51%	0.67	0.00	0.67	0
1.968	5617.98	198.9	2.435	198.9	3.1	1.34	1.22%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	338.113	4699.77	392.74	2005	1.22%	1.3	51%	0.68	0.00	0.68	0
2.133	5617.82	169.5	1.671	169.5	3.4	1.46	0.99%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	288.167	4005.52	334.73	1578	0.99%	1.2	51%	0.69	0.00	0.69	0
2.297	5617.65	152.5	1.369	152.5	3.4	1.45	0.90%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	258.952	3599.44	300.80	1318	0.90%	1.2	51%	0.70	0.00	0.70	0
2.461	5617.49	96.6	1.501	96.6	1.4	0.60	1.55%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	164.203	2282.42	190.73	779	1.56%	1.5	51%	0.70	0.00	0.70	0
2.625	5617.33	111.8	1.580	111.8	1.3	0.55	1.41%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.70	190.060	2641.83	220.76	845	1.41%	1.5	51%	0.71	0.00	0.71	0
2.789	5617.16	136.8	1.973	136.8	1.2	0.50	1.44%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0	1.61	220.642	3066.92	256.28	973	1.44%	1.5	51%	0.72	0.00	0.72	0
2.953	5617.00	124.7	1.720	124.7	1.6	0.69	1.38%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0	1.64	204.705	2845.41	237.77	837	1.38%	1.5	51%	0.73	0.00	0.73	0
3.117	5616.83	124.7	1.712	124.7	1.4	0.61	1.37%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0	1.63	202.585	2815.93	235.31	793	1.37%	1.5	51%	0.74	0.00	0.74	0
3.281	5616.67	121.9	1.635	121.9	1.2	0.52	1.34%	Sand Tailings	0.051	102.8	0.17	0.00	0.17	0	1.62	197.463	2744.73	229.35	736	1.34%	1.5	18%	0.75	0.00	0.75	0
3.445	5616.51	125.5	1.702	125.5	0.9	0.41	1.36%	Sand Tailings	0.051	102.8	0.17	0.00	0.17	0	1.59	199.479	2772.75	231.69	721	1.36%	1.5	18%	0.75	0.00	0.75	0
3.609	5616.34	150.5	1.842	150.5	1.6	0.68	1.22%	Sand Tailings	0.051	102.8	0.18	0.00	0.18	0	1.51	226.750	3151.82	263.37	825	1.22%	1.4	18%	0.76	0.00	0.76	0
3.773	5616.18	107.6	1.906	107.6	1.3	0.56	1.77%	Sand Tailings	0.051	102.8	0.19	0.00	0.19	0	1.63	175.430	2438.48	203.77	563	1.78%	1.6	18%	0.77	0.00	0.77	0
3.937	5616.01	87.2	1.794	87.2	1.1	0.46	2.06%	Sand-Slime Tailings	0.047	93.3	0.20	0.00	0.20	0	1.70	148.257	2060.77	172.20	439	2.06%	1.7	47%	0.78	0.00	0.78	0
4.101	5615.85	65.2	1.491	65.2	1.0	0.41	2.29%	Sand-Slime Tailings	0.047	93.3	0.21	0.00	0.21	0	1.70	110.823	1540.44	128.73	315	2.29%	1.9	47%	0.79	0.00	0.79	0
4.265	5615.68	46.2	1.366	46.2	0.5	0.23	2.96%	Sand-Slime Tailings	0.047	93.3	0.21	0.00	0.21	0	1.70	78.506	1091.23	91.19	215	2.97%	2.0	47%	0.79	0.00	0.79	0
4.429	5615.52	32.1	1.104	32.1	0.4	0.18	3.44%	Slime Tailings	0.041	82.7	0.22	0.00	0.22	0	1.70	54.519	757.81	63.33	144	3.47%	2.2	71%	0.80	0.00	0.80	0
4.593	5615.36	21.5	0.652	21.5	-0.3	-0.13	3.03%	Slime Tailings	0.041	82.7	0.23	0.00	0.23	0	1.70	36.601	508.75	42.51	94	3.06%	2.3	71%	0.81	0.00	0.81	0
4.757	5615.19	14.9	0.336	15.0	-0.3	-0.11	2.25%	Sand-Slime Tailings	0.047	93.3	0.23	0.00	0.23	0	1.70	25.415	353.27	29.51	63	2.28%	2.3	47%	0.82	0.00	0.82	0
4.921	5615.03	12.8	0.162	12.8	2.1	0.92	1.27%	Sand-Slime Tailings	0.047	93.3	0.24	0.00	0.24	0	1.70	21.675	301.28	25.20	52	1.29%	2.2	47%	0.82	0.00	0.82	0
5.085	5614.86	42.1	0.172	42.1	8.1	3.53	0.41%	Sand Tailings	0.051	102.8	0.25	0.00	0.25	0	1.70	71.536	994.35	83.19	167	0.41%	1.5	18%	0.83	0.00	0.83	0
5.249	5614.70	49.6	0.237	49.6	-0.1	-0.03	0.48%	Sand Tailings	0.051	102.8	0.26	0.00	0.26	0	1.70	84.371	1172.76	97.99	190	0.48%	1.5	18%	0.84	0.00	0.84	0
5.413	5614.54	53.8	0.297	53.8	0.1	0.06	0.55%	Sand Tailings	0.051	102.8	0.27	0.00	0.27	0	1.70	91.511	1272.00	106.29	200	0.55%	1.5	18%	0.85	0.00	0.85	0
5.577	5614.37	52.6	0.352	52.6	-0.1	-0.03	0.67%	Sand Tailings	0.051	102.8	0.28	0.00	0.28	0	1.70	89.454	1243.41	103.89	189	0.67%	1.6	18%	0.86	0.00	0.86	0
5.741	5614.21	48.6	0.424	48.6	-0.1	-0.03	0.87%	Sand Tailings	0.051	102.8	0.28	0.00	0.28	0	1.70	82.637	1148.65	95.98	170	0.88%	1.7	18%	0.87	0.00	0.87	0
5.905	5614.04	40.4	0.469	40.4	-0.1	-0.02	1.16%	Sand-Slime Tailings	0.047	93.3	0.29	0.00	0.29	0	1.70	68.646	954.18	79.73	137	1.17%	1.9	47%	0.87	0.00	0.87	0
6.069	5613.88	31.5	0.463	31.5	-0.1	-0.02	1.47%	Sand-Slime Tailings	0.047	93.3	0.30	0.00	0.30	0	1.70	53.584	744.82	62.23	104	1.48%	2.0	47%	0.88	0.00	0.88	0
6.234	5613.72	26.6	0.418	26.6	-0.2	-0.07	1.57%	Sand-Slime Tailings	0.047	93.3	0.31	0.00	0.31	0	1.70	45.254	629.03	52.56	86	1.59%	2.1	47%	0.89	0.00	0.89	0
6.398	5613.55	29.2	0.352	29.2	-0.1	-0.04	1.20%	Sand-Slime Tailings	0.047	93.3	0.32	0.00	0.32	0	1.70	49.674	690.47	57.69	92	1.22%	2.0	47%	0.90	0.00	0.90	0
6.562	5613.39	31.3	0.327	31.3	-0.1	-0.04	1.04%	Sand-Slime Tailings	0.047	93.3	0.32	0.00	0.32	0	1.70	53.244	740.09	61.84	96	1.05%	1.9	47%	0.90	0.00	0.90	0
6.726	5613.22	39.3	0.336	39.4	-0.1	-0.06	0.85%	Sand Tailings	0.051	102.8	0.33	0.00	0.33	0	1.70	66.713	927.31	77.48	118	0.86%	1.8	18%	0.91	0.00	0.91	0
6.890	5613.06	39.3	0.331	39.4	-0.2	-0.10	0.84%	Sand Tailings	0.062	125.3	0.34	0.00	0.34	1	1.67	65.899	915.99	76.53	115	0.85%	1.8	18%	0.92	0.00	0.92	0
7.054	5612.90	38.3	0.410	38.3	-0.2	-0.07	1.07%	Sand-Slime Tailings	0.059	119.0	0.35	0.01	0.34	1	1.67	63.953	888.95	74.28	110	1.08%	1.9	47%	0.93	0.00	0.93	0
7.218	5612.73	36.3	0.454	36.4	-0.2	-0.09	1.25%	Sand-Slime Tailings	0.059	119.0	0.35	0.01	0.35	1	1.67	60.858	845.93	70.68	103	1.26%	2.0	47%	0.94	0.00	0.94	0
7.382	5612.57	32.3	0.463	32.3	-0.5	-0.21	1.43%	Sand-Slime Tailings	0.059	119.0	0.37	0.02	0.35	1	1.69	54.740	760.88	63.57	90	1.45%	2.0	47%	0.95	0.00	0.95	0
7.546	5612.40	29.1	0.420	29.1	-0.5	-0.23	1.44%	Sand-Slime Tailings	0.059	119.0	0.38	0.02	0.36	1	1.70	49.419	686.92	57.39	80	1.46%	2.1	47%	0.96	0.00	0.96	0
7.710	5612.24	35.5	0.360	35.5	-0.4	-0.19	1.01%	Sand-Slime Tailings	0.059	119.0	0.39	0.03	0.36	1	1.65	58.534	813.62	67.98	97	1.03%	1.9	47%	0.97	0.00	0.97	0
7.874	5612.08	29.1	0.340	29.1	-0.8	-0.33	1.17%	Sand-Slime Tailings	0.059	119.0	0.40	0.03	0.37	1	1.69	48.995	681.04	56.90	78	1.19%	2.0	47%	0.98	0.00	0.98	0
8.038	5611.91	19.8	0.302	19.8	-0.8	-0.33	1.53%	Sand-Slime Tailings	0.059	119.0	0.41	0.04	0.37	1	1.70	33.592	466.93	39.01	52	1.56%	2.3	47%	0.99	0.00	0.99	0
8.202	5611.75	15.7	0.241	15.7	-0.7	-0.32	1.53%	Sand-Slime Tailings	0.059	119.0	0.42	0.04	0.38	1	1.70	26.758	371.94	31.07	41	1.57%	2.3	47%	1.00	0.00	1.00	0
8.366	5611.58	12.1	0.199	12.1	0.0	0.00	1.64%	Sand-Slime Tailings	0.059	119.0	0.43	0.05	0.38	1	1.70	20.587	286.16	23.91	31	1.70%	2.5	47%	1.01	0.00	1.01	0
8.530	5611.42	12.2	0.172	12.2	1.6	0.68	1.41%	Sand-Slime Tailings	0.059	119.0	0.44	0.05	0.39	1	1.70	20.672	287.34	24.03	30	1.47%	2.4	47%	1.02	0.00	1.02	0
8.694	5611.26	15.4	0.055	15.4	3.8	1.64	0.36%	Sand-Slime Tailings	0.059	119.0	0.45	0.06	0.39	1	1.70	26.197	364.14	30.47	38	0.37%	2.0	47%	1.03	0.00	1.03	0
8.858	5611.09	18.3	0.062	18.3	2.3	0.99	0.34%	Sand-Slime Tailings	0.059	119.0	0.46	0.06	0.40	1	1.70	31.076	431.96	36.12	45	0.35%	2.0	47%	1.04	0.00	1.04	0
9.022	5610.93	16.7	0.107	16.7	1.6	0.68	0.64%	Sand-Slime Tailings	0.059	119.0	0.47	0.07	0.40	1	1.70	28.441	395.33	33.05	41	0.66%	2.1	47%	1.05	0.00	1.05	0
9.186	5610.76	20.6	0.079	20.6	2.3	1.01	0.38%	Sand-Slime Tailings	0.059	119.0	0.48	0.07	0.41	1	1.67	34.288	476.60	39.85	50	0.39%	2.0	47%	1.06	0.00	1.06	0
9.350	5610.60	19.5	0.075	19.5	1.6	0.68	0.38%	Sand-Slime Tailings	0.059	119.0	0.49	0.08	0.41	1	1.67	32.552	452.47	37.83	46	0.39%	2.0	47%	1.07	0.00	1.07	0
9.514	5610.44	17.8	0.086	17.8	1.5	0.66	0.48%	Sand-Slime Tailings	0.059	119.0	0.50	0.08	0.41	1	1.67	29.767	413.77	34.59	42	0.50%	2.1	47%	1.08	0.00	1.08	0
9.678	5610.27	15.7	0.078	15.6	1.8	0.77	0.50%	Sand-Slime Tailings	0.059	119.0	0.51	0.09	0.42	1	1.68	26.331	366.00	30.60	36	0.52%	2.1	47%	1.09	0.00	1.09	0
9.842	5610.11	16.0	0.072	16.0	2.3	1.01	0.45%	Sand-Slime Tailings	0.059	119.0	0.52	0.09	0.42	1	1.67	26.712	371.30	31.05	37	0.46%	2.1	47%	1.10	0.00	1.10	0
10.006	5609.94	15.8	0.137	15.8	2.7	1.18	0.87%	Sand-Slime Tailings	0.059	119.0	0.53	0.10	0.43	1	1.66	26.226	364.54	30.49	36	0.89%	2.2	47%	1.11	0.00	1.11	0
10.170	5609.78	17.6	0.093	17.6	0.8	0.35	0.53%	Sand-Slime Tailings	0.059	119.0	0.54	0.10	0.43	1	1.63	28.606	397.62	33.23	39	0.55%	2.1	47%	1.12	0.00	1.12	0
10.335	5609.62	16.3	0.209	16.3	0.9	0.39	1.28%	Sand-Slime Tailings	0.059	119.0	0.55	0.11	0.44	1	1.63	26.555	369.12	30.85	36	1.33%	2.3	47%	1.13	0.00	1.13	0
10.499	5609.45	17.8	0.152	17.8	2.3	1.00	0.85%	Sand-Slime Tailings	0.059	119.0	0.56	0.11	0.44	1	1.60	28.581	397.27	33.22	39	0.88%	2.2	47%	1.14	0.00	1.14	0
10.663	5609.29	19.9	0.083	19.9	0.8	0.33	0.42%	Sand-Slime Tailings	0.059	119.0	0.57	0.12	0.45	1	1.58	31.420	436.73	36.50	43	0.43%	2.0	47%	1.15	0.00	1.15	0
10.827	5609.12	16.0	0.095	16.0	-0.5	-0.20	0.59%	Sand-Slime Tailings	0.059	119.0	0.58	0.12	0.45	1	1.60	25.570	355.42	29.69	34	0.62%	2.2	47%	1.16	0.00	1.16	0
10.991	5608.96	13.0	0.120	13.0	0.1	0.02	0.92%	Sand-Slime Tailings	0.059	119.0	0.59	0.13	0.46	1	1.62	21.109	293.42	24.52	27	0.96%	2.4	47%	1.17	0.00	1.17	0
11.155	5608.80	10.5	0.104	10.5	0.8	0.35	0.99%	Sand-Slime Tailings	0.059	119.0	0.60	0.13	0.46	1	1.63	17.098	237.66	19.87	21	1.05%	2.5	47%	1.18	0.00	1.18	0
11.319	5608.63	9.8	0.058	9.8	2.8	1.20	0.59%	Sand-Slime Tailings	0.059	119.0	0.60	0.14	0.47	1	1.62	15.832	220.07	18.42	20	0.63%	2.4	47%	1.19	0.00	1.19	0
11.483	5608.47	10.7	0.143	10.7	4.7	2.02	1.33%	Sand-Slime Tailings	0.059	119.0	0.61	0.14	0.47	1	1.60	17.154	238.45	19.98	21	1.42%	2.5	47%	1.20	0.00	1.20	0
11.647	5608.30	9.4	0.085	9.4	6.2	2.70	0.91%	Sand-Slime Tailings	0.059	119.0	0.62	0.15	0.47	1	1.59	14.889	206.96	17.37	18	0.97%	2.5	47%	1.20	0.00	1.20	0
11.811	5608.14	9.7	0.067	9.6	8.3	3.60	0.69%	Sand-Slime Tailings	0.059	119.0	0.63	0.15	0.48	1	1.58	15.172	210.89	17.72	19	0.74%	2.5	47%	1.21	0.00	1.21	0
11.975	5607.98	9.5	0.042	9.4	9.2	3.97	0.44%	Sand-Slime Tailings	0.059	119.0	0.64	0.16	0.48	1	1.57	14.744	204.94	17.23	18	0.48%	2.4	47%	1.22	0.00	1.22	0
12.139	5607.81	8.5	0.033	8.5	11.3	4.90	0.39%	Sand-Slime Tailings	0.059	119.0	0.65	0.17	0.49	1	1.56	13.171	183.08	15.43	16	0.42%	2.4	47%	1.23	0.00	1.23	0
12.303	5607.65	7.5	0.137	7.4	15.9	6.87	1.83%	Slime Tailings	0.057	113.1	0.66	0.17	0.49	1	1.55	11.398	158.44	13.42	14	2.01%	2.8	71%	1.24	0.00	1.24	0
12.467	5607.48	9.8	0.166	9.7	9.9	4.27	1.70%	Sand-Slime Tailings	0.059	119.0	0.67	0.18	0.50	1	1.54	14.939	207.65	17.46	18	1.82%	2.7	47%	1.25	0.00	1.25	0
12.631	5607.32	8.6	0.151	8.5	17.3	7.50	1.76%	Slime Tailings	0.057	113.1	0.68	0.18	0.50	1	1.53	12.904	179.37	15.18	16	1.91%	2.7	71%	1.26	0.00	1.26	0
12.795	5607.15	13.0	0.092	12.9	18.8	8.15	0.71%	Sand-Slime Tailings	0.059	119.0	0.69	0.19	0.51	1	1.51	19.343	268.87	22.67	24	0.75%	2.4	47%	1.27	0.00	1.27	0
12.959	5606.99	16.0	0.166	15.9	19.0	8.23	1.04%	Sand-Slime Tailings	0.059	119.0	0.70	0.19	0.51	1	1.47	23.423	325.57	27.41	30	1.08%	2.4	47%	1.28	0.00	1.28	0
13.123	5606.83	14.4	0.162	14.3	15.8	6.85	1.13%	Sand-Slime Tailings	0.059	119.0	0.71	0.20	0.52	1	1.48	21.034	292.37	24.60	26	1.19%	2.4	47%	1.29	0.00	1.29	0
13.287	5606.66	17.3	0.194	17.2	19.5	8.43	1.12%	Sand-Slime Tailings	0.059	119.0	0.72	0.20	0.52	1	1.45	24.868	345.66	29.09	32	1.17%	2.4	47%	1.30	0.00	1.30	0
13.451	5606.50	19.4	0.173	19.3	8.1	3.49	0.89%	Sand-Slime Tailings	0.059	119.0	0.73	0.21	0.52	1	1.43	27.509	382.38	32.03	35	0.93%	2.3	47%	1.31	0.00	1.31	0
13.615	5606.33	16.0	0.144	15.9	7.5	3.27	0.90%	Sand-Slime Tailings	0.059	119.0	0.74	0.21	0.53	1	1.44	22.875	317.96	26.65	29	0.95%	2.3	47%	1.32	0.00	1.32	0
13.779	5606.17	12.6	0.124	12.5	6.8	2.94	0.99%	Sand-Slime Tailings	0.059	119.0	0.75	0.22	0.53	1	1.45	18.200	252.98	21.21	22	1.05%	2.5	47%	1.33	0.00	1.33	0
13.943	5606.01	11.2	0.094	11.1	15.0	6.52	0.84%	Sand-Slime Tailings	0.059	119.0	0.76	0.22	0.54	1	1.44	16.070	223.37	18.82	19	0.90%	2.5	47%	1.34	0.00	1.34	0
14.107	5605.84	10.0	0.113	9.9	19.5	8.43	1.13%	Sand-Slime Tailings	0.059	119.0	0.77	0.23	0.54	1	1.43	14.143	196.59	16.63	17	1.23%	2.6	47%	1.35	0.00	1.35	0
14.271	5605.68	9.1	0.159	8.8	48.1	20.86	1.75%	Slime Tailings	0.057	113.1	0.78	0.23	0.55	1	1.42	12.506	173.84	15.02	15	1.92%	2.7	71%	1.36	0.00	1.36	0
14.436	5605.51	14.3	0.207	13.9	61.3	26.57	1.45%	Sand-Slime Tailings	0.059	119.0	0.79	0.24	0.55	1	1.41	19.507	271.15	23.28	24	1.54%	2.5	47%	1.37	0.00	1.37	0
14.600	5605.35	20.5	0.331	20.4	11.3	4.89	1.62%	Sand-Slime Tailings	0.059	119.0	0.80	0.24	0.56	1	1.37	27.819	386.69	32.42	35	1.68%	2.4	47%	1.38	0.00	1.38	0
14.764	5605.19	14.9	0.361	14.8	6.9	3.00	2.43%	Slime Tailings	0.057	113.1	0.81	0.25	0.56	1	1.39	20.567	285.88	23.96	25	2.56%	2.6	71%	1.39	0.00	1.39	0
14.928	5605.02	12.9	0.158	12.8	9.8	4.24	1.23%	Sand-Slime Tailings	0.059	119.0	0.82	0.25	0.57	1	1.39	17.775	247.07	20.74	21	1.31%	2.5	47%	1.40	0.00	1.40	0
15.092	5604.86	13.3	0.157	13.3	13.5	5.85	1.18%	Sand-Slime Tailings	0.059	119.0	0.83	0.26	0.57	1	1.38	18.278	254.06	21.36	22	1.25%	2.5	47%	1.41	0.00	1.41	0
15.256	5604.69	16.0	0.117	16.0	9.0	3.88	0.73%	Sand-Slime Tailings	0.059	119.0	0.84	0.26	0.57	1	1.36	21.654	300.99	25.24	26	0.77%	2.3	47%	1.42	0.00	1.42	0
15.420	5604.53	20.1	0.148	20.0	8.1	3.53	0.74%	Sand-Slime Tailings	0.059	119.0	0.85	0.27	0.58	1	1.33	26.610	369.88	30.98	33	0.77%	2.2	47%	1.43	0.00	1.43	0
15.584	5604.37	17.1	0.147	17.1	5.0	2.18	0.86%	Sand-Slime Tailings	0.059	119.0	0.86	0.27	0.58	1	1.34	22.799	316.91	26.53	28	0.90%	2.3	47%	1.44	0.00	1.44	0
15.748	5604.20	24.6	0.148	24.6	5.9	2.55	0.60%	Sand-Slime Tailings	0.059	119.0	0.87	0.28	0.59	1	1.30	31.972	444.41	37.19	40	0.62%	2.1	47%	1.45	0.00	1.45	0
15.912	5604.04	28.1	0.259	28.1	1.3	0.58	0.92%	Sand-Slime Tailings	0.059	119.0	0.88	0.28	0.59	1	1.28	36.048	501.07	41.88	46	0.95%	2.2	47%	1.46	0.00	1.46	0
16.076	5603.87	18.4	0.329	18.4	2.2	0.96	1.79%	Sand-Slime Tailings	0.059	119.0	0.89	0.29	0.60	1	1.31	24.074	334.62	27.98	29	1.88%	2.5	47%	1.47	0.00	1.47	0
16.240	5603.71	15.8	0.279	15.8	3.6	1.57	1.76%	Sand-Slime Tailings	0.059	119.0	0.90	0.29	0.60	1	1.31	20.712	287.90	24.09	25	1.87%	2.6	47%	1.48	0.00	1.48	0
16.404	5603.55	16.9	0.229	16.8	5.1	2.20	1.36%	Sand-Slime Tailings	0.059	119.0	0.91	0.30	0.61	1	1.30	21.871	304.00	25.45	26	1.44%	2.5	47%	1.49	0.00	1.49	0
16.568	5603.38	15.2	0.239	15.2	7.9	3.42	1.57%	Sand-Slime Tailings	0.059	119.0	0.92	0.30	0.61	1	1.30	19.693	273.73	22.95	23	1.67%	2.5	47%	1.50	0.00	1.50	0
16.732	5603.22	13.1	0.158	13.0	11.1	4.82	1.21%	Sand-Slime Tailings	0.059	119.0	0.93	0.31	0.62	1	1.30	16.874	234.55	19.70	20	1.30%	2.6	47%	1.51	0.00	1.51	0
16.896	5603.05	15.1	0.126	15.0	13.3	5.78	0.84%	Sand-Slime Tailings	0.059	119.0	0.93	0.31	0.62	1	1.29	19.254	267.63	22.49	23	0.89%	2.4	47%	1.52	0.00	1.52	0
17.060	5602.89	12.8	0.181	12.7	13.0	5.63	1.41%	Sand-Slime Tailings	0.059	119.0	0.94	0.32	0.63	1	1.28	16.345	227.19	19.10	19	1.52%	2.6	47%	1.53	0.00	1.53	0
17.224	5602.73	12.9	0.200	12.8	18.8	8.16	1.55%	Sand-Slime Tailings	0.059	119.0	0.95	0.32	0.63	1	1.28	16.340	227.12	19.15	19	1.67%	2.6	47%	1.53	0.00	1.53	0

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	Idriss & Boulanger (2008) Cyclic Stress Ratio r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Cyclic Resistance Ratio Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd et al. (2001) Cyclic Stress Ratio r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
0.164	1.00	0.06	1.02	1.0	0.059	39.67	66.30	0.095	1.61	0.98	0.30	0.80	2.53	1.0	0.017	1.00	26.63	0.072	174.99	88.30	2
0.328	1.00	0.09	1.03	1.0	0.060	55.88	128.72	0.200	3.35	0.97	0.49	0.75	2.65	1.0	0.016	1.00	72.84	0.116	140.58	71.97	2
0.492	1.00	0.10	1.03	1.0	0.060	61.84	151.66	0.279	4.67	0.97	0.55	0.73	2.64	1.0	0.016	1.00	89.82	0.147	119.19	61.93	2
0.656	1.00	0.17	1.06	1.0	0.061	84.80	240.06	1.000	16.37	0.97	0.72	0.64	3.23	1.0	0.013	1.00	155.26	0.428	259.71	138.04	2
0.820	1.00	0.30	1.10	1.0	0.063	122.79	386.30	1.000	15.76	0.97	0.94	0.60	3.37	1.0	0.013	1.00	263.50	1.000	485.59	250.68	2
0.984	1.00	0.30	1.09	1.0	0.063	140.94	456.15	1.000	15.82	0.97	1.03	0.60	3.13	1.0	0.014	1.00	315.21	1.000	404.82	210.32	2
1.148	1.00	0.30	1.09	1.0	0.063	170.26	569.04	1.000	15.87	0.97	1.15	0.60	2.95	1.0	0.015	1.00	398.78	1.000	347.12	181.50	2
1.312	1.00	0.30	1.09	1.0	0.063	225.78	782.76	1.000	15.93	0.97	1.36	0.60	2.79	1.0	0.015	1.00	556.98	1.000	303.85	159.89	2
1.476	1.00	0.30	1.08	1.0	0.063	209.49	720.03	1.000	15.99	0.97	1.30	0.60	2.66	1.0	0.016	1.00	510.55	1.000	270.20	143.09	2
1.640	1.00	0.30	1.08	1.0	0.062	171.33	573.15	1.000	16.04	0.97	1.16	0.60	2.55	1.0	0.017	1.00	401.82	1.000	243.27	129.66	2
1.804	1.00	0.30	1.07	1.0	0.062	166.65	555.12	1.000	16.10	0.97	1.14	0.60	2.46	1.0	0.017	1.00	388.47	1.000	221.25	118.67	2
1.968	1.00	0.30	1.07	1.0	0.062	168.14	560.88	1.000	16.17	0.97	1.14	0.60	2.37	1.0	0.018	1.00	392.74	1.000	202.89	109.53	2
2.133	1.00	0.30	1.07	1.0	0.062	147.79	482.52	1.000	16.23	0.97	1.06	0.60	2.30	1.0	0.019	1.00	334.73	1.000	187.35	101.79	2
2.297	1.00	0.30	1.06	1.0	0.061	135.88	436.68	1.000	16.30	0.97	1.00	0.60	2.23	1.0	0.019	1.00	300.80	1.000	174.04	95.17	2
2.461	1.00	0.24	1.05	1.0	0.060	97.25	287.98	1.000	16.57	0.97	0.80	0.60	2.17	1.0	0.020	1.00	190.73	1.000	162.50	89.54	2
2.625	1.00	0.30	1.06	1.0	0.061	107.79	328.55	1.000	16.44	0.97	0.86	0.60	2.12	1.0	0.020	1.00	220.76	1.000	152.41	84.42	2
2.789	0.99	0.30	1.05	1.0	0.061	120.26	376.53	1.000	16.51	0.97	0.92	0.60	2.07	1.0	0.021	1.00	256.28	1.000	143.50	80.00	2
2.953	0.99	0.30	1.05	1.0	0.060	113.76	351.53	1.000	16.58	0.97	0.89	0.60	2.02	1.0	0.021	1.00	237.77	1.000	135.58	76.08	2
3.117	0.99	0.30	1.05	1.0	0.060	112.90	348.20	1.000	16.64	0.97	0.89	0.60	1.98	1.0	0.022	1.00	235.31	1.000	128.49	72.57	2
3.281	0.99	0.30	1.04	1.0	0.060	80.72	310.08	1.000	16.71	0.97	0.87	0.60	1.93	1.0	0.022	1.00	229.35	1.000	121.99	69.35	2
3.445	0.99	0.30	1.04	1.0	0.060	81.32	313.02	1.000	16.78	0.97	0.88	0.60	1.90	1.0	0.022	1.00	231.69	1.000	116.12	66.45	2
3.609	0.99	0.30	1.04	1.0	0.059	89.42	352.79	1.000	16.85	0.97	0.94	0.60	1.86	1.0	0.023	1.00	263.37	1.000	110.79	63.82	2
3.773	0.99	0.27	1.03	1.0	0.059	74.18	277.95	1.000	16.97	0.97	0.82	0.60	1.83	1.0	0.023	1.00	203.77	1.000	105.93	61.45	2
3.937	0.99	0.20	1.02	1.0	0.058	90.70	262.90	1.000	17.16	0.97	0.76	0.62	1.74	1.0	0.024	1.07	183.75	1.000	101.89	59.52	2
4.101	0.99	0.13	1.01	1.0	0.058	75.45	204.17	1.000	17.30	0.97	0.66	0.67	1.60	1.0	0.027	1.15	147.94	0.381	37.40	27.35	2
4.265	0.99	0.10	1.01	1.0	0.058	62.28	153.47	0.288	5.01	0.97	0.55	0.72	1.47	1.0	0.029	1.36	123.57	0.255	24.18	14.60	2
4.429	0.99	0.08	1.01	1.0	0.057	52.14	115.47	0.170	2.97	0.97	0.46	0.77	1.37	1.0	0.031	1.65	104.62	0.186	17.12	10.04	2
4.593	0.98	0.07	1.00	1.0	0.057	44.89	87.40	0.123	2.15	0.96	0.38	0.80	1.31	1.0	0.033	1.86	78.93	0.126	11.20	6.68	2
4.757	0.98	0.06	1.00	1.0	0.057	40.65	70.17	0.100	1.75	0.96	0.31	0.80	1.30	1.0	0.033	1.95	57.54	0.098	8.43	5.09	2
4.921	0.98	0.06	1.00	1.0	0.057	39.14	64.34	0.093	1.63	0.96	0.29	0.80	1.29	1.0	0.033	1.68	42.30	0.085	7.12	4.37	2
5.085	0.98	0.09	1.00	1.0	0.057	43.36	126.54	0.194	3.41	0.96	0.53	0.74	1.38	1.0	0.031	1.00	83.19	0.134	10.78	7.10	2
5.249	0.98	0.10	1.00	1.0	0.057	47.14	145.13	0.251	4.41	0.96	0.57	0.71	1.41	1.0	0.030	1.00	97.99	0.168	13.09	8.75	2
5.413	0.98	0.11	1.00	1.0	0.057	49.26	155.55	0.299	5.27	0.96	0.60	0.70	1.42	1.0	0.030	1.00	106.29	0.192	14.51	9.89	2
5.577	0.98	0.11	1.00	1.0	0.057	48.65	152.54	0.283	5.00	0.96	0.59	0.71	1.40	1.0	0.030	1.00	103.89	0.184	13.54	9.27	2
5.741	0.98	0.10	1.00	1.0	0.057	46.63	142.60	0.241	4.27	0.96	0.57	0.72	1.37	1.0	0.031	1.04	99.63	0.172	12.26	8.27	2
5.905	0.98	0.09	1.00	1.0	0.056	58.26	137.99	0.226	4.00	0.96	0.52	0.74	1.32	1.0	0.032	1.15	91.53	0.151	10.51	7.26	2
6.069	0.98	0.08	1.00	1.0	0.056	52.13	114.36	0.168	2.98	0.96	0.46	0.77	1.27	1.0	0.033	1.32	81.85	0.131	8.87	5.93	2
6.234	0.98	0.07	1.00	1.0	0.056	48.73	101.29	0.145	2.57	0.96	0.42	0.79	1.24	1.0	0.034	1.44	75.88	0.121	7.97	5.27	2
6.398	0.97	0.08	1.00	1.0	0.056	50.54	108.23	0.157	2.79	0.96	0.44	0.78	1.25	1.0	0.034	1.29	74.59	0.119	7.65	5.22	2
6.562	0.97	0.08	1.00	1.0	0.056	51.99	113.83	0.167	2.98	0.96	0.45	0.77	1.25	1.0	0.034	1.23	75.92	0.121	7.60	5.29	2
6.726	0.97	0.09	0.99	1.0	0.056	41.90	119.38	0.178	3.19	0.96	0.51	0.75	1.27	1.0	0.033	1.12	86.56	0.140	8.62	5.90	2
6.890	0.97	0.09	0.99	1.0	0.056	41.66	118.19	0.176	3.15	0.96	0.51	0.75	1.26	1.0	0.033	1.12	85.79	0.139	8.30	5.72	2
7.054	0.97	0.09	0.99	1.0	0.056	56.35	130.63	0.205	3.67	0.96	0.50	0.75	1.26	1.0	0.034	1.19	88.39	0.144	8.51	6.09	2
7.218	0.97	0.08	0.99	1.0	0.056	55.09	125.77	0.193	3.46	0.96	0.49	0.76	1.24	1.0	0.034	1.26	88.99	0.146	8.48	5.97	2
7.382	0.97	0.08	0.99	1.0	0.056	52.60	116.17	0.172	3.09	0.96	0.46	0.77	1.23	1.0	0.034	1.37	87.13	0.142	8.14	5.62	2
7.546	0.97	0.08	0.99	1.0	0.055	50.43	107.82	0.156	2.81	0.96	0.44	0.78	1.21	1.0	0.035	1.44	82.66	0.133	7.53	5.17	2
7.710	0.97	0.08	0.99	1.0	0.055	54.14	122.12	0.184	3.33	0.96	0.48	0.76	1.23	1.0	0.034	1.22	82.74	0.133	7.44	5.39	2
7.874	0.96	0.08	0.99	1.0	0.055	50.26	107.15	0.155	2.80	0.96	0.44	0.78	1.20	1.0	0.035	1.36	77.25	0.123	6.81	4.81	2
8.038	0.96	0.06	0.99	1.0	0.055	43.98	82.99	0.117	2.11	0.96	0.36	0.80	1.18	1.0	0.036	1.81	70.50	0.113	6.17	4.14	2
8.202	0.96	0.06	0.99	1.0	0.055	41.20	72.27	0.102	1.86	0.96	0.32	0.80	1.18	1.0	0.036	2.08	64.68	0.105	5.69	3.77	2
8.366	0.96	0.06	0.99	1.0	0.055	38.69	62.60	0.091	1.65	0.96	0.28	0.80	1.18	1.0	0.036	2.57	61.41	0.102	5.43	3.54	2
8.530	0.96	0.06	0.99	1.0	0.055	38.73	62.76	0.091	1.65	0.96	0.28	0.80	1.17	1.0	0.036	2.41	57.94	0.098	5.18	3.42	2
8.694	0.96	0.06	0.99	1.0	0.055	40.99	71.46	0.101	1.85	0.96	0.32	0.80	1.17	1.0	0.036	1.36	41.48	0.085	4.42	3.13	2
8.858	0.96	0.06	0.99	1.0	0.055	42.97	79.09	0.111	2.03	0.95	0.35	0.80	1.17	1.0	0.036	1.26	45.58	0.088	4.54	3.29	2
9.022	0.96	0.06	0.99	1.0	0.055	41.89	74.95	0.106	1.94	0.95	0.33	0.80	1.17	1.0	0.036	1.51	50.04	0.092	4.68	3.31	2
9.186	0.96	0.06	0.99	1.0	0.055	44.28	84.13	0.118	2.17	0.95	0.36	0.80	1.16	1.0	0.036	1.24	49.54	0.091	4.61	3.39	2
9.350	0.96	0.06	0.99	1.0	0.054	43.57	81.39	0.115	2.10	0.95	0.36	0.80	1.16	1.0	0.036	1.27	48.15	0.090	4.50	3.30	2
9.514	0.95	0.06	0.99	1.0	0.054	42.43	77.02	0.109	2.00	0.95	0.34	0.80	1.16	1.0	0.036	1.39	48.17	0.090	4.45	3.23	2
9.678	0.95	0.06	0.99	1.0	0.054	41.03	71.64	0.102	1.87	0.95	0.32	0.80	1.15	1.0	0.036	1.51	46.09	0.088	4.32	3.10	2
9.842	0.95	0.06	0.99	1.0	0.054	41.19	72.24	0.102	1.89	0.95	0.32	0.80	1.15	1.0	0.036	1.46	45.31	0.088	4.24	3.07	2
10.006	0.95	0.06	0.99	1.0	0.054	41.00	71.49	0.101	1.87	0.95	0.32	0.80	1.15	1.0	0.037	1.79	54.55	0.095	4.55	3.21	2
10.170	0.95	0.06	0.98	1.0	0.054	41.96	75.19	0.106	1.97	0.95	0.33	0.80	1.15	1.0	0.037	1.46	48.69	0.091	4.29	3.13	2
10.335	0.95	0.06	0.98	1.0	0.054	41.12	71.97	0.102	1.89	0.95	0.32	0.80	1.14	1.0	0.037	2.08	64.08	0.104	4.90	3.40	2
10.499	0.95	0.06	0.98	1.0	0.054	41.95	75.17	0.106	1.97	0.95	0.33	0.80	1.14	1.0	0.037	1.69	56.22	0.097	4.48	3.23	2
10.663	0.95	0.06	0.98	1.0	0.054	43.10	79.60	0.112	2.09	0.95	0.35	0.80	1.14	1.0	0.037	1.33	48.51	0.090	4.16	3.12	2
10.827	0.95	0.06	0.98	1.0	0.054	40.72	70.41	0.100	1.86	0.95	0.31	0.80	1.14	1.0	0.037	1.63	48.41	0.090	4.11	2.99	2
10.991	0.94	0.06	0.98	1.0	0.054	38.90	63.42	0.092	1.71	0.95	0.29	0.80	1.14	1.0	0.037	2.17	53.19	0.094	4.24	2.97	2
11.155	0.94	0.05	0.98	1.0	0.054	37.27	57.14	0.085	1.58	0.95	0.26	0.80	1.13	1.0	0.037	2.63	52.29	0.093	4.16	2.87	2
11.319	0.94	0.05	0.98	1.0	0.054	36.76	55.18	0.083	1.54	0.95	0.25	0.80	1.13	1.0	0.037	2.32	42.69	0.086	3.78	2.66	2
11.483	0.94	0.05	0.98	1.0	0.053	37.31	57.29	0.085	1.59	0.95	0.26	0.80	1.13	1.0	0.037	2.98	59.46	0.100	4.36	2.97	2
11.647	0.94	0.05	0.98	1.0	0.053	36.39	53.76	0.081	1.52	0.95	0.24	0.80	1.13	1.0	0.037	2.83	49.19	0.091	3.95	2.73	2
11.811	0.94	0.05	0.98	1.0	0.053	36.51	54.23	0.082	1.53	0.95	0.24	0.80	1.12	1.0	0.037	2.54	44.93	0.087	3.76	2.64	2
11.975	0.94	0.05	0.98	1.0	0.053	36.34	53.57	0.081	1.52	0.95	0.24	0.80	1.12	1.0	0.037	2.25	38.83	0.082	3.51	2.51	2
12.139	0.94	0.05	0.98	1.0	0.053	35.71	51.14	0.079	1.48	0.95	0.23	0.80	1.12	1.0	0.037	2.37	36.59	0.080	3.39	2.44	2
12.303	0.94	0.05	0.98	1.0	0.053	34.76	48.18	0.076	1.43	0.95	0.21	0.80	1.12	1.0	0.037	4.65	62.38	0.103	4.29	2.86	2
12.467	0.93	0.05	0.98	1.0	0.053	36.43	53.88	0.081	1.54	0.95	0.24	0.80	1.12	1.0	0.037	3.70	64.54	0.105	4.35	2.95	2
12.631	0.93	0.05	0.98	1.0	0.053	35.37	50.55	0.078	1.47	0.95	0.22	0.80	1.11	1.0	0.037	4.18	63.47	0.104	4.27	2.87	2
12.795	0.93	0.05	0.98	1.0	0.053	38.25	60.92	0.089	1.69	0.95	0.27	0.80	1.11	1.0	0.037	2.14	48.49	0.090	3.69	2.69	2
12.959	0.93	0.06	0.98	1.0	0.053	39.91	67.32	0.096	1.83	0.95	0.30	0.80	1.11	1.0	0.038	2.14	58.59	0.099	3.99	2.91	2
13.123	0.93	0.06	0.98	1.0	0.053	38.93	63.53	0.092	1.75	0.94	0.29	0.80	1.11	1.0	0.038	2.41	59.16	0.099	3.98	2.86	2
13.287	0.93	0.06	0.98	1.0	0.052	40.50	69.59	0.099	1.89	0.94	0.31	0.80	1.11	1.0	0.038	2.12	61.68	0.102	4.05	2.97	2
13.451	0.93	0.06	0.97	1.0	0.052	41.54	73.57	0.104	1.99	0.94	0.33	0.80	1.10	1.0	0.038	1.82	58.33	0.098	3.88	2.94	2
13.615	0.93	0.06	0.98	1.0	0.052	39.65	66.29	0.095	1.82	0.94	0.30	0.80	1.10	1.0	0.038	2.08	55.52	0.096	3.75	2.78	2
13.779	0.92	0.05	0.98	1.0	0.052	37.74	58.95	0.087	1.66	0.94	0.27	0.80	1.10	1.0	0.038	2.58	54.62	0.095	3.69	2.67	2
13.943	0.92	0.05	0.98	1.0	0.052	36.90	55.72	0.083	1.60	0.94	0.25	0.80	1.10	1.0	0.038	2.65	49.94	0.092	3.52	2.56	2
14.107	0.92	0.05	0.98	1.0	0.052	36.13	52.76	0.080	1.54	0.94	0.24	0.80	1.10	1.0	0.038	3.29	54.75	0.095	3.63	2.59	2
14.271	0.92	0.05	0.98	1.0	0.052	35.32	50.34	0.078	1.50	0.94	0.22	0.80	1.09	1.0	0.038	4.28	64.34	0.105	3.97	2.73	2
14.436	0.92	0.05	0.97	1.0	0.052	38.47	61.75	0.090	1.73	0.94	0.28	0.80	1.09	1.0	0.038	2.84	66.01	0.107	4.01	2.87	2
14.600	0.92	0.06	0.97	1.0	0.052	41.67	74.09	0.105	2.03	0.94	0.33	0.80	1.09	1.0	0.038	2.34	75.74	0.120	4.48	3.26	2
14.764	0.92	0.06	0.97	1.0	0.052	38.43	62.39	0.091	1.75	0.94	0.28	0.80	1.09	1.0	0.038	3.55	84.93	0.137	5.07	3.41	2
14.928	0.92	0.05	0.97	1.0	0.052	37.58	58.32	0.086	1.67	0.94	0.26	0.80	1.09	1.0	0.038	2.90	60.16	0.100	3.68	2.67	2
15.092	0.91	0.05	0.97	1.0	0.051	37.79	59.16	0.087	1.69	0.94	0.27	0.80	1.09	1.0	0.038	2.79	59.56	0.100	3.63	2.66	2
15.256	0.91	0.06	0.97	1.0	0.051	39.15	64.39	0.093	1.81	0.94	0.29	0.80	1.08	1.0	0.038	2.04	51.53	0.093	3.35	2.58	2
15.420	0.91	0.06	0.97	1.0	0.051	41.17	72.15	0.102	2.00	0.94	0.32	0.80	1.08	1.0	0.038	1.78	55.03	0.095	3.42	2.71	2
15.584	0.91	0.06	0.97	1.0	0.051	39.61	66.13	0.095	1.86	0.94	0.30	0.80	1.08	1.0	0.038	2.09	55.54	0.096	3.41	2.64	2
15.748	0.91	0.06	0.97	1.0	0.051	43.34	80.53	0.113	2.23	0.94	0.35	0.80	1.08	1.0	0.038	1.50	55.66	0.096	3.39	2.81	2
15.912	0.91	0.07	0.97	1.0	0.051	44.99	86.87	0.122	2.41	0.94	0.37	0.80	1.08	1.0	0.038	1.60	66.81	0.108	3.78	3.10	2
16.076	0.91	0.06	0.97	1.0	0.051	40.11	68.10	0.097	1.91	0.94	0.31	0.80	1.08	1.0	0.038	2.76	77.26	0.123	4.28	3.10	2
16.240	0.91	0.06	0.97	1.0	0.051	38.75	62.84	0.091	1.79	0.94	0.28	0.80	1.07	1.0	0.038	3.07	74.03	0.118	4.07	2.93	2
16.404	0.90	0.06	0.97	1.0	0.051	39.23	64.68	0.093	1.84	0.94	0.29	0.80	1.07	1.0	0.039	2.62	66.75	0.108	3.69	2.77	2
16.568	0.90	0.05	0.97	1.0	0.051	38.35	61.30	0.089	1.76	0.94	0.28	0.80	1.07	1.0	0.039	3.03	69.61	0.111	3.79	2.78	2
16.732	0.90	0.05	0.97	1.0	0.051	37.21	56.91	0.085	1.67	0.94	0.26	0.80	1.07	1.0	0.039	3.05	60.03	0.100	3.39	2.53	2
16.896	0.90	0.05	0.97	1.0	0.050	38.19	60.67	0.089	1.76	0.94	0.27	0.80	1.07	1.0	0.039	2.38	53.50	0.094	3.16	2.46	2
17.060	0.90	0.05	0.97	1.0	0.050	37.00	56.11	0.084	1.66	0.94	0.25	0.80	1.07	1.0	0.039	3.34	63.84	0.104	3.47	2.57	2
17.224	0.90	0.05	0.97	1.0	0.050	37.02	56.17	0.084	1.66	0.94	0.25	0.80	1.06	1.0	0.039	3.48	66.58	0.107	3.56	2.61	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.468

Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
3.25	594	1.6E-03	5.5E+02	1.0E-04	11	0.177	9820	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.30	594	1.6E-03	5.5E+02	1.1E-04	11	0.178	9763	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.35	594	1.6E-03	5.5E+02	1.1E-04	11	0.178	9708	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.40	594	1.6E-03	5.5E+02	1.1E-04	11	0.179	9653	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.45	594	1.6E-03	5.5E+02	1.1E-04	11	0.180	9600	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.50	594	1.6E-03	5.5E+02	1.1E-04	11	0.180	9547	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.55	594	1.6E-03	5.5E+02	1.1E-04	11	0.181	9496	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.60	594	1.6E-03	5.5E+02	1.1E-04	11	0.182	9445	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.65	594	1.6E-03	5.5E+02	1.2E-04	11	0.182	9395	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.70	594	1.6E-03	5.5E+02	1.2E-04	11	0.183	9347	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.75	594	1.6E-03	5.5E+02	1.2E-04	11	0.183	9299	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.80	594	1.6E-03	5.5E+02	1.2E-04	11	0.184	9252	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.85	594	1.6E-03	5.5E+02	1.2E-04	11	0.184	9205	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.90	594	1.6E-03	5.5E+02	1.2E-04	11	0.185	9160	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.95	594	1.6E-03	5.5E+02	1.2E-04	11	0.186	9115	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.00	594	1.6E-03	5.5E+02	1.3E-04	11	0.186	9071	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.05	594	1.6E-03	5.5E+02	1.3E-04	11	0.187	9028	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.10	594	1.6E-03	5.5E+02	1.3E-04	11	0.187	8985	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.15	495	1.6E-03	3.8E+02	1.9E-04	11	0.188	8943	0.03%	2.00	0.65	0.03%	0.002	0.34	0.079	0.765	0.24%	0.0004
4.20	495	1.6E-03	3.9E+02	1.9E-04	0	0.193	11508	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.04%	0.0001
4.25	495	1.6E-03	3.9E+02	1.9E-04	0	0.193	11455	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.04%	0.0001
4.30	495	1.6E-03	3.9E+02	1.9E-04	0	0.194	11403	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.04%	0.0001
4.35	495	1.6E-03	3.9E+02	1.9E-04	0	0.194	11351	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.05%	0.0001
4.40	495	1.4E-03	3.5E+02	2.1E-04	10	0.191	8976	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.83%	0.0014
4.45	495	1.4E-03	3.5E+02	2.2E-04	10	0.191	8939	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.87%	0.0014
4.50	495	1.4E-03	3.5E+02	2.2E-04	10	0.192	8904	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.90%	0.0015
4.55	495	1.3E-03	3.1E+02	2.5E-04	16	0.444	7299	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.70%	0.0028
4.60	495	1.3E-03	3.1E+02	2.5E-04	16	0.445	7273	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.73%	0.0028
4.65	495	1.4E-03	3.5E+02	2.2E-04	10	0.193	8807	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.99%	0.0016
4.70	495	1.4E-03	3.5E+02	2.3E-04	10	0.193	8773	0.05%	2.00	0.65	0.03%	0.007	0.34	0.079	0.765	1.02%	0.0017
4.75	495	1.6E-03	3.9E+02	2.1E-04	0	0.197	11007	0.05%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.07%	0.0001
4.80	495	1.6E-03	3.9E+02	2.1E-04	0	0.198	10961	0.05%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.07%	0.0001
4.85	495	1.6E-03	3.9E+02	2.1E-04	0	0.198	10916	0.05%	2.20	1.00	0.03%	0.001	0.34	0.079	0.765	0.08%	0.0001
4.90	495	1.6E-03	3.9E+02	2.1E-04	0	0.199	10872	0.05%	2.20	1.00	0.03%	0.001	0.34	0.079	0.765	0.08%	0.0001
4.95	495	1.6E-03	3.9E+02	2.2E-04	0	0.199	10829	0.05%	2.20	1.00	0.03%	0.001	0.34	0.079	0.765	0.08%	0.0001
5.00	495	1.4E-03	3.5E+02	2.4E-04	10	0.196	8561	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.23%	0.0020
5.05	495	1.4E-03	3.5E+02	2.4E-04	10	0.197	8531	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.26%	0.0021
5.10	495	1.4E-03	3.5E+02	2.4E-04	10	0.197	8500	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.30%	0.0021
5.15	495	1.4E-03	3.5E+02	2.5E-04	10	0.198	8470	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.33%	0.0022
5.20	495	1.4E-03	3.5E+02	2.5E-04	10	0.198	8440	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.36%	0.0022
5.25	495	1.6E-03	3.9E+02	2.3E-04	0	0.202	10598	0.06%	2.20	1.00	0.03%	0.001	0.34	0.079	0.765	0.11%	0.0002
5.30	495	1.9E-03	4.7E+02	1.9E-04	0	0.202	10550	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.03%	0.0001
5.35	495	1.8E-03	4.5E+02	2.0E-04	10	0.200	8333	0.03%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.46%	0.0008
5.40	495	1.8E-03	4.5E+02	2.0E-04	10	0.200	8297	0.04%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.50%	0.0008
5.45	495	1.8E-03	4.5E+02	2.0E-04	10	0.201	8261	0.04%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.53%	0.0009
5.50	495	1.8E-03	4.5E+02	2.1E-04	10	0.201	8227	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.57%	0.0009
5.55	495	1.8E-03	4.5E+02	2.1E-04	10	0.202	8192	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.60%	0.0010
5.60	495	1.8E-03	4.5E+02	2.1E-04	10	0.202	8158	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.64%	0.0010
5.65	495	1.8E-03	4.5E+02	2.1E-04	10	0.203	8125	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.67%	0.0011
5.70	495	1.8E-03	4.5E+02	2.2E-04	10	0.203	8092	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.70%	0.0012
5.75	495	1.8E-03	4.5E+02	2.2E-04	10	0.204	8059	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.73%	0.0012
5.80	495	1.8E-03	4.5E+02	2.2E-04	10	0.204	8027	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.77%	0.0013
5.85	495	1.8E-03	4.5E+02	2.2E-04	10	0.205	7996	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.80%	0.0013
5.90	495	1.8E-03	4.5E+02	2.2E-04	10	0.205	7964	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.83%	0.0014
5.95	495	1.8E-03	4.5E+02	2.3E-04	10	0.206	7934	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.86%	0.0014
6.00	495	1.8E-03	4.5E+02	2.3E-04	10	0.206	7903	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.89%	0.0015
6.05	460	1.8E-03	3.9E+02	2.7E-04	10	0.207	7873	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.54%	0.0025
6.10	460	1.8E-03	3.9E+02	2.7E-04	10	0.207	7844	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.58%	0.0026
6.15	460	1.8E-03	3.9E+02	2.7E-04	10	0.208	7814	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.61%	0.0026
6.20	460	1.8E-03	3.9E+02	2.7E-04	10	0.208	7785	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.65%	0.0027
6.25	460	1.8E-03	3.9E+02	2.8E-04	10	0.209	7757	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.68%	0.0028
6.30	460	1.8E-03	3.9E+02	2.8E-04	10	0.209	7729	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.72%	0.0028
6.35	460	1.8E-03	3.9E+02	2.8E-04	10	0.209	7701	0.07%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.76%	0.0029
6.40	460	1.8E-03	3.9E+02	2.8E-04	10	0.210	7673	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.79%	0.0029
6.45	460	1.8E-03	3.9E+02	2.9E-04	10	0.210	7646	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.83%	0.0030
6.50	460	1.8E-03	3.9E+02	2.9E-04	10	0.211	7619	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.86%	0.0031
6.55	460	1.8E-03	3.9E+02	2.9E-04	10	0.211	7593	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.90%	0.0031
6.60	460	1.8E-03	3.9E+02	2.9E-04	10	0.212	7567	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.93%	0.0032
6.65	460	1.8E-03	3.9E+02	3.0E-04	10	0.212	7541	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.97%	0.0032
6.70	460	1.8E-03	3.9E+02	3.0E-04	10	0.213	7515	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.00%	0.0033
6.75	460	1.8E-03	3.9E+02	3.0E-04	10	0.213	7490	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.04%	0.0033
6.80	460	1.8E-03	3.9E+02	3.0E-04	10	0.214	7465	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.08%	0.0034
6.85	460	1.8E-03	3.9E+02	3.1E-04	10	0.214	7440	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.11%	0.0035
6.90	460	1.8E-03	3.9E+02	3.1E-04	10	0.214	7416	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.15%	0.0035
6.95	460	1.8E-03	3.7E+02	3.3E-04	16	0.466	6088	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.67%	0.0044
7.00	460	1.8E-03	3.9E+02	3.1E-04	10	0.215	7369	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.22%	0.0036
7.05	460	1.8E-03	3.7E+02	3.3E-04	16	0.467	6050	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.74%	0.0045
7.10	460	1.8E-03	3.9E+02	3.2E-04	10	0.216	7323	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.29%	0.0038
7.15	460	1.8E-03	3.9E+02	3.2E-04	10	0.216	7300	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.33%	0.0038
7.20	460	1.8E-03	3.9E+02	3.2E-04	10	0.217	7277	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.36%	0.0039
7.25	460	1.8E-03	3.9E+02	3.2E-04	10	0.217	7254	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.40%	0.0039
7.30	460	1.8E-03	3.9E+02	3.3E-04	10	0.218	7232	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.44%	0.0040
7.35	460	1.8E-03	3.9E+02	3.3E-04	10	0.218	7210	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.48%	0.0041
7.40	460	1.8E-03	3.9E+02	3.3E-04	10	0.219	7188	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.51%	0.0041
7.45	460	1.8E-03	3.9E+02	3.3E-04	10	0.219	7166	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.55%	0.0042
7.50	460	1.8E-03	3.9E+02	3.4E-04	10	0.219	7144	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.59%	0.0042
7.55	460	1.8E-03	3.7E+02	3.6E-04	16	0.471	5869	0.12%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.13%	0.0051
7.60	460	1.8E-03	3.9E+02	3.4E-04	10	0.220	7103	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.66%	0.0044
7.65	500	1.8E-03	4.6E+02	2.9E-04	10	0.220	7082	0.07%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.74%	0.0029
7.70	500	1.8E-03	4.4E+02	3.1E-04	16	0.472	5818	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.20%	0.0036
7.75	500	1.8E-03	4.6E+02	3.0E-04	10	0.221	7042	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.80%	0.0029
7.80	500	1.8E-03	4.6E+02	3.0E-04	10	0.222	7022	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.82%	0.0030
7.85	500	1.8E-03	4.6E+02	3.0E-04	10	0.222	7002	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.85%	0.0030
7.90	500	1.8E-03	4.6E+02	3.0E-04	10	0.222	6982	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.88%	0.0031
7.95	500	1.8E-03	4.6E+02	3.0E-04	10	0.223	6962	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.91%	0.0031
8.00	500	1.8E-03	4.6E+02	3.1E-04	10	0.223	6943	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.94%	0.0032
8.05	500	1.8E-03	4.6E+02	3.1E-04	10	0.224	6923	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.96%	0.0032
8.10	500	1.8E-03	4.6E+02	3.1E-04	10	0.224	6904	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.99%	0.0033
8.15	500	1.8E-03	4.6E+02	3.1E-04	10	0.224	6885	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.02%	0.0033
8.20	500	1.8E-03	4.6E+02	3.1E-04	10	0.225	6866	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.05%	0.0034
8.25	500	1.8E-03	4.6E+02	3.2E-04	10	0.225	6848	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.08%	0.0034
8.30	500	1.8E-03	4.6E+02	3.2E-04	10	0.225	6829	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.11%	0.0035
8.35	500	1.8E-03	4.6E+02	3.2E-04	10	0.226	6811	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.13%	0.0035
8.40	500	1.8E-03	4.6E+02	3.2E-04	10	0.226	6793	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.16%	0.0035
8.45	500	1.8E-03	4.6E+02	3.2E-04	10	0.227	6775	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.19%	0.0036

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2E1

Data File: 13-52106_SP2E1-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Dat

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5613.10	Water surface elevation during CPT investigation (ft a
5611.67	Water surface elevation at t_0 (ft amsl)
5595.46	Water surface elevation at t_1 (ft amsl)
5590.46	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earth
7.51	Equiv. Number of Uniform Strain Cycles, N

5619.95	Ground Surface Elevation at time of CPT (ft amsl)
5630.46	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after place
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
2.51	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1160.95	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5590.46	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5630.21	5629.96	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5628.21	5626.46	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5624.46	5622.46	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334	1.83	508	1.9E-03	4.8E+02	6.8E-05	11	0.153	12419	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######	5621.21	5619.95	2.51	0.050	101	0.580	0.517	0.00	0.00	0.580	0.517	2.82	508	1.6E-03	4.0E+02	1.2E-04	11	0.171	10362	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No
17.388	5602.56	12.5	0.226	12.4	18.9	8.17	1.81%	Sand-Slime Tailin	0.059	119.0	0.96	0.33	0.64	1
17.552	5602.40	10.1	0.119	9.9	19.4	8.42	1.18%	Sand-Slime Tailin	0.059	119.0	0.97	0.33	0.64	1
17.716	5602.23	11.0	0.133	10.8	23.1	10.02	1.21%	Sand-Slime Tailin	0.059	119.0	0.98	0.34	0.64	1
17.880	5602.07	10.6	0.104	10.5	25.6	11.08	0.98%	Sand-Slime Tailin	0.059	119.0	0.99	0.34	0.65	1
18.044	5601.91	15.6	0.215	15.4	27.3	11.85	1.38%	Sand-Slime Tailin	0.059	119.0	1.00	0.35	0.65	1
18.208	5601.74	11.4	0.182	11.3	22.1	9.59	1.59%	Sand-Slime Tailin	0.059	119.0	1.01	0.35	0.66	1
18.372	5601.58	9.5	0.143	9.3	33.5	14.51	1.50%	Sand-Slime Tailin	0.059	119.0	1.02	0.36	0.66	1
18.537	5601.41	16.2	0.140	15.9	56.4	24.43	0.86%	Sand-Slime Tailin	0.059	119.0	1.03	0.36	0.67	1
18.701	5601.25	17.9	0.177	17.7	23.0	9.97	0.99%	Sand-Slime Tailin	0.059	119.0	1.04	0.37	0.67	1
18.865	5601.09	14.9	0.143	14.7	24.5	10.62	0.96%	Sand-Slime Tailin	0.059	119.0	1.05	0.37	0.68	1
19.029	5600.92	18.2	0.189	18.2	13.4	5.82	1.04%	Sand-Slime Tailin	0.059	119.0	1.06	0.38	0.68	1
19.193	5600.76	15.7	0.226	15.6	17.1	7.41	1.44%	Sand-Slime Tailin	0.059	119.0	1.07	0.39	0.69	1
19.357	5600.59	12.4	0.221	12.1	42.6	18.48	1.79%	Sand-Slime Tailin	0.059	119.0	1.08	0.39	0.69	1
19.521	5600.43	15.2	0.223	14.8	64.4	27.89	1.47%	Sand-Slime Tailin	0.059	119.0	1.09	0.40	0.70	1
19.685	5600.27	12.3	0.248	12.1	35.7	15.47	2.01%	Sand-Slime Tailin	0.059	119.0	1.10	0.40	0.70	1
19.849	5600.10	12.3	0.010	12.0	55.6	24.11	0.08%	Sand-Slime Tailin	0.059	119.0	1.11	0.41	0.70	1
20.013	5599.94	16.7	0.105	16.5	32.1	13.89	0.63%	Sand-Slime Tailin	0.059	119.0	1.12	0.41	0.71	1
20.177	5599.77	11.0	0.151	11.0	8.6	3.72	1.37%	Sand-Slime Tailin	0.059	119.0	1.13	0.42	0.71	1
20.341	5599.61	16.5	0.104	16.4	12.3	5.34	0.63%	Sand-Slime Tailin	0.059	119.0	1.14	0.42	0.72	1
20.505	5599.45	26.3	0.244	26.2	16.8	7.29	0.93%	Sand-Slime Tailin	0.059	119.0	1.15	0.43	0.72	1
20.669	5599.28	18.0	0.319	18.0	11.3	4.89	1.77%	Sand-Slime Tailin	0.059	119.0	1.16	0.43	0.73	1
20.833	5599.12	15.8	0.362	15.7	15.0	6.52	2.29%	Sand-Slime Tailin	0.059	119.0	1.17	0.44	0.73	1
20.997	5598.95	13.5	0.268	13.3	25.6	11.09	1.99%	Sand-Slime Tailin	0.059	119.0	1.18	0.44	0.74	1
21.161	5598.79	13.5	0.247	13.3	33.1	14.34	1.83%	Sand-Slime Tailin	0.059	119.0	1.19	0.45	0.74	1
21.325	5598.62	14.2	0.171	14.0	32.9	14.27	1.20%	Sand-Slime Tailin	0.059	119.0	1.20	0.45	0.75	1
21.489	5598.46	21.5	0.169	21.3	27.8	12.05	0.79%	Sand-Slime Tailin	0.059	119.0	1.21	0.46	0.75	1
21.653	5598.30	19.5	0.201	19.4	19.6	8.49	1.03%	Sand-Slime Tailin	0.059	119.0	1.22	0.46	0.76	1
21.817	5598.13	15.2	0.196	15.1	19.5	8.45	1.29%	Sand-Slime Tailin	0.059	119.0	1.23	0.47	0.76	1
21.981	5597.97	13.5	0.188	13.3	22.6	9.79	1.40%	Sand-Slime Tailin	0.059	119.0	1.24	0.47	0.77	1
22.145	5597.80	12.1	0.166	12.0	27.8	12.05	1.37%	Sand-Slime Tailin	0.059	119.0	1.25	0.48	0.77	1
22.309	5597.64	9.5	0.208	9.3	33.0	14.31	2.19%	Slime Tailings	0.057	113.1	1.26	0.48	0.78	1
22.473	5597.48	10.2	0.214	9.9	57.5	24.93	2.09%	Slime Tailings	0.057	113.1	1.27	0.49	0.78	1
22.638	5597.31	12.2	0.168	12.0	43.6	18.90	1.37%	Sand-Slime Tailin	0.059	119.0	1.28	0.49	0.78	1
22.802	5597.15	15.7	0.124	15.5	28.3	12.28	0.79%	Sand-Slime Tailin	0.059	119.0	1.29	0.50	0.79	1
22.966	5596.98	18.3	0.115	18.2	21.4	9.29	0.63%	Sand-Slime Tailin	0.059	119.0	1.29	0.50	0.79	1
23.130	5596.82	17.6	0.122	17.5	22.6	9.77	0.69%	Sand-Slime Tailin	0.059	119.0	1.30	0.51	0.80	1
23.294	5596.66	16.7	0.117	16.6	23.3	10.10	0.70%	Sand-Slime Tailin	0.059	119.0	1.31	0.51	0.80	1
23.458	5596.49	18.6	0.112	18.5	23.3	10.10	0.60%	Sand-Slime Tailin	0.059	119.0	1.32	0.52	0.81	1
23.622	5596.33	24.6	0.061	24.5	18.8	8.15	0.25%	Sand-Slime Tailin	0.059	119.0	1.33	0.52	0.81	1
23.786	5596.16	27.8	0.103	27.7	11.3	4.89	0.37%	Sand-Slime Tailin	0.059	119.0	1.34	0.53	0.82	1
23.950	5596.00	23.4	0.209	23.4	12.0	5.22	0.89%	Sand-Slime Tailin	0.059	119.0	1.35	0.53	0.82	1
24.114	5595.84	18.1	0.289	18.0	13.9	6.03	1.60%	Sand-Slime Tailin	0.059	119.0	1.36	0.54	0.82	1
24.278	5595.67	18.2	0.238	18.1	15.7	6.80	1.31%	Sand-Slime Tailin	0.059	119.0	1.37	0.54	0.83	1
24.442	5595.51	24.4	0.195	24.3	16.8	7.27	0.80%	Sand-Slime Tailin	0.059	119.0	1.38	0.55	0.83	1
24.606	5595.34	34.4	0.343	34.3	15.2	6.60	1.00%	Sand-Slime Tailin	0.059	119.0	1.39	0.55	0.84	1
24.770	5595.18	20.5	0.393	20.4	14.3	6.19	1.91%	Sand-Slime Tailin	0.059	119.0	1.40	0.56	0.84	1
24.934	5595.02	16.7	0.314	16.6	16.6	7.19	1.89%	Sand-Slime Tailin	0.059	119.0	1.41	0.56	0.85	1
25.098	5594.85	14.6	0.266	14.4	26.3	11.40	1.83%	Sand-Slime Tailin	0.059	119.0	1.42	0.57	0.85	1
25.262	5594.69	24.0	0.214	23.8	30.2	13.07	0.89%	Sand-Slime Tailin	0.059	119.0	1.43	0.57	0.86	1
25.426	5594.52	24.6	0.322	24.5	24.1	10.42	1.31%	Sand-Slime Tailin	0.059	119.0	1.44	0.58	0.86	1
25.590	5594.36	18.9	0.380	18.7	25.6	11.07	2.01%	Sand-Slime Tailin	0.059	119.0	1.45	0.58	0.87	1
25.754	5594.20	17.6	0.410	17.4	32.3	14.00	2.33%	Sand-Slime Tailin	0.059	119.0	1.46	0.59	0.87	1
25.918	5594.03	15.1	0.388	14.8	47.4	20.55	2.56%	Slime Tailings	0.057	113.1	1.47	0.59	0.88	1
26.082	5593.87	12.7	0.338	12.4	51.7	22.40	2.65%	Slime Tailings	0.057	113.1	1.48	0.60	0.88	1
26.246	5593.70	17.4	0.296	17.0	74.4	32.24	1.70%	Sand-Slime Tailin	0.059	119.0	1.49	0.61	0.88	1
26.410	5593.54	15.8	0.331	15.5	39.8	17.23	2.10%	Sand-Slime Tailin	0.059	119.0	1.50	0.61	0.89	1
26.574	5593.38	15.8	0.404	15.3	86.3	37.40	2.55%	Slime Tailings	0.057	113.1	1.51	0.62	0.89	1
26.739	5593.21	16.2	0.416	16.0	39.0	16.89	2.56%	Slime Tailings	0.057	113.1	1.52	0.62	0.90	1
26.903	5593.05	19.8	0.353	19.4	59.3	25.69	1.78%	Sand-Slime Tailin	0.059	119.0	1.53	0.63	0.90	1
27.067	5592.88	25.7	0.481	25.6	31.0	13.43	1.87%	Sand-Slime Tailin	0.059	119.0	1.54	0.63	0.91	1
27.231	5592.72	23.6	0.456	23.3	42.6	18.45	1.93%	Sand-Slime Tailin	0.059	119.0	1.55	0.64	0.91	1
27.395	5592.56	22.8	0.504	22.4	57.1	24.73	2.21%	Sand-Slime Tailin	0.059	119.0	1.56	0.64	0.92	1
27.559	5592.39	17.8	0.379	17.4	71.1	30.80	2.13%	Sand-Slime Tailin	0.059	119.0	1.57	0.65	0.92	1
27.723	5592.23	23.3	0.387	22.9	65.4	28.36	1.66%	Sand-Slime Tailin	0.059	119.0	1.58	0.65	0.92	1
27.887	5592.06	19.0	0.387	18.8	36.8	15.95	2.03%	Sand-Slime Tailin	0.059	119.0	1.59	0.66	0.93	1
28.051	5591.90	23.9	0.387	23.5	75.0	32.50	1.62%	Sand-Slime Tailin	0.059	119.0	1.60	0.66	0.93	1
29.490	5590.46							Sand-Slime Tailin	0.059	119.0				

CPT Data Interpretations (continued) / Conditions at t_1

Depth at time of CPT (ft)	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
17.388	1.27	15.676	217.89	18.38	18	1.96%	2.7	47%	1.54	0.00	1.54	0
17.552	1.26	12.535	174.24	14.74	14	1.31%	2.7	47%	1.55	0.00	1.55	0
17.716	1.25	13.593	188.94	16.00	16	1.33%	2.6	47%	1.56	0.00	1.56	0
17.880	1.25	13.043	181.30	15.38	15	1.08%	2.6	47%	1.57	0.00	1.57	0
18.044	1.24	19.083	265.26	22.41	22	1.47%	2.5	47%	1.58	0.00	1.58	0
18.208	1.23	13.923	193.53	16.37	16	1.75%	2.7	47%	1.59	0.00	1.59	0
18.372	1.23	11.418	158.71	13.56	13	1.68%	2.8	47%	1.60	0.00	1.60	0
18.537	1.22	19.318	268.52	22.93	23	0.92%	2.4	47%	1.61	0.00	1.61	0
18.701	1.21	21.370	297.05	25.02	25	1.05%	2.4	47%	1.62	0.00	1.62	0
18.865	1.21	17.787	247.23	20.87	20	1.03%	2.5	47%	1.63	0.00	1.63	0
19.029	1.19	21.656	301.01	25.27	25	1.10%	2.4	47%	1.64	0.00	1.64	0
19.193	1.19	18.615	258.74	21.77	21	1.54%	2.6	47%	1.65	0.00	1.65	0
19.357	1.19	14.370	199.75	17.06	16	1.96%	2.7	47%	1.66	0.00	1.66	0
19.521	1.18	17.474	242.88	20.65	20	1.58%	2.6	47%	1.67	0.00	1.67	0
19.685	1.18	14.233	197.84	16.84	16	2.21%	2.8	47%	1.68	0.00	1.68	0
19.849	1.17	14.008	194.71	16.74	16	0.09%	2.3	47%	1.69	0.00	1.69	0
20.013	1.16	19.178	266.58	22.54	22	0.67%	2.4	47%	1.70	0.00	1.70	0
20.177	1.16	12.696	176.48	14.82	14	1.53%	2.7	47%	1.71	0.00	1.71	0
20.341	1.15	18.850	262.02	22.00	21	0.68%	2.4	47%	1.72	0.00	1.72	0
20.505	1.13	29.559	410.87	34.47	35	0.97%	2.3	47%	1.73	0.00	1.73	0
20.669	1.14	20.422	283.87	23.81	23	1.89%	2.6	47%	1.74	0.00	1.74	0
20.833	1.13	17.855	248.19	20.86	20	2.47%	2.7	47%	1.75	0.00	1.75	0
20.997	1.13	15.024	208.84	17.66	17	2.18%	2.7	47%	1.76	0.00	1.76	0
21.161	1.12	14.951	207.82	17.63	17	2.00%	2.7	47%	1.77	0.00	1.77	0
21.325	1.12	15.661	217.68	18.46	17	1.31%	2.6	47%	1.78	0.00	1.78	0
21.489	1.11	23.539	327.20	27.56	27	0.83%	2.3	47%	1.79	0.00	1.79	0
21.653	1.10	21.372	297.07	24.98	24	1.10%	2.4	47%	1.80	0.00	1.80	0
21.817	1.10	16.637	231.26	19.48	18	1.40%	2.6	47%	1.81	0.00	1.81	0
21.981	1.10	14.595	202.88	17.13	16	1.54%	2.7	47%	1.82	0.00	1.82	0
22.145	1.09	13.053	181.44	15.38	14	1.52%	2.7	47%	1.83	0.00	1.83	0
22.309	1.09	10.097	140.34	11.99	11	2.52%	2.9	71%	1.84	0.00	1.84	0
22.473	1.08	10.671	148.33	12.85	12	2.39%	2.9	71%	1.85	0.00	1.85	0
22.638	1.08	12.884	179.09	15.30	14	1.53%	2.7	47%	1.86	0.00	1.86	0
22.802	1.07	16.653	231.47	19.56	18	0.86%	2.5	47%	1.87	0.00	1.87	0
22.966	1.07	19.355	269.03	22.65	21	0.68%	2.4	47%	1.88	0.00	1.88	0
23.130	1.06	18.534	257.62	21.70	20	0.75%	2.4	47%	1.89	0.00	1.89	0
23.294	1.06	17.505	243.32	20.51	19	0.76%	2.4	47%	1.89	0.00	1.89	0
23.458	1.05	19.432	270.11	22.75	21	0.65%	2.4	47%	1.90	0.00	1.90	0
23.622	1.04	25.556	355.23	29.82	29	0.26%	2.1	47%	1.91	0.00	1.91	0
23.786	1.04	28.802	400.34	33.54	32	0.39%	2.1	47%	1.92	0.00	1.92	0
23.950	1.04	24.226	336.75	28.23	27	0.95%	2.4	47%	1.93	0.00	1.93	0
24.114	1.03	18.635	259.03	21.75	20	1.73%	2.6	47%	1.94	0.00	1.94	0
24.278	1.03	18.616	258.76	21.74	20	1.42%	2.6	47%	1.95	0.00	1.95	0
24.442	1.02	24.907	346.21	29.05	28	0.85%	2.3	47%	1.96	0.00	1.96	0
24.606	1.02	34.889	484.95	40.63	39	1.04%	2.2	47%	1.97	0.00	1.97	1
24.770	1.02	20.768	288.68	24.23	23	2.05%	2.6	47%	1.98	0.01	1.97	1
24.934	1.01	16.751	232.84	19.58	18	2.06%	2.7	47%	1.99	0.01	1.98	1
25.098	1.01	14.503	201.59	17.04	15	2.03%	2.7	47%	2.00	0.02	1.98	1
25.262	1.00	23.851	331.52	27.92	26	0.95%	2.4	47%	2.01	0.02	1.99	1
25.426	1.00	24.455	339.93	28.58	27	1.39%	2.5	47%	2.02	0.03	1.99	1
25.590	1.00	18.640	259.10	21.83	20	2.18%	2.7	47%	2.03	0.03	2.00	1
25.754	0.99	17.234	239.55	20.25	19	2.54%	2.7	47%	2.04	0.04	2.00	1
25.918	0.99	14.652	203.67	17.36	16	2.84%	2.8	71%	2.05	0.04	2.01	1
26.082	0.98	12.217	169.82	14.56	13	3.00%	2.9	71%	2.06	0.05	2.01	1
26.246	0.98	16.605	230.81	19.81	18	1.86%	2.7	47%	2.07	0.05	2.01	1
26.410	0.98	15.162	210.75	17.89	16	2.32%	2.8	47%	2.08	0.06	2.02	1
26.574	0.97	14.863	206.60	17.87	16	2.82%	2.8	71%	2.09	0.07	2.02	1
26.739	0.97	15.487	215.27	18.26	16	2.83%	2.8	71%	2.10	0.07	2.03	1
26.903	0.97	18.751	260.63	22.19	20	1.93%	2.6	47%	2.11	0.08	2.03	1
27.067	0.96	24.609	342.07	28.80	27	1.99%	2.5	47%	2.12	0.08	2.04	1
27.231	0.96	22.359	310.79	26.26	24	2.07%	2.6	47%	2.13	0.09	2.04	1
27.395	0.95	21.416	297.69	25.27	23	2.37%	2.6	47%	2.14	0.09	2.05	1
27.559	0.95	16.510	229.49	19.67	18	2.33%	2.7	47%	2.15	0.10	2.05	1
27.723	0.95	21.674	301.27	25.62	23	1.78%	2.6	47%	2.16	0.10	2.06	1
27.887	0.94	17.700	246.03	20.81	19	2.22%	2.7	47%	2.17	0.11	2.06	1
28.051	0.94	22.063	306.68	26.14	24	1.73%	2.6	47%	2.18	0.11	2.06	1
29.490									2.26	0.13	2.13	1

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	Idriss & Boulanger (2008) Cyclic Stress Ratio r_d	C_σ	K_σ	K_a	CSR M=7.5, s'v=1atm	Cyclic Resistance Ratio Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd et al. (2001) Cyclic Stress Ratio r_d	D_r	f	K_σ	K_a	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
17.388	0.90	0.05	0.97	1.0	0.050	36.75	55.13	0.083	1.64	0.93	0.25	0.80	1.06	1.0	0.039	3.85	70.78	0.113	3.71	2.68	2
17.552	0.90	0.05	0.97	1.0	0.050	35.47	50.21	0.078	1.54	0.93	0.22	0.80	1.06	1.0	0.039	3.82	56.34	0.097	3.16	2.35	2
17.716	0.89	0.05	0.97	1.0	0.050	35.91	51.91	0.079	1.58	0.93	0.23	0.80	1.06	1.0	0.039	3.62	57.91	0.098	3.18	2.38	2
17.880	0.89	0.05	0.97	1.0	0.050	35.70	51.08	0.079	1.57	0.93	0.23	0.80	1.06	1.0	0.039	3.44	52.94	0.094	3.02	2.29	2
18.044	0.89	0.05	0.97	1.0	0.050	38.16	60.57	0.088	1.77	0.93	0.27	0.80	1.06	1.0	0.039	2.95	66.15	0.107	3.42	2.60	2
18.208	0.89	0.05	0.97	1.0	0.050	36.04	52.41	0.080	1.60	0.93	0.23	0.80	1.06	1.0	0.039	4.00	65.53	0.106	3.37	2.49	2
18.372	0.89	0.05	0.97	1.0	0.050	35.06	48.62	0.076	1.53	0.93	0.21	0.80	1.05	1.0	0.039	4.53	61.47	0.102	3.21	2.37	2
18.537	0.89	0.05	0.97	1.0	0.050	38.34	61.28	0.089	1.80	0.93	0.28	0.80	1.05	1.0	0.039	2.40	55.11	0.096	3.00	2.40	2
18.701	0.89	0.06	0.96	1.0	0.049	39.08	64.10	0.093	1.87	0.93	0.29	0.80	1.05	1.0	0.039	2.38	59.44	0.100	3.10	2.49	2
18.865	0.89	0.05	0.97	1.0	0.049	37.62	58.49	0.086	1.74	0.93	0.26	0.80	1.05	1.0	0.039	2.70	56.46	0.097	3.00	2.37	2
19.029	0.88	0.06	0.96	1.0	0.049	39.16	64.43	0.093	1.89	0.93	0.29	0.80	1.05	1.0	0.039	2.41	60.84	0.101	3.11	2.50	2
19.193	0.88	0.05	0.97	1.0	0.049	37.94	59.70	0.088	1.78	0.93	0.27	0.80	1.05	1.0	0.039	3.11	67.59	0.109	3.32	2.55	2
19.357	0.88	0.05	0.97	1.0	0.049	36.28	53.34	0.081	1.64	0.93	0.24	0.80	1.04	1.0	0.039	4.12	70.25	0.112	3.41	2.52	2
19.521	0.88	0.05	0.96	1.0	0.049	37.61	58.46	0.086	1.76	0.93	0.26	0.80	1.04	1.0	0.039	3.25	67.72	0.109	3.29	2.52	2
19.685	0.88	0.05	0.97	1.0	0.049	36.21	53.04	0.080	1.64	0.93	0.24	0.80	1.04	1.0	0.039	4.39	73.96	0.118	3.53	2.59	2
19.849	0.88	0.05	0.97	1.0	0.049	36.17	52.91	0.080	1.64	0.93	0.24	0.80	1.04	1.0	0.039	1.87	31.30	0.076	2.27	1.96	2
20.013	0.88	0.05	0.96	1.0	0.049	38.21	60.75	0.089	1.82	0.93	0.27	0.80	1.04	1.0	0.039	2.20	49.63	0.091	2.72	2.27	2
20.177	0.87	0.05	0.97	1.0	0.049	35.50	50.32	0.078	1.59	0.92	0.22	0.80	1.04	1.0	0.039	4.13	61.27	0.101	3.00	2.30	2
20.341	0.87	0.05	0.96	1.0	0.049	38.02	60.01	0.088	1.81	0.92	0.27	0.80	1.04	1.0	0.039	2.25	49.58	0.091	2.69	2.25	2
20.505	0.87	0.06	0.96	1.0	0.048	42.39	76.86	0.108	2.25	0.92	0.34	0.80	1.04	1.0	0.039	1.88	64.63	0.105	3.08	2.66	2
20.669	0.87	0.05	0.96	1.0	0.048	38.65	62.46	0.091	1.87	0.92	0.28	0.80	1.03	1.0	0.039	3.22	76.70	0.122	3.55	2.71	2
20.833	0.87	0.05	0.96	1.0	0.048	37.62	58.48	0.086	1.78	0.92	0.26	0.80	1.03	1.0	0.039	4.01	83.73	0.135	3.90	2.84	2
20.997	0.87	0.05	0.96	1.0	0.048	36.50	54.15	0.082	1.69	0.92	0.24	0.80	1.03	1.0	0.039	4.26	75.26	0.120	3.45	2.57	2
21.161	0.87	0.05	0.96	1.0	0.048	36.49	54.12	0.082	1.69	0.92	0.24	0.80	1.03	1.0	0.039	4.11	72.54	0.115	3.32	2.50	2
21.325	0.87	0.05	0.96	1.0	0.048	36.77	55.23	0.083	1.72	0.91	0.25	0.80	1.03	1.0	0.039	3.32	61.36	0.101	2.90	2.31	2
21.489	0.86	0.06	0.96	1.0	0.048	39.97	67.53	0.097	2.02	0.91	0.30	0.80	1.03	1.0	0.039	2.07	57.16	0.097	2.77	2.39	2
21.653	0.86	0.06	0.96	1.0	0.048	39.06	64.04	0.092	1.93	0.91	0.29	0.80	1.03	1.0	0.039	2.48	61.83	0.102	2.89	2.41	2
21.817	0.86	0.05	0.96	1.0	0.048	37.13	56.61	0.084	1.76	0.91	0.25	0.80	1.03	1.0	0.039	3.29	64.11	0.105	2.95	2.35	2
21.981	0.86	0.05	0.96	1.0	0.048	36.31	53.44	0.081	1.69	0.91	0.24	0.80	1.02	1.0	0.039	3.77	64.60	0.105	2.95	2.32	2
22.145	0.86	0.05	0.96	1.0	0.048	35.70	51.08	0.079	1.64	0.91	0.23	0.80	1.02	1.0	0.039	4.08	62.70	0.103	2.87	2.26	2
22.309	0.86	0.05	0.96	1.0	0.048	34.26	46.25	0.074	1.55	0.91	0.20	0.80	1.02	1.0	0.039	6.02	72.19	0.115	3.20	2.37	2
22.473	0.86	0.05	0.96	1.0	0.048	34.56	47.41	0.075	1.57	0.91	0.21	0.80	1.02	1.0	0.039	5.61	72.09	0.115	3.18	2.38	2
22.638	0.85	0.05	0.96	1.0	0.048	35.67	50.97	0.078	1.65	0.90	0.23	0.80	1.02	1.0	0.039	4.11	62.96	0.103	2.85	2.25	2
22.802	0.85	0.05	0.96	1.0	0.047	37.16	56.72	0.084	1.78	0.90	0.26	0.80	1.02	1.0	0.039	2.72	53.26	0.094	2.58	2.18	2
22.966	0.85	0.05	0.96	1.0	0.047	38.24	60.89	0.089	1.88	0.90	0.27	0.80	1.02	1.0	0.039	2.24	50.80	0.092	2.52	2.20	2
23.130	0.85	0.05	0.96	1.0	0.047	37.91	59.61	0.087	1.86	0.90	0.27	0.80	1.02	1.0	0.039	2.40	52.09	0.093	2.54	2.20	2
23.294	0.85	0.05	0.96	1.0	0.047	37.49	58.00	0.086	1.82	0.90	0.26	0.80	1.01	1.0	0.039	2.52	51.71	0.093	2.52	2.17	2
23.458	0.85	0.05	0.96	1.0	0.047	38.28	61.03	0.089	1.90	0.90	0.28	0.80	1.01	1.0	0.039	2.21	50.28	0.092	2.48	2.19	2
23.622	0.85	0.06	0.95	1.0	0.047	40.76	70.59	0.100	2.15	0.90	0.32	0.80	1.01	1.0	0.039	1.48	44.02	0.087	2.33	2.24	2
23.786	0.85	0.06	0.95	1.0	0.046	42.06	75.60	0.107	2.30	0.89	0.33	0.80	1.01	1.0	0.039	1.49	50.05	0.092	2.45	2.38	2
23.950	0.84	0.06	0.95	1.0	0.047	40.20	68.43	0.098	2.10	0.89	0.31	0.80	1.01	1.0	0.039	2.17	61.33	0.101	2.70	2.40	2
24.114	0.84	0.05	0.96	1.0	0.047	37.93	59.68	0.087	1.88	0.89	0.27	0.80	1.01	1.0	0.039	3.37	73.35	0.117	3.10	2.49	2
24.278	0.84	0.05	0.96	1.0	0.046	37.93	59.66	0.087	1.88	0.89	0.27	0.80	1.01	1.0	0.039	3.10	67.33	0.108	2.87	2.37	2
24.442	0.84	0.06	0.95	1.0	0.046	40.49	69.54	0.099	2.14	0.89	0.31	0.80	1.01	1.0	0.039	2.05	59.56	0.100	2.62	2.38	2
24.606	0.84	0.07	0.95	1.0	0.046	44.55	85.19	0.120	2.61	0.89	0.37	0.80	1.01	1.0	0.039	1.79	72.69	0.116	3.03	2.82	2
24.770	0.84	0.06	0.95	1.0	0.046	38.80	63.02	0.091	1.97	0.89	0.28	0.80	1.00	1.0	0.039	3.40	82.30	0.132	3.43	2.70	2
24.934	0.84	0.05	0.96	1.0	0.047	37.17	56.75	0.084	1.81	0.89	0.26	0.80	1.00	1.0	0.039	3.96	77.45	0.123	3.18	2.50	2
25.098	0.83	0.05	0.96	1.0	0.047	36.28	53.31	0.081	1.73	0.88	0.24	0.80	1.00	1.0	0.039	4.34	73.97	0.118	3.02	2.38	2
25.262	0.83	0.06	0.95	1.0	0.046	40.09	68.01	0.097	2.09	0.88	0.31	0.80	1.00	1.0	0.039	2.21	61.74	0.102	2.60	2.35	2
25.426	0.83	0.06	0.95	1.0	0.046	40.32	68.90	0.098	2.12	0.88	0.31	0.80	1.00	1.0	0.039	2.54	72.71	0.116	2.93	2.52	2
25.590	0.83	0.05	0.95	1.0	0.047	37.96	59.79	0.088	1.88	0.88	0.27	0.80	1.00	1.0	0.040	3.77	82.36	0.132	3.32	2.60	2
25.754	0.83	0.05	0.96	1.0	0.047	37.40	57.65	0.085	1.83	0.88	0.26	0.80	1.00	1.0	0.040	4.27	86.54	0.140	3.51	2.67	2
25.918	0.83	0.05	0.96	1.0	0.047	36.13	53.49	0.081	1.73	0.88	0.24	0.80	1.00	1.0	0.040	5.00	86.83	0.141	3.50	2.62	2
26.082	0.83	0.05	0.96	1.0	0.047	35.16	49.72	0.077	1.65	0.88	0.22	0.80	1.00	1.0	0.040	5.79	84.24	0.136	3.35	2.50	2
26.246	0.82	0.05	0.96	1.0	0.047	37.25	57.06	0.085	1.81	0.87	0.26	0.80	0.99	1.0	0.040	3.77	74.76	0.119	2.92	2.37	2
26.410	0.82	0.05	0.96	1.0	0.047	36.58	54.47	0.082	1.75	0.87	0.24	0.80	0.99	1.0	0.040	4.48	80.16	0.128	3.13	2.44	2
26.574	0.82	0.05	0.96	1.0	0.047	36.31	54.18	0.082	1.74	0.87	0.24	0.80	0.99	1.0	0.040	4.91	87.67	0.143	3.47	2.60	2
26.739	0.82	0.05	0.96	1.0	0.047	36.45	54.71	0.082	1.75	0.87	0.25	0.80	0.99	1.0	0.040	4.84	88.43	0.144	3.49	2.62	2
26.903	0.82	0.05	0.95	1.0	0.047	38.08	60.28	0.088	1.88	0.87	0.27	0.80	0.99	1.0	0.040	3.55	78.85	0.126	3.02	2.45	2
27.067	0.82	0.06	0.95	1.0	0.047	40.40	69.20	0.099	2.11	0.87	0.31	0.80	0.99	1.0	0.040	3.01	86.67	0.141	3.36	2.73	2
27.231	0.82	0.06	0.95	1.0	0.047	39.51	65.78	0.094	2.02	0.87	0.30	0.80	0.99	1.0	0.040	3.27	85.87	0.139	3.30	2.66	2
27.395	0.82	0.06	0.95	1.0	0.047	39.16	64.43	0.093	1.98	0.87	0.29	0.80	0.99	1.0	0.040	3.59	90.66	0.149	3.52	2.75	2
27.559	0.81	0.05	0.95	1.0	0.047	37.20	56.86	0.084	1.80	0.86	0.26	0.80	0.99	1.0	0.040	4.23	83.15	0.133	3.13	2.46	2
27.723	0.81	0.06	0.95	1.0	0.047	39.29	64.91	0.093	1.99	0.86	0.29	0.80	0.99	1.0	0.040	3.11	79.73	0.127	2.97	2.48	2
27.887	0.81	0.05	0.95	1.0	0.047	37.60	58.41	0.086	1.83	0.86	0.26	0.80	0.98	1.0	0.041	3.98	82.85	0.133	3.08	2.46	2
28.051	0.81	0.06	0.95	1.0	0.047	39.47	65.61	0.094	2.01	0.86	0.30	0.80	0.98	1.0	0.041	3.04	79.33	0.126	2.92	2.46	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.468

Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
8.50	500	1.8E-03	4.6E+02	3.3E-04	10	0.227	6757	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.22%	0.0036
8.55	500	1.8E-03	4.6E+02	3.3E-04	10	0.227	6740	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.25%	0.0037
8.60	500	1.8E-03	4.6E+02	3.3E-04	10	0.228	6722	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.28%	0.0037
8.65	500	1.8E-03	4.6E+02	3.3E-04	10	0.228	6705	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.31%	0.0038
8.70	500	1.8E-03	4.6E+02	3.3E-04	10	0.228	6688	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.34%	0.0038
8.75	500	1.8E-03	4.6E+02	3.4E-04	10	0.229	6671	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.37%	0.0039
8.80	500	1.8E-03	4.6E+02	3.4E-04	10	0.229	6654	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.39%	0.0039
8.85	500	1.8E-03	4.6E+02	3.4E-04	10	0.229	6637	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.42%	0.0040
8.90	500	1.8E-03	4.6E+02	3.4E-04	10	0.230	6620	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.45%	0.0040
8.95	500	1.8E-03	4.6E+02	3.4E-04	10	0.230	6604	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.48%	0.0041
9.00	500	1.8E-03	4.6E+02	3.5E-04	10	0.230	6588	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.51%	0.0041
9.05	500	1.8E-03	4.6E+02	3.5E-04	10	0.231	6572	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.54%	0.0042
9.10	500	1.8E-03	4.6E+02	3.5E-04	10	0.231	6556	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.57%	0.0042
9.15	500	1.8E-03	4.6E+02	3.5E-04	10	0.232	6540	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.60%	0.0043
9.20	538	1.8E-03	5.3E+02	3.1E-04	10	0.232	6524	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.81%	0.0030
9.25	538	1.8E-03	5.3E+02	3.1E-04	10	0.232	6508	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.84%	0.0030
9.30	538	1.8E-03	5.3E+02	3.1E-04	10	0.233	6493	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.86%	0.0031
9.35	538	1.8E-03	5.3E+02	3.1E-04	10	0.233	6477	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.88%	0.0031
9.40	538	1.8E-03	5.3E+02	3.1E-04	10	0.233	6462	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.91%	0.0031
9.45	538	1.8E-03	5.3E+02	3.2E-04	10	0.234	6447	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.93%	0.0032
9.50	538	1.8E-03	5.3E+02	3.2E-04	10	0.234	6432	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.95%	0.0032
9.55	538	1.8E-03	5.3E+02	3.2E-04	10	0.234	6417	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.97%	0.0032
9.60	538	1.8E-03	5.3E+02	3.2E-04	10	0.235	6402	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.00%	0.0033
9.65	538	1.8E-03	5.3E+02	3.2E-04	10	0.235	6388	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.02%	0.0033
9.70	538	1.8E-03	5.3E+02	3.2E-04	10	0.235	6373	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.04%	0.0034
9.75	538	1.8E-03	5.3E+02	3.3E-04	10	0.236	6359	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.07%	0.0034
9.80	538	1.8E-03	5.3E+02	3.3E-04	10	0.236	6344	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.09%	0.0034
9.85	538	1.8E-03	5.3E+02	3.3E-04	10	0.236	6330	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.11%	0.0035
9.90	538	1.8E-03	5.3E+02	3.3E-04	10	0.236	6316	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.14%	0.0035
9.95	538	1.8E-03	5.3E+02	3.3E-04	10	0.237	6302	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.16%	0.0035
10.00	538	1.8E-03	5.1E+02	3.5E-04	16	0.488	5186	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.61%	0.0043
10.05	538	1.8E-03	5.1E+02	3.5E-04	16	0.488	5176	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.63%	0.0043
10.10	538	1.8E-03	5.3E+02	3.4E-04	10	0.238	6262	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.23%	0.0037
10.15	538	1.8E-03	5.3E+02	3.4E-04	10	0.238	6248	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.25%	0.0037
10.20	538	1.8E-03	5.3E+02	3.4E-04	10	0.238	6235	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.27%	0.0037
10.25	538	1.8E-03	5.3E+02	3.4E-04	10	0.239	6221	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.30%	0.0038
10.30	538	1.8E-03	5.3E+02	3.5E-04	10	0.239	6208	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.32%	0.0038
10.35	538	1.8E-03	5.3E+02	3.5E-04	10	0.239	6195	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.35%	0.0038
10.40	538	1.8E-03	5.3E+02	3.5E-04	10	0.240	6182	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.37%	0.0039
10.45	538	1.8E-03	5.3E+02	3.5E-04	10	0.240	6169	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.39%	0.0039
10.50	538	1.8E-03	5.3E+02	3.5E-04	10	0.240	6156	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.42%	0.0040
10.55	538	1.8E-03	5.3E+02	3.5E-04	10	0.241	6143	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.44%	0.0040
10.60	538	1.8E-03	5.3E+02	3.6E-04	10	0.241	6130	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.46%	0.0040
10.65	538	1.8E-03	5.3E+02	3.6E-04	10	0.241	6118	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.49%	0.0041
10.70	538	1.8E-03	5.3E+02	3.6E-04	10	0.241	6110	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.51%	0.0041
10.75	594	1.8E-03	6.5E+02	3.0E-04	10	0.241	6104	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.54%	0.0025
10.80	594	1.8E-03	6.5E+02	3.0E-04	10	0.242	6098	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.56%	0.0026
10.85	594	1.8E-03	6.5E+02	3.0E-04	10	0.242	6092	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.58%	0.0026
10.90	594	1.8E-03	6.5E+02	3.0E-04	10	0.242	6086	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.60%	0.0026
10.95	594	1.8E-03	6.5E+02	3.0E-04	10	0.242	6080	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.62%	0.0027
11.00	594	1.8E-03	6.5E+02	3.0E-04	10	0.242	6074	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.64%	0.0027
11.05	594	1.8E-03	6.5E+02	3.1E-04	10	0.242	6068	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.66%	0.0027
11.10	594	1.8E-03	6.2E+02	3.2E-04	16	0.493	5002	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.05%	0.0034
11.15	594	1.8E-03	6.2E+02	3.2E-04	16	0.493	4998	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.06%	0.0034
11.20	594	1.8E-03	6.5E+02	3.1E-04	10	0.243	6052	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.71%	0.0028
11.25	594	1.8E-03	6.5E+02	3.1E-04	10	0.243	6046	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.73%	0.0028
11.30	594	1.8E-03	6.2E+02	3.3E-04	16	0.494	4984	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.13%	0.0035
11.35	594	1.8E-03	6.2E+02	3.3E-04	16	0.494	4980	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.15%	0.0035
11.40	594	1.8E-03	6.5E+02	3.2E-04	10	0.243	6030	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.79%	0.0029
11.45	594	1.8E-03	6.5E+02	3.2E-04	10	0.243	6025	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.81%	0.0030
11.50	594	1.8E-03	6.5E+02	3.2E-04	10	0.244	6019	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.83%	0.0030
11.55	594	1.8E-03	6.5E+02	3.2E-04	10	0.244	6013	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.85%	0.0030
11.60	594	1.8E-03	6.5E+02	3.2E-04	10	0.244	6008	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.87%	0.0031
11.65	594	1.8E-03	6.5E+02	3.2E-04	10	0.244	6002	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.88%	0.0031
11.70	594	1.8E-03	6.5E+02	3.2E-04	10	0.244	5996	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.90%	0.0031
11.75	594	1.8E-03	6.5E+02	3.3E-04	10	0.244	5991	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.92%	0.0032
12.19	594	1.8E-03	6.5E+02	3.4E-04	10	0.246	5916	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.09%	0.0301

Extra layer added to analyze seismic settlement of tailings below the bottom of CPT investigation.

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-1S

Data File: 13-52106_SP3-1S-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Description
5608.00	Water surface elevation during CPT investigation (ft amsl)
5604.28	Water surface elevation at t_0 (ft amsl)
5595.59	Water surface elevation at t_1 (ft amsl)
5590.59	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Eart
7.51	Equiv. Number of Uniform Strain Cycles, N
5612.56	Ground Surface Elevation at time of CPT (ft amsl)
5620.47	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
0.41	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
887.10	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5590.59	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	$P = \gamma_{eff}*(G_{eff}/G_{max})$ (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5620.22	5619.97	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5618.22	5616.47	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5614.72	5612.97	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320	1.75	508	1.9E-03	4.8E+02	6.5E-05	11	0.152	12657	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######	5612.77	5612.56	0.41	0.050	101	0.445	0.434	0.00	0.00	0.445	0.434	2.35	508	1.6E-03	4.0E+02	1.0E-04	11	0.164	11140	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q	Normalized Friction Ratio, F (%)	Type Index, Ic	FC %
0.164	5612.40	1.0	0.010	1.0	-0.2	-0.10	1.00%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	1.700	23.63	1.97	120	1.01%	1.9	51%
0.328	5612.23	1.0	0.010	1.0	-0.2	0.19	1.00%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	1.700	23.63	1.98	60	1.01%	2.1	51%
0.492	5612.07	1.0	0.010	1.0	-0.1	-0.04	1.00%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	1.700	23.63	1.97	39	1.03%	2.2	51%
0.656	5611.90	1.0	0.010	1.0	-0.2	-0.08	1.00%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	1.700	23.63	1.97	29	1.04%	2.4	51%
0.820	5611.74	5.6	0.026	5.6	14.4	6.23	0.46%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	9.435	131.15	11.14	136	0.46%	1.6	51%
0.984	5611.58	9.5	0.093	9.4	16.6	7.20	0.98%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	15.929	221.41	18.71	190	0.99%	1.7	51%
1.148	5611.41	19.7	0.245	19.6	13.4	5.80	1.24%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	33.371	463.86	38.92	340	1.25%	1.6	51%
1.312	5611.25	35.4	0.510	35.4	11.0	4.76	1.44%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	60.146	836.03	69.99	535	1.44%	1.6	51%
1.476	5611.08	80.0	0.912	79.9	17.9	7.76	1.14%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	135.830	1888.04	157.98	1075	1.14%	1.4	51%
1.640	5610.92	89.0	1.063	88.9	17.5	7.59	1.19%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	151.130	2100.71	175.74	1076	1.20%	1.4	51%
1.804	5610.76	96.1	1.232	96.1	7.4	3.19	1.28%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	163.370	2270.84	189.84	1057	1.28%	1.4	51%
1.968	5610.59	77.7	1.349	77.7	5.5	2.40	1.74%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	132.073	1835.81	153.46	783	1.74%	1.6	51%
2.133	5610.43	53.3	1.640	53.3	9.6	4.14	3.07%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	90.576	1259.01	105.32	496	3.08%	1.9	51%
2.297	5610.26	46.3	1.974	46.2	9.6	4.14	4.27%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	78.557	1091.94	91.36	399	4.28%	2.0	51%
2.461	5610.10	39.8	1.642	39.7	8.0	3.48	4.13%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	67.507	938.35	78.50	320	4.14%	2.1	51%
2.625	5609.94	45.3	1.613	45.3	4.3	1.87	3.56%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.70	76.959	1069.73	89.44	342	3.57%	2.0	51%
2.789	5609.77	38.8	1.441	38.8	0.7	0.30	3.72%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0	1.70	65.892	915.90	76.54	275	3.73%	2.1	51%
2.953	5609.61	36.0	1.125	36.0	0.5	0.22	3.13%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0	1.70	61.149	849.97	71.03	241	3.14%	2.0	51%
3.117	5609.44	31.9	1.113	31.9	-1.8	-0.76	3.49%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0	1.70	54.213	753.56	62.94	202	3.51%	2.1	51%
3.281	5609.28	30.2	1.010	30.2	-1.8	-0.77	3.35%	Slime Tailings	0.041	82.7	0.16	0.00	0.16	0	1.70	51.306	713.15	59.57	183	3.37%	2.1	71%
3.445	5609.12	27.8	0.976	27.8	-1.7	-0.73	3.52%	Slime Tailings	0.041	82.7	0.17	0.00	0.17	0	1.70	47.209	656.21	54.81	162	3.54%	2.2	71%
3.609	5608.95	23.2	0.881	23.2	-1.0	-0.45	3.80%	Slime Tailings	0.041	82.7	0.18	0.00	0.18	0	1.70	39.406	547.74	45.75	130	3.83%	2.3	71%
3.773	5608.79	18.8	1.037	18.8	-0.3	-0.12	5.50%	Slime Tailings	0.041	82.7	0.18	0.00	0.18	0	1.70	32.028	445.19	37.20	101	5.56%	2.5	71%
3.937	5608.62	11.7	1.018	11.7	-0.3	-0.13	8.69%	Slime Tailings	0.041	82.7	0.19	0.00	0.19	0	1.70	19.907	276.71	23.12	60	8.84%	2.7	71%
4.101	5608.46	25.7	1.084	25.7	0.5	0.20	4.22%	Slime Tailings	0.041	82.7	0.20	0.00	0.20	0	1.70	43.622	606.35	50.67	129	4.26%	2.3	71%
4.265	5608.29	24.3	1.143	24.3	0.5	0.20	4.70%	Slime Tailings	0.041	82.7	0.20	0.00	0.20	0	1.70	41.361	574.92	48.04	118	4.74%	2.4	71%
4.429	5608.13	21.7	1.211	21.7	-1.0	-0.45	5.58%	Slime Tailings	0.041	82.7	0.21	0.00	0.21	0	1.70	36.907	513.01	42.85	102	5.63%	2.5	71%
4.593	5607.97	36.9	1.373	36.9	-0.2	-0.10	3.72%	Slime Tailings	0.057	113.1	0.22	0.00	0.22	1	1.70	62.696	871.47	72.81	167	3.75%	2.2	71%
4.757	5607.80	75.7	1.484	75.7	0.5	0.20	1.96%	Sand-Slime Tailings	0.059	119.0	0.23	0.01	0.22	1	1.70	128.690	1788.79	149.47	337	1.97%	1.8	47%
4.921	5607.64	90.7	1.093	90.7	1.8	0.79	1.21%	Sand Tailings	0.062	123.5	0.24	0.01	0.23	1	1.63	147.850	2055.11	171.74	395	1.21%	1.6	18%
5.085	5607.47	113.7	1.047	113.6	8.3	3.60	0.92%	Sand Tailings	0.062	123.5	0.25	0.02	0.23	1	1.53	173.889	2417.06	202.05	484	0.92%	1.4	18%
5.249	5607.31	123.4	0.699	123.3	4.9	2.11	0.57%	Sand Tailings	0.062	123.5	0.26	0.02	0.24	1	1.49	183.875	2555.86	213.61	515	0.57%	1.2	18%
5.413	5607.15	101.2	0.707	101.2	3.6	1.54	0.70%	Sand Tailings	0.062	123.5	0.27	0.03	0.24	1	1.56	157.808	2193.53	183.32	414	0.70%	1.4	18%
5.577	5606.98	80.8	0.675	80.8	2.2	0.94	0.84%	Sand Tailings	0.062	123.5	0.28	0.03	0.25	1	1.64	132.252	1838.30	153.63	323	0.84%	1.5	18%
5.741	5606.82	76.8	0.595	76.8	2.1	0.89	0.78%	Sand Tailings	0.062	123.5	0.29	0.04	0.25	1	1.65	126.407	1757.06	146.84	301	0.78%	1.5	18%
5.905	5606.65	74.6	0.547	74.6	2.0	0.86	0.73%	Sand Tailings	0.062	123.5	0.30	0.04	0.26	1	1.65	122.801	1706.93	142.65	287	0.74%	1.5	18%
6.069	5606.49	70.2	0.520	70.2	1.3	0.57	0.74%	Sand Tailings	0.062	123.5	0.31	0.05	0.26	1	1.66	116.482	1619.10	135.30	265	0.74%	1.5	18%
6.234	5606.33	60.0	0.488	60.0	1.2	0.52	0.81%	Sand Tailings	0.062	123.5	0.32	0.05	0.27	1	1.70	101.915	1416.62	118.38	222	0.82%	1.6	18%
6.398	5606.16	59.3	0.442	59.3	0.8	0.36	0.75%	Sand Tailings	0.062	123.5	0.33	0.06	0.27	1	1.70	100.623	1398.66	116.88	215	0.75%	1.6	18%
6.562	5606.00	58.2	0.392	58.2	1.2	0.52	0.67%	Sand Tailings	0.062	123.5	0.34	0.06	0.28	1	1.69	98.587	1370.35	114.52	207	0.68%	1.6	18%
6.726	5605.83	53.1	0.371	53.1	1.1	0.46	0.70%	Sand Tailings	0.062	123.5	0.35	0.07	0.28	1	1.70	90.304	1255.23	104.90	186	0.70%	1.6	18%
6.890	5605.67	49.1	0.311	49.1	0.6	0.26	0.63%	Sand Tailings	0.062	123.5	0.36	0.07	0.29	1	1.70	83.470	1160.23	96.95	169	0.64%	1.6	18%
7.054	5605.51	56.4	0.288	56.4	1.2	0.51	0.51%	Sand Tailings	0.062	123.5	0.37	0.08	0.29	1	1.67	94.245	1310.00	109.47	191	0.51%	1.5	18%
7.218	5605.34	56.4	0.275	56.4	1.4	0.59	0.49%	Sand Tailings	0.062	123.5	0.38	0.08	0.30	1	1.66	93.553	1300.38	108.67	187	0.49%	1.5	18%
7.382	5605.18	44.0	0.351	44.0	0.2	0.09	0.80%	Sand Tailings	0.062	123.5	0.39	0.09	0.30	1	1.70	74.766	1039.25	86.84	143	0.81%	1.7	18%
7.546	5605.01	36.9	0.372	36.9	-0.1	-0.05	1.01%	Sand-Slime Tailings	0.059	119.0	0.40	0.09	0.31	1	1.70	62.747	872.18	72.88	118	1.02%	1.9	47%
7.710	5604.85	30.0	0.299	30.0	0.2	0.08	1.00%	Sand-Slime Tailings	0.059	119.0	0.41	0.10	0.31	1	1.70	51.034	709.37	59.28	94	1.01%	1.9	47%
7.874	5604.69	32.9	0.212	32.9	1.1	0.46	0.64%	Sand-Slime Tailings	0.059	119.0	0.42	0.10	0.32	1	1.70	55.896	776.95	64.93	102	0.65%	1.8	47%
8.038	5604.52	38.9	0.166	38.9	2.2	0.94	0.43%	Sand Tailings	0.062	123.5	0.43	0.11	0.32	1	1.70	66.079	918.50	76.77	119	0.43%	1.6	18%
8.202	5604.36	38.5	0.158	38.5	1.2	0.52	0.41%	Sand Tailings	0.062	123.5	0.44	0.11	0.33	1	1.70	65.399	909.05	75.97	116	0.42%	1.6	18%
8.366	5604.19	36.9	0.159	36.9	0.5	0.22	0.43%	Sand Tailings	0.062	123.5	0.45	0.12	0.33	1	1.70	62.798	872.89	72.94	110	0.44%	1.7	18%
8.530	5604.03	31.2	0.156	31.2	-0.5	-0.20	0.50%	Sand-Slime Tailings	0.059	119.0	0.46	0.12	0.34	1	1.70	53.040	737.26	61.60	91	0.51%	1.8	47%
8.694	5603.87	24.0	0.142	24.0	-0.2	-0.09	0.59%	Sand-Slime Tailings	0.059	119.0	0.47	0.13	0.34	1	1.70	40.800	567.12	47.39	69	0.60%	1.9	47%
8.858	5603.70	20.0	0.119	20.0	3.7	1.59	0.60%	Sand-Slime Tailings	0.059	119.0	0.48	0.13	0.35	1	1.70	33.949	471.89	39.48	56	0.61%	2.0	47%
9.022	5603.54	23.7	0.086	23.7	6.8	2.94	0.36%	Sand-Slime Tailings	0.059	119.0	0.49	0.14	0.35	1	1.70	40.273	559.79	46.86	66	0.37%	1.8	47%
9.186	5603.37	27.5	0.145	27.5	5.4	2.34	0.53%	Sand-Slime Tailings	0.059	119.0	0.50	0.14	0.36	1	1.70	46.665	648.64	54.27	76	0.54%	1.9	47%
9.350	5603.21	37.0	0.177	37.0	6.8	2.95	0.48%	Sand Tailings	0.062	123.5	0.51	0.15	0.36	1	1.64	60.777	844.79	70.61	101	0.48%	1.7	18%
9.514	5603.05	43.3	0.205	43.3	8.3	3.61	0.47%	Sand Tailings	0.062	123.5	0.52	0.15	0.37	1	1.59	68.941	958.28	80.17	117	0.48%	1.7	18%
9.678	5602.88	41.4	0.300	41.3	6.0	2.61	0.73%	Sand Tailings	0.062	123.5	0.53	0.16	0.37	1	1.59	65.913	916.19	76.62	110	0.73%	1.8	18%
9.842	5602.72	27.8	0.053	27.7	6.0	2.62	0.19%	Sand-Slime Tailings	0.059	119.0	0.54	0.16	0.38	1	1.68	46.511	646.50	54.09	72	0.19%	1.7	47%
10.006	5602.55	18.0	0.353	17.9	7.9	3.43	1.96%	Sand-Slime Tailings	0.059	119.0	0.55	0.17	0.38	1	1.70	30.464	423.45	35.48	46	2.03%	2.4	47%
10.170	5602.39	8.2	0.125	8.2	7.0	3.02	1.52%	Slime Tailings	0.057	113.1	0.56	0.18	0.38	1	1.70	13.889	193.06	16.22	20	1.63%	2.6	71%
10.335	5602.23	13.5	0.090	13.4	11.9	5.17	0.67%	Sand-Slime Tailings	0.059	119.0	0.57	0.18	0.39	1	1.70	22.763	316.41	26.58	33	0.70%	2.2	47%
10.499	5602.06	10.5	0.118	10.3	21.6	9.36	1.13%	Sand-Slime Tailings	0.059	119.0	0.58	0.19	0.39	1	1.70	17.561	244.10	20.66	25	1.19%	2.4	47%
10.663	5601.90	9.7	0.087	9.5	38.5	16.68	0.89%	Sand-Slime Tailings	0.059	119.0	0.59	0.19	0.40	1	1.70	16.150	224.49	19.23	23	0.95%	2.4	47%
10.827	5601.73	10.0	0.117	9.7	46.7	20.25	1.17%	Sand-Slime Tailings	0.059	119.0	0.60	0.20	0.40	1	1.70	16.490	229.21	19.73	23	1.25%	2.5	47%
10.991	5601.57	10.2	0.059	9.9	46.8	20.28	0.58%	Sand-Slime Tailings	0.059	119.0	0.61	0.20	0.41	1	1.70	16.898	234.88	20.20	24	0.61%	2.3	47%
11.155	5601.41	16.6	0.090	16.3	43.7	18.93	0.54%	Sand-Slime Tailings	0.059	119.0	0.62	0.21	0.41	1	1.69	27.563	383.13	32.55	39	0.56%	2.1	47%
11.319	5601.24	15.8	0.118	15.7	25.2	10.92	0.75%	Sand-Slime Tailings	0.059	119.0	0.63	0.21	0.42	1	1.69	26.439	367.50	31.02	36	0.78%	2.2	47%
11.483	5601.08	12.9	0.083	12.7	24.3	10.51	0.64%	Sand-Slime Tailings	0.059	119.0	0.64	0.22	0.42	1	1.70	21.658	301.05	25.45	29	0.68%	2.3	47%
11.647	5600.91	11.0	0.114	10.8	43.0	18.65	1.03%	Sand-Slime Tailings	0.059	119.0	0.65	0.22	0.43	1	1.70	18.309	254.50	21.80	24	1.10%	2.4	47%
11.811	5600.75	9.6	0.088	9.2	64.1	27.78	0.91%	Sand-Slime Tailings	0.059	119.0	0.66	0.23	0.43	1	1.70	15.691	218.10	19.01	21	0.98%	2.5	47%
11.975	5600.59	9.8	0.035	9.4	61.1	26.46	0.36%	Sand-Slime Tailings	0.059	119.0	0.67	0.23	0.44	1	1.70	16.014	222.59	19.35	21	0.38%	2.1	47%
12.139	5600.42	9.7	0.064	9.4	51.9	22.49	0.66%	Sand-Slime Tailings	0.059	119.0	0.68	0.24	0.44	1	1.69	15.804	219.68	18.99	20	0.71%	2.4	47%
12.303	5600.26	11.1	0.121	10.7	65.5	28.37	1.09%	Sand-Slime Tailings	0.059	119.0	0.69	0.24	0.45	1	1.67	18.474	248.45	21.55	23	1.16%	2.5	47%
12.467	5600.09	16.8	0.110	16.4	67.8	29.38	0.66%	Sand-Slime Tailings	0.059	119.0	0.70	0.25	0.45	1	1.60	26.138	363.32	31.14	36	0.70%	2.2	47%
12.631	5599.93	30.9	0.086	30.8	23.6	10.23	0.28%	Sand Tailings	0.062	123.5	0.71	0.25	0.45	1	1.49	45.876	637.67	53.54	66	0.28%	1.8	18%
12.795	5599.76	30.6	0.167	30.5	23.2	10.07	0.55%	Sand-Slime Tailings	0.059	119.0	0.72	0.26	0.46	1	1.48	45.171	628.16	52.74	65	0.56%	1.9	47%
12.959	5599.60	24.9	0.293	24.8	9.7	4.19	1.18%	Sand-Slime Tailings	0.059	119.0	0.73	0.26	0.46	1	1.51	37.430	520.28	43.58	52	1.21%	2.2	47%
13.123	5599.44	22.1	0.250	22.0	13.6	5.90	1.13%	Sand-Slime Tailings	0.059	119.0	0.74	0.27	0.47	1	1.52	33.392	464.15	38.93	46	1.17%	2.2	47%
13.287	5599.27	17.9	0.174	17.8	18.4	7.98	0.97%	Sand-Slime Tailings	0.059	119.0	0.75	0.27	0.47	1	1.53	27.284	379.25	31.89	36	1.02%	2.3	47%
13.451	5599.11	18.6	0.120	18.3	33.7	14.61	0.65%	Sand-Slime Tailings	0.059	119.0	0.76	0.28	0.48	1	1.52	27.891	387.68	32.76	37	0.67%	2.2	47%
13.615	5598.94	19.0	0.093	18.8	27.6	11.94	0.49%	Sand-Slime Tailings	0.059	119.0	0.77	0.28	0.48	1	1.51	28.342	393.95	33.22	38	0.51%	2.1	47%
13.779	5598.78	18.8	0.035	18.6	24.7	10.70	0.19%	Sand-Slime Tailings	0.059	119.0	0.77	0.29	0.49	1	1.50	27.908	387.92	32.68	37	0.19%	2.0	47%
13.943	5598.62	17.5	0.045	17.4	14.9	6.47	0.26%	Sand-Slime Tailings	0.059	119.0	0.78	0.29	0.49	1	1.50	26.084	362.57	30.46	34	0.27%	2.0	47%
14.107	5598.45	15.4	0.100	15.2	27.0	11.68	0.65%	Sand-Slime Tailings	0.059	119.0	0.79	0.30	0.49	1	1.51	22.922	318.61	26.92	30	0.69%	2.3	47%
14.271	5598.29	16.8	0.261	16.6	35.9	15.54	1.55%	Sand-Slime Tailings	0.059	119.0	0.80	0.30	0.50	1	1.49	24.694	343.25	29.07	32	1.63%	2.5	47%
14.436	5598.12	15.9	0.208	15.7	41.2	17.86	1.31%	Sand-Slime Tailings	0.059	119.0	0.81	0.31	0.50	1	1.48	23.240	323.03	27.43	30	1.38%	2.5	47%
14.600	5597.96	17.8	0.165	17.6	26.3	11.41	0.93%	Sand-Slime Tailings	0.059	119.0	0.82	0.31	0.51	1	1.46	25.776	358.29	30.22	33	0.97%	2.3	47%
14.764	5597.80	15.1	0.105	15.0	23.2	10.06	0.70%	Sand-Slime Tailings	0.059	119.0	0.83	0.32	0.51	1	1.48	21.980	305.52	25.88	28	0.74%	2.3	47%
14.928	5597.63	16.4	0.396	16.2	36.8	15.96	2.41%	Sand-Slime Tailings	0.059	119.0	0.84	0.32	0.51	1	1.45	23.438	326.48	27.67	30	2.53%	2.6	47%
15.092	5597.47	15.6	0.201	15.3	59.5	25.80	1.29%	Sand-Slime Tailings	0.059	119.0	0.85	0.33	0.52	1	1.45	22.121	307.48	26.32	28	1.36%	2.4	47%
15.256	5597.30	25.6	0.270	25.4	23.7	10.26	1.05%	Sand-Slime Tailings	0.059	119.0	0.86	0.33	0.52	1	1.39	35.371	491.67	41.20	47	1.06%	2.1	47%
15.420	5597.14	21.4	0.308	21.3	15.0	6.48	1.44%	Sand-Slime Tailings	0.059	119.0	0.87	0.34	0.53	1	1.40	29.754	413.58	34.71	38	1.50%	2.3	47%
15.584	5596.98	18.8	0.188	18.7	18.8	8.16	1.00%	Sand-Slime Tailings	0.059	119.0	0.88	0.34	0.53	1	1.40	26.274	365.21	30.71	33	1.05%	2.3	47%
15.748	5596.81	20.6	0.295	20.4	17.8	7.78	1.44%	Sand-Slime Tailings	0.059	119.0	0.89	0.35	0.54	1	1.38	28.185	391.77	32.98	36	1.51%	2.3	47%
15.912	5596.65	16.7	0.237	16.4	37.1	16.09	1.42%	Sand-Slime Tailings	0.059	119.0	0.90	0.35	0.55	1	1.40	22.984	319.47	27.07	29	1.50%	2.4	47%
16.076	5596.48	19.3	0.193	19.0	48.9	21.20	1.00%	Sand-Slime Tailings	0.059	119.0	0.91	0.36	0.55	1	1.38	26.545	368.97	31.20	33	1.05%	2.3	47%
16.240	5596.32	21.9	0.284	21.7	42.0	18.19	1.30%	Sand-Slime Tailings	0.059	119.0	0.92	0.36	0.56	1	1.37	29.805	414.29	34.86	38	1.36%	2.3	47%
16.404	5596.16	21.9	0.319	21.5	65.3	28.28	1.46%	Sand-Slime Tailings	0.059	119.0	0.93	0.37	0.56	1	1.35	29.002	403.13	34.32	37	1.53%	2.4	47%
16.568	5595.99	28.0	0.500	27.9	24.0	10.38	1.78%	Sand-Slime Tailings	0.059	119.0	0.94	0.37	0.57	1	1.32	36.866	512.44	43.25	48	1.85%	2.3	47%
16.732	5595.83	19.0	0.522	18.7	40.7	17.62	2.75%	Slime Tailings	0.057	113.1	0.95	0.38	0.57	1	1.35	25.254	351.03	29.73	32	2.90%	2.6	71%
16.896	5595.66	22.1	0.393	21.7	112.6	48.78	1.78%	Sand-Slime Tailings	0.059	119.0	0.96	0.39	0.57	1	1.32	28.443	395.33	34.12	37	1.86%	2.4	47%
17.060	5595.50	22.9	0.460	22.6	47.8	20.69	2.01%	Sand-Slime Tailings	0.059	119.0	0.97	0.40	0.58	1	1.32	29.824	414.56	35.10	38	2.11%	2.5	47%
17.224	5595.34	19.0	0.308	18.5	76.9	33.34	1.62%	Sand-Slime Tailings	0.059	119.0	0.98	0.40	0.58	1	1.33	24.585	341.73	29.29	31	1.71%	2.5	47%

Conditions at t_1 / Liquefaction Triggering Analyses

Idriss & Boulanger (2008): Cyclic Stress Ratio (r_d, C_σ, K_σ, K_α, CSR M=7.5, s'v=1atm); Cyclic Resistance Ratio (Δqc_{1n}, qc_{1n-cs}, (CRR) M=7.5, s'v=1atm); FoS. Youd et al. (2001): Cyclic Stress Ratio (r_d, D_r, f, K_σ, K_α, CSR M=7.5, s'v=1atm); Kc, qc_{1n-cs}, (CRR) M=7.5, s'v=1atm; FoS.

Depth at time of CPT (ft)	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	I&B r_d	I&B C_σ	I&B K_σ	I&B K_α	I&B CSR	I&B Δqc_{1n}	I&B qc_{1n-cs}	I&B (CRR)	I&B FoS	Youd r_d	Youd D_r	Youd f	Youd K_σ	Youd K_α	Youd CSR	Youd Kc	Youd qc_{1n-cs}	Youd (CRR)	Youd FoS	Avg FoS	Liquefiable? 1=Yes 2=No
0.164	0.45	0.00	0.45	0	1.00	0.04	1.02	1.0	0.059	31.01	32.98	0.063	1.07	0.98	0.08	0.80	2.53	1.0	0.017	1.15	2.26	0.052	125.00	63.03	2
0.328	0.46	0.00	0.46	0	1.00	0.04	1.02	1.0	0.059	31.02	32.99	0.063	1.07	0.98	0.08	0.80	2.20	1.0	0.020	1.44	2.85	0.052	63.11	32.09	2
0.492	0.47	0.00	0.47	0	1.00	0.04	1.02	1.0	0.059	31.01	32.99	0.063	1.07	0.98	0.08	0.80	2.03	1.0	0.021	1.78	3.51	0.053	42.54	21.80	2
0.656	0.48	0.00	0.48	0	1.00	0.04	1.02	1.0	0.059	31.01	32.98	0.063	1.07	0.98	0.08	0.80	1.92	1.0	0.023	2.14	4.21	0.054	32.26	16.67	2
0.820	0.48	0.00	0.48	0	1.00	0.05	1.03	1.0	0.059	34.23	45.36	0.073	1.23	0.98	0.19	0.80	1.84	1.0	0.024	1.00	11.14	0.059	28.61	14.92	2
0.984	0.49	0.00	0.49	0	1.00	0.05	1.03	1.0	0.059	36.88	55.59	0.083	1.40	0.98	0.25	0.80	1.77	1.0	0.024	1.04	19.42	0.066	26.63	14.01	2
1.148	0.50	0.00	0.50	0	1.00	0.06	1.03	1.0	0.060	43.98	82.90	0.117	1.95	0.98	0.36	0.80	1.72	1.0	0.025	1.00	38.92	0.082	28.43	15.19	2
1.312	0.51	0.00	0.51	0	1.00	0.08	1.04	1.0	0.060	54.88	124.87	0.190	3.16	0.98	0.48	0.76	1.86	1.0	0.023	1.00	69.99	0.112	33.79	18.47	2
1.476	0.52	0.00	0.52	0	1.00	0.17	1.09	1.0	0.063	85.76	243.74	1.000	15.91	0.98	0.73	0.64	2.43	1.0	0.018	1.00	157.98	0.447	119.94	67.93	2
1.640	0.53	0.00	0.53	0	1.00	0.20	1.10	1.0	0.064	91.99	267.74	1.000	15.73	0.98	0.77	0.62	2.45	1.0	0.018	1.00	175.74	1.000	241.77	128.75	2
1.804	0.53	0.00	0.53	0	1.00	0.23	1.10	1.0	0.064	96.94	286.77	1.000	15.73	0.98	0.80	0.60	2.45	1.0	0.018	1.00	189.84	1.000	219.87	117.80	2
1.968	0.54	0.00	0.54	0	1.00	0.16	1.08	1.0	0.062	84.18	237.64	1.000	16.09	0.98	0.72	0.64	2.17	1.0	0.020	1.00	153.46	0.416	83.90	50.00	2
2.133	0.55	0.00	0.55	0	1.00	0.11	1.05	1.0	0.061	67.28	172.60	0.435	7.18	0.98	0.59	0.70	1.85	1.0	0.023	1.17	122.92	0.253	47.06	27.12	2
2.297	0.56	0.00	0.56	0	1.00	0.10	1.04	1.0	0.060	62.38	153.74	0.290	4.81	0.98	0.55	0.72	1.74	1.0	0.025	1.36	124.55	0.260	44.92	24.86	2
2.461	0.57	0.00	0.57	0	1.00	0.09	1.04	1.0	0.060	57.87	136.37	0.221	3.70	0.98	0.51	0.74	1.64	1.0	0.026	1.41	110.83	0.207	33.36	18.53	2
2.625	0.58	0.00	0.58	0	1.00	0.10	1.04	1.0	0.060	61.71	151.14	0.277	4.62	0.98	0.55	0.73	1.67	1.0	0.026	1.31	116.85	0.228	34.59	19.61	2
2.789	0.58	0.00	0.58	0	0.99	0.09	1.03	1.0	0.059	57.18	133.72	0.213	3.58	0.98	0.51	0.75	1.58	1.0	0.027	1.40	107.01	0.194	27.66	15.62	2
2.953	0.59	0.00	0.59	0	0.99	0.08	1.03	1.0	0.059	55.25	126.27	0.194	3.27	0.97	0.49	0.76	1.53	1.0	0.028	1.35	95.55	0.161	21.71	12.49	2
3.117	0.60	0.00	0.60	0	0.99	0.08	1.03	1.0	0.059	52.41	115.35	0.170	2.88	0.97	0.46	0.77	1.48	1.0	0.029	1.48	93.27	0.155	19.85	11.37	2
3.281	0.61	0.00	0.61	0	0.99	0.08	1.03	1.0	0.059	50.83	110.40	0.161	2.73	0.97	0.45	0.78	1.45	1.0	0.030	1.50	89.29	0.146	17.90	10.31	2
3.445	0.61	0.00	0.61	0	0.99	0.07	1.03	1.0	0.059	49.17	103.98	0.149	2.54	0.97	0.43	0.79	1.41	1.0	0.030	1.60	87.77	0.143	16.81	9.67	2
3.609	0.62	0.00	0.62	0	0.99	0.07	1.02	1.0	0.059	46.02	91.78	0.130	2.21	0.97	0.39	0.80	1.37	1.0	0.031	1.82	83.18	0.134	15.11	8.66	2
3.773	0.63	0.00	0.63	0	0.99	0.06	1.02	1.0	0.058	43.04	80.24	0.113	1.94	0.97	0.35	0.80	1.36	1.0	0.032	2.53	94.13	0.158	17.18	9.56	2
3.937	0.63	0.00	0.63	0	0.99	0.05	1.02	1.0	0.058	38.14	61.26	0.089	1.54	0.97	0.28	0.80	1.35	1.0	0.032	4.35	100.63	0.175	18.39	9.96	2
4.101	0.64	0.00	0.64	0	0.99	0.07	1.02	1.0	0.058	47.73	98.40	0.140	2.40	0.97	0.41	0.79	1.35	1.0	0.032	1.93	97.99	0.168	17.03	9.71	2
4.265	0.65	0.00	0.65	0	0.99	0.07	1.02	1.0	0.058	46.82	94.86	0.134	2.31	0.97	0.40	0.80	1.33	1.0	0.032	2.14	102.77	0.181	17.79	10.05	2
4.429	0.65	0.00	0.65	0	0.99	0.07	1.02	1.0	0.058	45.01	87.86	0.124	2.13	0.97	0.38	0.80	1.32	1.0	0.032	2.55	109.16	0.201	19.13	10.63	2
4.593	0.66	0.00	0.66	0	0.98	0.09	1.02	1.0	0.058	55.44	128.26	0.199	3.41	0.97	0.49	0.75	1.40	1.0	0.031	1.63	118.67	0.235	21.58	12.49	2
4.757	0.67	0.00	0.67	0	0.98	0.16	1.04	1.0	0.059	82.72	232.19	1.000	16.92	0.97	0.71	0.65	1.61	1.0	0.027	1.09	163.61	1.000	89.79	53.36	2
4.921	0.68	0.00	0.68	0	0.98	0.20	1.04	1.0	0.059	65.99	237.73	1.000	16.84	0.97	0.76	0.62	1.65	1.0	0.026	1.00	171.74	1.000	87.86	52.35	2
5.085	0.69	0.00	0.69	0	0.98	0.27	1.06	1.0	0.060	73.74	275.80	1.000	16.65	0.97	0.82	0.60	1.68	1.0	0.025	1.00	202.05	1.000	86.02	51.33	2
5.249	0.70	0.00	0.70	0	0.98	0.30	1.06	1.0	0.060	76.70	290.31	1.000	16.63	0.97	0.84	0.60	1.67	1.0	0.026	1.00	213.61	1.000	84.25	50.44	2
5.413	0.71	0.00	0.71	0	0.98	0.22	1.04	1.0	0.059	68.96	252.28	1.000	16.96	0.97	0.78	0.61	1.64	1.0	0.026	1.00	183.32	1.000	82.55	49.75	2
5.577	0.72	0.00	0.72	0	0.98	0.17	1.03	1.0	0.058	61.36	214.99	1.000	17.18	0.97	0.72	0.64	1.56	1.0	0.027	1.00	153.63	0.417	33.76	25.47	2
5.741	0.73	0.00	0.73	0	0.98	0.16	1.02	1.0	0.058	59.63	206.47	1.000	17.26	0.97	0.70	0.65	1.53	1.0	0.028	1.00	146.84	0.374	29.72	23.49	2
5.905	0.74	0.00	0.74	0	0.98	0.15	1.02	1.0	0.058	58.56	201.21	1.000	17.32	0.97	0.69	0.66	1.51	1.0	0.028	1.00	142.65	0.350	27.25	22.29	2
6.069	0.75	0.00	0.75	0	0.98	0.14	1.02	1.0	0.057	56.68	191.98	0.810	14.09	0.97	0.67	0.66	1.49	1.0	0.029	1.00	135.30	0.310	23.72	18.90	2
6.234	0.76	0.00	0.76	0	0.98	0.12	1.01	1.0	0.057	52.35	170.74	0.415	7.26	0.97	0.63	0.69	1.44	1.0	0.030	1.00	118.38	0.234	17.58	12.42	2
6.398	0.78	0.00	0.78	0	0.97	0.12	1.01	1.0	0.057	51.97	168.85	0.396	6.95	0.97	0.62	0.69	1.43	1.0	0.030	1.00	116.88	0.228	16.83	11.89	2
6.562	0.79	0.00	0.79	0	0.97	0.12	1.01	1.0	0.057	51.37	165.88	0.370	6.50	0.97	0.62	0.69	1.42	1.0	0.030	1.00	114.52	0.220	15.90	11.20	2
6.726	0.80	0.00	0.80	0	0.97	0.11	1.01	1.0	0.057	48.91	153.80	0.290	5.11	0.97	0.59	0.70	1.39	1.0	0.031	1.00	104.90	0.187	13.33	9.22	2
6.890	0.81	0.00	0.81	0	0.97	0.10	1.01	1.0	0.057	46.88	143.83	0.246	4.35	0.97	0.57	0.72	1.36	1.0	0.031	1.00	96.95	0.165	11.52	7.94	2
7.054	0.82	0.00	0.82	0	0.97	0.11	1.01	1.0	0.056	50.08	159.55	0.323	5.73	0.97	0.60	0.70	1.38	1.0	0.031	1.00	109.47	0.202	13.89	9.81	2
7.218	0.83	0.00	0.83	0	0.97	0.11	1.00	1.0	0.056	49.87	158.54	0.317	5.63	0.96	0.60	0.70	1.37	1.0	0.031	1.00	108.67	0.199	13.49	9.56	2
7.382	0.84	0.00	0.84	0	0.97	0.10	1.00	1.0	0.056	44.29	131.13	0.206	3.67	0.96	0.54	0.73	1.32	1.0	0.032	1.06	91.90	0.152	10.13	6.90	2
7.546	0.85	0.00	0.85	0	0.97	0.09	1.00	1.0	0.056	55.86	128.74	0.200	3.57	0.96	0.49	0.75	1.29	1.0	0.033	1.15	84.08	0.135	8.87	6.22	2
7.710	0.86	0.00	0.86	0	0.97	0.08	1.00	1.0	0.056	51.09	110.37	0.161	2.87	0.96	0.44	0.78	1.25	1.0	0.034	1.22	72.36	0.115	7.45	5.16	2
7.874	0.87	0.00	0.87	0	0.96	0.08	1.00	1.0	0.056	53.07	118.01	0.175	3.15	0.96	0.47	0.77	1.26	1.0	0.034	1.10	71.42	0.114	7.26	5.20	2
8.038	0.88	0.00	0.88	0	0.96	0.09	1.00	1.0	0.056	41.72	118.49	0.176	3.17	0.96	0.51	0.75	1.28	1.0	0.033	1.00	76.77	0.122	7.66	5.42	2
8.202	0.89	0.00	0.89	0	0.96	0.09	1.00	1.0	0.056	41.51	117.48	0.174	3.14	0.96	0.50	0.75	1.27	1.0	0.033	1.00	75.97	0.121	7.47	5.30	2
8.366	0.90	0.00	0.90	0	0.96	0.09	1.00	1.0	0.055	40.74	113.68	0.167	3.01	0.96	0.49	0.75	1.26	1.0	0.034	1.02	74.14	0.118	7.18	5.10	2
8.530	0.91	0.00	0.91	0	0.96	0.08	1.00	1.0	0.055	51.90	113.50	0.166	3.01	0.96	0.45	0.77	1.24	1.0	0.034	1.09	66.94	0.108	6.49	4.75	2
8.694	0.92	0.00	0.92	0	0.96	0.07	1.00	1.0	0.055	46.92	94.31	0.133	2.42	0.96	0.40	0.80	1.20	1.0	0.035	1.20	57.03	0.097	5.77	4.09	2
8.858	0.92	0.00	0.92	0	0.96	0.06	1.00	1.0	0.055	44.15	83.62	0.118	2.13	0.96	0.36	0.80	1.20	1.0	0.035	1.29	50.93	0.092	5.40	3.77	2
9.022	0.93	0.00	0.93	0	0.96	0.07	0.99	1.0	0.055	46.74	93.59	0.132	2.40	0.96	0.40	0.80	1.20	1.0	0.035	1.13	52.86	0.094	5.42	3.91	2
9.186	0.94	0.00	0.94	0	0.96	0.07	0.99	1.0	0.055	49.33	103.60	0.149	2.70	0.96	0.43	0.79	1.21	1.0	0.035	1.15	62.27	0.102	5.85	4.28	2
9.350	0.95	0.00	0.95	0	0.96	0.08	0.99	1.0	0.055	40.16	110.82	0.161	2.95	0.96	0.49	0.76	1.23	1.0	0.034	1.05	74.41	0.118	6.66	4.80	2
9.514	0.96	0.00	0.96	0	0.95	0.09	0.99	1.0	0.055	42.58	122.75	0.186	3.40	0.96	0.52	0.74	1.25	1.0	0.034	1.02	81.39	0.130	7.23	5.31	2
9.678	0.97	0.00	0.97	0	0.95	0.09	0.99	1.0	0.054	41.68	118.30	0.176	3.23	0.96	0.51	0.75	1.24	1.0	0.034	1.10	84.50	0.136	7.46	5.35	2
9.842	0.98	0.00	0.98	0	0.95	0.07	0.99	1.0	0.054	49.27	103.37	0.148	2.72	0.96	0.42	0.79	1.19	1.0	0.035	1.03	55.73	0.096	5.21	3.96	2
10.006	0.99	0.00	0.99	0	0.95	0.06	0.99	1.0	0.054	42.74	78.22	0.110	2.02	0.96	0.34	0.80	1.18	1.0	0.036	2.18	77.52	0.123	6.60	4.31	2
10.170	1.00	0.00	1.00	0	0.95	0.05	0.99	1.0	0.054	35.74	51.95	0.079	1.46	0.96	0.23	0.80	1.17	1.0	0.036	3.34	54.12	0.095	5.02	3.24	2
10.335	1.01	0.00	1.01	0	0.95	0.06	0.99	1.0	0.054	39.63	66.21	0.095	1.75	0.96	0.30	0.80	1.17	1.0	0.036	1.72	45.75	0.088	4.61	3.18	2
10.499	1.02	0.00	1.02	0	0.95	0.05	0.99	1.0	0.054	37.55	58.21	0.086	1.58	0.96	0.26	0.80	1.17	1.0	0.036	2.50	51.61	0.093	4.80	3.19	2
10.663	1.03	0.00	1.03	0	0.95	0.05	0.99	1.0	0.054	37.05	56.28	0.084	1.55	0.96	0.25	0.80	1.17	1.0	0.036	2.42	46.55	0.089	4.54	3.05	2
10.827	1.04	0.00	1.04	0	0.95	0.05	0.99	1.0	0.054	37.22	56.95	0.085	1.56	0.96	0.26	0.80	1.16	1.0	0.036	2.67	52.71	0.094	4.74	3.15	2
10.991	1.05	0.00	1.05	0	0.94	0.05	0.99	1.0	0.054	37.39	57.59	0.085	1.58	0.96	0.26	0.80	1.16	1.0	0.036	2.04	41.17	0.084	4.22	2.90	2
11.155	1.06	0.00	1.06	0	0.94	0.06	0.99	1.0	0.054	41.72	74.26	0.105	1.95	0.96	0.33	0.80	1.16	1.0	0.036	1.49	48.45	0.090	4.47	3.21	2
11.319	1.07	0.00	1.07	0	0.94	0.06	0.99	1.0	0.054	41.18	72.19	0.102	1.90	0.96	0.32	0.80	1.16	1.0	0.036	1.69	52.28	0.093	4.57	3.24	2
11.483	1.08	0.00	1.08	0	0.94	0.06	0.99	1.0	0.054	39.23	64.68	0.093	1.74	0.95	0.29	0.80	1.15	1.0	0.037	1.84	46.90	0.089	4.32	3.03	2
11.647	1.09	0.00	1.09	0	0.94	0.05	0.99	1.0	0.054	37.95	59.74	0.088	1.63	0.95	0.27	0.80	1.15	1.0	0.037	2.46	53.63	0.094	4.52	3.08	2
11.811	1.10	0.00	1.10	0	0.94	0.05	0.99	1.0	0.054	36.97	55.98	0.084	1.56	0.95	0.25	0.80	1.15	1.0	0.037	2.62	49.79	0.091	4.34	2.95	2
11.975	1.11	0.00	1.11	0	0.94	0.05	0.99	1.0	0.053	37.09	56.44	0.084	1.57	0.95	0.25	0.80	1.15	1.0	0.037	1.93	37.34	0.081	3.81	2.69	2
12.139	1.12	0.00	1.12	0	0.94	0.05	0.99	1.0	0.053	36.96	55.95	0.083	1.56	0.95	0.25	0.80	1.14	1.0	0.037	2.36	44.75	0.087	4.06	2.81	2
12.303	1.13	0.00	1.13	0	0.94	0.05	0.99	1.0	0.053	37.86	59.41	0.087	1.64	0.95	0.27	0.80	1.14	1.0	0.037	2.59	55.72	0.096	4.42	3.03	2
12.467	1.14	0.00	1.14	0	0.93	0.06	0.98	1.0	0.053	41.22	72.37	0.103	1.93	0.95	0.32	0.80	1.14	1.0	0.037	1.64	50.96	0.092	4.21	3.07	2
12.631	1.15	0.00	1.15	0	0.93	0.07	0.98	1.0	0.053	35.78	89.31	0.126	2.39	0.95	0.42	0.79	1.14	1.0	0.037	1.09	58.49	0.099	4.45	3.42	2
12.795	1.16	0.00	1.16	0	0.93	0.07	0.98	1.0	0.053	48.80	101.53	0.145	2.75	0.95	0.42	0.79	1.14	1.0	0.037	1.21	63.65	0.104	4.64	3.70	2
12.959	1.17	0.00	1.17	0	0.93	0.07	0.98	1.0	0.053	45.59	89.16	0.126	2.39	0.95	0.38	0.80	1.13	1.0	0.037	1.63	71.04	0.113	5.01	3.70	2
13.123	1.18	0.00	1.18	0	0.93	0.06	0.98	1.0	0.053	43.96	82.89	0.117	2.22	0.95	0.36	0.80	1.13	1.0	0.037	1.72	67.05	0.108	4.73	3.47	2
13.287	1.19	0.00	1.19	0	0.93	0.06	0.98	1.0	0.053	41.49	73.38	0.104	1.97	0.95	0.33	0.80	1.13	1.0	0.037	1.86	59.29	0.099	4.31	3.14	2
13.451	1.20	0.00	1.20	0	0.93	0.06	0.98	1.0	0.052	41.79	74.56	0.105	2.01	0.95	0.33	0.80	1.12	1.0	0.037	1.60	52.27	0.093	4.01	3.01	2
13.615	1.21	0.00	1.21	0	0.93	0.06	0.98	1.0	0.052	41.95	75.17	0.106	2.03	0.95	0.33	0.80	1.12	1.0	0.037	1.47	48.88	0.091	3.86	2.95	2
13.779	1.22	0.00	1.22	0	0.92	0.06	0.98	1.0	0.052	41.76	74.45	0.105	2.01	0.95	0.33	0.80	1.12	1.0	0.037	1.26	41.27	0.084	3.56	2.79	2
13.943	1.23	0.00	1.23	0	0.92	0.06	0.98	1.0	0.052	40.98	71.44	0.101	1.94	0.95	0.32	0.80	1.12	1.0	0.037	1.36	41.55	0.085	3.54	2.74	2
14.107	1.24	0.00	1.24	0	0.92	0.06	0.98	1.0	0.052	39.74	66.66	0.096	1.83	0.95	0.30	0.80	1.12	1.0	0.037	1.84	49.42	0.091	3.78	2.80	2
14.271	1.25	0.00	1.25	0	0.92	0.06	0.98	1.0	0.052	40.50	69.56	0.099	1.90	0.95	0.31	0.80	1.11	1.0	0.038	2.44	71.02	0.113	4.66	3.28	2
14.436	1.26	0.00	1.26	0	0.92	0.06	0.98	1.0	0.052	39.92	67.36	0.096	1.85	0.95	0.30	0.80	1.11	1.0	0.038	2.37	64.97	0.106	4.30	3.07	2
14.600	1.27	0.00	1.27	0	0.92	0.06	0.98	1.0	0.052	40.90	71.12	0.101	1.95	0.95	0.32	0.80	1.11	1.0	0.038	1.92	58.11	0.098	3.97	2.96	2
14.764	1.28	0.00	1.28	0	0.92	0.06	0.98	1.0	0.052	39.37	65.21	0.094	1.81	0.95	0.29	0.80	1.11	1.0	0.038	1.95	50.29	0.092	3.68	2.74	2
14.928	1.29	0.00	1.29	0	0.92	0.06	0.98	1.0	0.052	40.00	67.67	0.097	1.87	0.95	0.30	0.80	1.11	1.0	0.038	3.16	87.53	0.142	5.65	3.76	2
15.092	1.30	0.00	1.30	0	0.91	0.06	0.98	1.0	0.052	39.53	65.85	0.095	1.83	0.95	0.30	0.80	1.10	1.0	0.038	2.44	64.33	0.105	4.12	2.98	2
15.256	1.31	0.00	1.31	0	0.91	0.07	0.97	1.0	0.051	44.75	85.96	0.121	2.36	0.95	0.37	0.80	1.10	1.0	0.038	1.66	68.40	0.110	4.28	3.32	2
15.420	1.32	0.00	1.32	0	0.91	0.06	0.97	1.0	0.051	42.47	77.18	0.109	2.12	0.95	0.34	0.80	1.10	1.0	0.038	2.11	73.21	0.116	4.51	3.31	2
15.584	1.33	0.00	1.33	0	0.91	0.06	0.97	1.0	0.051	41.07	71.78	0.102	1.98	0.95	0.32	0.80	1.10	1.0	0.038	1.98	60.69	0.101	3.87	2.93	2
15.748	1.34	0.00	1.34	0	0.91	0.06	0.97	1.0	0.051	41.92	75.04	0.106	2.07	0.94	0.33	0.80	1.10	1.0	0.038	2.18	72.28	0.115	4.38	3.23	2
15.912	1.35	0.00	1.35	0	0.91	0.06	0.97	1.0	0.051	39.80	66.87	0.096	1.87	0.94	0.30	0.80	1.09	1.0	0.038	2.19	59.36	0.099	3.76	2.81	2
16.076	1.36	0.00	1.36	0	0.91	0.06	0.97	1.0	0.051	41.39	73.00	0.103	2.03	0.94	0.32	0.80	1.09	1.0	0.038	1.82	57.57	0.098	3.66	2.84	2
16.240	1.36	0.00	1.36	0	0.91	0.06	0.97	1.0	0.051	42.43	77.01	0.109	2.13	0.94	0.34	0.80	1.09	1.0	0.038	2.04	70.42	0.112	4.18	3.16	2
16.404	1.37	0.00	1.37	0	0.90	0.06	0.97	1.0	0.051	42.34	76.66	0.108	2.13	0.94	0.34	0.80	1.09	1.0	0.038	2.16	74.09	0.118	4.34	3.24	2
16.568	1.38	0.00	1.38	0	0.90	0.07	0.97	1.0	0.051	45.40	88.45	0.125	2.46	0.94	0.38	0.80	1.09	1.0	0.038	2.04	87.67	0.143	5.22	3.84	2
16.732	1.39	0.00	1.39	0	0.90	0.06	0.97	1.0	0.051	40.44	70.17	0.100	1.97	0.94	0.31	0.80	1.09	1.0	0.038	3.27	97.24	0.166	6.01	3.99	2
16.896	1.40	0.00	1.40	0	0.90	0.06	0.97	1.0	0.051	42.27	76.39	0.108	2.13	0.94	0.34	0.80	1.08	1.0	0.038	2.39	81.44	0.130	4.69	3.41	2
17.060	1.41	0.00	1.41	1	0.90	0.06	0.97	1.0	0.051	42.61	77.71	0.110	2.17	0.94	0.34	0.80	1.08	1.0	0.038	2.49	87.26	0.142	5.06	3.62	2
17.224	1.42	0.01	1.42	1	0.90	0.06	0.97	1.0	0.051	40.58	69.87	0.099	1.96	0.94	0.31	0.80	1.08	1.0	0.039	2.56	74.93	0.119	4.21	3.08	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.235

Depth at time of CPT (ft)	Depth at t_1, z_1 (m)	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} (tsf)	$P = \gamma_{eff}*(G_{eff}/G_{max})$ (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
0.164	2.46	594	1.6E-03	5.5E+02	8.0E-05	11	0.166	10961	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
0.328	2.51	594	1.6E-03	5.5E+02	8.1E-05	11	0.166	10879	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
0.492	2.56	594	1.6E-03	5.5E+02	8.3E-05	11	0.167	10799	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
0.656	2.61	594	1.6E-03	5.5E+02	8.4E-05	11	0.168	10720	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
0.820	2.66	594	1.6E-03	5.5E+02	8.6E-05	11	0.169	10644	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
0.984	2.71	594	1.6E-03	5.5E+02	8.7E-05	11	0.169	10570	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
1.148	2.76	594	1.6E-03	5.5E+02	8.9E-05	11	0.170	10497	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
1.312	2.81	594	1.6E-03	5.5E+02	9.0E-05	11	0.171	10426	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
1.476	2.86	594	1.6E-03	5.5E+02	9.2E-05	11	0.172	10357	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
1.640	2.91	594	1.6E-03	5.5E+02	9.3E-05	11	0.172	10289	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
1.804	2.96	594	1.6E-03	5.5E+02	9.4E-05	11	0.173	10223	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
1.968	3.01	594	1.6E-03	5.5E+02	9.6E-05	11	0.174	10158	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.133	3.06	594	1.6E-03	5.5E+02	9.7E-05	11	0.174	10094	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.297	3.11	594	1.6E-03	5.5E+02	9.9E-05	11	0.175	10032	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.461	3.16	594	1.6E-03	5.5E+02	1.0E-04	11	0.176	9971	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.625	3.21	594	1.6E-03	5.5E+02	1.0E-04	11	0.176	9911	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.789	3.26	594	1.6E-03	5.5E+02	1.0E-04	11	0.177	9853	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.953	3.31	594	1.6E-03	5.5E+02	1.0E-04	11	0.178	9796	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.117	3.36	495	1.6E-03	3.8E+02	1.5E-04	11	0.178	9739	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.281	3.41	495	1.3E-03	3.1E+02	1.9E-04	16	0.432	8182	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.75%	0.0012
3.445	3.46	495	1.3E-03	3.1E+02	1.9E-04	16	0.432	8145	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.79%	0.0013
3.609	3.51	495	1.3E-03	3.1E+02	1.9E-04	16	0.433	8108	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.82%	0.0013
3.773	3.56	495	1.3E-03	3.1E+02	1.9E-04	16	0.433	8072	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.86%	0.0014
3.937	3.61	495	1.3E-03	3.1E+02	2.0E-04	16	0.434	8036	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.89%	0.0015
4.101	3.66	495	1.3E-03	3.1E+02	2.0E-04	16	0.434	8001	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.93%	0.0015
4.265	3.71	495	1.3E-03	3.1E+02	2.0E-04	16	0.435	7966	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.96%	0.0016
4.429	3.76	495	1.3E-03	3.1E+02	2.0E-04	16	0.435	7932	0.04%	2.00	0.65	0.03%	0.007	0.34	0.079	0.765	1.00%	0.0016
4.593	3.81	495	1.8E-03	4.3E+02	1.5E-04	16	0.436	7886	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.757	3.86	495	1.8E-03	4.5E+02	1.5E-04	10	0.184	9531	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.921	3.91	495	1.9E-03	4.7E+02	1.4E-04	0	0.189	11924	0.02%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.085	3.96	495	1.9E-03	4.7E+02	1.4E-04	0	0.189	11852	0.02%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.249	4.01	495	1.9E-03	4.7E+02	1.5E-04	0	0.190	11782	0.03%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.413	4.06	495	1.9E-03	4.7E+02	1.5E-04	0	0.191	11713	0.03%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.577	4.11	495	1.9E-03	4.7E+02	1.5E-04	0	0.191	11646	0.03%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.741	4.16	495	1.9E-03	4.7E+02	1.5E-04	0	0.192	11580	0.03%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.905	4.21	495	1.9E-03	4.7E+02	1.5E-04	0	0.192	11515	0.03%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
6.069	4.26	495	1.9E-03	4.7E+02	1.6E-04	0	0.193	11452	0.03%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
6.234	4.31	495	1.9E-03	4.7E+02	1.6E-04	0	0.194	11389	0.03%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
6.398	4.36	495	1.9E-03	4.7E+02	1.6E-04	0	0.194	11328	0.03%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
6.562	4.41	495	1.9E-03	4.7E+02	1.6E-04	0	0.195	11268	0.03%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
6.726	4.46	495	1.9E-03	4.7E+02	1.7E-04	0	0.195	11209	0.03%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
6.890	4.51	495	1.9E-03	4.7E+02	1.7E-04	0	0.196	11151	0.03%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.01%	0.0000
7.054	4.56	495	1.9E-03	4.7E+02	1.7E-04	0	0.197	11094	0.03%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.01%	0.0000
7.218	4.61	495	1.9E-03	4.7E+02	1.7E-04	0	0.197	11038	0.03%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.01%	0.0000
7.382	4.66	495	1.9E-03	4.7E+02	1.7E-04	0	0.198	10983	0.03%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.01%	0.0000
7.546	4.71	495	1.8E-03	4.5E+02	1.8E-04	10	0.195	8675	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
7.710	4.76	495	1.8E-03	4.5E+02	1.8E-04	10	0.195	8633	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.06%	0.0001
7.874	4.81	495	1.8E-03	4.5E+02	1.9E-04	10	0.196	8593	0.03%	2.00	0.65	0.03%	0.001	0.34	0.079	0.765	0.14%	0.0002
8.038	4.86	495	1.9E-03	4.7E+02	1.8E-04	0	0.200	10777	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.02%	0.0000
8.202	4.91	495	1.9E-03	4.7E+02	1.8E-04	0	0.200	10727	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.02%	0.0000
8.366	4.96	495	1.9E-03	4.7E+02	1.9E-04	0	0.201	10677	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.03%	0.0000
8.530	5.01	495	1.8E-03	4.5E+02	1.9E-04	10	0.198	8433	0.03%	2.00	0.65	0.03%	0.002	0.34	0.079	0.765	0.35%	0.0006
8.694	5.06	495	1.8E-03	4.5E+02	2.0E-04	10	0.199	8395	0.03%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.39%	0.0006
8.858	5.11	495	1.8E-03	4.5E+02	2.0E-04	10	0.199	8359	0.03%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.43%	0.0007
9.022	5.16	495	1.8E-03	4.5E+02	2.0E-04	10	0.200	8322	0.03%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.47%	0.0008
9.186	5.21	495	1.8E-03	4.5E+02	2.0E-04	10	0.200	8287	0.04%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.51%	0.0008
9.350	5.26	460	1.9E-03	4.1E+02	2.3E-04	0	0.204	10401	0.06%	2.20	1.00	0.03%	0.001	0.34	0.079	0.765	0.11%	0.0002
9.514	5.31	460	1.9E-03	4.1E+02	2.3E-04	0	0.204	10356	0.06%	2.20	1.00	0.03%	0.001	0.34	0.079	0.765	0.11%	0.0002
9.678	5.36	460	1.9E-03	4.1E+02	2.3E-04	0	0.205	10312	0.06%	2.20	1.00	0.03%	0.001	0.34	0.079	0.765	0.11%	0.0002
9.842	5.41	460	1.8E-03	3.9E+02	2.5E-04	10	0.202	8145	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.24%	0.0020
10.006	5.46	460	1.8E-03	3.9E+02	2.5E-04	10	0.203	8112	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.28%	0.0021
10.170	5.51	460	1.8E-03	3.7E+02	2.6E-04	16	0.455	6651	0.07%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.75%	0.0029
10.335	5.56	460	1.8E-03	3.9E+02	2.5E-04	10	0.204	8048	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.35%	0.0022
10.499	5.61	460	1.8E-03	3.9E+02	2.6E-04	10	0.204	8016	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.38%	0.0023
10.663	5.66	460	1.8E-03	3.9E+02	2.6E-04	10	0.205	7985	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.42%	0.0023
10.827	5.71	460	1.8E-03	3.9E+02	2.6E-04	10	0.205	7953	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.45%	0.0024
10.991	5.76	460	1.8E-03	3.9E+02	2.6E-04	10	0.206	7923	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.49%	0.0024
11.155	5.81	460	1.8E-03	3.9E+02	2.6E-04	10	0.206	7893	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.52%	0.0025
11.319	5.86	460	1.8E-03	3.9E+02	2.7E-04	10	0.207	7863	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.56%	0.0026
11.483	5.91	460	1.8E-03	3.9E+02	2.7E-04	10	0.207	7833	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.59%	0.0026
11.647	5.96	460	1.8E-03	3.9E+02	2.7E-04	10	0.208	7804	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.63%	0.0027
11.811	6.01	460	1.8E-03	3.9E+02	2.7E-04	10	0.208	7775	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.66%	0.0027
11.975	6.06	460	1.8E-03	3.9E+02	2.8E-04	10	0.209	7747	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.70%	0.0028
12.139	6.11	460	1.8E-03	3.9E+02	2.8E-04	10	0.209	7719	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.73%	0.0028
12.303	6.16	460	1.8E-03	3.9E+02	2.8E-04	10	0.210	7691	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.77%	0.0029
12.467	6.21	460	1.8E-03	3.9E+02	2.8E-04	10	0.210	7664	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.80%	0.0030
12.631	6.26	460	1.9E-03	4.1E+02	2.8E-04	0	0.213	9635	0.09%	2.20	1.00	0.03%	0.001	0.34	0.079	0.765	0.21%	0.0003
12.795	6.31	460	1.8E-03	3.9E+02	2.9E-04	10	0.211	7609	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.87%	0.0031
12.959	6.36	460	1.8E-03	3.9E+02	2.9E-04	10	0.211	7583	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.91%	0.0031
13.123	6.41	460	1.8E-03	3.9E+02	2.9E-04	10	0.212	7557	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.95%	0.0032
13.287	6.46	460	1.8E-03	3.9E+02	3.0E-04	10	0.212	7531	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.98%	0.0033
13.451	6.51	460	1.8E-03	3.9E+02	3.0E-04	10	0.213	7505	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.02%	0.0033
13.615	6.56	460	1.8E-03	3.9E+02	3.0E-04	10	0.213	7480	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.05%	0.0034
13.779	6.61	460	1.8E-03	3.9E+02	3.0E-04	10	0.214	7455	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.09%	0.0034
13.943	6.66	460	1.8E-03	3.9E+02	3.1E-04	10	0.214	7431	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.13%	0.0035
14.107	6.71	460	1.8E-03	3.9E+02	3.1E-04	10	0.215	7406	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.16%	0.0035
14.271	6.76	460	1.8E-03	3.9E+02	3.1E-04	10	0.215	7382	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.20%	0.0036
14.436	6.81	460	1.8E-03	3.9E+02	3.1E-04	10	0.215	7358	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.24%	0.0037
14.600	6.86	500	1.8E-03	4.6E+02	2.7E-04	10	0.216	7335	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.42%	0.0023
14.764	6.91	500	1.8E-03	4.6E+02	2.7E-04	10	0.216	7312	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.45%	0.0024
14.928	6.96	500	1.8E-03	4.6E+02	2.7E-04	10	0.217	7289	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.48%	0.0024
15.092	7.01	500	1.8E-03	4.6E+02	2.7E-04	10	0.217	7266	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.51%	0.0025
15.256	7.06	500	1.8E-03	4.6E+02	2.8E-04	10	0.217	7243	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.53%	0.0025
15.420	7.11	500	1.8E-03	4.6E+02	2.8E-04	10	0.218	7221	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.56%	0.0026
15.584	7.16	500	1.8E-03	4.6E+02	2.8E-04	10	0.218	7199	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.59%	0.0026
15.748	7.21	500	1.8E-03	4.6E+02	2.8E-04	10	0.219	7177	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.62%	0.0027
15.912	7.26	500	1.8E-03	4.6E+02	2.8E-04	10	0.219	7155	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.64%	0.0027
16.076	7.31	500	1.8E-03	4.6E+02	2.9E-04	10	0.220	7134	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.67%	0.0027
16.240	7.36	500	1.8E-03	4.6E+02	2.9E-04	10	0.220	7113	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.70%	0.0028
16.404	7.41	500	1.8E-03	4.6E+02	2.9E-04	10	0.220	7092	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.73%	0.0028
16.568	7.46	500	1.8E-03	4.6E+02	2.9E-04	10	0.221	7071	0.07%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.76%	0.0029
16.732	7.51	500	1.8E-03	4.4E+02	3.1E-04	16	0.472	5809	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.21%	0.0036
16.896	7.56	500	1.8E-03	4.6E+02	3.0E-04	10	0.221	7031	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.81%	0.0030
17.060	7.61	500	1.8E-03	4.6E+02	3.0E-04	10	0.222	7017	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.84%	0.0030
17.224	7.66	500	1.8E-03	4.6E+02	3.0E-04	10	0.222	7007	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.87%	0.0031

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-1S

Data File: 13-52106_SP3-1S-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3 Field Data\2013 Field Investigation\Conetec Dat

Legend:
- Tailings Sands
- Tailings Sand-Slimes
- Tailings Slimes
- Interim Cover
- Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69

Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5608.00	Water surface elevation during CPT investigation (ft
5604.28	Water surface elevation at t_0 (ft amsl)
5595.59	Water surface elevation at t_1 (ft amsl)
5590.59	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Eart
7.51	Equiv. Number of Uniform Strain Cycles, N

Value	Parameter
5612.56	Ground Surface Elevation at time of CPT (ft amsl)
5620.47	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
0.41	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
887.10	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5590.59	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer
Erosion Protection Layer	######	5620.22	5619.97	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
Water Storage/Rooting Zone Layer	######	5618.22	5616.47	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5614.72	5612.97	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320
Platform/Random Fill Layer	######	5612.77	5612.56	0.41	0.050	101	0.445	0.434	0.00	0.00	0.445	0.434

Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
1.75	508	1.9E-03	4.8E+02	6.5E-05	11	0.152	12657	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
2.35	508	1.6E-03	4.0E+02	1.0E-04	11	0.164	11140	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No
17.388	5595.17	26.8	0.182	26.7	20.4	8.84	0.68%	Sand-Slime Tailin	0.059	119.0	0.99	0.40	0.59	1
17.552	5595.01	24.3	0.073	24.2	8.2	3.55	0.30%	Sand-Slime Tailin	0.059	119.0	1.00	0.41	0.59	1
17.716	5594.84	21.7	0.073	21.6	11.9	5.16	0.34%	Sand-Slime Tailin	0.059	119.0	1.01	0.41	0.60	1
17.880	5594.68	17.6	0.073	17.5	13.5	5.83	0.42%	Sand-Slime Tailin	0.059	119.0	1.02	0.42	0.60	1
21.970	5590.59							Sand-Slime Tailin	0.059	119.0				

CPT Data Interpretations (cont.) / Conditions at t_1

Depth at time of CPT (ft)	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
17.388	1.29	34.509	479.67	40.27	44	0.70%	2.1	47%	1.43	0.01	1.42	1
17.552	1.29	31.333	435.53	36.47	39	0.31%	2.0	47%	1.44	0.02	1.42	1
17.716	1.30	27.980	388.93	32.61	35	0.35%	2.1	47%	1.45	0.02	1.43	1
17.880	1.30	22.828	317.31	26.64	27	0.44%	2.2	47%	1.46	0.03	1.43	1
21.970									1.71	0.09	1.61	1

Liquefaction Triggering Analyses — Idriss & Boulanger (2008)

Depth at time of CPT (ft)	r_d	C_σ	K_σ	K_a	CSR M=7.5, s'v=1atm	Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS
17.388	0.90	0.07	0.97	1.0	0.051	44.43	84.70	0.119	2.35
17.552	0.90	0.06	0.97	1.0	0.051	43.09	79.56	0.112	2.21
17.716	0.89	0.06	0.97	1.0	0.051	41.74	74.35	0.105	2.06
17.880	0.89	0.06	0.97	1.0	0.051	39.64	66.29	0.095	1.86

Liquefaction Triggering Analyses — Youd et al. (2001)

Depth at time of CPT (ft)	r_d	D_r	f	K_σ	K_a	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
17.388	0.94	0.37	0.80	1.08	1.0	0.039	1.49	59.88	0.100	3.49	2.92	2
17.552	0.94	0.35	0.80	1.08	1.0	0.039	1.31	47.86	0.090	3.10	2.65	2
17.716	0.94	0.33	0.80	1.08	1.0	0.039	1.42	46.25	0.089	3.02	2.54	2
17.880	0.94	0.30	0.80	1.07	1.0	0.039	1.68	44.88	0.087	2.95	2.41	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.235

Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
7.71	500	1.8E-03	4.6E+02	3.0E-04	10	0.222	6998	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.90%	0.0031
7.76	500	1.8E-03	4.6E+02	3.0E-04	10	0.222	6988	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.94%	0.0032
7.81	500	1.8E-03	4.6E+02	3.1E-04	10	0.222	6979	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.97%	0.0032
7.86	500	1.8E-03	4.6E+02	3.1E-04	10	0.223	6969	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.00%	0.0033
9.11	538	1.8E-03	5.3E+02	3.1E-04	10	0.229	6637	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.92%	0.0786

Extra layer added to analyze seismic settlement of tailings below the bottom of CPT investigation.

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-2C

Data File:	13-52106_SP3-2C-BSC-CPT	**Idriss and Boulanger (2008)**			
Location:	White Mesa 2013 CPT Investigation	Max. Horiz. Acceleration, Amax/g:	0.15		
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da		Earthquake Moment Magnitude, M:	5.5		
	Tailings Sands	Magnitude Scaling Factor, MSF:	1.69		
	Tailings Sand-Slimes	**Youd, et al (2001)**			
	Tailings Slimes	Max. Horiz. Acceleration, Amax/g:	0.15		
	Interim Cover	Earthquake Moment Magnitude, M:	5.5		
	Cells Requiring User Input/Manipulation	Magnitude Scaling Factor, MSF:	2.21		

Value	Description
5605.30	Water surface elevation during CPT investigation (ft amsl)
5602.54	Water surface elevation at t_0 (ft amsl)
5591.64	Water surface elevation at t_1 (ft amsl)
5586.64	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earthquake
7.51	Equiv. Number of Uniform Strain Cycles, N
5610.82	Ground Surface Elevation at time of CPT (ft amsl)
5621.51	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
3.19	Thickness of Random/Platform Fill on top of existing interim cover (ft)
1167.12	Additional Stress due to Final Cover Placement, $\Delta\sigma_{fc}$ (psf)
5586.64	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pore Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15}	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5621.26	5621.01	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5619.26	5617.51	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5615.76	5614.01	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320	1.75	508	1.9E-03	4.8E+02	6.5E-05	11	0.152	12657	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######	5612.42	5610.82	3.19	0.050	101	0.585	0.504	0.00	0.00	0.585	0.504	2.77	508	1.6E-03	4.0E+02	1.2E-04	11	0.170	10470	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil. Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No
0.164	5610.66	9.5	0.818	9.5	10.4	4.49	8.58%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0
0.328	5610.49	67.8	0.428	67.8	8.7	3.76	0.63%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0
0.492	5610.33	104.7	0.603	104.6	7.9	3.44	0.58%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0
0.656	5610.16	73.4	0.695	73.3	5.6	2.42	0.95%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0
0.820	5610.00	90.8	1.617	90.7	4.4	1.90	1.78%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0
0.984	5609.84	98.7	0.951	98.7	4.8	2.06	0.96%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0
1.148	5609.67	142.9	1.153	142.9	5.8	2.53	0.81%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0
1.312	5609.51	142.3	0.768	142.3	5.6	2.43	0.54%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0
1.476	5609.34	150.3	0.964	150.3	3.4	1.49	0.64%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0
1.640	5609.18	142.9	0.948	142.9	4.8	2.08	0.66%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0
1.804	5609.02	129.8	0.906	129.8	4.9	2.12	0.70%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0
1.968	5608.85	134.9	1.437	134.9	3.7	1.61	1.07%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0
2.133	5608.69	130.9	0.753	130.9	2.7	1.15	0.58%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0
2.297	5608.52	120.4	0.968	120.4	3.4	1.47	0.80%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0
2.461	5608.36	98.7	1.136	98.7	3.8	1.64	1.15%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0
2.625	5608.20	75.5	1.164	75.5	3.5	1.50	1.54%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0
2.789	5608.03	54.0	0.768	54.0	2.0	0.85	1.42%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0
2.953	5607.87	50.1	0.997	50.1	1.2	0.53	1.99%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0
3.117	5607.70	56.9	1.094	56.9	2.7	1.18	1.92%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0
3.281	5607.54	64.2	0.738	64.2	2.1	0.92	1.15%	Sand Tailings	0.051	102.8	0.17	0.00	0.17	0
3.445	5607.38	52.1	0.886	52.1	2.0	0.87	1.70%	Sand-Slime Tailin	0.047	93.3	0.17	0.00	0.17	0
3.609	5607.21	29.1	1.041	29.1	0.7	0.30	3.58%	Slime Tailings	0.041	82.7	0.18	0.00	0.18	0
3.773	5607.05	21.5	1.042	21.5	1.5	0.65	4.84%	Slime Tailings	0.041	82.7	0.19	0.00	0.19	0
3.937	5606.88	16.3	0.676	16.3	3.3	1.44	4.14%	Slime Tailings	0.041	82.7	0.19	0.00	0.19	0
4.101	5606.72	18.3	0.612	18.2	5.0	2.18	3.35%	Slime Tailings	0.041	82.7	0.20	0.00	0.20	0
4.265	5606.55	15.1	0.610	15.0	4.1	1.76	4.05%	Slime Tailings	0.041	82.7	0.21	0.00	0.21	0
4.429	5606.39	19.3	0.601	19.3	4.8	2.09	3.11%	Slime Tailings	0.041	82.7	0.21	0.00	0.21	0
4.593	5606.23	24.6	0.687	24.5	4.0	1.73	2.80%	Sand-Slime Tailin	0.047	93.3	0.22	0.00	0.22	0
4.757	5606.06	24.5	0.631	24.5	2.1	0.90	2.57%	Sand-Slime Tailin	0.047	93.3	0.23	0.00	0.23	0
4.921	5605.90	23.4	0.399	23.4	5.1	2.21	1.71%	Sand-Slime Tailin	0.047	93.3	0.24	0.00	0.24	0
5.085	5605.73	25.5	0.327	25.5	7.2	3.11	1.28%	Sand-Slime Tailin	0.047	93.3	0.24	0.00	0.24	0
5.249	5605.57	20.3	0.310	20.3	1.4	0.60	1.53%	Sand-Slime Tailin	0.047	93.3	0.25	0.00	0.25	0
5.413	5605.41	11.2	0.265	11.2	0.7	0.29	2.37%	Slime Tailings	0.041	82.7	0.26	0.00	0.26	0
5.577	5605.24	7.5	0.141	7.5	0.6	0.27	1.88%	Slime Tailings	0.057	113.1	0.27	0.00	0.27	1
5.741	5605.08	7.7	0.089	7.7	1.1	0.47	1.15%	Sand-Slime Tailin	0.059	119.0	0.28	0.01	0.27	1
5.905	5604.91	9.9	0.084	9.9	2.9	1.27	0.84%	Sand-Slime Tailin	0.059	119.0	0.29	0.01	0.28	1
6.069	5604.75	5.9	0.088	5.9	2.9	1.27	1.50%	Slime Tailings	0.057	113.1	0.30	0.02	0.28	1
6.234	5604.59	5.6	0.085	5.5	4.4	1.92	1.53%	Slime Tailings	0.057	113.1	0.31	0.02	0.28	1
6.398	5604.42	7.0	0.088	6.9	6.4	2.77	1.26%	Slime Tailings	0.057	113.1	0.32	0.03	0.29	1
6.562	5604.26	7.1	0.082	7.1	6.8	2.93	1.15%	Slime Tailings	0.057	113.1	0.32	0.03	0.29	1
6.726	5604.09	10.7	0.082	10.6	7.0	3.03	0.77%	Sand-Slime Tailin	0.059	119.0	0.33	0.04	0.30	1
6.890	5603.93	13.4	0.114	13.4	5.9	2.54	0.85%	Sand-Slime Tailin	0.059	119.0	0.34	0.04	0.30	1
7.054	5603.77	15.0	0.134	14.9	5.2	2.24	0.90%	Sand-Slime Tailin	0.059	119.0	0.35	0.05	0.31	1
7.218	5603.60	22.4	0.135	22.4	8.0	3.48	0.60%	Sand-Slime Tailin	0.059	119.0	0.36	0.05	0.31	1
7.382	5603.44	17.5	0.162	17.4	10.4	4.51	0.93%	Sand-Slime Tailin	0.059	119.0	0.37	0.06	0.32	1
7.546	5603.27	15.5	0.200	15.4	24.6	10.65	1.29%	Sand-Slime Tailin	0.059	119.0	0.38	0.06	0.32	1
7.710	5603.11	17.0	0.227	16.8	44.3	19.18	1.33%	Sand-Slime Tailin	0.059	119.0	0.39	0.07	0.32	1
7.874	5602.95	17.9	0.174	17.6	42.1	18.26	0.97%	Sand-Slime Tailin	0.059	119.0	0.40	0.07	0.33	1
8.038	5602.78	20.6	0.144	20.4	32.2	13.94	0.70%	Sand-Slime Tailin	0.059	119.0	0.41	0.08	0.33	1
8.202	5602.62	26.4	0.168	26.2	32.9	14.27	0.64%	Sand-Slime Tailin	0.059	119.0	0.42	0.08	0.34	1
8.366	5602.45	29.9	0.252	29.7	36.5	15.81	0.84%	Sand-Slime Tailin	0.059	119.0	0.43	0.09	0.34	1
8.530	5602.29	22.3	0.277	22.1	28.4	12.32	1.24%	Sand-Slime Tailin	0.059	119.0	0.44	0.09	0.35	1
8.694	5602.13	21.8	0.392	21.5	41.9	18.15	1.80%	Sand-Slime Tailin	0.059	119.0	0.45	0.10	0.35	1
8.858	5601.96	21.4	0.248	21.0	63.0	27.28	1.16%	Sand-Slime Tailin	0.059	119.0	0.46	0.10	0.36	1
9.022	5601.80	29.7	0.307	29.5	36.3	15.73	1.03%	Sand-Slime Tailin	0.059	119.0	0.47	0.11	0.36	1
9.186	5601.63	22.6	0.143	22.5	10.6	4.58	0.63%	Sand-Slime Tailin	0.059	119.0	0.48	0.11	0.37	1
9.350	5601.47	17.7	0.143	17.7	4.4	1.92	0.81%	Sand-Slime Tailin	0.059	119.0	0.49	0.12	0.37	1
9.514	5601.31	14.2	0.178	14.2	4.4	1.90	1.25%	Sand-Slime Tailin	0.059	119.0	0.50	0.12	0.38	1
9.678	5601.14	11.7	0.202	11.6	7.4	3.22	1.73%	Sand-Slime Tailin	0.059	119.0	0.51	0.13	0.38	1
9.842	5600.98	11.3	0.120	11.2	13.3	5.76	1.07%	Sand-Slime Tailin	0.059	119.0	0.52	0.13	0.38	1
10.006	5600.81	14.4	0.083	14.3	11.9	5.15	0.58%	Sand-Slime Tailin	0.059	119.0	0.53	0.14	0.39	1
10.170	5600.65	18.3	0.069	18.3	7.0	3.04	0.38%	Sand-Slime Tailin	0.059	119.0	0.54	0.15	0.39	1
10.335	5600.49	20.6	0.093	20.6	5.9	2.55	0.45%	Sand-Slime Tailin	0.059	119.0	0.55	0.15	0.40	1
10.499	5600.32	21.3	0.111	21.3	5.5	2.39	0.52%	Sand-Slime Tailin	0.059	119.0	0.56	0.16	0.40	1
10.663	5600.16	23.3	0.126	23.3	6.1	2.63	0.54%	Sand-Slime Tailin	0.059	119.0	0.57	0.16	0.41	1
10.827	5599.99	23.4	0.148	23.4	6.7	2.88	0.63%	Sand-Slime Tailin	0.059	119.0	0.58	0.17	0.41	1
10.991	5599.83	23.4	0.151	23.3	6.8	2.96	0.65%	Sand-Slime Tailin	0.059	119.0	0.59	0.17	0.42	1
11.155	5599.67	23.8	0.188	23.7	7.4	3.19	0.79%	Sand-Slime Tailin	0.059	119.0	0.60	0.18	0.42	1
11.319	5599.50	20.6	0.235	20.6	7.4	3.21	1.14%	Sand-Slime Tailin	0.059	119.0	0.61	0.18	0.43	1
11.483	5599.34	17.6	0.198	17.5	8.1	3.49	1.13%	Sand-Slime Tailin	0.059	119.0	0.62	0.19	0.43	1
11.647	5599.17	21.4	0.168	21.3	8.2	3.53	0.79%	Sand-Slime Tailin	0.059	119.0	0.63	0.19	0.44	1
11.811	5599.01	21.3	0.146	21.2	7.4	3.21	0.69%	Sand-Slime Tailin	0.059	119.0	0.64	0.20	0.44	1
11.975	5598.85	23.0	0.133	23.0	8.9	3.84	0.58%	Sand-Slime Tailin	0.059	119.0	0.65	0.20	0.45	1
12.139	5598.68	25.0	0.154	24.9	8.9	3.84	0.62%	Sand-Slime Tailin	0.059	119.0	0.66	0.21	0.45	1
12.303	5598.52	23.3	0.135	23.3	8.9	3.84	0.58%	Sand-Slime Tailin	0.059	119.0	0.67	0.21	0.45	1
12.467	5598.35	19.3	0.160	19.2	8.9	3.87	0.83%	Sand-Slime Tailin	0.059	119.0	0.68	0.22	0.46	1
12.631	5598.19	20.3	0.143	20.3	8.0	3.47	0.70%	Sand-Slime Tailin	0.059	119.0	0.69	0.22	0.46	1
12.795	5598.02	20.0	0.132	19.9	7.5	3.24	0.66%	Sand-Slime Tailin	0.059	119.0	0.70	0.23	0.47	1
12.959	5597.86	21.7	0.151	21.6	9.5	4.12	0.70%	Sand-Slime Tailin	0.059	119.0	0.71	0.23	0.47	1
13.123	5597.70	20.7	0.179	20.6	8.8	3.79	0.87%	Sand-Slime Tailin	0.059	119.0	0.72	0.24	0.48	1
13.287	5597.53	20.4	0.271	20.3	9.5	4.12	1.33%	Sand-Slime Tailin	0.059	119.0	0.72	0.24	0.48	1
13.451	5597.37	17.5	0.436	17.4	12.5	5.40	2.49%	Sand-Slime Tailin	0.059	119.0	0.73	0.25	0.49	1
13.615	5597.20	16.3	0.451	16.2	16.3	7.05	2.77%	Slime Tailings	0.057	113.1	0.74	0.25	0.49	1
13.779	5597.04	20.4	0.353	20.2	19.3	8.35	1.73%	Sand-Slime Tailin	0.059	119.0	0.75	0.26	0.50	1
13.943	5596.88	25.7	0.379	25.6	13.1	5.68	1.48%	Sand-Slime Tailin	0.059	119.0	0.76	0.26	0.50	1
14.107	5596.71	19.0	0.491	19.0	7.7	3.35	2.58%	Slime Tailings	0.057	113.1	0.77	0.27	0.51	1
14.271	5596.55	14.6	0.427	14.6	5.8	2.51	2.92%	Slime Tailings	0.057	113.1	0.78	0.27	0.51	1
14.436	5596.38	9.2	0.378	9.2	7.3	3.14	4.11%	Slime Tailings	0.057	113.1	0.79	0.28	0.51	1
14.600	5596.22	10.5	0.412	10.2	45.5	19.71	3.91%	Slime Tailings	0.057	113.1	0.80	0.28	0.52	1
14.764	5596.06	12.3	0.360	12.1	42.1	18.25	2.92%	Slime Tailings	0.057	113.1	0.81	0.29	0.52	1
14.928	5595.89	11.4	0.381	11.1	52.4	22.72	3.35%	Slime Tailings	0.057	113.1	0.82	0.29	0.53	1
15.092	5595.73	10.8	0.299	10.3	74.3	32.20	2.78%	Slime Tailings	0.057	113.1	0.83	0.30	0.53	1
15.256	5595.56	19.3	0.291	19.3	9.6	4.14	1.50%	Sand-Slime Tailin	0.059	119.0	0.84	0.30	0.53	1
15.420	5595.40	21.0	0.161	20.9	6.0	2.61	0.77%	Sand-Slime Tailin	0.059	119.0	0.85	0.31	0.54	1
15.584	5595.24	22.2	0.159	22.2	3.5	1.51	0.72%	Sand-Slime Tailin	0.059	119.0	0.86	0.31	0.54	1
15.748	5595.07	20.4	0.160	20.4	2.7	1.19	0.78%	Sand-Slime Tailin	0.059	119.0	0.87	0.32	0.55	1
15.912	5594.91	19.5	0.171	19.4	8.7	3.77	0.88%	Sand-Slime Tailin	0.059	119.0	0.88	0.32	0.55	1
16.076	5594.74	19.6	0.146	19.5	14.0	6.06	0.74%	Sand-Slime Tailin	0.059	119.0	0.89	0.33	0.56	1
16.240	5594.58	22.3	0.122	22.2	15.7	6.79	0.55%	Sand-Slime Tailin	0.059	119.0	0.90	0.33	0.56	1
16.404	5594.42	25.7	0.298	25.6	17.8	7.69	1.16%	Sand-Slime Tailin	0.059	119.0	0.91	0.34	0.57	1
16.568	5594.25	18.5	0.396	18.4	22.8	9.87	2.14%	Sand-Slime Tailin	0.059	119.0	0.92	0.34	0.57	1
16.732	5594.09	15.3	0.462	15.1	35.8	15.50	3.02%	Slime Tailings	0.057	113.1	0.93	0.35	0.58	1
16.896	5593.92	15.4	0.350	14.9	88.5	38.34	2.27%	Sand-Slime Tailin	0.059	119.0	0.94	0.35	0.58	1
17.060	5593.76	26.3	0.276	25.8	72.4	31.36	1.05%	Sand-Slime Tailin	0.059	119.0	0.95	0.36	0.59	1
17.224	5593.60	20.8	0.402	20.7	18.6	8.07	1.93%	Sand-Slime Tailin	0.059	119.0	0.96	0.37	0.59	1
17.388	5593.43	15.3	0.334	15.2	21.0	9.11	2.19%	Sand-Slime Tailin	0.059	119.0	0.96	0.37	0.59	1
17.552	5593.27	16.5	0.162	16.3	36.5	15.82	0.98%	Sand-Slime Tailin	0.059	119.0	0.97	0.38	0.60	1
17.716	5593.10	24.5	0.248	24.3	32.1	13.91	1.01%	Sand-Slime Tailin	0.059	119.0	0.98	0.38	0.60	1
17.880	5592.94	17.1	0.328	16.9	29.7	12.85	1.92%	Sand-Slime Tailin	0.059	119.0	0.99	0.39	0.61	1
18.044	5592.78	15.0	0.452	14.8	43.2	18.70	3.01%	Slime Tailings	0.057	113.1	1.00	0.39	0.61	1
18.208	5592.61	12.2	0.284	11.8	60.5	26.21	2.32%	Slime Tailings	0.057	113.1	1.01	0.40	0.62	1

CPT Data Interpretations (continued) / Conditions at t_1

Depth at time of CPT (ft)	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil. Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
0.164	1.70	16.099	223.78	18.83	1153	8.59%	2.2	###	0.59	0.00	0.59	0
0.328	1.70	115.243	1601.88	133.95	4105	0.63%	1.0	###	0.60	0.00	0.60	0
0.492	1.70	177.871	2472.41	206.68	4223	0.58%	1.0	###	0.61	0.00	0.61	0
0.656	1.70	124.661	1732.79	144.86	2219	0.95%	1.2	###	0.62	0.00	0.62	0
0.820	1.70	154.241	2143.95	179.20	2196	1.78%	1.5	###	0.62	0.00	0.62	0
0.984	1.70	167.790	2332.28	194.94	1991	0.96%	1.2	###	0.63	0.00	0.63	0
1.148	1.70	242.879	3376.02	282.16	2470	0.81%	1.1	###	0.64	0.00	0.64	0
1.312	1.70	241.910	3362.55	281.03	2153	0.54%	1.0	###	0.65	0.00	0.65	0
1.476	1.70	255.544	3552.06	296.84	2021	0.64%	1.0	###	0.66	0.00	0.66	0
1.640	1.70	242.862	3375.78	282.13	1729	0.66%	1.1	###	0.67	0.00	0.67	0
1.804	1.70	220.643	3066.94	256.32	1428	0.70%	1.1	###	0.67	0.00	0.67	0
1.968	1.70	229.313	3187.45	266.38	1360	1.07%	1.3	###	0.68	0.00	0.68	0
2.133	1.70	222.496	3092.69	258.45	1218	0.58%	1.1	###	0.69	0.00	0.69	0
2.297	1.70	204.714	2845.52	237.80	1040	0.80%	1.2	###	0.70	0.00	0.70	0
2.461	1.70	167.773	2332.04	194.90	796	1.15%	1.4	###	0.71	0.00	0.71	0
2.625	1.70	128.367	1784.30	149.13	570	1.54%	1.6	###	0.72	0.00	0.72	0
2.789	1.70	91.749	1275.31	106.59	383	1.43%	1.6	###	0.72	0.00	0.72	0
2.953	1.70	85.136	1183.39	98.90	336	2.00%	1.8	###	0.73	0.00	0.73	0
3.117	1.70	96.713	1344.31	112.36	362	1.93%	1.8	###	0.74	0.00	0.74	0
3.281	1.70	109.174	1517.52	126.83	387	1.15%	1.6	###	0.75	0.00	0.75	0
3.445	1.70	88.570	1231.12	102.89	300	1.71%	1.8	###	0.76	0.00	0.76	0
3.609	1.70	49.436	687.16	57.43	161	3.60%	2.2	###	0.76	0.00	0.76	0
3.773	1.70	36.550	508.05	42.47	114	4.89%	2.4	###	0.77	0.00	0.77	0
3.937	1.70	27.744	385.64	32.26	83	4.19%	2.4	###	0.78	0.00	0.78	0
4.101	1.70	31.008	431.01	36.08	90	3.39%	2.3	###	0.78	0.00	0.78	0
4.265	1.70	25.568	355.40	29.75	72	4.11%	2.4	###	0.79	0.00	0.79	0
4.429	1.70	32.810	456.06	38.17	89	3.14%	2.3	###	0.80	0.00	0.80	0
4.593	1.70	41.701	579.64	48.48	110	2.82%	2.2	###	0.80	0.00	0.80	0
4.757	1.70	41.684	579.41	48.44	106	2.60%	2.2	###	0.81	0.00	0.81	0
4.921	1.70	39.712	552.00	46.19	98	1.72%	2.1	###	0.82	0.00	0.82	0
5.085	1.70	43.282	601.62	50.36	103	1.29%	2.0	###	0.83	0.00	0.83	0
5.249	1.70	34.425	478.51	40.00	79	1.55%	2.1	###	0.84	0.00	0.84	0
5.413	1.70	19.040	264.66	22.12	42	2.42%	2.4	###	0.84	0.00	0.84	0
5.577	1.70	12.750	177.23	14.82	27	1.95%	2.5	###	0.85	0.00	0.85	0
5.741	1.70	13.090	181.95	15.22	27	1.20%	2.4	###	0.86	0.00	0.86	0
5.905	1.70	16.881	234.65	19.64	35	0.87%	2.2	###	0.87	0.00	0.87	0
6.069	1.70	9.962	138.47	11.61	20	1.58%	2.6	###	0.88	0.00	0.88	0
6.234	1.70	9.418	130.91	10.99	19	1.62%	2.6	###	0.89	0.00	0.89	0
6.398	1.70	11.798	163.99	13.78	23	1.32%	2.5	###	0.90	0.00	0.90	0
6.562	1.70	12.019	167.06	14.04	23	1.21%	2.5	###	0.91	0.00	0.91	0
6.726	1.70	18.088	251.42	21.09	35	0.79%	2.2	###	0.92	0.00	0.92	0
6.890	1.70	22.746	316.17	26.49	43	0.87%	2.2	###	0.93	0.00	0.93	0
7.054	1.70	25.364	352.56	29.52	48	0.92%	2.1	###	0.94	0.00	0.94	0
7.218	1.70	38.029	528.60	44.27	71	0.61%	1.9	###	0.95	0.00	0.95	0
7.382	1.70	29.580	411.16	34.48	54	0.95%	2.1	###	0.96	0.00	0.96	0
7.546	1.70	26.112	362.96	30.63	47	1.32%	2.2	###	0.97	0.00	0.97	0
7.710	1.70	28.492	396.04	33.64	51	1.36%	2.2	###	0.98	0.00	0.98	0
7.874	1.70	29.903	415.65	35.25	53	1.00%	2.1	###	0.99	0.00	0.99	0
8.038	1.70	34.680	482.05	40.68	60	0.71%	2.0	###	1.00	0.00	1.00	0
8.202	1.70	44.557	619.34	52.16	77	0.65%	1.9	###	1.01	0.00	1.01	0
8.366	1.70	50.405	700.63	58.99	86	0.86%	1.9	###	1.02	0.00	1.02	0
8.530	1.70	37.621	522.93	44.04	63	1.27%	2.1	###	1.03	0.00	1.03	0
8.694	1.70	36.533	507.81	42.95	60	1.84%	2.2	###	1.04	0.00	1.04	0
8.858	1.70	35.768	497.18	42.32	59	1.18%	2.1	###	1.04	0.00	1.04	0
9.022	1.70	50.044	695.61	58.57	81	1.05%	2.0	###	1.05	0.00	1.05	0
9.186	1.70	38.267	531.91	44.58	60	0.65%	2.0	###	1.06	0.00	1.06	0
9.350	1.70	30.039	417.54	34.94	46	0.83%	2.1	###	1.07	0.00	1.07	0
9.514	1.70	24.072	334.60	28.01	36	1.30%	2.3	###	1.08	0.00	1.08	0
9.678	1.70	19.737	274.34	23.01	29	1.81%	2.5	###	1.09	0.00	1.09	0
9.842	1.70	18.989	263.95	22.22	28	1.12%	2.4	###	1.10	0.00	1.10	0
10.006	1.70	24.293	337.67	28.36	36	0.60%	2.2	###	1.11	0.00	1.11	0
10.170	1.70	31.110	432.43	36.22	45	0.39%	2.0	###	1.12	0.00	1.12	0
10.335	1.68	34.682	482.08	40.35	50	0.46%	2.0	###	1.13	0.00	1.13	0
10.499	1.67	35.475	493.10	41.27	51	0.53%	2.0	###	1.14	0.00	1.14	0
10.663	1.64	38.112	529.76	44.34	56	0.55%	2.0	###	1.15	0.00	1.15	0
10.827	1.63	38.033	528.66	44.25	55	0.65%	2.0	###	1.16	0.00	1.16	0
10.991	1.62	37.699	524.02	43.87	55	0.66%	2.0	###	1.17	0.00	1.17	0
11.155	1.60	37.995	528.13	44.21	55	0.81%	2.1	###	1.18	0.00	1.18	0
11.319	1.62	33.296	462.82	38.76	47	1.17%	2.2	###	1.19	0.00	1.19	0
11.483	1.63	28.640	398.09	33.36	39	1.17%	2.3	###	1.20	0.00	1.20	0
11.647	1.59	33.858	470.62	39.42	48	0.81%	2.1	###	1.21	0.00	1.21	0
11.811	1.58	33.555	466.42	39.06	47	0.71%	2.1	###	1.22	0.00	1.22	0
11.975	1.56	35.751	496.95	41.62	50	0.59%	2.0	###	1.23	0.00	1.23	0
12.139	1.53	38.252	531.70	44.53	54	0.63%	2.0	###	1.24	0.00	1.24	0
12.303	1.54	35.751	496.94	41.62	50	0.60%	2.0	###	1.25	0.00	1.25	0
12.467	1.56	29.859	415.03	34.78	40	0.86%	2.2	###	1.26	0.00	1.26	0
12.631	1.54	31.205	433.74	36.33	42	0.73%	2.1	###	1.27	0.00	1.27	0
12.795	1.53	30.469	423.52	35.47	41	0.69%	2.1	###	1.28	0.00	1.28	0
12.959	1.51	32.643	453.73	38.02	44	0.72%	2.1	###	1.29	0.00	1.29	0
13.123	1.51	31.051	431.61	36.16	42	0.90%	2.2	###	1.30	0.00	1.30	0
13.287	1.50	30.438	423.09	35.45	41	1.38%	2.3	###	1.31	0.00	1.31	0
13.451	1.51	26.315	365.78	30.70	34	2.60%	2.5	###	1.32	0.00	1.32	0
13.615	1.51	24.409	339.29	28.53	32	2.91%	2.6	###	1.33	0.00	1.33	0
13.779	1.47	29.819	414.48	34.84	40	1.80%	2.4	###	1.34	0.00	1.34	0
13.943	1.44	36.753	510.87	42.82	50	1.52%	2.3	###	1.35	0.00	1.35	0
14.107	1.46	27.769	385.99	32.33	36	2.69%	2.5	###	1.36	0.00	1.36	0
14.271	1.49	21.650	300.93	25.21	27	3.09%	2.7	###	1.37	0.00	1.37	0
14.436	1.50	13.706	190.52	16.00	16	4.50%	2.9	###	1.38	0.00	1.38	0
14.600	1.49	15.242	211.87	18.19	19	4.24%	2.9	###	1.38	0.00	1.38	0
14.764	1.48	17.857	248.22	21.19	22	3.12%	2.7	###	1.39	0.00	1.39	0
14.928	1.47	16.259	226.00	19.44	20	3.61%	2.8	###	1.40	0.00	1.40	0
15.092	1.46	15.049	209.18	18.27	19	3.01%	2.8	###	1.41	0.00	1.41	0
15.256	1.41	27.158	377.49	31.64	35	1.57%	2.4	###	1.42	0.00	1.42	0
15.420	1.39	29.142	405.07	33.91	37	0.80%	2.2	###	1.43	0.00	1.43	0
15.584	1.38	30.532	424.40	35.50	39	0.75%	2.2	###	1.44	0.00	1.44	0
15.748	1.38	28.088	390.43	32.65	36	0.82%	2.2	###	1.45	0.00	1.45	0
15.912	1.38	26.698	371.11	31.10	34	0.92%	2.3	###	1.46	0.00	1.46	0
16.076	1.37	26.712	371.29	31.16	34	0.78%	2.2	###	1.47	0.00	1.47	0
16.240	1.35	29.952	416.34	34.94	38	0.57%	2.1	###	1.48	0.00	1.48	0
16.404	1.33	34.002	472.62	39.66	44	1.20%	2.2	###	1.49	0.00	1.49	0
16.568	1.35	24.813	344.89	29.04	31	2.25%	2.5	###	1.50	0.00	1.50	0
16.732	1.36	20.475	284.61	24.13	25	3.21%	2.7	###	1.51	0.00	1.51	0
16.896	1.35	20.091	279.26	24.20	25	2.41%	2.6	###	1.52	0.00	1.52	0
17.060	1.30	33.545	466.27	39.64	43	1.09%	2.2	###	1.53	0.00	1.53	0
17.224	1.31	27.153	377.43	31.71	34	2.02%	2.5	###	1.54	0.00	1.54	0
17.388	1.33	20.107	279.49	23.56	24	2.33%	2.6	###	1.55	0.00	1.55	0
17.552	1.31	21.424	297.79	25.23	26	1.04%	2.4	###	1.56	0.00	1.56	0
17.716	1.28	31.128	432.68	36.45	39	1.05%	2.3	###	1.57	0.00	1.57	0
17.880	1.30	21.982	305.54	25.81	27	2.03%	2.6	###	1.58	0.00	1.58	0
18.044	1.30	19.195	266.82	22.70	23	3.22%	2.7	###	1.59	0.00	1.59	0
18.208	1.30	15.367	213.60	18.42	18	2.53%	2.7	###	1.60	0.00	1.60	0

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	I&B r_d	I&B C_σ	I&B K_σ	I&B K_α	I&B CSR M=7.5, σ'=1atm	I&B Δq_{c1N}	I&B q_{c1N-cs}	I&B (CRR) M=7.5, σ'=1atm	I&B FoS	Youd r_d	Youd D_r	Youd f	Youd f	Youd K_σ	Youd K_α	Youd CSR	Youd K_c	Youd q_{c1N-cs}	Youd (CRR) M=7.5, σ'=1atm	Youd FoS	Avg FoS	Liquefiable? 1=Yes 2=No
0.164	1.00	0.05	1.02	1.0	0.059	36.93	55.75	0.083	1.41	0.97	0.25	0.80	0.80	2.53	1.0	0.017	1.65	31.02	0.076	183.93	92.67	2
0.328	1.00	0.14	1.05	1.0	0.061	77.33	211.28	1.000	16.47	0.97	0.67	0.67	0.67	3.75	1.0	0.011	1.00	133.95	1.000	368.22	192.34	2
0.492	1.00	0.28	1.10	1.0	0.064	102.85	309.54	1.000	15.74	0.97	0.83	0.58	0.58	4.36	1.0	0.010	1.00	206.68	1.000	809.03	412.39	2
0.656	1.00	0.15	1.05	1.0	0.061	81.15	226.01	1.000	16.46	0.97	0.69	0.65	0.65	3.10	1.0	0.011	1.00	144.86	0.363	220.15	118.30	2
0.820	1.00	0.21	1.07	1.0	0.063	93.21	272.40	1.000	16.21	0.97	0.77	0.61	0.61	3.23	1.0	0.013	1.00	179.20	1.000	489.80	251.00	2
0.984	1.00	0.25	1.08	1.0	0.062	98.73	293.67	1.000	16.07	0.97	0.81	0.60	0.60	3.13	1.0	0.014	1.00	194.94	1.000	404.99	210.53	2
1.148	1.00	0.30	1.09	1.0	0.063	129.34	411.50	1.000	15.89	0.97	0.97	0.60	0.60	2.95	1.0	0.015	1.00	282.16	1.000	347.27	181.58	2
1.312	1.00	0.30	1.08	1.0	0.063	128.94	409.98	1.000	15.95	0.97	0.97	0.60	0.60	2.79	1.0	0.015	1.00	281.03	1.000	303.98	159.97	2
1.476	1.00	0.30	1.08	1.0	0.062	134.49	431.33	1.000	16.01	0.97	0.99	0.60	0.60	2.66	1.0	0.016	1.00	296.84	1.000	270.31	143.16	2
1.640	1.00	0.30	1.08	1.0	0.062	129.33	411.46	1.000	16.06	0.97	0.97	0.60	0.60	2.55	1.0	0.016	1.00	282.13	1.000	243.38	129.72	2
1.804	1.00	0.30	1.07	1.0	0.062	120.27	376.60	1.000	16.12	0.97	0.92	0.60	0.60	2.46	1.0	0.017	1.00	256.32	1.000	221.34	118.73	2
1.968	1.00	0.30	1.07	1.0	0.062	123.80	390.18	1.000	16.19	0.97	0.94	0.60	0.60	2.37	1.0	0.018	1.00	266.38	1.000	202.98	109.58	2
2.133	1.00	0.30	1.07	1.0	0.062	121.02	379.47	1.000	16.25	0.97	0.93	0.60	0.60	2.30	1.0	0.018	1.00	258.45	1.000	187.44	101.85	2
2.297	1.00	0.30	1.06	1.0	0.061	113.77	351.58	1.000	16.32	0.97	0.89	0.60	0.60	2.23	1.0	0.019	1.00	237.80	1.000	174.12	95.22	2
2.461	1.00	0.25	1.05	1.0	0.060	98.72	293.62	1.000	16.55	0.97	0.81	0.60	0.60	2.17	1.0	0.020	1.00	194.90	1.000	162.57	89.56	2
2.625	1.00	0.16	1.03	1.0	0.059	82.66	231.79	1.000	16.88	0.97	0.71	0.65	0.65	1.94	1.0	0.021	1.00	149.13	0.388	59.23	38.05	2
2.789	0.99	0.11	1.02	1.0	0.059	67.72	174.31	0.455	7.77	0.97	0.60	0.70	0.70	1.72	1.0	0.025	1.00	106.59	0.193	27.65	17.71	2
2.953	0.99	0.11	1.02	1.0	0.058	65.03	163.92	0.354	6.06	0.97	0.57	0.71	0.71	1.66	1.0	0.026	1.10	108.69	0.199	27.05	16.55	2
3.117	0.99	0.12	1.02	1.0	0.058	69.75	182.11	0.572	9.79	0.97	0.61	0.69	0.69	1.68	1.0	0.025	1.08	121.15	0.245	31.54	20.67	2
3.281	0.99	0.13	1.02	1.0	0.058	54.51	181.34	0.558	9.56	0.97	0.65	0.67	0.67	1.71	1.0	0.025	1.00	126.83	0.270	32.92	21.24	2
3.445	0.99	0.11	1.01	1.0	0.058	66.39	169.28	0.400	6.89	0.97	0.59	0.71	0.71	1.60	1.0	0.027	1.08	110.88	0.207	24.13	15.51	2
3.609	0.99	0.08	1.01	1.0	0.058	50.09	107.51	0.155	2.69	0.97	0.44	0.78	0.78	1.41	1.0	0.030	1.62	93.01	0.155	17.39	10.04	2
3.773	0.99	0.07	1.01	1.0	0.058	44.88	87.35	0.123	2.13	0.97	0.38	0.80	0.80	1.36	1.0	0.031	2.21	93.92	0.157	17.01	9.57	2
3.937	0.99	0.06	1.00	1.0	0.058	41.52	73.59	0.104	1.81	0.97	0.33	0.80	0.80	1.35	1.0	0.032	2.74	88.42	0.120	12.54	7.17	2
4.101	0.99	0.06	1.01	1.0	0.057	42.65	78.73	0.111	1.93	0.97	0.35	0.80	0.80	1.34	1.0	0.032	1.99	71.97	0.115	11.59	6.76	2
4.265	0.99	0.06	1.00	1.0	0.057	40.45	70.19	0.100	1.74	0.97	0.31	0.80	0.80	1.33	1.0	0.032	2.49	74.20	0.118	11.64	6.64	2
4.429	0.99	0.06	1.00	1.0	0.057	43.38	81.55	0.115	2.00	0.96	0.36	0.80	0.80	1.32	1.0	0.032	1.92	73.46	0.117	11.07	6.54	2
4.593	0.98	0.07	1.00	1.0	0.057	47.31	95.79	0.136	2.37	0.96	0.40	0.80	0.80	1.31	1.0	0.032	1.67	80.91	0.129	11.78	7.07	2
4.757	0.98	0.07	1.00	1.0	0.057	47.29	95.73	0.136	2.38	0.96	0.40	0.80	0.80	1.30	1.0	0.033	1.62	78.55	0.125	11.06	6.72	2
4.921	0.98	0.07	1.00	1.0	0.057	46.50	92.69	0.131	2.30	0.96	0.39	0.80	0.80	1.29	1.0	0.033	1.41	65.26	0.106	9.06	5.68	2
5.085	0.98	0.07	1.00	1.0	0.057	47.96	98.32	0.140	2.46	0.96	0.41	0.80	0.80	1.29	1.0	0.033	1.27	63.77	0.104	8.64	5.55	2
5.249	0.98	0.06	1.00	1.0	0.057	44.33	84.33	0.119	2.09	0.96	0.37	0.80	0.80	1.28	1.0	0.033	1.47	58.96	0.099	7.97	5.03	2
5.413	0.98	0.05	1.00	1.0	0.057	37.79	59.91	0.088	1.55	0.96	0.27	0.80	0.80	1.27	1.0	0.033	2.50	55.31	0.096	7.51	4.53	2
5.577	0.98	0.05	1.00	1.0	0.057	35.25	50.06	0.078	1.37	0.96	0.22	0.80	0.80	1.26	1.0	0.034	2.95	43.70	0.086	6.59	3.98	2
5.741	0.98	0.05	1.00	1.0	0.056	35.64	50.85	0.078	1.39	0.96	0.23	0.80	0.80	1.26	1.0	0.034	2.36	35.90	0.080	5.99	3.69	2
5.905	0.98	0.05	1.00	1.0	0.056	37.19	56.83	0.084	1.50	0.96	0.26	0.80	0.80	1.26	1.0	0.034	1.79	35.17	0.079	5.85	3.67	2
6.069	0.98	0.05	1.00	1.0	0.056	34.13	45.74	0.074	1.30	0.96	0.20	0.80	0.80	1.25	1.0	0.034	3.28	38.05	0.082	5.94	3.62	2
6.234	0.98	0.05	1.00	1.0	0.056	33.92	44.91	0.073	1.29	0.96	0.19	0.80	0.80	1.25	1.0	0.034	3.48	38.27	0.082	5.86	3.58	2
6.398	0.97	0.05	1.00	1.0	0.056	34.89	48.67	0.076	1.36	0.96	0.21	0.80	0.80	1.25	1.0	0.034	2.75	37.89	0.082	5.76	3.56	2
6.562	0.97	0.05	1.00	1.0	0.056	34.98	49.02	0.077	1.37	0.96	0.22	0.80	0.80	1.24	1.0	0.034	2.61	36.66	0.081	5.63	3.50	2
6.726	0.97	0.05	1.00	1.0	0.056	37.70	58.79	0.087	1.54	0.96	0.27	0.80	0.80	1.24	1.0	0.034	1.74	36.71	0.081	5.53	3.54	2
6.890	0.97	0.06	1.00	1.0	0.056	39.59	66.08	0.095	1.70	0.96	0.30	0.80	0.80	1.23	1.0	0.034	1.60	42.25	0.085	5.75	3.73	2
7.054	0.97	0.06	1.00	1.0	0.056	40.66	70.18	0.100	1.79	0.96	0.31	0.80	0.80	1.23	1.0	0.034	1.55	45.64	0.088	5.82	3.82	2
7.218	0.97	0.07	0.99	1.0	0.056	45.83	90.09	0.127	2.28	0.96	0.39	0.80	0.80	1.23	1.0	0.035	1.19	52.69	0.094	6.15	4.22	2
7.382	0.97	0.06	0.99	1.0	0.056	42.40	76.88	0.108	1.95	0.96	0.34	0.80	0.80	1.22	1.0	0.035	1.47	50.71	0.092	5.96	3.95	2
7.546	0.97	0.06	0.99	1.0	0.056	41.04	71.67	0.102	1.83	0.96	0.32	0.80	0.80	1.22	1.0	0.035	1.77	54.31	0.095	6.05	3.94	2
7.710	0.97	0.06	0.99	1.0	0.056	42.10	75.74	0.107	1.93	0.96	0.33	0.80	0.80	1.22	1.0	0.035	1.72	57.87	0.098	6.16	4.04	2
7.874	0.96	0.06	0.99	1.0	0.055	42.50	77.11	0.109	1.98	0.96	0.33	0.80	0.80	1.21	1.0	0.035	1.55	54.63	0.095	5.83	3.91	2
8.038	0.96	0.06	0.99	1.0	0.055	44.57	85.24	0.120	2.17	0.96	0.37	0.80	0.80	1.21	1.0	0.035	1.30	52.92	0.094	5.73	3.95	2
8.202	0.96	0.07	0.99	1.0	0.055	48.59	100.75	0.144	2.61	0.96	0.42	0.79	0.79	1.21	1.0	0.035	1.18	61.54	0.102	6.13	4.37	2
8.366	0.96	0.08	0.99	1.0	0.055	50.99	109.98	0.160	2.91	0.96	0.44	0.78	0.78	1.23	1.0	0.034	1.21	71.32	0.114	6.77	4.84	2
8.530	0.96	0.07	0.99	1.0	0.055	45.75	89.79	0.127	2.31	0.96	0.38	0.80	0.80	1.20	1.0	0.035	1.27	55.98	0.097	5.83	4.07	2
8.694	0.96	0.07	0.99	1.0	0.055	45.36	88.31	0.124	2.26	0.95	0.38	0.80	0.80	1.20	1.0	0.035	1.79	77.08	0.123	7.11	4.69	2
8.858	0.96	0.07	0.99	1.0	0.055	45.14	87.46	0.123	2.25	0.95	0.38	0.80	0.80	1.19	1.0	0.035	1.53	64.55	0.105	6.02	4.13	2
9.022	0.96	0.08	0.99	1.0	0.055	50.84	109.41	0.159	2.91	0.95	0.44	0.78	0.78	1.21	1.0	0.035	1.29	75.74	0.120	6.81	4.86	2
9.186	0.96	0.07	0.99	1.0	0.054	45.93	90.51	0.128	2.34	0.95	0.39	0.80	0.80	1.19	1.0	0.035	1.27	56.79	0.097	5.42	3.88	2
9.350	0.96	0.06	0.99	1.0	0.054	42.56	77.50	0.109	2.01	0.95	0.33	0.80	0.80	1.18	1.0	0.035	1.52	53.08	0.094	5.18	3.60	2
9.514	0.95	0.06	0.99	1.0	0.054	38.97	63.98	0.092	1.70	0.95	0.30	0.80	0.80	1.18	1.0	0.035	2.06	57.62	0.098	5.32	3.55	2
9.678	0.95	0.05	0.99	1.0	0.054	38.37	61.39	0.089	1.64	0.95	0.28	0.80	0.80	1.18	1.0	0.036	2.72	62.50	0.103	5.54	3.59	2
9.842	0.95	0.05	0.99	1.0	0.054	38.09	60.31	0.088	1.62	0.95	0.28	0.80	0.80	1.17	1.0	0.036	1.80	40.01	0.083	4.60	3.11	2
10.006	0.95	0.05	0.99	1.0	0.054	40.23	68.61	0.098	1.81	0.95	0.31	0.80	0.80	1.17	1.0	0.036	1.58	44.88	0.087	4.80	3.21	2
10.170	0.95	0.06	0.99	1.0	0.054	43.00	79.22	0.112	2.07	0.95	0.35	0.80	0.80	1.17	1.0	0.036	1.28	46.49	0.089	4.62	3.34	2
10.335	0.95	0.07	0.98	1.0	0.054	44.85	84.81	0.119	2.22	0.95	0.37	0.80	0.80	1.17	1.0	0.036	1.27	51.31	0.093	4.76	3.49	2
10.499	0.95	0.07	0.98	1.0	0.054	44.78	86.04	0.121	2.25	0.95	0.37	0.80	0.80	1.16	1.0	0.036	1.30	53.68	0.094	4.80	3.51	2
10.663	0.95	0.07	0.98	1.0	0.054	45.85	90.19	0.127	2.36	0.95	0.38	0.80	0.80	1.16	1.0	0.036	1.27	56.24	0.097	4.86	3.62	2
10.827	0.95	0.07	0.98	1.0	0.054	45.82	90.07	0.127	2.37	0.95	0.38	0.80	0.80	1.16	1.0	0.036	1.31	58.18	0.098	4.90	3.63	2
10.991	0.94	0.07	0.98	1.0	0.053	45.69	89.56	0.126	2.36	0.95	0.38	0.80	0.80	1.15	1.0	0.036	1.33	58.30	0.098	4.85	3.61	2
11.155	0.94	0.07	0.98	1.0	0.053	45.58	89.78	0.127	2.38	0.95	0.38	0.80	0.80	1.15	1.0	0.036	1.40	61.77	0.102	4.97	3.67	2
11.319	0.94	0.06	0.98	1.0	0.053	43.89	82.65	0.116	2.18	0.95	0.36	0.80	0.80	1.15	1.0	0.036	1.70	65.83	0.106	5.14	3.66	2
11.483	0.94	0.06	0.98	1.0	0.053	42.00	75.36	0.106	2.00	0.95	0.33	0.80	0.80	1.15	1.0	0.036	1.87	62.34	0.103	4.89	3.45	2
11.647	0.94	0.06	0.98	1.0	0.053	44.13	83.54	0.118	2.21	0.95	0.36	0.80	0.80	1.15	1.0	0.036	1.49	58.73	0.099	4.67	3.44	2
11.811	0.94	0.06	0.98	1.0	0.053	44.00	83.06	0.117	2.20	0.95	0.36	0.80	0.80	1.14	1.0	0.037	1.51	58.96	0.099	4.52	3.36	2
11.975	0.94	0.07	0.98	1.0	0.053	44.90	86.52	0.122	2.30	0.95	0.37	0.80	0.80	1.14	1.0	0.037	1.34	55.78	0.096	4.45	3.38	2
12.139	0.94	0.07	0.98	1.0	0.053	45.22	87.75	0.124	2.33	0.95	0.37	0.80	0.80	1.14	1.0	0.037	1.32	58.78	0.099	4.53	3.48	2
12.303	0.94	0.07	0.98	1.0	0.053	44.90	86.52	0.122	2.31	0.95	0.37	0.80	0.80	1.14	1.0	0.037	1.34	55.97	0.096	4.37	3.34	2
12.467	0.94	0.06	0.98	1.0	0.052	42.20	76.98	0.108	2.05	0.94	0.34	0.80	0.80	1.14	1.0	0.037	1.55	53.90	0.094	4.28	3.16	2
12.631	0.94	0.06	0.98	1.0	0.052	43.04	79.37	0.112	2.12	0.94	0.35	0.80	0.80	1.13	1.0	0.037	1.53	55.52	0.096	4.27	3.20	2
12.795	0.93	0.06	0.98	1.0	0.052	42.74	78.21	0.110	2.10	0.94	0.35	0.80	0.80	1.13	1.0	0.037	1.52	54.00	0.095	4.17	3.14	2
12.959	0.93	0.06	0.98	1.0	0.052	43.63	81.65	0.115	2.19	0.94	0.36	0.80	0.80	1.13	1.0	0.037	1.49	56.54	0.097	4.23	3.21	2
13.123	0.93	0.06	0.98	1.0	0.052	42.51	78.66	0.111	2.13	0.94	0.35	0.80	0.80	1.13	1.0	0.037	1.65	59.68	0.101	4.31	3.22	2
13.287	0.93	0.06	0.98	1.0	0.052	42.74	78.19	0.110	2.10	0.94	0.34	0.80	0.80	1.13	1.0	0.037	1.96	69.60	0.111	4.77	3.44	2
13.451	0.93	0.06	0.98	1.0	0.052	41.07	71.77	0.102	1.96	0.94	0.31	0.80	0.80	1.13	1.0	0.038	2.72	83.57	0.134	5.44	3.70	2
13.615	0.93	0.06	0.98	1.0	0.052	40.02	68.55	0.098	1.88	0.94	0.30	0.80	0.80	1.12	1.0	0.037	3.28	93.45	0.156	6.57	4.22	2
13.779	0.93	0.06	0.98	1.0	0.052	42.55	77.39	0.109	2.10	0.94	0.35	0.80	0.80	1.12	1.0	0.037	1.86	64.84	0.105	4.64	3.37	2
13.943	0.92	0.07	0.98	1.0	0.052	45.30	88.12	0.124	2.37	0.94	0.37	0.80	0.80	1.12	1.0	0.037	1.52	65.14	0.106	4.75	3.56	2
14.107	0.92	0.06	0.98	1.0	0.052	41.64	73.98	0.105	2.02	0.94	0.33	0.80	0.80	1.12	1.0	0.037	2.90	93.82	0.157	6.43	4.23	2
14.271	0.92	0.05	0.98	1.0	0.052	37.38	58.59	0.086	1.66	0.94	0.26	0.80	0.80	1.11	1.0	0.037	3.45	87.00	0.141	6.35	4.01	2
14.436	0.92	0.05	0.98	1.0	0.051	34.71	50.71	0.079	1.54	0.94	0.22	0.80	0.80	1.11	1.0	0.037	5.41	86.47	0.140	6.16	3.85	2
14.600	0.92	0.05	0.98	1.0	0.051	35.42	53.61	0.082	1.60	0.94	0.23	0.80	0.80	1.11	1.0	0.038	5.41	98.39	0.169	6.76	4.17	2
14.764	0.92	0.05	0.98	1.0	0.051	35.04	56.23	0.083	1.62	0.94	0.25	0.80	0.80	1.11	1.0	0.038	4.23	89.55	0.147	5.84	3.73	2
14.928	0.92	0.05	0.97	1.0	0.051	34.68	54.12	0.081	1.58	0.94	0.24	0.80	0.80	1.11	1.0	0.038	4.80	93.41	0.156	6.15	3.89	2
15.092	0.91	0.05	0.97	1.0	0.051	34.35	52.62	0.079	1.55	0.94	0.23	0.80	0.80	1.10	1.0	0.038	5.20	95.00	0.160	6.28	3.91	2
15.256	0.91	0.06	0.97	1.0	0.051	38.91	70.55	0.100	1.96	0.94	0.30	0.80	0.80	1.10	1.0	0.038	1.86	58.84	0.099	4.45	3.25	2
15.420	0.91	0.06	0.97	1.0	0.051	42.19	76.10	0.107	2.06	0.94	0.34	0.80	0.80	1.10	1.0	0.038	1.68	56.97	0.097	3.75	2.92	2
15.584	0.91	0.06	0.97	1.0	0.051	42.75	78.25	0.110	2.12	0.93	0.35	0.80	0.80	1.10	1.0	0.038	1.60	56.82	0.097	3.71	2.94	2
15.748	0.91	0.06	0.97	1.0	0.051	41.92	74.57	0.106	2.04	0.93	0.33	0.80	0.80	1.09	1.0	0.038	1.73	56.48	0.097	3.70	2.86	2
15.912	0.91	0.06	0.97	1.0	0.051	41.21	72.30	0.102	1.98	0.93	0.32	0.80	0.80	1.09	1.0	0.038	1.92	59.62	0.100	3.70	2.84	2
16.076	0.91	0.06	0.97	1.0	0.051	41.45	72.61	0.103	2.01	0.93	0.32	0.80	0.80	1.09	1.0	0.038	1.77	55.11	0.095	3.57	2.79	2
16.240	0.91	0.06	0.97	1.0	0.051	42.56	77.50	0.109	2.14	0.93	0.34	0.80	0.80	1.09	1.0	0.038	1.50	52.57	0.094	3.45	2.80	2
16.404	0.90	0.07	0.97	1.0	0.050	44.21	83.87	0.118	2.31	0.93	0.36	0.80	0.80	1.09	1.0	0.038	1.72	68.22	0.111	3.94	3.13	2
16.568	0.90	0.06	0.97	1.0	0.050	41.04	70.08	0.100	1.96	0.93	0.30	0.80	0.80	1.09	1.0	0.038	2.92	84.80	0.137	4.99	3.47	2
16.732	0.90	0.05	0.97	1.0	0.050	38.49	62.62	0.091	1.79	0.93	0.28	0.80	0.80	1.08	1.0	0.038	3.33	80.35	0.128	4.67	3.23	2
16.896	0.90	0.05	0.97	1.0	0.050	38.79	62.99	0.092	1.81	0.93	0.28	0.80	0.80	1.08	1.0	0.038	3.45	83.47	0.134	4.86	3.33	2
17.060	0.90	0.06	0.97	1.0	0.050	42.46	82.10	0.115	2.27	0.93	0.36	0.80	0.80	1.08	1.0	0.038	1.52	60.25	0.100	3.66	2.96	2
17.224	0.90	0.06	0.97	1.0	0.050	41.42	73.14	0.104	2.05	0.93	0.32	0.80	0.80	1.08	1.0	0.038	2.62	83.22	0.134	4.73	3.40	2
17.388	0.90	0.05	0.97	1.0	0.050	38.19	61.75	0.090	1.78	0.93	0.28	0.80	0.80	1.08	1.0	0.039	2.91	68.66	0.112	3.95	2.87	2
17.552	0.90	0.05	0.97	1.0	0.050	39.15	64.38	0.093	1.85	0.93	0.29	0.80	0.80	1.08	1.0	0.038	2.31	58.30	0.099	3.43	2.64	2
17.716	0.89	0.06	0.97	1.0	0.050	42.17	77.90	0.110	2.19	0.93	0.34	0.80	0.80	1.07	1.0	0.038	1.94	70.71	0.113	3.96	3.07	2
17.880	0.89	0.05	0.97	1.0	0.050	38.55	64.36	0.093	1.86	0.93	0.29	0.80	0.80	1.07	1.0	0.038	3.10	80.03	0.128	4.43	3.15	2
18.044	0.89	0.05	0.97	1.0	0.050	37.99	60.69	0.089	1.78	0.93	0.27	0.80	0.80	1.07	1.0	0.038	4.20	95.31	0.161	5.48	3.63	2
18.208	0.89	0.05	0.97	1.0	0.050	36.50	54.92	0.082	1.65	0.93	0.25	0.80	0.80	1.07	1.0	0.038	4.32	79.57	0.127	4.31	2.98	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.397

Depth at t_1, z_1 (m)	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15}	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
3.31	594	1.6E-03	5.5E+02	1.0E-04	11	0.177	9799	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.36	594	1.6E-03	5.5E+02	1.1E-04	11	0.178	9742	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.41	594	1.6E-03	5.5E+02	1.1E-04	11	0.179	9687	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.46	594	1.6E-03	5.5E+02	1.1E-04	11	0.179	9633	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.51	594	1.6E-03	5.5E+02	1.1E-04	11	0.180	9580	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.56	594	1.6E-03	5.5E+02	1.1E-04	11	0.181	9528	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.61	594	1.6E-03	5.5E+02	1.1E-04	11	0.181	9477	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.66	594	1.6E-03	5.5E+02	1.1E-04	11	0.182	9426	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.71	594	1.6E-03	5.5E+02	1.2E-04	11	0.182	9377	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.76	594	1.6E-03	5.5E+02	1.2E-04	11	0.183	9329	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.81	594	1.6E-03	5.5E+02	1.2E-04	11	0.184	9281	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.86	594	1.6E-03	5.5E+02	1.2E-04	11	0.184	9234	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.91	594	1.6E-03	5.5E+02	1.2E-04	11	0.185	9188	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.96	594	1.6E-03	5.5E+02	1.2E-04	11	0.185	9143	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.01	594	1.6E-03	5.5E+02	1.2E-04	11	0.186	9099	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.06	594	1.6E-03	5.5E+02	1.3E-04	11	0.186	9055	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.11	594	1.6E-03	5.5E+02	1.3E-04	11	0.187	9012	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.16	594	1.6E-03	5.5E+02	1.3E-04	11	0.187	8969	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.21	495	1.6E-03	3.8E+02	1.9E-04	11	0.188	8928	0.03%	2.00	0.65	0.03%	0.002	0.34	0.079	0.765	0.26%	0.0004
4.26	495	1.6E-03	3.9E+02	1.9E-04	0	0.193	11488	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.04%	0.0001
4.31	495	1.4E-03	3.5E+02	2.1E-04	10	0.189	9084	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.74%	0.0012
4.36	495	1.3E-03	3.1E+02	2.4E-04	16	0.442	7445	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.52%	0.0025
4.41	495	1.3E-03	3.1E+02	2.4E-04	16	0.442	7417	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.55%	0.0025
4.46	495	1.3E-03	3.1E+02	2.4E-04	16	0.443	7391	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.59%	0.0026
4.51	495	1.3E-03	3.1E+02	2.4E-04	16	0.443	7364	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.62%	0.0027
4.56	495	1.3E-03	3.1E+02	2.5E-04	16	0.444	7338	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.65%	0.0027
4.61	495	1.3E-03	3.1E+02	2.5E-04	16	0.444	7312	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.68%	0.0028
4.66	495	1.4E-03	3.5E+02	2.2E-04	10	0.192	8854	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.95%	0.0016
4.71	495	1.4E-03	3.5E+02	2.2E-04	10	0.193	8819	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.98%	0.0016
4.76	495	1.4E-03	3.5E+02	2.3E-04	10	0.193	8785	0.05%	2.00	0.65	0.03%	0.007	0.34	0.079	0.765	1.01%	0.0017
4.81	495	1.4E-03	3.5E+02	2.3E-04	10	0.194	8751	0.05%	2.00	0.65	0.03%	0.007	0.34	0.079	0.765	1.05%	0.0017
4.86	495	1.4E-03	3.5E+02	2.3E-04	10	0.194	8718	0.05%	2.00	0.65	0.03%	0.007	0.34	0.079	0.765	1.08%	0.0018
4.91	495	1.3E-03	3.1E+02	2.6E-04	16	0.447	7148	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.90%	0.0031
4.96	495	1.8E-03	4.3E+02	1.9E-04	16	0.447	7116	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.60%	0.0010
5.01	495	1.8E-03	4.5E+02	1.9E-04	10	0.196	8608	0.03%	2.00	0.65	0.03%	0.001	0.34	0.079	0.765	0.11%	0.0002
5.06	495	1.8E-03	4.5E+02	1.9E-04	10	0.196	8568	0.03%	2.00	0.65	0.03%	0.001	0.34	0.079	0.765	0.18%	0.0003
5.11	495	1.8E-03	4.3E+02	2.0E-04	16	0.449	7019	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.71%	0.0012
5.16	495	1.8E-03	4.3E+02	2.0E-04	16	0.449	6989	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.74%	0.0012
5.21	495	1.8E-03	4.3E+02	2.0E-04	16	0.450	6959	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.77%	0.0013
5.26	495	1.8E-03	4.3E+02	2.1E-04	16	0.450	6930	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.81%	0.0013
5.31	495	1.8E-03	4.5E+02	2.0E-04	10	0.199	8384	0.03%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.40%	0.0007
5.36	495	1.8E-03	4.5E+02	2.0E-04	10	0.199	8347	0.03%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.44%	0.0007
5.41	495	1.8E-03	4.5E+02	2.0E-04	10	0.200	8311	0.03%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.48%	0.0008
5.46	495	1.8E-03	4.5E+02	2.0E-04	10	0.200	8276	0.04%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.52%	0.0008
5.51	495	1.8E-03	4.5E+02	2.1E-04	10	0.201	8241	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.55%	0.0009
5.56	495	1.8E-03	4.5E+02	2.1E-04	10	0.201	8206	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.59%	0.0010
5.61	495	1.8E-03	4.5E+02	2.1E-04	10	0.202	8172	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.62%	0.0010
5.66	495	1.8E-03	4.5E+02	2.1E-04	10	0.203	8138	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.66%	0.0011
5.71	495	1.8E-03	4.5E+02	2.1E-04	10	0.203	8105	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.69%	0.0011
5.76	495	1.8E-03	4.5E+02	2.2E-04	10	0.204	8072	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.72%	0.0012
5.81	495	1.8E-03	4.5E+02	2.2E-04	10	0.204	8040	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.75%	0.0012
5.86	495	1.8E-03	4.5E+02	2.2E-04	10	0.205	8008	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.78%	0.0013
5.91	495	1.8E-03	4.5E+02	2.2E-04	10	0.205	7977	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.82%	0.0013
5.96	495	1.8E-03	4.5E+02	2.3E-04	10	0.206	7946	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.85%	0.0014
6.01	495	1.8E-03	4.5E+02	2.3E-04	10	0.206	7915	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.88%	0.0014
6.06	495	1.8E-03	4.5E+02	2.3E-04	10	0.206	7885	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.91%	0.0015
6.11	460	1.8E-03	3.9E+02	2.7E-04	10	0.207	7856	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.57%	0.0026
6.16	460	1.8E-03	3.9E+02	2.7E-04	10	0.207	7826	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.60%	0.0026
6.21	460	1.8E-03	3.9E+02	2.7E-04	10	0.208	7797	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.64%	0.0027
6.26	460	1.8E-03	3.9E+02	2.8E-04	10	0.208	7768	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.67%	0.0027
6.31	460	1.8E-03	3.9E+02	2.8E-04	10	0.209	7740	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.71%	0.0028
6.36	460	1.8E-03	3.9E+02	2.8E-04	10	0.209	7712	0.07%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.74%	0.0029
6.41	460	1.8E-03	3.9E+02	2.8E-04	10	0.210	7685	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.78%	0.0029
6.46	460	1.8E-03	3.9E+02	2.8E-04	10	0.210	7657	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.81%	0.0030
6.51	460	1.8E-03	3.9E+02	2.9E-04	10	0.211	7630	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.85%	0.0030
6.56	460	1.8E-03	3.9E+02	2.9E-04	10	0.211	7604	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.88%	0.0031
6.61	460	1.8E-03	3.9E+02	2.9E-04	10	0.212	7577	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.92%	0.0031
6.66	460	1.8E-03	3.9E+02	2.9E-04	10	0.212	7551	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.95%	0.0032
6.71	460	1.8E-03	3.9E+02	3.0E-04	10	0.212	7526	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.99%	0.0033
6.76	460	1.8E-03	3.9E+02	3.0E-04	10	0.213	7500	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.03%	0.0033
6.81	460	1.8E-03	3.9E+02	3.0E-04	10	0.213	7475	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.06%	0.0034
6.86	460	1.8E-03	3.9E+02	3.0E-04	10	0.214	7450	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.10%	0.0034
6.91	460	1.8E-03	3.9E+02	3.1E-04	10	0.214	7426	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.13%	0.0035
6.96	460	1.8E-03	3.9E+02	3.1E-04	10	0.215	7401	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.17%	0.0036
7.01	460	1.8E-03	3.9E+02	3.1E-04	10	0.215	7377	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.21%	0.0036
7.06	460	1.8E-03	3.9E+02	3.1E-04	10	0.215	7354	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.24%	0.0037
7.11	460	1.8E-03	3.9E+02	3.2E-04	10	0.216	7330	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.28%	0.0037
7.16	460	1.8E-03	3.9E+02	3.2E-04	10	0.216	7307	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.32%	0.0038
7.21	460	1.8E-03	3.9E+02	3.2E-04	10	0.217	7284	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.35%	0.0039
7.26	460	1.8E-03	3.9E+02	3.2E-04	10	0.217	7261	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.39%	0.0039
7.31	460	1.8E-03	3.9E+02	3.3E-04	10	0.218	7239	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.43%	0.0040
7.36	460	1.8E-03	3.9E+02	3.3E-04	10	0.218	7216	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.46%	0.0040
7.41	460	1.8E-03	3.7E+02	3.5E-04	16	0.470	5927	0.11%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.00%	0.0049
7.46	460	1.8E-03	3.9E+02	3.3E-04	10	0.219	7174	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.54%	0.0042
7.51	460	1.8E-03	3.9E+02	3.4E-04	10	0.219	7152	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.58%	0.0042
7.56	460	1.8E-03	3.9E+02	3.4E-04	10	0.220	7131	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.61%	0.0043
7.61	460	1.8E-03	3.7E+02	3.6E-04	16	0.471	5858	0.12%	2.00	0.65	0.03%	0.021	0.34	0.079	0.765	3.16%	0.0052
7.66	460	1.8E-03	3.7E+02	3.6E-04	16	0.472	5841	0.12%	2.00	0.65	0.03%	0.021	0.34	0.079	0.765	3.20%	0.0052
7.71	500	1.8E-03	4.4E+02	3.1E-04	16	0.472	5825	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.19%	0.0036
7.76	500	1.8E-03	4.4E+02	3.1E-04	16	0.472	5809	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.21%	0.0036
7.81	500	1.8E-03	4.4E+02	3.1E-04	16	0.473	5793	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.24%	0.0037
7.86	500	1.8E-03	4.4E+02	3.1E-04	16	0.473	5778	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.27%	0.0037
7.91	500	1.8E-03	4.6E+02	3.0E-04	10	0.222	6993	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.86%	0.0031
7.96	500	1.8E-03	4.6E+02	3.0E-04	10	0.223	6973	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.89%	0.0031
8.01	500	1.8E-03	4.6E+02	3.0E-04	10	0.223	6953	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.92%	0.0032
8.06	500	1.8E-03	4.6E+02	3.1E-04	10	0.223	6934	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.95%	0.0032
8.11	500	1.8E-03	4.6E+02	3.1E-04	10	0.224	6915	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.98%	0.0032
8.16	500	1.8E-03	4.6E+02	3.1E-04	10	0.224	6896	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.00%	0.0033
8.21	500	1.8E-03	4.6E+02	3.1E-04	10	0.224	6877	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.03%	0.0033
8.26	500	1.8E-03	4.6E+02	3.1E-04	10	0.225	6858	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.06%	0.0034
8.31	500	1.8E-03	4.6E+02	3.2E-04	10	0.225	6839	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.09%	0.0034
8.36	500	1.8E-03	4.4E+02	3.4E-04	16	0.477	5622	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.56%	0.0042
8.41	500	1.8E-03	4.6E+02	3.2E-04	10	0.226	6804	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.15%	0.0035
8.46	500	1.8E-03	4.6E+02	3.2E-04	10	0.226	6786	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.17%	0.0036
8.51	500	1.8E-03	4.6E+02	3.2E-04	10	0.227	6768	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.20%	0.0036
8.56	500	1.8E-03	4.6E+02	3.3E-04	10	0.227	6750	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.23%	0.0037
8.61	500	1.8E-03	4.6E+02	3.3E-04	10	0.227	6733	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.26%	0.0037
8.66	500	1.8E-03	4.6E+02	3.3E-04	10	0.228	6715	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.29%	0.0038
8.71	500	1.8E-03	4.6E+02	3.3E-04	10	0.228	6698	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.32%	0.0038
8.76	500	1.8E-03	4.4E+02	3.5E-04	16	0.480	5507	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.80%	0.0046
8.81	500	1.8E-03	4.4E+02	3.5E-04	16	0.480	5494	0.10%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.83%	0.0046

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-2C

Data File: 13-52106_SP3-2C-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend
Tailings Sands
Tailings Sand-Slimes
Tailings Slimes
Interim Cover
Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69

Youd, et al (2001)		
Max. Horiz. Acceleration, Amax/g:	0.15	
Earthquake Moment Magnitude, M:	5.5	
Magnitude Scaling Factor, MSF:	2.21	2.21

Value	Parameter
5605.30	Water surface elevation during CPT investigation (ft
5602.54	Water surface elevation at t_0 (ft amsl)
5591.64	Water surface elevation at t_1 (ft amsl)
5586.64	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Eart
7.51	Equiv. Number of Uniform Strain Cycles, N

Value	Parameter
5610.82	Ground Surface Elevation at time of CPT (ft amsl)
5621.51	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after plac
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
3.19	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1167.12	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5586.64	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)		Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-}	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######		5621.26	5621.01	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######		5619.26	5617.51	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######		5615.76	5614.01	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320	1.75	508	1.9E-03	4.8E+02	6.5E-05	11	0.152	12657	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######		5612.42	5610.82	3.19	0.050	101	0.585	0.504	0.00	0.00	0.585	0.504	2.77	508	1.6E-03	4.0E+02	1.2E-04	11	0.170	10470	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %
18.372	5592.45	20.9	0.383	20.4	78.0	33.81	1.83%	Sand-Slime Tailin	0.059	119.0	1.02	0.40	0.62	1	1.27	25.871	359.60	30.76	32	1.92%	2.5	###
18.537	5592.28	18.1	0.296	17.9	41.0	17.77	1.63%	Sand-Slime Tailin	0.059	119.0	1.03	0.41	0.63	1	1.27	22.684	315.30	26.72	27	1.73%	2.5	###
18.701	5592.12	21.8	0.387	21.4	62.7	27.18	1.78%	Sand-Slime Tailin	0.059	119.0	1.04	0.41	0.63	1	1.25	26.759	371.95	31.65	33	1.87%	2.5	###
18.865	5591.96	18.8	0.412	18.5	46.5	20.15	2.19%	Sand-Slime Tailin	0.059	119.0	1.05	0.42	0.64	1	1.25	23.212	322.65	27.38	28	2.32%	2.6	###
19.029	5591.79	18.5	0.428	18.4	22.2	9.62	2.31%	Sand-Slime Tailin	0.059	119.0	1.06	0.42	0.64	1	1.25	22.958	319.11	26.86	27	2.45%	2.6	###
19.193	5591.63	13.1	0.382	12.9	32.2	13.96	2.91%	Slime Tailings	0.057	113.1	1.07	0.43	0.64	1	1.25	16.221	225.48	19.13	19	3.17%	2.8	###
19.357	5591.46	11.8	0.318	11.1	110.7	47.96	2.70%	Slime Tailings	0.057	113.1	1.08	0.43	0.65	1	1.25	13.843	192.42	17.08	17	2.97%	2.8	###
19.521	5591.30	14.0	0.235	13.6	73.8	31.99	1.67%	Sand-Slime Tailin	0.059	119.0	1.09	0.44	0.65	1	1.24	16.857	234.31	20.24	20	1.81%	2.6	###
19.685	5591.14	14.0	0.240	13.3	116.1	50.29	1.72%	Sand-Slime Tailin	0.059	119.0	1.10	0.44	0.66	1	1.23	16.369	227.53	20.05	20	1.86%	2.6	###
19.849	5590.97	13.0	0.220	12.4	100.8	43.68	1.69%	Sand-Slime Tailin	0.059	119.0	1.11	0.45	0.66	1	1.23	15.187	211.09	18.54	18	1.85%	2.7	###
20.013	5590.81	12.6	0.337	11.7	147.5	63.92	2.68%	Slime Tailings	0.057	113.1	1.12	0.45	0.67	1	1.22	14.257	198.18	17.87	17	2.94%	2.8	###
20.177	5590.64	16.5	0.337	15.6	147.0	63.70	2.05%	Sand-Slime Tailin	0.059	119.0	1.13	0.46	0.67	1	1.21	18.838	261.85	23.17	23	2.20%	2.6	###
20.341	5590.48	20.1	0.337	19.5	94.3	40.85	1.68%	Sand-Slime Tailin	0.059	119.0	1.14	0.46	0.68	1	1.20	23.344	324.48	27.93	28	1.78%	2.5	###
24.180	5586.64							Sand-Slime Tailin	0.059	119.0												

Conditions at t_1 / Liquefaction Triggering Analyses

Depth at time of CPT (ft)	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	Idriss & Boulanger (2008) Cyclic Stress Ratio r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Cyclic Resistance Ratio Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd et al. (2001) Cyclic Stress Ratio r_d	D_r	f	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
18.372	1.61	0.00	1.61	0	0.89	0.06	0.96	1.0	0.050	41.09	71.85	0.102	2.06	0.93	0.32	0.80	0.80	1.07	1.0	0.039	2.64	81.26	0.130	4.38	3.22	2
18.537	1.62	0.00	1.62	0	0.89	0.06	0.96	1.0	0.049	39.67	66.40	0.095	1.92	0.93	0.30	0.80	0.80	1.07	1.0	0.039	2.78	74.25	0.118	3.95	2.94	2
18.701	1.63	0.00	1.63	0	0.89	0.06	0.96	1.0	0.049	41.40	73.05	0.103	2.10	0.93	0.32	0.80	0.80	1.06	1.0	0.039	2.56	81.00	0.129	4.30	3.20	2
18.865	1.64	0.00	1.64	0	0.89	0.06	0.96	1.0	0.049	39.90	67.29	0.096	1.95	0.93	0.30	0.80	0.80	1.06	1.0	0.039	3.15	86.26	0.140	4.61	3.28	2
19.029	1.65	0.00	1.65	0	0.88	0.06	0.96	1.0	0.049	39.72	66.59	0.095	1.94	0.93	0.30	0.80	0.80	1.06	1.0	0.039	3.28	88.21	0.144	4.72	3.33	2
19.193	1.65	0.00	1.65	1	0.88	0.05	0.97	1.0	0.049	36.75	55.88	0.083	1.69	0.93	0.25	0.80	0.80	1.06	1.0	0.039	4.71	90.11	0.148	4.82	3.26	2
19.357	1.66	0.01	1.66	1	0.88	0.05	0.97	1.0	0.049	36.04	53.12	0.081	1.63	0.93	0.24	0.80	0.80	1.06	1.0	0.039	4.94	84.32	0.136	4.38	3.01	2
19.521	1.67	0.01	1.66	1	0.88	0.05	0.97	1.0	0.049	37.40	57.64	0.085	1.73	0.93	0.26	0.80	0.80	1.06	1.0	0.039	3.50	70.92	0.113	3.62	2.67	2
19.685	1.68	0.02	1.67	1	0.88	0.05	0.97	1.0	0.050	37.33	57.38	0.085	1.72	0.93	0.26	0.80	0.80	1.06	1.0	0.039	3.57	71.65	0.114	3.62	2.67	2
19.849	1.69	0.02	1.67	1	0.88	0.05	0.97	1.0	0.050	36.80	55.34	0.083	1.67	0.93	0.25	0.80	0.80	1.05	1.0	0.039	3.77	69.95	0.112	3.52	2.59	2
20.013	1.70	0.03	1.68	1	0.88	0.05	0.97	1.0	0.050	36.31	54.17	0.082	1.64	0.92	0.24	0.80	0.80	1.05	1.0	0.039	4.79	85.49	0.138	4.31	2.98	2
20.177	1.71	0.03	1.68	1	0.87	0.05	0.96	1.0	0.050	38.43	61.60	0.090	1.81	0.92	0.28	0.80	0.80	1.05	1.0	0.039	3.49	80.79	0.129	4.00	2.90	2
20.341	1.72	0.04	1.69	1	0.87	0.06	0.96	1.0	0.050	40.10	68.03	0.097	1.96	0.92	0.31	0.80	0.80	1.05	1.0	0.040	2.77	77.23	0.123	3.77	2.87	2
24.180	1.95	0.10	1.85	1																						

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.397

Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-}	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
8.86	500	1.8E-03	4.6E+02	3.4E-04	10	0.229	6649	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.40%	0.0039
8.91	500	1.8E-03	4.6E+02	3.4E-04	10	0.230	6632	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.43%	0.0040
8.96	500	1.8E-03	4.6E+02	3.4E-04	10	0.230	6616	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.46%	0.0040
9.01	500	1.8E-03	4.6E+02	3.5E-04	10	0.230	6599	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.49%	0.0041
9.06	500	1.8E-03	4.6E+02	3.5E-04	10	0.231	6583	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.52%	0.0041
9.11	500	1.8E-03	4.4E+02	3.7E-04	16	0.482	5415	0.11%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.02%	0.0050
9.16	500	1.8E-03	4.4E+02	3.7E-04	16	0.482	5409	0.11%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.05%	0.0050
9.21	500	1.8E-03	4.6E+02	3.5E-04	10	0.231	6554	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.62%	0.0043
9.26	538	1.8E-03	5.3E+02	3.1E-04	10	0.231	6546	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.83%	0.0030
9.31	538	1.8E-03	5.3E+02	3.1E-04	10	0.232	6539	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.85%	0.0030
9.36	538	1.8E-03	5.1E+02	3.3E-04	16	0.483	5385	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.29%	0.0038
9.41	538	1.8E-03	5.3E+02	3.1E-04	10	0.232	6524	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.90%	0.0031
9.46	538	1.8E-03	5.3E+02	3.1E-04	10	0.232	6517	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.93%	0.0032
10.63	538	1.8E-03	5.3E+02	3.6E-04	10	0.238	6265	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.52%	0.0966

Extra layer added to analyze seismic settlement of tailings below the bottom of CPT investigation.

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-3S

Data File: 13-52106_SP3-3S-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Dat

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5605.60	Water surface elevation during CPT investigation (ft amsl)
5601.35	Water surface elevation at t_1 (ft amsl)
5582.14	Water surface elevation at t_2 (ft amsl)
5577.14	Water surface elevation at t_3 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earthquake
7.51	Equiv. Number of Uniform Strain Cycles, N
5609.63	Ground Surface Elevation at time of CPT (ft amsl)
5620.49	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pl
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
3.36	Thickness of Random/Platform Fill on top of existing interim cover (ft)
1184.24	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5577.14	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight t (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5620.24	5619.99	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5618.24	5616.49	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5614.74	5612.99	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320	1.75	508	1.9E-03	4.8E+02	6.5E-05	11	0.152	12657	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######	5611.31	5609.63	3.36	0.050	101	0.593	0.509	0.00	0.00	0.593	0.509	2.80	508	1.6E-03	4.0E+02	1.2E-04	11	0.171	10433	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Qt	Normalized Friction Ratio, F_r (%)	Soil Behavior Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
0.164	5609.47	13.9	0.034	13.9	1.5	0.64	0.25%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	23.545	327.28	27.36	1677	0.25%	0.7	51%	0.60	0.00	0.60	0
0.328	5609.30	18.4	0.072	18.4	2.3	1.01	0.39%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	31.246	434.32	36.32	1112	0.39%	0.9	51%	0.61	0.00	0.61	0
0.492	5609.14	58.6	0.077	58.5	4.8	2.06	0.13%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	99.501	1383.06	115.62	2362	0.13%	0.4	51%	0.62	0.00	0.62	0
0.656	5608.97	73.3	0.296	73.3	3.9	1.68	0.40%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	124.644	1732.55	144.81	2218	0.40%	0.8	51%	0.63	0.00	0.63	0
0.820	5608.81	81.4	0.267	81.4	3.7	1.62	0.33%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	138.414	1923.95	160.81	1971	0.33%	0.8	51%	0.63	0.00	0.63	0
0.984	5608.65	84.2	0.326	84.2	3.9	1.68	0.39%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	143.072	1988.70	166.22	1697	0.39%	0.8	51%	0.64	0.00	0.64	0
1.148	5608.48	84.7	0.187	84.7	2.9	1.27	0.22%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	143.939	2000.75	167.21	1463	0.22%	0.6	51%	0.65	0.00	0.65	0
1.312	5608.32	73.0	0.231	72.9	3.0	1.31	0.32%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	123.998	1723.57	144.05	1103	0.32%	0.8	51%	0.66	0.00	0.66	0
1.476	5608.15	71.2	0.308	71.2	1.7	0.72	0.43%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	120.955	1681.27	140.50	956	0.43%	1.0	51%	0.67	0.00	0.67	0
1.640	5607.99	55.2	0.236	55.2	3.7	1.59	0.43%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	93.772	1303.43	108.96	667	0.43%	1.1	51%	0.67	0.00	0.67	0
1.804	5607.83	55.4	0.150	55.4	1.9	0.82	0.27%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	94.095	1307.92	109.31	608	0.27%	0.9	51%	0.68	0.00	0.68	0
1.968	5607.66	54.7	0.208	54.7	1.6	0.70	0.38%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	92.905	1291.38	107.92	536	0.38%	1.1	51%	0.69	0.00	0.69	0
2.133	5607.50	53.2	0.150	53.2	1.9	0.83	0.28%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	90.491	1257.82	105.12	495	0.28%	1.0	51%	0.70	0.00	0.70	0
2.297	5607.33	46.8	0.504	46.8	2.3	1.01	1.08%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	79.560	1105.88	92.43	404	1.08%	1.5	51%	0.71	0.00	0.71	0
2.461	5607.17	59.1	1.594	59.1	3.4	1.48	2.70%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	100.470	1396.53	116.73	476	2.70%	1.8	51%	0.72	0.00	0.72	0
2.625	5607.01	70.3	1.024	70.2	6.0	2.59	1.46%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.70	119.408	1659.77	138.76	531	1.46%	1.6	51%	0.72	0.00	0.72	0
2.789	5606.84	132.5	0.906	132.5	6.2	2.67	0.68%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0	1.63	215.362	2993.54	250.20	942	0.68%	1.2	51%	0.73	0.00	0.73	0
2.953	5606.68	69.0	0.500	69.0	1.8	0.78	0.72%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0	1.70	117.249	1629.76	136.20	463	0.73%	1.3	51%	0.74	0.00	0.74	0
3.117	5606.51	83.8	0.682	83.8	0.9	0.37	0.81%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0	1.70	142.375	1979.01	165.37	533	0.82%	1.4	51%	0.75	0.00	0.75	0
3.281	5606.35	49.0	0.298	49.0	3.9	1.69	0.61%	Sand Tailings	0.051	102.8	0.17	0.00	0.17	0	1.70	83.334	1158.34	96.84	296	0.61%	1.4	18%	0.76	0.00	0.76	0
3.445	5606.19	47.2	0.382	47.2	0.2	0.09	0.81%	Sand Tailings	0.051	102.8	0.17	0.00	0.17	0	1.70	80.172	1114.39	93.12	270	0.81%	1.5	18%	0.77	0.00	0.77	0
3.609	5606.02	46.3	0.306	46.3	0.6	0.28	0.66%	Sand Tailings	0.051	102.8	0.18	0.00	0.18	0	1.70	78.761	1094.78	91.48	253	0.66%	1.5	18%	0.77	0.00	0.77	0
3.773	5605.86	55.3	0.508	55.3	1.0	0.42	0.92%	Sand Tailings	0.051	102.8	0.19	0.00	0.19	0	1.70	94.044	1307.21	109.24	289	0.92%	1.6	18%	0.78	0.00	0.78	0
3.937	5605.69	80.4	1.013	80.4	1.5	0.64	1.26%	Sand Tailings	0.051	102.8	0.20	0.00	0.20	0	1.70	136.731	1900.56	158.83	403	1.26%	1.6	18%	0.79	0.00	0.79	0
4.101	5605.53	74.3	1.624	74.3	3.7	1.58	2.19%	Sand-Slime Tailings	0.059	119.0	0.21	0.00	0.21	1	1.70	126.310	1755.71	146.75	359	2.19%	1.8	47%	0.80	0.00	0.80	0
4.265	5605.36	52.7	1.775	52.6	12.2	5.30	3.37%	Sand-Slime Tailings	0.059	119.0	0.22	0.01	0.21	1	1.70	89.471	1243.65	104.07	248	3.38%	2.1	47%	0.81	0.00	0.81	0
4.429	5605.20	70.0	1.960	69.6	74.7	32.37	2.80%	Sand-Slime Tailings	0.059	119.0	0.23	0.01	0.22	1	1.70	118.286	1644.18	138.30	323	2.81%	1.9	47%	0.82	0.00	0.82	0
4.593	5605.04	105.7	1.513	105.3	62.4	27.03	1.43%	Sand Tailings	0.062	123.5	0.24	0.02	0.22	1	1.58	166.632	2316.18	194.25	477	1.43%	1.6	18%	0.83	0.00	0.83	0
4.757	5604.87	102.3	1.285	102.2	16.0	6.92	1.26%	Sand Tailings	0.062	123.5	0.25	0.02	0.23	1	1.59	162.173	2254.20	188.54	452	1.26%	1.6	18%	0.84	0.00	0.84	0
4.921	5604.71	80.0	0.626	80.0	8.5	3.69	0.78%	Sand Tailings	0.062	123.5	0.26	0.03	0.23	1	1.68	134.193	1865.28	155.96	345	0.79%	1.5	18%	0.85	0.00	0.85	0
5.085	5604.54	81.2	0.386	81.2	9.8	4.26	0.48%	Sand Tailings	0.062	123.5	0.27	0.03	0.24	1	1.66	134.859	1874.54	156.75	343	0.48%	1.3	18%	0.86	0.00	0.86	0
5.249	5604.38	87.3	0.391	87.3	7.2	3.11	0.45%	Sand Tailings	0.062	123.5	0.28	0.04	0.24	1	1.62	141.409	1968.64	164.58	361	0.45%	1.3	18%	0.87	0.00	0.87	0
5.413	5604.22	72.7	0.332	72.7	2.6	1.13	0.46%	Sand Tailings	0.062	123.5	0.29	0.04	0.25	1	1.68	122.447	1702.01	142.25	294	0.46%	1.3	18%	0.88	0.00	0.88	0
5.577	5604.05	65.2	0.279	65.2	0.5	0.21	0.43%	Sand Tailings	0.062	123.5	0.30	0.05	0.25	1	1.70	110.874	1541.15	128.78	259	0.43%	1.4	18%	0.89	0.00	0.89	0
5.741	5603.89	56.7	0.216	56.7	-0.1	-0.05	0.38%	Sand Tailings	0.062	123.5	0.31	0.05	0.26	1	1.70	96.458	1340.77	112.03	220	0.38%	1.4	18%	0.90	0.00	0.90	0
5.905	5603.72	48.8	0.259	48.8	-0.3	-0.13	0.53%	Sand Tailings	0.062	123.5	0.32	0.06	0.26	1	1.70	83.028	1154.09	96.43	186	0.53%	1.5	18%	0.91	0.00	0.91	0
6.069	5603.56	32.1	0.220	32.1	-0.3	-0.12	0.68%	Sand-Slime Tailings	0.059	119.0	0.33	0.06	0.27	1	1.70	54.621	759.23	63.44	120	0.69%	1.7	47%	0.92	0.00	0.92	0
6.234	5603.40	28.8	0.202	28.8	2.7	1.18	0.70%	Sand-Slime Tailings	0.059	119.0	0.34	0.07	0.27	1	1.70	48.875	679.36	56.80	105	0.71%	1.8	47%	0.93	0.00	0.93	0
6.398	5603.23	33.3	0.244	33.3	9.5	4.10	0.73%	Sand-Slime Tailings	0.059	119.0	0.35	0.07	0.27	1	1.70	56.559	786.17	65.81	120	0.74%	1.8	47%	0.94	0.00	0.94	0
6.562	5603.07	23.8	0.288	23.8	5.0	2.17	1.21%	Sand-Slime Tailings	0.059	119.0	0.36	0.08	0.28	1	1.70	40.392	561.45	46.97	84	1.23%	2.0	47%	0.95	0.00	0.95	0
6.726	5602.90	18.2	0.238	18.1	12.5	5.43	1.31%	Sand-Slime Tailings	0.059	119.0	0.37	0.08	0.28	1	1.70	30.753	427.47	35.87	63	1.34%	2.1	47%	0.96	0.00	0.96	0
6.890	5602.74	11.8	0.147	11.7	14.5	6.28	1.25%	Sand-Slime Tailings	0.059	119.0	0.38	0.09	0.29	1	1.70	19.907	276.71	23.30	40	1.29%	2.3	47%	0.97	0.00	0.97	0
7.054	5602.58	9.2	0.122	9.1	23.8	10.33	1.32%	Sand-Slime Tailings	0.059	119.0	0.39	0.09	0.29	1	1.70	15.453	214.80	18.24	30	1.38%	2.4	47%	0.98	0.00	0.98	0
7.218	5602.41	9.2	0.089	9.0	30.6	13.24	0.97%	Sand-Slime Tailings	0.059	119.0	0.40	0.10	0.30	1	1.70	15.232	211.72	18.07	29	1.02%	2.3	47%	0.99	0.00	0.99	0
7.382	5602.25	9.9	0.100	9.7	31.6	13.69	1.01%	Sand-Slime Tailings	0.059	119.0	0.41	0.10	0.30	1	1.70	16.524	229.68	19.58	31	1.05%	2.3	47%	1.00	0.00	1.00	0
7.546	5602.08	8.5	0.080	8.3	34.3	14.88	0.94%	Sand-Slime Tailings	0.059	119.0	0.42	0.11	0.31	1	1.70	14.127	196.37	16.83	26	0.99%	2.4	47%	1.01	0.00	1.01	0
7.710	5601.92	10.2	0.068	10.0	38.1	16.51	0.67%	Sand-Slime Tailings	0.059	119.0	0.43	0.11	0.31	1	1.70	16.932	235.35	20.13	31	0.70%	2.2	47%	1.02	0.00	1.02	0
7.874	5601.76	8.5	0.060	8.2	38.1	16.49	0.71%	Sand-Slime Tailings	0.059	119.0	0.44	0.12	0.32	1	1.70	14.008	194.71	16.74	25	0.75%	2.3	47%	1.03	0.00	1.03	0
8.038	5601.59	7.6	0.064	7.3	45.6	19.77	0.84%	Sand-Slime Tailings	0.059	119.0	0.45	0.13	0.32	1	1.70	12.478	173.44	15.05	22	0.89%	2.4	47%	1.04	0.00	1.04	0
8.202	5601.43	8.1	0.076	7.8	53.2	23.04	0.94%	Sand-Slime Tailings	0.059	119.0	0.46	0.13	0.33	1	1.70	13.226	183.84	16.02	23	0.99%	2.4	47%	1.05	0.00	1.05	0
8.366	5601.26	9.0	0.102	8.6	58.4	25.30	1.14%	Sand-Slime Tailings	0.059	119.0	0.47	0.14	0.33	1	1.70	14.637	203.45	17.72	26	1.20%	2.4	47%	1.06	0.00	1.06	0
8.530	5601.10	9.6	0.210	9.2	60.7	26.28	2.18%	Slime Tailings	0.057	113.1	0.48	0.14	0.33	1	1.70	15.708	218.34	18.99	27	2.30%	2.6	71%	1.07	0.00	1.07	0
8.694	5600.94	9.5	0.212	9.1	55.4	24.01	2.23%	Slime Tailings	0.057	113.1	0.48	0.15	0.34	1	1.70	15.487	215.27	18.67	26	2.36%	2.6	71%	1.08	0.00	1.08	0
8.858	5600.77	13.5	0.188	13.3	28.4	12.31	1.39%	Sand-Slime Tailings	0.059	119.0	0.49	0.15	0.34	1	1.70	22.610	314.28	26.61	38	1.45%	2.3	47%	1.09	0.00	1.09	0
9.022	5600.61	9.0	0.166	8.9	12.6	5.48	1.85%	Slime Tailings	0.057	113.1	0.50	0.16	0.35	1	1.70	15.130	210.31	17.73	24	1.96%	2.6	71%	1.10	0.00	1.10	0
9.186	5600.44	7.1	0.173	6.9	30.7	13.29	2.45%	Slime Tailings	0.057	113.1	0.51	0.16	0.35	1	1.70	11.662	162.10	13.92	19	2.65%	2.7	71%	1.10	0.00	1.10	0
9.350	5600.28	12.4	0.106	12.1	47.2	20.44	0.86%	Sand-Slime Tailings	0.059	119.0	0.52	0.17	0.36	1	1.70	20.536	285.45	24.43	33	0.89%	2.3	47%	1.11	0.00	1.11	0
9.514	5600.12	15.4	0.097	15.3	14.9	6.47	0.63%	Sand-Slime Tailings	0.059	119.0	0.53	0.17	0.36	1	1.70	25.959	360.83	30.33	41	0.65%	2.1	47%	1.12	0.00	1.12	0
9.678	5599.95	15.1	0.080	15.0	11.2	4.83	0.53%	Sand-Slime Tailings	0.059	119.0	0.54	0.18	0.37	1	1.70	25.517	354.69	29.77	40	0.55%	2.1	47%	1.13	0.00	1.13	0
9.842	5599.79	22.9	0.122	22.8	15.7	6.78	0.53%	Sand-Slime Tailings	0.059	119.0	0.55	0.18	0.37	1	1.70	38.743	538.53	45.19	60	0.55%	1.9	47%	1.14	0.00	1.14	0
10.006	5599.62	18.5	0.100	18.4	10.4	4.49	0.54%	Sand-Slime Tailings	0.059	119.0	0.56	0.19	0.38	1	1.70	31.263	434.56	36.44	48	0.56%	2.0	47%	1.15	0.00	1.15	0
10.170	5599.46	16.5	0.082	16.5	6.1	2.66	0.50%	Sand-Slime Tailings	0.059	119.0	0.57	0.19	0.38	1	1.70	28.050	389.90	32.65	42	0.51%	2.1	47%	1.16	0.00	1.16	0
10.335	5599.30	11.5	0.074	11.5	5.9	2.54	0.64%	Sand-Slime Tailings	0.059	119.0	0.58	0.20	0.38	1	1.70	19.482	270.80	22.70	28	0.68%	2.3	47%	1.17	0.00	1.17	0
10.499	5599.13	8.2	0.078	8.2	6.6	2.85	0.95%	Sand-Slime Tailings	0.059	119.0	0.59	0.20	0.39	1	1.70	13.855	192.58	16.17	20	1.03%	2.5	47%	1.18	0.00	1.18	0
10.663	5598.97	8.3	0.043	8.3	9.0	3.92	0.52%	Sand-Slime Tailings	0.059	119.0	0.60	0.21	0.39	1	1.70	14.059	195.42	16.44	20	0.56%	2.4	47%	1.19	0.00	1.19	0
10.827	5598.80	9.2	0.024	9.2	10.5	4.53	0.26%	Sand-Slime Tailings	0.059	119.0	0.61	0.21	0.40	1	1.70	15.589	216.69	18.23	22	0.28%	2.2	47%	1.20	0.00	1.20	0
10.991	5598.64	8.6	0.074	8.5	13.3	5.75	0.87%	Sand-Slime Tailings	0.059	119.0	0.62	0.22	0.40	1	1.70	14.399	200.15	16.89	20	0.94%	2.5	47%	1.21	0.00	1.21	0
11.155	5598.48	6.3	0.099	6.2	15.1	6.52	1.58%	Slime Tailings	0.057	113.1	0.63	0.22	0.41	1	1.70	10.489	145.80	12.37	14	1.76%	2.8	71%	1.22	0.00	1.22	0
11.319	5598.31	5.1	0.105	5.0	18.6	8.07	2.06%	Slime Tailings	0.057	113.1	0.64	0.23	0.41	1	1.70	8.449	117.44	10.04	11	2.36%	2.9	71%	1.23	0.00	1.23	0
11.483	5598.15	4.3	0.115	4.1	26.9	11.65	2.67%	Slime Tailings	0.057	113.1	0.65	0.23	0.42	1	1.70	7.038	97.83	8.51	9	3.14%	3.1	71%	1.24	0.00	1.24	0
11.647	5597.98	7.3	0.094	7.1	44.1	19.13	1.28%	Slime Tailings	0.057	113.1	0.66	0.24	0.42	1	1.70	12.019	167.06	14.50	16	1.41%	2.6	71%	1.25	0.00	1.25	0
11.811	5597.82	9.0	0.165	8.8	27.6	11.97	1.84%	Slime Tailings	0.057	113.1	0.67	0.24	0.43	1	1.70	14.943	207.71	17.70	20	1.99%	2.7	71%	1.26	0.00	1.26	0
11.975	5597.66	8.6	0.084	8.5	20.2	8.75	0.98%	Sand-Slime Tailings	0.059	119.0	0.68	0.25	0.43	1	1.70	14.416	200.38	16.99	19	1.06%	2.5	47%	1.27	0.00	1.27	0
12.139	5597.49	10.5	0.047	10.4	14.1	6.11	0.45%	Sand-Slime Tailings	0.059	119.0	0.69	0.25	0.43	1	1.70	17.663	245.52	20.69	23	0.48%	2.3	47%	1.28	0.00	1.28	0
12.303	5597.33	10.3	0.077	10.2	9.8	4.26	0.75%	Sand-Slime Tailings	0.059	119.0	0.70	0.26	0.44	1	1.70	17.390	241.72	20.29	22	0.80%	2.4	47%	1.29	0.00	1.29	0
12.467	5597.16	6.7	0.073	6.6	12.8	5.56	1.09%	Slime Tailings	0.057	113.1	0.71	0.26	0.45	1	1.70	11.118	154.55	13.07	14	1.23%	2.7	71%	1.30	0.00	1.30	0
12.631	5597.00	8.2	0.034	8.1	16.4	7.12	0.41%	Sand-Slime Tailings	0.059	119.0	0.72	0.27	0.45	1	1.67	13.584	188.82	15.98	17	0.45%	2.4	47%	1.31	0.00	1.31	0
12.795	5596.83	9.4	0.032	9.2	15.5	6.73	0.34%	Sand-Slime Tailings	0.059	119.0	0.72	0.27	0.45	1	1.66	15.282	212.42	17.94	19	0.37%	2.3	47%	1.32	0.00	1.32	0
12.959	5596.67	9.4	0.033	9.3	15.5	6.73	0.36%	Sand-Slime Tailings	0.059	119.0	0.73	0.28	0.46	1	1.64	15.259	212.10	17.91	19	0.39%	2.3	47%	1.33	0.00	1.33	0
13.123	5596.51	9.5	0.043	9.4	15.8	6.83	0.45%	Sand-Slime Tailings	0.059	119.0	0.74	0.28	0.46	1	1.63	15.350	213.37	18.02	19	0.49%	2.4	47%	1.34	0.00	1.34	0
13.287	5596.34	9.1	0.054	9.0	16.3	7.05	0.59%	Sand-Slime Tailings	0.059	119.0	0.75	0.29	0.46	1	1.62	14.632	203.38	17.18	18	0.64%	2.4	47%	1.35	0.00	1.35	0
13.451	5596.18	9.2	0.068	9.1	17.0	7.36	0.74%	Sand-Slime Tailings	0.059	119.0	0.76	0.29	0.47	1	1.61	14.615	203.15	17.17	18	0.81%	2.5	47%	1.36	0.00	1.36	0
13.615	5596.01	9.3	0.080	9.2	17.0	7.38	0.86%	Sand-Slime Tailings	0.059	119.0	0.77	0.30	0.47	1	1.59	14.710	204.47	17.28	18	0.93%	2.5	47%	1.37	0.00	1.37	0
13.779	5595.85	11.2	0.068	11.1	17.5	7.60	0.61%	Sand-Slime Tailings	0.059	119.0	0.78	0.30	0.48	1	1.58	17.525	243.59	20.55	22	0.65%	2.4	47%	1.38	0.00	1.38	0
13.943	5595.69	14.4	0.082	14.3	15.5	6.70	0.57%	Sand-Slime Tailings	0.059	119.0	0.79	0.31	0.48	1	1.54	22.107	307.29	25.85	28	0.61%	2.3	47%	1.39	0.00	1.39	0
14.107	5595.52	11.4	0.115	11.3	15.5	6.72	1.01%	Sand-Slime Tailings	0.059	119.0	0.80	0.31	0.49	1	1.56	17.669	245.60	20.72	22	1.09%	2.5	47%	1.40	0.00	1.40	0
14.271	5595.36	8.1	0.115	8.0	17.0	7.37	1.43%	Slime Tailings	0.057	113.1	0.81	0.32	0.49	1	1.57	12.321	171.26	14.50	15	1.59%	2.7	71%	1.40	0.00	1.40	0
14.436	5595.19	7.0	0.051	6.9	19.3	8.34	0.73%	Sand-Slime Tailings	0.059	119.0	0.82	0.32	0.50	1	1.60	10.571	146.94	12.49	12	0.83%	2.6	47%	1.41	0.00	1.41	0
14.600	5595.03	6.4	0.033	6.3	17.8	7.71	0.52%	Sand-Slime Tailings	0.059	119.0	0.83	0.33	0.50	1	1.53	9.534	132.52	11.27	11	0.60%	2.6	47%	1.42	0.00	1.42	0
14.764	5594.87	5.4	0.063	5.2	23.0	9.95	1.17%	Slime Tailings	0.057	113.1	0.84	0.33	0.51	1	1.52	7.926	110.18	9.43	9	1.40%	2.9	71%	1.43	0.00	1.43	0
14.928	5594.70	4.8	0.108	4.6	28.3	12.24	2.27%	Slime Tailings	0.057	113.1	0.85	0.34	0.51	1	1.51	6.912	96.08	8.34	8	2.71%	3.1	71%	1.44	0.00	1.44	0
15.092	5594.54	4.8	0.126	4.7	28.1	12.16	2.60%	Slime Tailings	0.057	113.1	0.86	0.35	0.51	1	1.50	6.988	97.13	8.42	8	3.16%	3.1	71%	1.45	0.00	1.45	0
15.256	5594.37	5.7	0.083	5.6	15.5	6.72	1.45%	Slime Tailings	0.057	113.1	0.87	0.35	0.52	1	1.49	8.357	116.16	9.87	9	1.71%	2.9	71%	1.46	0.00	1.46	0
15.420	5594.21	8.3	0.060	8.2	16.1	6.98	0.72%	Sand-Slime Tailings	0.059	119.0	0.88	0.36	0.52	1	1.48	12.153	168.92	14.29	14	0.81%	2.6	47%	1.47	0.00	1.47	0
15.584	5594.05	8.4	0.058	8.3	19.3	8.37	0.68%	Sand-Slime Tailings	0.059	119.0	0.89	0.36	0.53	1	1.47	12.348	171.63	14.44	14	0.76%	2.6	47%	1.48	0.00	1.48	0
15.748	5593.88	7.7	0.056	7.6	18.4	7.95	0.72%	Sand-Slime Tailings	0.059	119.0	0.90	0.37	0.53	1	1.46	11.104	154.36	12.99	13	0.82%	2.6	47%	1.49	0.00	1.49	0
15.912	5593.72	8.0	0.059	7.9	13.9	6.00	0.74%	Sand-Slime Tailings	0.059	119.0	0.91	0.37	0.54	1	1.45	11.457	159.25	13.45	13	0.84%	2.6	47%	1.50	0.00	1.50	0
16.076	5593.55	8.3	0.070	8.2	17.5	7.57	0.85%	Sand-Slime Tailings	0.059	119.0	0.92	0.38	0.54	1	1.44	11.783	163.79	13.80	13	0.96%	2.6	47%	1.51	0.00	1.51	0
16.240	5593.39	8.3	0.062	8.2	21.2	9.17	0.75%	Sand-Slime Tailings	0.059	119.0	0.93	0.38	0.55	1	1.43	11.779	163.73	13.74	13	0.85%	2.6	47%	1.52	0.00	1.52	0
16.404	5593.23	8.1	0.200	8.0	21.3	9.25	2.46%	Slime Tailings	0.057	113.1	0.94	0.39	0.55	1	1.42	11.536	160.35	13.62	13	2.79%	2.9	71%	1.53	0.00	1.53	0
16.568	5593.06	7.0	0.183	6.9	21.4	9.27	2.60%	Slime Tailings	0.057	113.1	0.95	0.39	0.56	1	1.41	9.747	135.49	11.54	11	3.00%	3.0	71%	1.54	0.00	1.54	0
16.732	5592.90	6.2	0.154	6.1	20.6	8.92	2.48%	Slime Tailings	0.057	113.1	0.96	0.40	0.56	1	1.40	8.540	118.71	10.13	9	2.90%	3.0	71%	1.55	0.00	1.55	0
16.896	5592.73	6.9	0.091	6.7	28.8	12.50	1.33%	Slime Tailings	0.057	113.1	0.97	0.40	0.57	1	1.39	9.383	130.43	11.19	10	1.55%	2.8	71%	1.56	0.00	1.56	0
17.060	5592.57	9.6	0.063	9.5	23.8	10.31	0.65%	Sand-Slime Tailings	0.059	119.0	0.97	0.41	0.57	1	1.38	13.119	182.36	15.46	15	0.72%	2.5	47%	1.57	0.00	1.57	0
17.224	5592.41	11.3	0.052	11.2	22.1	9.56	0.46%	Sand-Slime Tailings	0.059	119.0	0.98	0.41	0.57	1	1.38	15.417	214.30	18.13	18	0.50%	2.4	47%	1.58	0.00	1.58	0

Liquefaction Triggering Analyses

Depth (ft)	I&B (2008) r_d	C_σ	K_σ	K_α	CSR M=7.5 σ'v=1atm	Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5 σ'v=1atm	FoS	Youd (2001) r_d	D_r	f	K_σ	K_α	CSR M=7.5 σ'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5 σ'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
0.164	1.00	0.06	1.02	1.0	0.059	39.92	67.29	0.096	1.63	0.97	0.35	0.80	2.53	1.0	0.017	1.00	27.36	0.073	176.61	89.12	2
0.328	1.00	0.06	1.02	1.0	0.059	43.07	79.38	0.112	1.89	0.97	0.35	0.80	2.20	1.0	0.019	1.00	36.32	0.080	97.39	49.64	2
0.492	1.00	0.12	1.04	1.0	0.060	70.90	186.52	0.662	11.01	0.97	0.62	0.69	3.01	1.0	0.014	1.00	115.62	0.224	181.10	96.05	2
0.656	1.00	0.15	1.05	1.0	0.061	81.14	225.95	1.000	16.49	0.97	0.69	0.65	3.10	1.0	0.014	1.00	144.81	0.362	220.09	118.29	2
0.820	1.00	0.18	1.05	1.0	0.061	86.75	247.56	1.000	16.41	0.97	0.73	0.63	3.04	1.0	0.014	1.00	160.81	1.000	486.00	251.21	2
0.984	1.00	0.19	1.05	1.0	0.061	88.65	254.87	1.000	16.41	0.97	0.74	0.63	2.89	1.0	0.015	1.00	166.22	1.000	405.16	210.78	2
1.148	1.00	0.19	1.05	1.0	0.061	89.00	256.21	1.000	16.43	0.97	0.75	0.63	2.74	1.0	0.016	1.00	167.21	1.000	347.42	181.93	2
1.312	1.00	0.15	1.04	1.0	0.060	80.87	224.93	1.000	16.62	0.97	0.69	0.65	2.43	1.0	0.018	1.00	144.05	0.358	108.87	62.75	2
1.476	1.00	0.15	1.04	1.0	0.060	79.63	220.13	1.000	16.67	0.97	0.68	0.66	2.31	1.0	0.019	1.00	140.50	0.334	91.39	54.03	2
1.640	1.00	0.11	1.03	1.0	0.059	68.56	177.51	0.498	8.38	0.97	0.60	0.70	2.03	1.0	0.021	1.00	108.96	0.200	48.77	28.57	2
1.804	1.00	0.11	1.03	1.0	0.059	68.68	177.99	0.505	8.50	0.97	0.60	0.70	1.97	1.0	0.022	1.00	109.31	0.201	44.61	26.56	2
1.968	1.00	0.11	1.02	1.0	0.059	68.19	176.12	0.478	8.08	0.97	0.60	0.70	1.91	1.0	0.022	1.00	107.92	0.197	39.98	24.03	2
2.133	1.00	0.11	1.02	1.0	0.059	67.21	172.33	0.432	7.32	0.97	0.59	0.70	1.85	1.0	0.023	1.00	105.12	0.188	35.26	21.29	2
2.297	1.00	0.10	1.02	1.0	0.059	62.76	155.19	0.297	5.06	0.97	0.56	0.72	1.75	1.0	0.024	1.00	92.43	0.153	26.73	15.89	2
2.461	1.00	0.12	1.02	1.0	0.059	71.29	188.02	0.698	11.85	0.97	0.62	0.69	1.83	1.0	0.023	1.13	131.98	0.294	47.78	29.82	2
2.625	1.00	0.13	1.03	1.0	0.059	79.02	217.77	1.000	16.95	0.97	0.68	0.66	1.89	1.0	0.023	1.00	138.76	0.328	50.10	33.52	2
2.789	0.99	0.30	1.05	1.0	0.060	#####	368.33	1.000	16.58	0.97	0.91	0.60	2.07	1.0	0.021	1.00	250.20	1.000	143.62	80.10	2
2.953	0.99	0.14	1.02	1.0	0.059	78.12	214.32	1.000	17.04	0.97	0.67	0.66	1.81	1.0	0.024	1.00	136.20	0.315	42.74	29.89	2
3.117	0.99	0.18	1.03	1.0	0.059	88.35	253.72	1.000	16.98	0.97	0.74	0.63	1.88	1.0	0.023	1.00	165.37	1.000	128.60	72.79	2
3.281	0.99	0.10	1.01	1.0	0.058	46.85	143.68	0.245	4.22	0.97	0.57	0.72	1.60	1.0	0.027	1.00	96.84	0.164	20.08	12.15	2
3.445	0.99	0.10	1.01	1.0	0.058	45.69	139.01	0.229	3.95	0.97	0.56	0.72	1.56	1.0	0.027	1.00	93.12	0.155	18.02	10.99	2
3.609	0.99	0.10	1.01	1.0	0.058	45.48	136.96	0.223	3.85	0.97	0.55	0.72	1.54	1.0	0.028	1.00	91.48	0.151	16.59	10.22	2
3.773	0.99	0.11	1.01	1.0	0.058	50.02	159.25	0.321	5.56	0.97	0.60	0.70	1.58	1.0	0.027	1.00	109.24	0.201	21.33	13.45	2
3.937	0.99	0.17	1.01	1.0	0.058	62.69	221.52	1.000	17.25	0.97	0.73	0.64	1.70	1.0	0.025	1.00	158.82	0.453	45.97	31.61	2
4.101	0.99	0.16	1.01	1.0	0.058	81.77	228.51	1.000	17.32	0.97	0.70	0.65	1.65	1.0	0.026	1.11	163.40	1.000	97.90	57.61	2
4.265	0.99	0.12	1.01	1.0	0.058	66.80	170.86	0.416	7.25	0.96	0.59	0.71	1.51	1.0	0.028	1.38	143.17	0.353	30.88	20.53	2
4.429	0.99	0.14	1.01	1.0	0.057	78.81	217.11	1.000	17.43	0.96	0.68	0.66	1.60	1.0	0.027	1.21	167.80	1.000	93.77	55.60	2
4.593	0.98	0.25	1.01	1.0	0.057	71.75	266.00	1.000	17.41	0.96	0.80	0.60	1.72	1.0	0.025	1.00	194.25	1.000	91.68	54.55	2
4.757	0.98	0.23	1.01	1.0	0.057	70.29	258.83	1.000	17.48	0.96	0.79	0.60	1.70	1.0	0.025	1.00	188.54	1.000	89.68	53.58	2
4.921	0.98	0.17	1.00	1.0	0.057	61.96	217.92	1.000	17.56	0.96	0.72	0.64	1.61	1.0	0.026	1.00	155.96	0.433	37.99	27.78	2
5.085	0.98	0.17	1.00	1.0	0.057	62.16	218.91	1.000	17.61	0.96	0.72	0.64	1.60	1.0	0.027	1.00	156.75	0.438	37.66	27.64	2
5.249	0.98	0.18	1.00	1.0	0.057	64.16	228.74	1.000	17.67	0.96	0.74	0.63	1.60	1.0	0.026	1.00	164.58	1.000	84.19	50.93	2
5.413	0.98	0.15	1.00	1.0	0.056	58.45	200.70	1.000	17.71	0.96	0.69	0.66	1.54	1.0	0.028	1.00	142.25	0.348	28.69	23.20	2
5.577	0.98	0.13	1.00	1.0	0.056	55.01	183.79	0.604	10.72	0.96	0.66	0.67	1.50	1.0	0.028	1.00	128.78	0.279	22.54	16.63	2
5.741	0.98	0.12	0.99	1.0	0.056	50.73	162.76	0.345	6.14	0.96	0.61	0.69	1.45	1.0	0.029	1.00	112.03	0.211	16.72	11.43	2
5.905	0.98	0.10	0.99	1.0	0.056	46.74	143.17	0.243	4.34	0.96	0.57	0.72	1.40	1.0	0.030	1.00	96.43	0.163	12.72	8.53	2
6.069	0.98	0.08	0.99	1.0	0.056	52.65	115.98	0.171	3.05	0.96	0.46	0.77	1.31	1.0	0.032	1.07	67.96	0.109	8.36	5.70	2
6.234	0.98	0.08	0.99	1.0	0.056	50.22	107.02	0.154	2.76	0.96	0.44	0.78	1.29	1.0	0.033	1.11	62.92	0.103	7.76	5.26	2
6.398	0.97	0.08	0.99	1.0	0.056	53.38	119.19	0.178	3.18	0.96	0.47	0.77	1.31	1.0	0.033	1.08	71.27	0.114	8.41	5.80	2
6.562	0.97	0.07	0.99	1.0	0.056	46.78	93.75	0.133	2.37	0.96	0.40	0.80	1.25	1.0	0.034	1.34	62.78	0.103	7.50	4.94	2
6.726	0.97	0.06	0.99	1.0	0.056	42.88	78.75	0.111	1.99	0.96	0.35	0.80	1.25	1.0	0.034	1.55	55.52	0.096	6.87	4.43	2
6.890	0.97	0.05	0.99	1.0	0.056	38.47	61.77	0.090	1.61	0.96	0.28	0.80	1.24	1.0	0.034	1.94	45.17	0.088	6.18	3.90	2
7.054	0.97	0.05	0.99	1.0	0.056	37.10	54.94	0.082	1.48	0.96	0.25	0.80	1.24	1.0	0.034	2.36	42.97	0.086	5.96	3.72	2
7.218	0.97	0.05	0.99	1.0	0.056	36.64	54.71	0.082	1.46	0.96	0.25	0.80	1.23	1.0	0.034	2.11	38.20	0.082	5.59	3.54	2
7.382	0.97	0.05	0.99	1.0	0.056	37.17	56.75	0.084	1.52	0.96	0.26	0.80	1.23	1.0	0.034	2.05	40.20	0.083	5.62	3.57	2
7.546	0.97	0.05	0.99	1.0	0.055	36.20	53.04	0.080	1.45	0.96	0.24	0.80	1.23	1.0	0.034	2.24	37.68	0.081	5.40	3.43	2
7.710	0.97	0.05	0.99	1.0	0.055	37.36	57.50	0.085	1.54	0.96	0.26	0.80	1.23	1.0	0.034	1.78	35.77	0.080	5.22	3.38	2
7.874	0.96	0.05	0.99	1.0	0.055	36.17	52.91	0.080	1.45	0.96	0.24	0.80	1.22	1.0	0.035	2.07	34.68	0.079	5.09	3.27	2
8.038	0.96	0.05	0.99	1.0	0.055	35.58	50.64	0.078	1.41	0.96	0.22	0.80	1.22	1.0	0.035	2.41	36.22	0.080	5.16	3.29	2
8.202	0.96	0.05	0.99	1.0	0.055	35.92	51.94	0.079	1.44	0.96	0.23	0.80	1.21	1.0	0.035	2.42	38.81	0.082	5.16	3.30	2
8.366	0.96	0.05	0.99	1.0	0.055	36.52	54.24	0.082	1.49	0.96	0.24	0.80	1.21	1.0	0.035	2.46	43.59	0.086	5.34	3.41	2
8.530	0.96	0.05	0.99	1.0	0.055	36.75	55.12	0.083	1.52	0.95	0.25	0.80	1.21	1.0	0.035	3.18	60.45	0.101	6.14	3.83	2
8.694	0.96	0.05	0.99	1.0	0.055	36.59	55.26	0.083	1.51	0.95	0.25	0.80	1.20	1.0	0.035	3.29	61.47	0.102	6.13	3.82	2
8.858	0.96	0.06	0.99	1.0	0.055	39.63	66.24	0.095	1.74	0.95	0.30	0.80	1.20	1.0	0.035	2.09	55.72	0.096	5.72	3.73	2
9.022	0.96	0.05	0.99	1.0	0.055	36.26	53.99	0.081	1.49	0.95	0.24	0.80	1.20	1.0	0.035	3.17	56.22	0.097	5.68	3.59	2
9.186	0.96	0.05	0.99	1.0	0.055	34.94	48.86	0.076	1.40	0.95	0.22	0.80	1.20	1.0	0.035	4.35	60.51	0.101	5.86	3.63	2
9.350	0.96	0.06	0.98	1.0	0.054	38.87	63.30	0.092	1.68	0.95	0.29	0.80	1.19	1.0	0.035	1.87	45.60	0.088	5.06	3.37	2
9.514	0.96	0.06	0.98	1.0	0.054	41.09	71.42	0.101	1.86	0.95	0.32	0.80	1.19	1.0	0.035	1.50	45.61	0.088	5.05	3.45	2
9.678	0.95	0.06	0.98	1.0	0.054	40.74	70.52	0.100	1.85	0.95	0.32	0.80	1.18	1.0	0.035	1.46	43.48	0.086	4.83	3.34	2
9.842	0.95	0.07	0.98	1.0	0.054	45.15	90.35	0.128	2.39	0.95	0.39	0.80	1.18	1.0	0.035	1.23	55.64	0.096	5.32	3.85	2
10.006	0.95	0.06	0.98	1.0	0.054	43.08	79.52	0.112	2.07	0.95	0.35	0.80	1.18	1.0	0.036	1.35	49.19	0.091	4.98	3.53	2
10.170	0.95	0.06	0.98	1.0	0.054	41.75	74.41	0.105	1.95	0.95	0.33	0.80	1.18	1.0	0.036	1.40	45.68	0.088	4.76	3.36	2
10.335	0.95	0.05	0.98	1.0	0.054	38.26	60.96	0.089	1.65	0.95	0.28	0.80	1.18	1.0	0.036	1.87	42.42	0.085	4.56	3.10	2
10.499	0.95	0.05	0.98	1.0	0.054	35.97	52.15	0.080	1.48	0.95	0.23	0.80	1.17	1.0	0.036	2.78	45.02	0.087	4.62	3.05	2
10.663	0.95	0.05	0.98	1.0	0.054	36.03	52.51	0.080	1.49	0.95	0.23	0.80	1.17	1.0	0.036	2.24	36.81	0.081	4.21	2.85	2
10.827	0.95	0.05	0.98	1.0	0.054	36.70	54.93	0.082	1.53	0.95	0.25	0.80	1.17	1.0	0.036	1.76	32.06	0.077	3.96	2.75	2
10.991	0.95	0.05	0.98	1.0	0.054	36.22	53.11	0.081	1.50	0.95	0.24	0.80	1.17	1.0	0.036	2.64	44.52	0.087	4.47	2.99	2
11.155	0.94	0.05	0.98	1.0	0.054	34.39	46.76	0.074	1.39	0.95	0.20	0.80	1.16	1.0	0.036	4.38	54.23	0.095	4.79	3.09	2
11.319	0.94	0.05	0.98	1.0	0.054	33.58	43.63	0.072	1.34	0.95	0.18	0.80	1.16	1.0	0.036	5.80	58.28	0.098	4.93	3.13	2
11.483	0.94	0.04	0.98	1.0	0.054	33.02	41.56	0.070	1.31	0.95	0.17	0.80	1.16	1.0	0.036	7.36	62.61	0.103	5.10	3.20	2
11.647	0.94	0.05	0.98	1.0	0.053	35.14	49.64	0.077	1.45	0.95	0.21	0.80	1.16	1.0	0.036	3.63	52.71	0.094	4.60	3.02	2
11.811	0.94	0.05	0.98	1.0	0.053	36.25	53.95	0.081	1.52	0.95	0.24	0.80	1.16	1.0	0.036	2.93	43.68	0.086	4.16	2.84	2
11.975	0.94	0.05	0.98	1.0	0.053	36.26	53.25	0.081	1.52	0.95	0.23	0.80	1.16	1.0	0.036	2.93	49.71	0.091	4.40	2.96	2
12.139	0.94	0.05	0.98	1.0	0.053	37.56	58.25	0.086	1.62	0.95	0.26	0.80	1.15	1.0	0.036	1.95	40.29	0.084	3.98	2.80	2
12.303	0.94	0.05	0.98	1.0	0.053	37.42	57.70	0.085	1.61	0.95	0.26	0.80	1.15	1.0	0.036	2.34	47.56	0.090	4.23	2.92	2
12.467	0.93	0.05	0.98	1.0	0.053	34.61	47.77	0.075	1.42	0.94	0.21	0.80	1.14	1.0	0.037	3.83	58.12	0.098	4.57	2.99	2
12.631	0.93	0.05	0.98	1.0	0.053	35.90	51.88	0.079	1.49	0.94	0.23	0.80	1.14	1.0	0.037	2.35	37.50	0.081	3.76	2.63	2
12.795	0.93	0.05	0.98	1.0	0.053	36.59	54.53	0.082	1.55	0.94	0.24	0.80	1.14	1.0	0.037	2.04	36.66	0.081	3.69	2.62	2
12.959	0.93	0.05	0.98	1.0	0.053	36.58	54.49	0.082	1.55	0.94	0.24	0.80	1.14	1.0	0.037	2.08	37.23	0.081	3.68	2.62	2
13.123	0.93	0.05	0.98	1.0	0.053	36.71	54.96	0.082	1.56	0.94	0.24	0.80	1.14	1.0	0.037	2.20	39.63	0.083	3.73	2.65	2
13.287	0.93	0.05	0.98	1.0	0.053	36.62	54.63	0.082	1.56	0.94	0.24	0.80	1.13	1.0	0.037	2.33	42.44	0.085	3.81	2.68	2
13.451	0.93	0.05	0.98	1.0	0.052	36.32	53.50	0.081	1.54	0.94	0.23	0.80	1.13	1.0	0.037	2.69	46.27	0.089	3.90	2.72	2
13.615	0.93	0.05	0.98	1.0	0.052	36.34	53.62	0.081	1.55	0.94	0.23	0.80	1.13	1.0	0.037	2.84	49.02	0.091	3.97	2.76	2
13.779	0.93	0.05	0.98	1.0	0.052	37.51	58.07	0.086	1.65	0.94	0.26	0.80	1.13	1.0	0.037	2.20	45.71	0.088	3.79	2.72	2
13.943	0.92	0.06	0.98	1.0	0.052	39.37	65.22	0.094	1.81	0.94	0.29	0.80	1.13	1.0	0.037	1.79	45.18	0.088	3.81	2.81	2
14.107	0.92	0.06	0.98	1.0	0.052	37.91	58.26	0.087	1.66	0.94	0.26	0.80	1.12	1.0	0.037	2.40	47.03	0.089	3.79	2.72	2
14.271	0.92	0.05	0.98	1.0	0.052	35.14	49.64	0.077	1.48	0.94	0.21	0.80	1.12	1.0	0.037	4.03	58.43	0.099	4.15	2.82	2
14.436	0.92	0.06	0.98	1.0	0.052	34.68	47.17	0.075	1.44	0.94	0.20	0.80	1.12	1.0	0.037	3.54	44.20	0.087	3.62	2.53	2
14.600	0.92	0.05	0.98	1.0	0.052	34.25	45.52	0.073	1.41	0.94	0.19	0.80	1.12	1.0	0.038	3.48	39.19	0.083	3.42	2.42	2
14.764	0.92	0.04	0.97	1.0	0.052	32.66	39.46	0.067	1.30	0.94	0.16	0.80	1.12	1.0	0.038	5.88	55.61	0.096	3.78	2.57	2
14.928	0.92	0.04	0.97	1.0	0.052	32.99	41.33	0.070	1.33	0.94	0.17	0.80	1.12	1.0	0.038	7.58	63.21	0.103	4.22	2.78	2
15.092	0.92	0.04	0.97	1.0	0.052	33.02	41.44	0.070	1.35	0.94	0.17	0.80	1.11	1.0	0.038	7.94	66.87	0.108	4.26	2.85	2
15.256	0.91	0.04	0.97	1.0	0.052	32.70	40.25	0.069	1.33	0.93	0.17	0.80	1.11	1.0	0.038	9.73	84.97	0.130	4.98	3.16	2
15.420	0.91	0.05	0.97	1.0	0.051	35.31	49.60	0.077	1.50	0.93	0.21	0.80	1.11	1.0	0.038	3.18	45.42	0.088	3.49	2.50	2
15.584	0.91	0.05	0.97	1.0	0.051	35.46	50.55	0.078	1.52	0.93	0.22	0.80	1.11	1.0	0.038	3.10	44.78	0.087	3.44	2.48	2
15.748	0.91	0.05	0.97	1.0	0.051	34.86	47.84	0.075	1.46	0.93	0.20	0.80	1.10	1.0	0.038	4.67	60.47	0.101	3.88	2.67	2
15.912	0.91	0.05	0.97	1.0	0.051	35.02	48.47	0.076	1.48	0.93	0.20	0.80	1.10	1.0	0.038	3.39	45.63	0.088	3.41	2.45	2
16.076	0.91	0.05	0.97	1.0	0.051	35.40	49.81	0.077	1.51	0.93	0.21	0.80	1.10	1.0	0.038	3.28	48.10	0.090	3.47	2.49	2
16.240	0.91	0.05	0.97	1.0	0.051	35.45	50.14	0.078	1.52	0.93	0.21	0.80	1.10	1.0	0.038	3.24	48.56	0.091	3.49	2.50	2
16.404	0.90	0.05	0.97	1.0	0.051	35.42	50.03	0.078	1.52	0.93	0.21	0.80	1.10	1.0	0.038	3.47	52.00	0.093	3.58	2.55	2
16.568	0.90	0.05	0.97	1.0	0.051	34.11	45.65	0.073	1.44	0.93	0.19	0.80	1.09	1.0	0.038	5.33	66.75	0.106	4.03	2.74	2
16.732	0.90	0.06	0.97	1.0	0.051	33.61	43.74	0.072	1.41	0.93	0.18	0.80	1.09	1.0	0.039	6.88	69.68	0.111	4.16	2.79	2
16.896	0.90	0.04	0.97	1.0	0.051	33.35	42.50	0.071	1.39	0.93	0.17	0.80	1.09	1.0	0.039	7.42	72.60	0.114	4.27	2.83	2
17.060	0.90	0.05	0.97	1.0	0.051	36.15	52.52	0.080	1.58	0.93	0.23	0.80	1.09	1.0	0.039	2.67	43.00	0.086	3.21	2.40	2
17.224	0.90	0.05	0.97	1.0	0.050	36.66	54.79	0.082	1.63	0.93	0.25	0.80	1.09	1.0	0.038	2.30	41.65	0.085	3.09	2.36	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.414

Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
3.36	594	1.6E-03	5.5E+02	1.1E-04	11	0.178	9740	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.41	594	1.6E-03	5.5E+02	1.1E-04	11	0.179	9685	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.46	594	1.6E-03	5.5E+02	1.1E-04	11	0.179	9631	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.51	594	1.6E-03	5.5E+02	1.1E-04	11	0.180	9578	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.56	594	1.6E-03	5.5E+02	1.1E-04	11	0.181	9526	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.61	594	1.6E-03	5.5E+02	1.1E-04	11	0.181	9475	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.66	594	1.6E-03	5.5E+02	1.1E-04	11	0.182	9425	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.71	594	1.6E-03	5.5E+02	1.2E-04	11	0.182	9375	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.76	594	1.6E-03	5.5E+02	1.2E-04	11	0.183	9327	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.81	594	1.6E-03	5.5E+02	1.2E-04	11	0.184	9279	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.86	594	1.6E-03	5.5E+02	1.2E-04	11	0.184	9233	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.91	594	1.6E-03	5.5E+02	1.2E-04	11	0.185	9187	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.96	594	1.6E-03	5.5E+02	1.2E-04	11	0.185	9141	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.01	594	1.6E-03	5.5E+02	1.3E-04	11	0.186	9097	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.06	594	1.6E-03	5.5E+02	1.3E-04	11	0.186	9053	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.11	594	1.6E-03	5.5E+02	1.3E-04	11	0.187	9010	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.16	594	1.6E-03	5.5E+02	1.3E-04	11	0.187	8968	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.21	594	1.6E-03	5.5E+02	1.3E-04	11	0.188	8926	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.26	495	1.6E-03	3.8E+02	1.9E-04	11	0.189	8885	0.03%	2.00	0.65	0.03%	0.002	0.34	0.079	0.765	0.31%	0.0005
4.31	495	1.6E-03	3.9E+02	1.9E-04	0	0.193	11435	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.04%	0.0001
4.36	495	1.6E-03	3.9E+02	1.9E-04	0	0.194	11383	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.04%	0.0001
4.41	495	1.6E-03	3.9E+02	1.9E-04	0	0.194	11332	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.05%	0.0001
4.46	495	1.6E-03	3.9E+02	2.0E-04	0	0.195	11282	0.05%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.05%	0.0001
4.51	495	1.6E-03	3.9E+02	2.0E-04	0	0.195	11232	0.05%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.05%	0.0001
4.56	495	1.8E-03	4.5E+02	1.7E-04	10	0.192	8872	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.61	495	1.8E-03	4.5E+02	1.7E-04	10	0.193	8827	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.66	495	1.8E-03	4.5E+02	1.8E-04	10	0.193	8784	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
4.71	495	1.9E-03	4.7E+02	1.7E-04	0	0.197	11011	0.03%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.01%	0.0000
4.76	495	1.9E-03	4.7E+02	1.7E-04	0	0.198	10956	0.03%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.01%	0.0000
4.81	495	1.9E-03	4.7E+02	1.8E-04	0	0.198	10903	0.03%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.02%	0.0000
4.86	495	1.9E-03	4.7E+02	1.8E-04	0	0.199	10850	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.02%	0.0000
4.91	495	1.9E-03	4.7E+02	1.8E-04	0	0.200	10798	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.02%	0.0000
4.96	495	1.9E-03	4.7E+02	1.8E-04	0	0.200	10747	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.02%	0.0000
5.01	495	1.9E-03	4.7E+02	1.9E-04	0	0.201	10697	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.03%	0.0000
5.06	495	1.9E-03	4.7E+02	1.9E-04	0	0.201	10647	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.03%	0.0000
5.11	495	1.9E-03	4.7E+02	1.9E-04	0	0.202	10599	0.04%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.03%	0.0001
5.16	495	1.8E-03	4.5E+02	2.0E-04	10	0.199	8371	0.03%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.42%	0.0007
5.21	495	1.8E-03	4.5E+02	2.0E-04	10	0.200	8335	0.03%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.46%	0.0007
5.26	495	1.8E-03	4.5E+02	2.0E-04	10	0.200	8299	0.04%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.49%	0.0008
5.31	495	1.8E-03	4.5E+02	2.0E-04	10	0.201	8263	0.04%	2.00	0.65	0.03%	0.003	0.34	0.079	0.765	0.53%	0.0009
5.36	495	1.8E-03	4.5E+02	2.1E-04	10	0.201	8228	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.57%	0.0009
5.41	495	1.8E-03	4.5E+02	2.1E-04	10	0.202	8194	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.60%	0.0010
5.46	495	1.8E-03	4.5E+02	2.1E-04	10	0.202	8160	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.63%	0.0010
5.51	495	1.8E-03	4.5E+02	2.1E-04	10	0.203	8127	0.04%	2.00	0.65	0.03%	0.004	0.34	0.079	0.765	0.67%	0.0011
5.56	495	1.8E-03	4.5E+02	2.2E-04	10	0.203	8094	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.70%	0.0011
5.61	495	1.8E-03	4.5E+02	2.2E-04	10	0.204	8061	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.73%	0.0012
5.66	495	1.8E-03	4.5E+02	2.2E-04	10	0.204	8029	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.76%	0.0013
5.71	495	1.8E-03	4.5E+02	2.2E-04	10	0.205	7997	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.80%	0.0013
5.76	495	1.8E-03	4.5E+02	2.2E-04	10	0.205	7966	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.83%	0.0014
5.81	495	1.8E-03	4.5E+02	2.3E-04	10	0.206	7935	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.86%	0.0014
5.86	495	1.8E-03	4.5E+02	2.3E-04	10	0.206	7905	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.89%	0.0015
5.91	495	1.8E-03	4.3E+02	2.4E-04	16	0.458	6484	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.32%	0.0022
5.96	495	1.8E-03	4.3E+02	2.4E-04	16	0.459	6461	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.35%	0.0022
6.01	495	1.8E-03	4.5E+02	2.3E-04	10	0.208	7819	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.98%	0.0016
6.06	495	1.8E-03	4.3E+02	2.5E-04	16	0.460	6414	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.41%	0.0023
6.11	495	1.8E-03	4.3E+02	2.5E-04	16	0.460	6392	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.44%	0.0024
6.16	460	1.8E-03	3.9E+02	2.8E-04	10	0.209	7736	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.71%	0.0028
6.21	460	1.8E-03	3.9E+02	2.8E-04	10	0.209	7708	0.07%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.75%	0.0029
6.26	460	1.8E-03	3.9E+02	2.8E-04	10	0.210	7680	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.78%	0.0029
6.31	460	1.8E-03	3.9E+02	2.9E-04	10	0.210	7653	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.82%	0.0030
6.36	460	1.8E-03	3.9E+02	2.9E-04	10	0.211	7626	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.85%	0.0030
6.41	460	1.8E-03	3.9E+02	2.9E-04	10	0.211	7600	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.89%	0.0031
6.46	460	1.8E-03	3.9E+02	2.9E-04	10	0.212	7573	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.92%	0.0032
6.51	460	1.8E-03	3.9E+02	3.0E-04	10	0.212	7547	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.96%	0.0032
6.56	460	1.8E-03	3.9E+02	3.0E-04	10	0.213	7522	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.99%	0.0033
6.61	460	1.8E-03	3.9E+02	3.0E-04	10	0.213	7496	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.03%	0.0033
6.66	460	1.8E-03	3.9E+02	3.0E-04	10	0.213	7471	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.07%	0.0034
6.71	460	1.8E-03	3.7E+02	3.2E-04	16	0.465	6133	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.58%	0.0042
6.76	460	1.8E-03	3.7E+02	3.2E-04	16	0.466	6114	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.62%	0.0043
6.81	460	1.8E-03	3.7E+02	3.3E-04	16	0.466	6095	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.65%	0.0044
6.86	460	1.8E-03	3.7E+02	3.3E-04	16	0.467	6077	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.69%	0.0044
6.91	460	1.8E-03	3.7E+02	3.3E-04	16	0.467	6058	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.73%	0.0045
6.96	460	1.8E-03	3.9E+02	3.2E-04	10	0.216	7332	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.28%	0.0037
7.01	460	1.8E-03	3.9E+02	3.2E-04	10	0.216	7309	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.31%	0.0038
7.06	460	1.8E-03	3.9E+02	3.2E-04	10	0.217	7286	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.35%	0.0039
7.11	460	1.8E-03	3.7E+02	3.4E-04	16	0.469	5983	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.88%	0.0047
7.16	460	1.8E-03	3.9E+02	3.3E-04	10	0.218	7242	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.42%	0.0040
7.21	460	1.8E-03	3.9E+02	3.3E-04	10	0.218	7219	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.46%	0.0040
7.26	460	1.8E-03	3.9E+02	3.3E-04	10	0.218	7197	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.50%	0.0041
7.31	460	1.8E-03	3.9E+02	3.3E-04	10	0.219	7176	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.53%	0.0042
7.36	460	1.8E-03	3.9E+02	3.4E-04	10	0.219	7154	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.57%	0.0042
7.41	460	1.8E-03	3.9E+02	3.4E-04	10	0.220	7133	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.61%	0.0043
7.46	460	1.8E-03	3.9E+02	3.4E-04	10	0.220	7111	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.65%	0.0043
7.51	460	1.8E-03	3.9E+02	3.4E-04	10	0.220	7090	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.69%	0.0044
7.56	460	1.8E-03	3.9E+02	3.5E-04	10	0.221	7070	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.72%	0.0045
7.61	460	1.8E-03	3.9E+02	3.5E-04	10	0.221	7049	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.76%	0.0045
7.66	460	1.8E-03	3.7E+02	3.7E-04	16	0.473	5792	0.12%	2.00	0.65	0.03%	0.022	0.34	0.079	0.765	3.31%	0.0054
7.71	460	1.8E-03	3.9E+02	3.5E-04	10	0.222	7010	0.10%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.84%	0.0047
7.76	500	1.8E-03	4.6E+02	3.0E-04	10	0.222	6990	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.87%	0.0031
7.81	500	1.8E-03	4.4E+02	3.2E-04	16	0.474	5743	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.33%	0.0038
7.86	500	1.8E-03	4.4E+02	3.2E-04	16	0.474	5728	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.36%	0.0039
7.91	500	1.8E-03	4.4E+02	3.2E-04	16	0.475	5713	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.39%	0.0039
7.96	500	1.8E-03	4.4E+02	3.2E-04	16	0.475	5698	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.42%	0.0040
8.01	500	1.8E-03	4.6E+02	3.1E-04	10	0.224	6896	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.00%	0.0033
8.06	500	1.8E-03	4.6E+02	3.1E-04	10	0.224	6878	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.03%	0.0033
8.11	500	1.8E-03	4.6E+02	3.1E-04	10	0.225	6859	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.06%	0.0034
8.16	500	1.8E-03	4.6E+02	3.2E-04	10	0.225	6840	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.09%	0.0034
8.21	500	1.8E-03	4.6E+02	3.2E-04	10	0.226	6822	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.12%	0.0035
8.26	500	1.8E-03	4.6E+02	3.2E-04	10	0.226	6804	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.15%	0.0035
8.31	500	1.8E-03	4.4E+02	3.4E-04	16	0.477	5593	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.62%	0.0043
8.36	500	1.8E-03	4.4E+02	3.4E-04	16	0.478	5579	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.65%	0.0044
8.41	500	1.8E-03	4.4E+02	3.4E-04	16	0.478	5565	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.68%	0.0044
8.46	500	1.8E-03	4.4E+02	3.5E-04	16	0.478	5552	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.71%	0.0044
8.51	500	1.8E-03	4.6E+02	3.3E-04	10	0.228	6719	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.28%	0.0037
8.56	500	1.8E-03	4.6E+02	3.3E-04	10	0.228	6701	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.31%	0.0038

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-3S

Data File: 13-52106_SP3-3S-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Dat

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5605.60	Water surface elevation during CPT investigation (ft
5601.35	Water surface elevation at t_0 (ft amsl)
5582.14	Water surface elevation at t_1 (ft amsl)
5577.14	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Eart
7.51	Equiv. Number of Uniform Strain Cycles, N

5609.63	Ground Surface Elevation at time of CPT (ft amsl)
5620.49	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
3.36	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1184.24	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5577.14	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5620.24	5619.99	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5618.24	5616.49	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5614.74	5612.99	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320	1.75	508	1.9E-03	4.8E+02	6.5E-05	11	0.152	12657	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######	5611.31	5609.63	3.36	0.050	101	0.593	0.509	0.00	0.00	0.593	0.509	2.80	508	1.6E-03	4.0E+02	1.2E-04	11	0.171	10433	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
17.388	5592.24	12.6	0.071	12.4	21.2	9.17	0.57%	Sand-Slime Tailin	0.059	119.0	0.99	0.42	0.58	1	1.37	16.989	236.15	19.94	20	0.61%	2.4	47%	1.59	0.00	1.59	0
17.552	5592.08	13.7	0.092	13.6	19.3	8.35	0.67%	Sand-Slime Tailin	0.059	119.0	1.00	0.42	0.58	1	1.36	18.404	255.82	21.57	22	0.73%	2.4	47%	1.60	0.00	1.60	0
17.716	5591.91	13.7	0.124	13.6	19.8	8.56	0.91%	Sand-Slime Tailin	0.059	119.0	1.01	0.43	0.59	1	1.35	18.297	254.32	21.44	22	0.98%	2.5	47%	1.61	0.00	1.61	0
17.880	5591.75	11.4	0.157	11.3	19.8	8.58	1.38%	Sand-Slime Tailin	0.059	119.0	1.02	0.43	0.59	1	1.34	15.145	210.51	17.78	18	1.51%	2.6	47%	1.61	0.00	1.61	0
18.044	5591.59	10.6	0.162	10.5	21.3	9.25	1.52%	Sand-Slime Tailin	0.059	119.0	1.03	0.44	0.60	1	1.33	14.025	194.94	16.50	16	1.69%	2.7	47%	1.62	0.00	1.62	0
18.208	5591.42	9.0	0.183	8.9	21.8	9.45	2.03%	Slime Tailings	0.057	113.1	1.04	0.44	0.60	1	1.33	11.759	163.45	13.87	13	2.30%	2.8	71%	1.63	0.00	1.63	0
18.372	5591.26	8.4	0.100	8.2	27.4	11.89	1.19%	Sand-Slime Tailin	0.059	119.0	1.05	0.45	0.60	1	1.32	10.844	150.73	12.86	12	1.36%	2.7	47%	1.64	0.00	1.64	0
18.537	5591.09	13.5	0.095	13.4	21.3	9.22	0.70%	Sand-Slime Tailin	0.059	119.0	1.06	0.45	0.61	1	1.31	17.559	244.07	20.60	20	0.76%	2.4	47%	1.65	0.00	1.65	0
18.701	5590.93	10.1	0.120	10.0	17.8	7.69	1.19%	Sand-Slime Tailin	0.059	119.0	1.07	0.46	0.61	1	1.30	12.971	180.29	15.23	15	1.33%	2.7	47%	1.66	0.00	1.66	0
18.865	5590.77	9.9	0.116	9.8	18.7	8.10	1.17%	Sand-Slime Tailin	0.059	119.0	1.08	0.46	0.62	1	1.30	12.648	175.81	14.87	14	1.32%	2.7	47%	1.67	0.00	1.67	0
19.029	5590.60	14.0	0.163	13.9	13.3	5.75	1.17%	Sand-Slime Tailin	0.059	119.0	1.09	0.47	0.62	1	1.29	17.870	248.39	20.88	21	1.27%	2.5	47%	1.68	0.00	1.68	0
19.193	5590.44	13.6	0.284	13.5	11.7	5.08	2.09%	Sand-Slime Tailin	0.059	119.0	1.10	0.47	0.63	1	1.28	17.279	240.18	20.18	20	2.28%	2.7	47%	1.69	0.00	1.69	0
19.357	5590.27	10.2	0.200	10.1	14.7	6.36	1.96%	Slime Tailings	0.057	113.1	1.11	0.48	0.63	1	1.27	12.883	179.08	15.10	14	2.20%	2.8	71%	1.70	0.00	1.70	0
19.521	5590.11	17.8	0.357	17.7	18.6	8.07	2.00%	Sand-Slime Tailin	0.059	119.0	1.12	0.48	0.64	1	1.25	22.210	308.72	25.96	26	2.14%	2.6	47%	1.71	0.00	1.71	0
19.685	5589.95	22.3	0.302	22.2	25.3	10.96	1.35%	Sand-Slime Tailin	0.059	119.0	1.13	0.49	0.64	1	1.24	27.383	380.62	32.03	33	1.43%	2.4	47%	1.72	0.00	1.72	0
19.849	5589.78	22.1	0.259	21.8	57.2	24.79	1.17%	Sand-Slime Tailin	0.059	119.0	1.14	0.49	0.65	1	1.23	26.790	372.39	31.63	33	1.23%	2.4	47%	1.73	0.00	1.73	0
20.013	5589.62	20.9	0.204	20.3	100.3	43.47	0.98%	Sand-Slime Tailin	0.059	119.0	1.15	0.50	0.65	1	1.23	24.850	345.41	29.75	30	1.03%	2.3	47%	1.74	0.00	1.74	0
20.177	5589.45	18.6	0.237	17.7	151.5	65.65	1.27%	Sand-Slime Tailin	0.059	119.0	1.16	0.50	0.65	1	1.23	21.715	301.84	26.57	27	1.36%	2.5	47%	1.75	0.00	1.75	0
20.341	5589.29	19.8	0.274	18.9	136.1	58.99	1.39%	Sand-Slime Tailin	0.059	119.0	1.17	0.51	0.66	1	1.22	23.028	320.09	27.95	28	1.47%	2.5	47%	1.76	0.00	1.76	0
20.505	5589.13	25.1	0.237	24.5	96.6	41.86	0.95%	Sand-Slime Tailin	0.059	119.0	1.18	0.51	0.66	1	1.20	29.354	408.02	34.93	36	0.99%	2.3	47%	1.77	0.00	1.77	0
20.669	5588.96	31.4	0.092	31.0	58.2	25.23	0.29%	Sand Tailings	0.062	123.5	1.19	0.52	0.67	1	1.18	36.693	510.03	43.12	45	0.30%	1.9	18%	1.78	0.00	1.78	0
20.833	5588.80	32.9	0.194	32.7	35.6	15.43	0.59%	Sand Tailings	0.062	123.5	1.20	0.52	0.67	1	1.17	38.397	533.72	44.90	47	0.61%	2.1	18%	1.79	0.00	1.79	0
20.997	5588.63	22.6	0.202	22.3	42.9	18.60	0.90%	Sand-Slime Tailin	0.059	119.0	1.21	0.53	0.68	1	1.19	26.475	368.01	31.12	31	0.95%	2.3	47%	1.80	0.00	1.80	0
21.161	5588.47	21.0	0.114	20.8	20.1	8.70	0.54%	Sand-Slime Tailin	0.059	119.0	1.22	0.53	0.68	1	1.18	24.679	343.04	28.84	29	0.58%	2.2	47%	1.81	0.00	1.81	0
21.325	5588.30	21.1	0.201	20.9	37.0	16.04	0.95%	Sand-Slime Tailin	0.059	119.0	1.23	0.54	0.69	1	1.18	24.625	342.29	28.92	29	1.01%	2.4	47%	1.82	0.00	1.82	0
21.489	5588.14	22.3	0.267	21.9	66.8	28.93	1.20%	Sand-Slime Tailin	0.059	119.0	1.24	0.54	0.69	1	1.17	25.657	356.63	30.37	30	1.27%	2.4	47%	1.83	0.00	1.83	0
21.653	5587.98	18.5	0.419	18.0	91.4	39.59	2.26%	Sand-Slime Tailin	0.059	119.0	1.25	0.55	0.70	1	1.17	21.059	292.72	25.24	25	2.42%	2.6	47%	1.84	0.00	1.84	0
21.817	5587.81	22.9	0.248	22.0	149.4	64.72	1.08%	Sand-Slime Tailin	0.059	119.0	1.26	0.55	0.70	1	1.16	25.478	354.15	30.85	31	1.15%	2.4	47%	1.85	0.00	1.85	0
21.981	5587.65	28.4	0.235	27.8	83.5	36.19	0.83%	Sand-Slime Tailin	0.059	119.0	1.27	0.56	0.71	1	1.15	31.904	443.46	37.75	38	0.87%	2.2	47%	1.86	0.00	1.86	0
22.145	5587.48	22.2	0.322	21.0	195.5	84.71	1.45%	Sand-Slime Tailin	0.059	119.0	1.28	0.57	0.71	1	1.15	24.097	334.94	29.62	29	1.54%	2.4	47%	1.87	0.00	1.87	0
22.309	5587.32	25.0	0.216	23.6	231.9	100.47	0.86%	Sand-Slime Tailin	0.059	119.0	1.29	0.57	0.72	1	1.14	26.878	373.60	33.13	33	0.91%	2.3	47%	1.88	0.00	1.88	0
22.473	5587.16	25.7	0.237	24.6	172.5	74.75	0.92%	Sand-Slime Tailin	0.059	119.0	1.30	0.58	0.72	1	1.13	27.896	387.75	33.82	34	0.97%	2.3	47%	1.89	0.00	1.89	0
22.638	5586.99	25.4	0.261	24.2	200.2	86.77	1.03%	Sand-Slime Tailin	0.059	119.0	1.31	0.58	0.72	1	1.13	27.284	379.24	33.33	33	1.08%	2.3	47%	1.90	0.00	1.90	0
22.802	5586.83	25.6	0.229	24.5	184.7	80.05	0.89%	Sand-Slime Tailin	0.059	119.0	1.32	0.59	0.73	1	1.12	27.506	382.34	33.45	33	0.94%	2.3	47%	1.91	0.00	1.91	0
22.966	5586.66	28.5	0.145	27.4	181.5	78.63	0.51%	Sand-Slime Tailin	0.059	119.0	1.33	0.59	0.73	1	1.12	30.592	425.22	37.00	37	0.53%	2.1	47%	1.92	0.00	1.92	0
23.130	5586.50	30.4	0.223	29.5	150.3	65.13	0.73%	Sand-Slime Tailin	0.059	119.0	1.33	0.60	0.74	1	1.11	32.742	455.12	39.24	39	0.77%	2.2	47%	1.93	0.00	1.93	0
23.294	5586.34	35.2	0.314	34.0	190.1	82.37	0.89%	Sand-Slime Tailin	0.059	119.0	1.34	0.60	0.74	1	1.10	37.465	520.76	45.03	46	0.93%	2.2	47%	1.94	0.00	1.94	0
23.458	5586.17	38.3	0.271	37.3	170.9	74.04	0.71%	Sand Tailings	0.062	123.5	1.35	0.61	0.75	1	1.09	40.792	567.01	48.73	49	0.73%	2.1	18%	1.95	0.00	1.95	0
23.622	5586.01	38.4	0.271	37.3	171.7	74.40	0.71%	Sand Tailings	0.062	123.5	1.36	0.61	0.75	1	1.09	40.621	564.64	48.54	49	0.73%	2.1	18%	1.96	0.00	1.96	0
23.786	5585.84	41.4	0.271	40.3	174.7	75.68	0.66%	Sand Tailings	0.062	123.5	1.37	0.62	0.76	1	1.08	43.621	606.34	52.04	53	0.68%	2.0	18%	1.97	0.00	1.97	0
32.490	5577.14							Sand Tailings	0.062	123.5													2.50	0.02	2.48	1

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	I&B (2008) r_d	C_σ	K_σ	K_a	CSR M=7.5, s'v=1atm	Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd et al. (2001) r_d	D_r	f	K_σ	K_a	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
17.388	0.90	0.05	0.97	1.0	0.050	37.30	57.24	0.085	1.69	0.93	0.26	0.80	1.08	1.0	0.038	2.28	45.39	0.088	3.18	2.44	2
17.552	0.90	0.05	0.97	1.0	0.050	37.86	59.43	0.087	1.74	0.93	0.27	0.80	1.08	1.0	0.038	2.27	48.98	0.091	3.27	2.50	2
17.716	0.89	0.05	0.97	1.0	0.050	37.82	59.27	0.087	1.74	0.93	0.27	0.80	1.08	1.0	0.038	2.55	54.65	0.095	3.40	2.57	2
17.880	0.89	0.05	0.97	1.0	0.050	36.54	54.32	0.082	1.64	0.93	0.24	0.80	1.08	1.0	0.038	3.51	62.37	0.103	3.63	2.64	2
18.044	0.89	0.05	0.97	1.0	0.050	36.09	52.58	0.080	1.60	0.93	0.23	0.80	1.08	1.0	0.038	3.89	64.15	0.105	3.68	2.64	2
18.208	0.89	0.05	0.97	1.0	0.050	34.92	48.78	0.076	1.53	0.93	0.21	0.80	1.08	1.0	0.038	5.05	70.01	0.112	3.91	2.72	2
18.372	0.89	0.05	0.97	1.0	0.050	34.81	47.67	0.075	1.51	0.93	0.21	0.80	1.07	1.0	0.038	4.32	55.55	0.096	3.33	2.42	2
18.537	0.89	0.05	0.97	1.0	0.050	37.52	58.12	0.086	1.73	0.93	0.26	0.80	1.07	1.0	0.038	2.41	49.69	0.091	3.15	2.44	2
18.701	0.89	0.05	0.97	1.0	0.050	35.64	50.88	0.078	1.58	0.93	0.23	0.80	1.07	1.0	0.038	3.77	57.42	0.098	3.34	2.46	2
18.865	0.89	0.05	0.97	1.0	0.050	35.52	50.38	0.078	1.57	0.93	0.22	0.80	1.07	1.0	0.038	3.83	56.90	0.097	3.30	2.44	2
19.029	0.88	0.05	0.96	1.0	0.049	37.62	58.50	0.086	1.75	0.93	0.26	0.80	1.07	1.0	0.038	2.92	60.91	0.101	3.41	2.58	2
19.193	0.88	0.05	0.96	1.0	0.049	37.38	57.56	0.085	1.73	0.93	0.26	0.80	1.07	1.0	0.038	3.88	78.37	0.125	4.18	2.96	2
19.357	0.88	0.05	0.97	1.0	0.049	35.35	50.44	0.078	1.58	0.93	0.22	0.80	1.06	1.0	0.038	4.70	70.98	0.113	3.77	2.68	2
19.521	0.88	0.06	0.96	1.0	0.049	39.41	65.37	0.094	1.92	0.93	0.29	0.80	1.06	1.0	0.038	3.15	81.85	0.131	4.34	3.13	2
19.685	0.88	0.06	0.96	1.0	0.049	41.53	73.56	0.104	2.14	0.93	0.33	0.80	1.06	1.0	0.038	2.26	72.25	0.115	3.79	2.96	2
19.849	0.88	0.06	0.96	1.0	0.049	41.39	73.02	0.103	2.13	0.92	0.32	0.80	1.06	1.0	0.038	2.14	67.74	0.109	3.57	2.85	2
20.013	0.88	0.06	0.96	1.0	0.049	40.74	70.49	0.100	2.06	0.92	0.31	0.80	1.06	1.0	0.038	2.08	62.00	0.102	3.33	2.69	2
20.177	0.87	0.06	0.96	1.0	0.049	39.62	66.19	0.095	1.96	0.92	0.30	0.80	1.06	1.0	0.038	2.53	67.18	0.108	3.50	2.73	2
20.341	0.87	0.06	0.96	1.0	0.048	40.10	68.05	0.097	2.01	0.92	0.31	0.80	1.05	1.0	0.038	2.53	70.78	0.113	3.64	2.82	2
20.505	0.87	0.06	0.96	1.0	0.048	42.55	77.49	0.109	2.27	0.92	0.34	0.80	1.05	1.0	0.038	1.85	64.63	0.105	3.36	2.82	2
20.669	0.87	0.07	0.95	1.0	0.048	33.11	76.23	0.108	2.25	0.92	0.38	0.80	1.05	1.0	0.038	1.24	53.32	0.094	2.99	2.62	2
20.833	0.87	0.07	0.95	1.0	0.048	33.57	78.47	0.111	2.31	0.92	0.39	0.80	1.05	1.0	0.038	1.39	62.28	0.102	3.24	2.78	2
20.997	0.87	0.06	0.96	1.0	0.048	41.22	72.33	0.103	2.14	0.91	0.32	0.80	1.05	1.0	0.038	1.97	61.27	0.101	3.19	2.66	2
21.161	0.87	0.06	0.96	1.0	0.048	40.41	69.25	0.099	2.06	0.91	0.31	0.80	1.05	1.0	0.038	1.76	50.76	0.092	2.88	2.47	2
21.325	0.87	0.06	0.96	1.0	0.048	40.44	69.36	0.099	2.06	0.91	0.31	0.80	1.05	1.0	0.038	2.13	61.57	0.102	3.17	2.62	2
21.489	0.86	0.06	0.96	1.0	0.048	40.95	71.32	0.101	2.12	0.91	0.32	0.80	1.04	1.0	0.038	2.26	68.55	0.110	3.40	2.76	2
21.653	0.86	0.06	0.96	1.0	0.048	39.15	64.39	0.093	1.94	0.91	0.29	0.80	1.04	1.0	0.038	3.47	87.68	0.143	4.39	3.17	2
21.817	0.86	0.06	0.95	1.0	0.048	41.12	71.97	0.102	2.15	0.91	0.32	0.80	1.04	1.0	0.038	2.15	66.25	0.107	3.28	2.71	2
21.981	0.86	0.06	0.95	1.0	0.047	43.54	81.29	0.114	2.42	0.91	0.35	0.80	1.04	1.0	0.038	1.70	64.18	0.105	3.19	2.80	2
22.145	0.86	0.06	0.95	1.0	0.047	40.69	70.30	0.100	2.11	0.91	0.31	0.80	1.04	1.0	0.038	2.51	74.48	0.118	3.59	2.85	2
22.309	0.86	0.06	0.95	1.0	0.047	41.92	75.06	0.106	2.25	0.90	0.33	0.80	1.04	1.0	0.038	1.88	62.32	0.103	3.09	2.67	2
22.473	0.86	0.06	0.95	1.0	0.047	42.16	75.98	0.107	2.28	0.90	0.34	0.80	1.04	1.0	0.038	1.90	64.40	0.105	3.15	2.71	2
22.638	0.85	0.06	0.95	1.0	0.047	41.99	75.32	0.106	2.26	0.90	0.33	0.80	1.03	1.0	0.038	2.01	66.86	0.108	3.22	2.74	2
22.802	0.85	0.06	0.95	1.0	0.047	42.03	75.49	0.107	2.27	0.90	0.33	0.80	1.03	1.0	0.038	1.90	63.56	0.104	3.09	2.68	2
22.966	0.85	0.06	0.95	1.0	0.047	43.28	80.28	0.113	2.42	0.90	0.35	0.80	1.03	1.0	0.038	1.50	55.48	0.096	2.84	2.63	2
23.130	0.85	0.06	0.95	1.0	0.047	44.06	83.30	0.117	2.51	0.90	0.36	0.80	1.03	1.0	0.038	1.61	63.15	0.103	3.05	2.78	2
23.294	0.85	0.07	0.94	1.0	0.046	46.09	91.13	0.129	2.77	0.90	0.39	0.80	1.03	1.0	0.038	1.59	71.48	0.114	3.34	3.06	2
23.458	0.85	0.07	0.94	1.0	0.046	34.55	83.28	0.117	2.54	0.89	0.40	0.80	1.03	1.0	0.038	1.42	69.29	0.111	3.23	2.88	2
23.622	0.85	0.07	0.94	1.0	0.046	34.50	83.03	0.117	2.53	0.89	0.40	0.80	1.03	1.0	0.038	1.43	69.22	0.111	3.22	2.87	2
23.786	0.85	0.07	0.94	1.0	0.046	35.39	87.43	0.123	2.68	0.89	0.42	0.79	1.03	1.0	0.038	1.36	70.53	0.113	3.25	2.96	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.414

Depth at time of CPT (ft)	Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
17.388	8.61	500	1.8E-03	4.6E+02	3.3E-04	10	0.228	6684	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.34%	0.0038
17.552	8.66	500	1.8E-03	4.6E+02	3.4E-04	10	0.229	6667	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.37%	0.0039
17.716	8.71	500	1.8E-03	4.6E+02	3.4E-04	10	0.229	6650	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.40%	0.0039
17.880	8.76	500	1.8E-03	4.6E+02	3.4E-04	10	0.229	6634	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.43%	0.0040
18.044	8.81	500	1.8E-03	4.6E+02	3.4E-04	10	0.230	6617	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.46%	0.0040
18.208	8.86	500	1.8E-03	4.4E+02	3.6E-04	16	0.481	5442	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.95%	0.0048
18.372	8.91	500	1.8E-03	4.6E+02	3.5E-04	10	0.231	6585	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.52%	0.0041
18.537	8.96	500	1.8E-03	4.6E+02	3.5E-04	10	0.231	6569	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.55%	0.0042
18.701	9.01	500	1.8E-03	4.6E+02	3.5E-04	10	0.231	6553	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.58%	0.0042
18.865	9.06	500	1.8E-03	4.6E+02	3.5E-04	10	0.232	6537	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.61%	0.0043
19.029	9.11	500	1.8E-03	4.6E+02	3.6E-04	10	0.232	6521	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.64%	0.0043
19.193	9.16	500	1.8E-03	4.6E+02	3.6E-04	10	0.232	6506	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.67%	0.0044
19.357	9.21	500	1.8E-03	4.4E+02	3.8E-04	16	0.484	5351	0.12%	2.00	0.65	0.03%	0.021	0.34	0.079	0.765	3.17%	0.0052
19.521	9.26	500	1.8E-03	4.6E+02	3.6E-04	10	0.233	6476	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.73%	0.0045
19.685	9.31	538	1.8E-03	5.3E+02	3.1E-04	10	0.233	6460	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.91%	0.0031
19.849	9.36	538	1.8E-03	5.3E+02	3.2E-04	10	0.234	6445	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.93%	0.0032
20.013	9.41	538	1.8E-03	5.3E+02	3.2E-04	10	0.234	6430	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.95%	0.0032
20.177	9.46	538	1.8E-03	5.3E+02	3.2E-04	10	0.234	6415	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.98%	0.0032
20.341	9.51	538	1.8E-03	5.3E+02	3.2E-04	10	0.235	6401	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.00%	0.0033
20.505	9.56	538	1.8E-03	5.3E+02	3.2E-04	10	0.235	6386	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.02%	0.0033
20.669	9.61	538	1.9E-03	5.5E+02	3.1E-04	0	0.235	8055	0.10%	2.20	1.00	0.03%	0.002	0.34	0.079	0.765	0.23%	0.0004
20.833	9.66	538	1.9E-03	5.5E+02	3.1E-04	0	0.236	8037	0.10%	2.20	1.00	0.03%	0.002	0.34	0.079	0.765	0.24%	0.0004
20.997	9.71	538	1.8E-03	5.3E+02	3.3E-04	10	0.236	6342	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.09%	0.0034
21.161	9.76	538	1.8E-03	5.3E+02	3.3E-04	10	0.236	6327	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.12%	0.0035
21.325	9.81	538	1.8E-03	5.3E+02	3.3E-04	10	0.237	6313	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.14%	0.0035
21.489	9.86	538	1.8E-03	5.3E+02	3.3E-04	10	0.237	6299	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.16%	0.0036
21.653	9.91	538	1.8E-03	5.3E+02	3.4E-04	10	0.237	6285	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.19%	0.0036
21.817	9.96	538	1.8E-03	5.3E+02	3.4E-04	10	0.238	6272	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.21%	0.0036
21.981	10.01	538	1.8E-03	5.3E+02	3.4E-04	10	0.238	6258	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.23%	0.0037
22.145	10.06	538	1.8E-03	5.3E+02	3.4E-04	10	0.238	6244	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.26%	0.0037
22.309	10.11	538	1.8E-03	5.3E+02	3.4E-04	10	0.238	6231	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.28%	0.0037
22.473	10.16	538	1.8E-03	5.3E+02	3.4E-04	10	0.239	6218	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.30%	0.0038
22.638	10.21	538	1.8E-03	5.3E+02	3.5E-04	10	0.239	6204	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.33%	0.0038
22.802	10.26	538	1.8E-03	5.3E+02	3.5E-04	10	0.239	6191	0.09%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.35%	0.0039
22.966	10.31	538	1.8E-03	5.3E+02	3.5E-04	10	0.240	6178	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.38%	0.0039
23.130	10.36	538	1.8E-03	5.3E+02	3.5E-04	10	0.240	6165	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.40%	0.0039
23.294	10.41	538	1.8E-03	5.3E+02	3.5E-04	10	0.240	6152	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.42%	0.0040
23.458	10.46	538	1.9E-03	5.5E+02	3.4E-04	0	0.240	7765	0.12%	2.20	1.00	0.03%	0.002	0.34	0.079	0.765	0.31%	0.0005
23.622	10.51	538	1.9E-03	5.5E+02	3.4E-04	0	0.241	7749	0.12%	2.20	1.00	0.03%	0.002	0.34	0.079	0.765	0.31%	0.0005
23.786	10.56	538	1.9E-03	5.5E+02	3.5E-04	0	0.241	7732	0.12%	2.20	1.00	0.03%	0.002	0.34	0.079	0.765	0.32%	0.0005
32.490	13.21	594	1.9E-03	6.8E+02	3.6E-04	0	0.254	7027	0.12%	5.00	1.00	0.03%	0.005	0.34	0.079	0.765	0.70%	0.0607

Extra layer added to analyze seismic settlement of tailings below the bottom of CPT investigation.

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-4N

Data File: 13-52106_SP3-4N-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3 Field Data\2013 Field Investigation\Conetec Dat

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5606.00	Water surface elevation during CPT investigation (ft
5600.42	Water surface elevation at t_0 (ft amsl)
5583.71	Water surface elevation at t_1 (ft amsl)
5578.71	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Eart
7.51	Equiv. Number of Uniform Strain Cycles, N
5608.70	Ground Surface Elevation at time of CPT (ft amsl)
5623.35	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pl
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
7.15	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1565.99	Additional Stress due to Final Cover Placement, $\Delta\sigma_{fc}$ (psf)
5578.71	Elevation of bottom of tailings (liner) (ft amsl)

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %
0.164	5608.54	29.3	0.127	29.3	1.0	0.44	0.43%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	49.810	692.36	57.86	3546	0.43%	0.9	51%
0.328	5608.37	57.0	0.266	57.0	1.3	0.55	0.47%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	96.951	1347.62	112.62	3451	0.47%	0.9	51%
0.492	5608.21	65.8	0.294	65.8	3.7	1.58	0.45%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	111.894	1555.33	130.00	2656	0.45%	0.9	51%
0.656	5608.04	65.5	0.343	65.4	1.6	0.71	0.52%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	111.248	1546.35	129.23	1980	0.52%	1.0	51%
0.820	5607.88	64.9	0.350	64.9	2.1	0.89	0.54%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	110.279	1532.88	128.11	1570	0.54%	1.0	51%
0.984	5607.72	63.6	0.317	63.6	-0.1	-0.04	0.50%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	108.103	1502.63	125.55	1282	0.50%	1.0	51%
1.148	5607.55	65.1	0.361	65.1	0.3	0.12	0.55%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	110.704	1538.79	128.58	1125	0.55%	1.1	51%
1.312	5607.39	54.3	0.552	54.3	0.6	0.24	1.02%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	92.293	1282.87	107.20	820	1.02%	1.3	51%
1.476	5607.22	52.5	0.448	52.5	1.4	0.61	0.85%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	89.250	1240.58	103.68	705	0.85%	1.3	51%
1.640	5607.06	62.6	0.320	62.6	0.2	0.10	0.51%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	106.369	1478.53	123.54	756	0.51%	1.1	51%
1.804	5606.90	50.3	0.452	50.3	0.5	0.20	0.90%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	85.459	1187.88	99.26	552	0.90%	1.4	51%
1.968	5606.73	47.8	0.549	47.8	1.6	0.68	1.15%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	81.243	1129.28	94.38	481	1.15%	1.5	51%
2.133	5606.57	63.2	0.574	63.2	4.1	1.77	0.91%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	107.355	1492.23	124.74	587	0.91%	1.4	51%
2.297	5606.40	106.2	0.582	106.2	6.9	2.99	0.55%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	180.489	2508.80	209.71	917	0.55%	1.1	51%
2.461	5606.24	97.4	0.552	97.4	1.7	0.72	0.57%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	165.546	2301.09	192.29	785	0.57%	1.1	51%
2.625	5606.08	86.1	0.510	86.1	0.3	0.11	0.59%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.70	146.370	2034.54	170.00	650	0.59%	1.2	51%
2.789	5605.91	76.9	0.485	76.9	0.2	0.09	0.63%	Interim Cover	0.050	100.7	0.14	0.00	0.14	1	1.70	130.764	1817.62	151.88	558	0.63%	1.3	51%
2.953	5605.75	71.5	0.471	71.5	0.3	0.11	0.66%	Interim Cover	0.050	100.7	0.15	0.01	0.14	1	1.70	121.567	1689.78	141.20	507	0.66%	1.3	51%
3.117	5605.58	59.8	0.416	59.8	-0.4	-0.18	0.70%	Interim Cover	0.050	100.7	0.16	0.01	0.14	1	1.70	101.728	1414.02	118.15	415	0.70%	1.4	51%
3.281	5605.42	51.6	0.323	51.6	-0.5	-0.22	0.63%	Sand Tailings	0.062	123.5	0.17	0.02	0.15	1	1.70	87.652	1218.36	101.80	345	0.63%	1.4	18%
3.445	5605.26	44.7	0.266	44.7	-0.6	-0.26	0.60%	Sand Tailings	0.062	123.5	0.18	0.02	0.15	1	1.70	75.956	1055.79	88.21	289	0.60%	1.4	18%
3.609	5605.09	39.4	0.205	39.4	-0.5	-0.22	0.52%	Sand Tailings	0.062	123.5	0.19	0.03	0.16	1	1.70	66.963	930.79	77.77	247	0.52%	1.4	18%
3.773	5604.93	37.6	0.191	37.6	-0.5	-0.22	0.51%	Sand Tailings	0.062	123.5	0.20	0.03	0.16	1	1.70	63.937	888.72	74.25	228	0.51%	1.4	18%
3.937	5604.76	39.1	0.168	39.1	1.0	0.43	0.43%	Sand Tailings	0.062	123.5	0.21	0.04	0.17	1	1.70	66.538	924.88	77.29	230	0.43%	1.4	18%
4.101	5604.60	40.3	0.180	40.4	-0.4	-0.16	0.45%	Sand Tailings	0.062	123.5	0.22	0.04	0.17	1	1.70	68.595	953.47	79.66	231	0.45%	1.4	18%
4.265	5604.43	39.7	0.206	39.7	0.2	0.07	0.52%	Sand Tailings	0.062	123.5	0.23	0.05	0.18	1	1.70	67.507	938.35	78.41	221	0.52%	1.5	18%
4.429	5604.27	38.6	0.225	38.6	0.9	0.39	0.58%	Sand Tailings	0.062	123.5	0.24	0.05	0.18	1	1.70	65.552	911.17	76.15	208	0.59%	1.5	18%
4.593	5604.11	38.4	0.229	38.4	1.2	0.52	0.60%	Sand Tailings	0.062	123.5	0.25	0.06	0.19	1	1.70	65.348	908.34	75.91	202	0.60%	1.5	18%
4.757	5603.94	38.8	0.235	38.8	1.1	0.48	0.61%	Sand Tailings	0.062	123.5	0.26	0.06	0.19	1	1.70	65.994	917.32	76.66	199	0.61%	1.5	18%
4.921	5603.78	37.7	0.214	37.7	1.2	0.54	0.57%	Sand Tailings	0.062	123.5	0.27	0.07	0.20	1	1.70	64.039	890.14	74.39	188	0.57%	1.5	18%
5.085	5603.61	35.6	0.246	35.6	1.2	0.52	0.69%	Sand Tailings	0.062	123.5	0.28	0.07	0.20	1	1.70	60.554	841.70	70.34	173	0.70%	1.6	18%
5.249	5603.45	30.5	0.236	30.5	0.3	0.13	0.77%	Sand-Slime Tailings	0.059	119.0	0.29	0.08	0.21	1	1.70	51.850	720.72	60.22	145	0.78%	1.7	47%
5.413	5603.29	27.1	0.216	27.1	1.1	0.48	0.80%	Sand-Slime Tailings	0.059	119.0	0.30	0.08	0.21	1	1.70	46.121	641.08	53.58	126	0.80%	1.8	47%
5.577	5603.12	26.7	0.176	26.7	1.6	0.68	0.66%	Sand-Slime Tailings	0.059	119.0	0.31	0.09	0.22	1	1.70	45.356	630.45	52.70	121	0.67%	1.7	47%
5.741	5602.96	25.2	0.169	25.2	1.8	0.76	0.67%	Sand-Slime Tailings	0.059	119.0	0.32	0.09	0.22	1	1.70	42.857	595.71	49.80	112	0.68%	1.8	47%
5.905	5602.79	22.4	0.156	22.3	1.8	0.78	0.70%	Sand-Slime Tailings	0.059	119.0	0.33	0.10	0.23	1	1.70	37.978	527.89	44.13	97	0.71%	1.8	47%
6.069	5602.63	20.9	0.135	20.9	2.6	1.11	0.64%	Sand-Slime Tailings	0.059	119.0	0.34	0.11	0.23	1	1.70	35.581	494.58	41.36	89	0.66%	1.8	47%
6.234	5602.47	20.2	0.127	20.2	2.1	0.93	0.63%	Sand-Slime Tailings	0.059	119.0	0.35	0.11	0.24	1	1.70	34.289	476.62	39.85	84	0.64%	1.9	47%
6.398	5602.30	20.6	0.117	20.6	2.6	1.13	0.57%	Sand-Slime Tailings	0.059	119.0	0.36	0.12	0.24	1	1.70	34.935	485.60	40.61	84	0.58%	1.8	47%
6.562	5602.14	22.3	0.113	22.3	2.7	1.16	0.51%	Sand-Slime Tailings	0.059	119.0	0.37	0.12	0.25	1	1.70	37.859	526.24	44.00	89	0.52%	1.8	47%
6.726	5601.97	22.1	0.120	22.1	2.6	1.14	0.54%	Sand-Slime Tailings	0.059	119.0	0.38	0.13	0.25	1	1.70	37.621	522.93	43.73	87	0.55%	1.8	47%
6.890	5601.81	21.1	0.125	21.1	3.5	1.52	0.59%	Sand-Slime Tailings	0.059	119.0	0.39	0.13	0.26	1	1.70	35.785	497.41	41.61	81	0.60%	1.9	47%
7.054	5601.65	19.4	0.130	19.3	4.1	1.77	0.67%	Sand-Slime Tailings	0.059	119.0	0.40	0.14	0.26	1	1.70	32.861	456.77	38.22	73	0.69%	1.9	47%
7.218	5601.48	18.3	0.128	18.3	4.2	1.81	0.70%	Sand-Slime Tailings	0.059	119.0	0.41	0.14	0.26	1	1.70	31.025	431.25	36.09	68	0.72%	2.0	47%
7.382	5601.32	17.3	0.127	17.3	4.7	2.05	0.73%	Sand-Slime Tailings	0.059	119.0	0.42	0.15	0.27	1	1.70	29.393	408.56	34.20	63	0.75%	2.0	47%
7.546	5601.15	16.0	0.118	16.0	4.7	2.05	0.74%	Sand-Slime Tailings	0.059	119.0	0.42	0.15	0.27	1	1.70	27.234	378.55	31.69	57	0.76%	2.0	47%
7.710	5600.99	15.9	0.100	15.8	4.8	2.10	0.63%	Sand-Slime Tailings	0.059	119.0	0.43	0.16	0.28	1	1.70	26.894	373.83	31.30	55	0.65%	2.0	47%
7.874	5600.83	14.1	0.079	14.0	5.5	2.40	0.56%	Sand-Slime Tailings	0.059	119.0	0.44	0.16	0.28	1	1.70	23.868	331.77	27.79	48	0.58%	2.0	47%
8.038	5600.66	12.3	0.079	12.3	7.0	3.05	0.64%	Sand-Slime Tailings	0.059	119.0	0.45	0.17	0.29	1	1.70	20.842	289.70	24.29	41	0.67%	2.1	47%
8.202	5600.50	10.1	0.079	10.1	7.8	3.40	0.78%	Sand-Slime Tailings	0.059	119.0	0.46	0.17	0.29	1	1.70	17.153	238.43	20.02	33	0.82%	2.3	47%
8.366	5600.33	10.5	0.074	10.5	7.9	3.42	0.70%	Sand-Slime Tailings	0.059	119.0	0.47	0.18	0.30	1	1.70	17.782	247.17	20.75	34	0.74%	2.2	47%
8.530	5600.17	11.2	0.094	11.1	7.1	3.07	0.84%	Sand-Slime Tailings	0.059	119.0	0.48	0.18	0.30	1	1.70	18.887	262.53	22.02	35	0.88%	2.2	47%
8.694	5600.01	9.4	0.107	9.4	7.9	3.44	1.13%	Sand-Slime Tailings	0.059	119.0	0.49	0.19	0.31	1	1.70	15.946	221.65	18.62	29	1.20%	2.4	47%
8.858	5599.84	8.8	0.081	8.7	12.4	5.35	0.92%	Sand-Slime Tailings	0.059	119.0	0.50	0.19	0.31	1	1.70	14.756	205.11	17.29	27	0.98%	2.4	47%
9.022	5599.68	11.1	0.076	11.1	5.6	2.43	0.68%	Sand-Slime Tailings	0.059	119.0	0.51	0.20	0.32	1	1.70	18.870	262.29	21.99	34	0.72%	2.2	47%
9.186	5599.51	9.6	0.061	9.6	2.1	0.91	0.63%	Sand-Slime Tailings	0.059	119.0	0.52	0.20	0.32	1	1.70	16.337	227.08	19.00	28	0.67%	2.3	47%
9.350	5599.35	12.2	0.050	12.2	2.4	1.04	0.41%	Sand-Slime Tailings	0.059	119.0	0.53	0.21	0.32	1	1.70	20.672	287.34	24.04	36	0.43%	2.1	47%
9.514	5599.19	10.4	0.053	10.4	2.6	1.12	0.51%	Sand-Slime Tailings	0.059	119.0	0.54	0.21	0.33	1	1.70	17.646	245.28	20.53	30	0.54%	2.2	47%
9.678	5599.02	8.2	0.072	8.2	6.3	2.75	0.87%	Sand-Slime Tailings	0.059	119.0	0.55	0.22	0.33	1	1.70	13.957	194.00	16.29	23	0.94%	2.4	47%
9.842	5598.86	6.7	0.056	6.7	7.3	3.18	0.83%	Slime Tailings	0.057	113.1	0.56	0.22	0.34	1	1.70	11.356	157.85	13.28	18	0.91%	2.5	71%
10.006	5598.69	5.1	0.106	5.0	9.4	4.07	2.09%	Slime Tailings	0.057	113.1	0.57	0.23	0.34	1	1.70	8.534	118.62	10.03	13	2.35%	2.8	71%
10.170	5598.53	3.9	0.092	3.9	4.9	2.13	2.36%	Slime Tailings	0.057	113.1	0.58	0.23	0.35	1	1.70	6.562	91.21	7.68	10	2.78%	3.0	71%
10.335	5598.37	5.5	0.171	5.5	6.9	2.99	3.11%	Slime Tailings	0.057	113.1	0.59	0.24	0.35	1	1.70	9.265	128.78	10.85	14	3.49%	2.9	71%
10.499	5598.20	10.4	0.222	10.4	3.4	1.48	2.14%	Slime Tailings	0.057	113.1	0.60	0.24	0.35	1	1.70	17.612	244.81	20.50	28	2.27%	2.6	71%
10.663	5598.04	4.3	0.241	4.2	13.2	5.72	5.67%	Slime Tailings	0.057	113.1	0.61	0.25	0.36	1	1.70	7.089	98.54	8.40	10	6.61%	3.2	71%
10.827	5597.87	5.7	0.239	5.6	23.2	10.07	4.17%	Slime Tailings	0.057	113.1	0.62	0.25	0.36	1	1.70	9.486	131.86	11.30	14	4.68%	3.0	71%
10.991	5597.71	11.2	0.225	11.1	15.4	6.69	2.01%	Slime Tailings	0.057	113.1	0.63	0.26	0.37	1	1.70	18.904	262.77	22.15	29	2.12%	2.5	71%
11.155	5597.55	3.0	0.253	2.9	12.9	5.59	8.49%	Slime Tailings	0.057	113.1	0.64	0.26	0.37	1	1.70	4.930	68.53	5.88	6	10.79%	3.5	71%
11.319	5597.38	2.8	0.251	2.7	7.9	3.44	9.10%	Slime Tailings	0.057	113.1	0.64	0.27	0.38	1	1.70	4.607	64.04	5.45	6	11.87%	3.6	71%
11.483	5597.22	12.0	0.174	12.0	3.9	1.69	1.45%	Sand-Slime Tailings	0.059	119.0	0.65	0.27	0.38	1	1.70	20.417	283.80	23.76	30	1.53%	2.4	47%
11.647	5597.05	28.9	0.523	28.8	10.2	4.41	1.81%	Sand-Slime Tailings	0.059	119.0	0.66	0.28	0.38	1	1.65	47.502	660.28	55.29	73	1.85%	2.2	47%
11.811	5596.89	85.4	0.752	85.2	32.0	13.87	0.88%	Sand Tailings	0.062	123.5	0.67	0.28	0.39	1	1.40	119.039	1654.64	138.58	217	0.89%	1.6	18%
11.975	5596.73	141.3	0.619	140.6	118.3	51.27	0.44%	Sand Tailings	0.062	123.5	0.68	0.29	0.39	1	1.28	179.877	2500.28	210.01	356	0.44%	1.3	18%
12.139	5596.56	153.1	1.039	152.7	76.3	33.05	0.68%	Sand Tailings	0.062	123.5	0.69	0.29	0.40	1	1.26	192.043	2669.40	223.74	381	0.68%	1.4	18%
12.303	5596.40	126.4	0.970	126.3	17.7	7.67	0.77%	Sand Tailings	0.062	123.5	0.70	0.30	0.40	1	1.30	163.560	2273.49	190.13	310	0.77%	1.5	18%
12.467	5596.23	12.1	0.808	12.0	22.2	9.64	6.66%	Slime Tailings	0.057	113.1	0.71	0.30	0.41	1	1.70	20.400	283.56	23.97	28	7.07%	2.9	71%
12.631	5596.07	18.2	0.402	18.1	12.5	5.41	2.21%	Sand-Slime Tailings	0.059	119.0	0.72	0.31	0.41	1	1.67	30.267	420.71	35.30	42	2.30%	2.4	47%
12.795	5595.90	26.5	0.286	26.5	1.9	0.81	1.08%	Sand-Slime Tailings	0.059	119.0	0.73	0.31	0.42	1	1.59	42.092	585.08	48.91	62	1.11%	2.1	47%
12.959	5595.74	36.4	0.258	36.4	1.4	0.59	0.71%	Sand Tailings	0.062	123.5	0.74	0.32	0.42	1	1.52	55.289	768.51	64.23	84	0.72%	1.9	18%
13.123	5595.58	11.0	0.376	10.9	16.2	7.02	3.43%	Slime Tailings	0.057	113.1	0.75	0.33	0.43	1	1.70	18.462	256.62	21.64	24	3.68%	2.8	71%
13.287	5595.41	24.7	0.375	24.6	16.4	7.12	1.52%	Sand-Slime Tailings	0.059	119.0	0.76	0.33	0.43	1	1.57	38.712	538.09	45.15	55	1.57%	2.2	47%
13.451	5595.25	8.9	0.177	8.8	15.2	6.59	1.99%	Slime Tailings	0.057	113.1	0.77	0.34	0.44	1	1.70	14.960	207.94	17.56	19	2.18%	2.7	71%
13.615	5595.08	3.6	0.140	3.4	36.3	15.72	3.88%	Slime Tailings	0.057	113.1	0.78	0.34	0.44	1	1.69	5.708	79.34	7.07	6	4.95%	3.3	71%
13.779	5594.92	4.3	0.102	4.0	46.1	19.97	2.37%	Slime Tailings	0.057	113.1	0.79	0.35	0.44	1	1.68	6.739	93.67	8.39	8	2.90%	3.1	71%
13.943	5594.76	4.7	0.064	4.4	49.6	21.48	1.35%	Slime Tailings	0.057	113.1	0.80	0.35	0.45	1	1.66	7.355	102.24	9.14	9	1.63%	2.9	71%
14.107	5594.59	5.1	0.026	4.8	50.7	21.98	0.51%	Slime Tailings	0.057	113.1	0.81	0.36	0.45	1	1.65	7.897	109.77	9.78	9	0.61%	2.7	71%
14.271	5594.43	9.8	0.045	9.6	29.9	12.96	0.46%	Sand-Slime Tailings	0.059	119.0	0.82	0.36	0.46	1	1.64	15.784	219.40	18.69	20	0.50%	2.4	47%
14.436	5594.26	8.9	0.082	8.9	8.8	3.82	0.92%	Sand-Slime Tailings	0.059	119.0	0.83	0.37	0.46	1	1.63	14.408	200.27	16.84	17	1.01%	2.5	47%
14.600	5594.10	6.1	0.065	6.0	10.0	4.33	1.07%	Slime Tailings	0.057	113.1	0.84	0.37	0.47	1	1.61	9.689	134.68	11.37	11	1.24%	2.8	71%
14.764	5593.94	6.3	0.071	6.2	13.9	6.00	1.13%	Slime Tailings	0.057	113.1	0.85	0.38	0.47	1	1.60	9.927	137.98	11.69	12	1.31%	2.8	71%
14.928	5593.77	9.5	0.050	9.4	12.9	5.57	0.53%	Sand-Slime Tailings	0.059	119.0	0.86	0.38	0.48	1	1.59	15.023	208.82	17.60	18	0.58%	2.4	47%
15.092	5593.61	8.2	0.031	8.1	11.9	5.14	0.38%	Sand-Slime Tailings	0.059	119.0	0.87	0.39	0.48	1	1.58	12.809	178.04	15.01	15	0.42%	2.4	47%
15.256	5593.44	12.5	0.026	12.4	11.9	5.14	0.21%	Sand-Slime Tailings	0.059	119.0	0.88	0.39	0.48	1	1.56	19.333	268.72	22.59	24	0.22%	2.2	47%
15.420	5593.28	13.4	0.032	13.4	10.3	4.47	0.24%	Sand-Slime Tailings	0.059	119.0	0.89	0.40	0.49	1	1.54	20.554	285.71	23.99	26	0.26%	2.2	47%
15.584	5593.12	13.2	0.032	13.1	11.4	4.95	0.24%	Sand-Slime Tailings	0.059	119.0	0.90	0.40	0.49	1	1.53	20.065	278.90	23.43	25	0.26%	2.2	47%
15.748	5592.95	12.9	0.034	12.9	12.5	5.42	0.26%	Sand-Slime Tailings	0.059	119.0	0.91	0.41	0.50	1	1.52	19.566	271.97	22.86	24	0.28%	2.2	47%
15.912	5592.79	13.3	0.033	13.2	12.9	5.61	0.25%	Sand-Slime Tailings	0.059	119.0	0.92	0.41	0.50	1	1.51	19.983	277.76	23.35	25	0.27%	2.2	47%
16.076	5592.62	12.7	0.033	12.6	12.9	5.58	0.26%	Sand-Slime Tailings	0.059	119.0	0.93	0.42	0.51	1	1.50	18.976	263.76	22.18	23	0.28%	2.2	47%
16.240	5592.46	12.7	0.036	12.6	13.1	5.68	0.28%	Sand-Slime Tailings	0.059	119.0	0.93	0.42	0.51	1	1.49	18.852	262.04	22.04	23	0.31%	2.2	47%
16.404	5592.30	13.4	0.038	13.3	13.6	5.91	0.28%	Sand-Slime Tailings	0.059	119.0	0.94	0.43	0.52	1	1.48	19.694	273.75	23.02	24	0.31%	2.2	47%
16.568	5592.13	14.1	0.045	14.0	13.7	5.93	0.32%	Sand-Slime Tailings	0.059	119.0	0.95	0.43	0.52	1	1.46	20.524	285.29	23.98	25	0.34%	2.2	47%
16.732	5591.97	13.5	0.052	13.4	13.7	5.93	0.39%	Sand-Slime Tailings	0.059	119.0	0.96	0.44	0.53	1	1.46	19.527	271.42	22.82	24	0.42%	2.3	47%
16.896	5591.80	13.5	0.050	13.5	14.1	6.13	0.37%	Sand-Slime Tailings	0.059	119.0	0.97	0.44	0.53	1	1.45	19.512	271.22	22.81	24	0.40%	2.3	47%
17.060	5591.64	14.2	0.052	14.1	14.4	6.25	0.37%	Sand-Slime Tailings	0.059	119.0	0.98	0.45	0.54	1	1.44	20.251	281.48	23.67	25	0.39%	2.2	47%
17.224	5591.48	15.7	0.057	15.6	14.5	6.26	0.36%	Sand-Slime Tailings	0.059	119.0	0.99	0.45	0.54	1	1.42	22.160	308.02	25.89	27	0.39%	2.2	47%

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-4N

Data File: 13-52106_SP3-4N-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3 Field Data\2013 Field Investigation\Conetec Dat

Legend:
- Tailings Sands
- Tailings Sand-Slimes
- Tailings Slimes
- Interim Cover
- Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69

Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5606.00	Water surface elevation during CPT investigation (ft
5600.42	Water surface elevation at t_0 (ft amsl)
5583.71	Water surface elevation at t_1 (ft amsl)
5578.71	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Eart
7.51	Equiv. Number of Uniform Strain Cycles, N

Value	Parameter
5608.70	Ground Surface Elevation at time of CPT (ft amsl)
5623.35	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
7.15	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1565.99	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5578.71	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5623.1	5622.85	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5621.1	5619.35	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5617.6	5615.85	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320	1.75	508	1.9E-03	4.8E+02	6.5E-05	11	0.152	12657	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######	5612.28	5608.70	7.15	0.050	101	0.784	0.604	0.00	0.00	0.784	0.604	3.38	508	1.6E-03	4.0E+02	1.5E-04	11	0.178	9715	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
17.388	5591.31	16.7	0.068	16.6	14.7	6.37	0.41%	Sand-Slime Tailin	0.059	119.0	1.00	0.46	0.54	1	1.40	23.276	323.53	27.18	29	0.43%	2.2	47%	1.79	0.00	1.79	0
17.552	5591.15	17.4	0.079	17.3	15.0	6.49	0.45%	Sand-Slime Tailin	0.059	119.0	1.01	0.46	0.55	1	1.39	24.051	334.31	28.09	30	0.48%	2.2	47%	1.80	0.00	1.80	0
17.716	5590.98	17.4	0.085	17.3	15.1	6.52	0.49%	Sand-Slime Tailin	0.059	119.0	1.02	0.47	0.55	1	1.38	24.003	333.64	28.03	30	0.52%	2.2	47%	1.81	0.00	1.81	0
17.880	5590.82	16.7	0.082	16.7	15.2	6.57	0.49%	Sand-Slime Tailin	0.059	119.0	1.03	0.47	0.56	1	1.38	22.974	319.34	26.83	28	0.52%	2.2	47%	1.82	0.00	1.82	0
18.044	5590.66	15.6	0.083	15.5	15.5	6.70	0.53%	Sand-Slime Tailin	0.059	119.0	1.04	0.48	0.56	1	1.38	21.358	296.87	24.96	26	0.57%	2.3	47%	1.83	0.00	1.83	0
18.208	5590.49	15.5	0.082	15.4	15.8	6.83	0.53%	Sand-Slime Tailin	0.059	119.0	1.05	0.48	0.57	1	1.37	21.066	292.82	24.62	25	0.57%	2.3	47%	1.83	0.00	1.83	0
18.372	5590.33	15.5	0.076	15.4	15.9	6.89	0.49%	Sand-Slime Tailin	0.059	119.0	1.06	0.49	0.57	1	1.36	21.021	292.19	24.57	25	0.53%	2.3	47%	1.84	0.00	1.84	0
18.537	5590.16	15.0	0.075	14.9	15.9	6.90	0.50%	Sand-Slime Tailin	0.059	119.0	1.07	0.49	0.58	1	1.36	20.261	281.63	23.69	24	0.54%	2.3	47%	1.85	0.00	1.85	0
18.701	5590.00	14.3	0.060	14.2	15.9	6.90	0.42%	Sand-Slime Tailin	0.059	119.0	1.08	0.50	0.58	1	1.35	19.251	267.59	22.51	23	0.45%	2.3	47%	1.86	0.00	1.86	0
18.865	5589.84	14.4	0.060	14.3	15.9	6.90	0.42%	Sand-Slime Tailin	0.059	119.0	1.09	0.50	0.59	1	1.34	19.229	267.28	22.49	23	0.45%	2.3	47%	1.87	0.00	1.87	0
19.029	5589.67	13.4	0.061	13.3	15.9	6.87	0.46%	Sand-Slime Tailin	0.059	119.0	1.10	0.51	0.59	1	1.34	17.843	248.02	20.88	21	0.50%	2.3	47%	1.88	0.00	1.88	0
19.193	5589.51	13.3	0.066	13.2	16.5	7.15	0.50%	Sand-Slime Tailin	0.059	119.0	1.11	0.51	0.60	1	1.33	17.561	244.10	20.56	20	0.54%	2.4	47%	1.89	0.00	1.89	0
19.357	5589.34	13.3	0.073	13.2	16.6	7.18	0.55%	Sand-Slime Tailin	0.059	119.0	1.12	0.52	0.60	1	1.33	17.469	242.81	20.45	20	0.60%	2.4	47%	1.90	0.00	1.90	0
19.521	5589.18	13.2	0.076	13.1	16.9	7.33	0.58%	Sand-Slime Tailin	0.059	119.0	1.13	0.52	0.61	1	1.32	17.192	238.98	20.13	20	0.63%	2.4	47%	1.91	0.00	1.91	0
19.685	5589.02	13.3	0.078	13.2	17.3	7.51	0.59%	Sand-Slime Tailin	0.059	119.0	1.14	0.53	0.61	1	1.31	17.260	239.92	20.21	20	0.64%	2.4	47%	1.92	0.00	1.92	0
19.849	5588.85	14.4	0.075	14.3	17.5	7.57	0.52%	Sand-Slime Tailin	0.059	119.0	1.15	0.54	0.61	1	1.30	18.534	257.63	21.69	22	0.57%	2.3	47%	1.93	0.00	1.93	0
20.013	5588.69	17.2	0.080	17.1	18.1	7.83	0.47%	Sand-Slime Tailin	0.059	119.0	1.16	0.54	0.62	1	1.28	21.877	304.09	25.58	26	0.50%	2.3	47%	1.94	0.00	1.94	0
20.177	5588.52	20.3	0.100	20.2	18.0	7.79	0.49%	Sand-Slime Tailin	0.059	119.0	1.17	0.55	0.62	1	1.26	25.566	355.37	29.86	31	0.52%	2.2	47%	1.95	0.00	1.95	0
20.341	5588.36	21.7	0.131	21.6	18.0	7.79	0.60%	Sand-Slime Tailin	0.059	119.0	1.18	0.55	0.63	1	1.25	27.037	375.81	31.57	33	0.64%	2.2	47%	1.96	0.00	1.96	0
20.505	5588.20	22.7	0.153	22.6	18.4	7.99	0.67%	Sand-Slime Tailin	0.059	119.0	1.19	0.56	0.63	1	1.24	28.112	390.75	32.82	34	0.71%	2.2	47%	1.97	0.00	1.97	0
20.669	5588.03	23.1	0.172	23.0	18.7	8.09	0.74%	Sand-Slime Tailin	0.059	119.0	1.20	0.56	0.64	1	1.24	28.492	396.03	33.26	34	0.78%	2.2	47%	1.98	0.00	1.98	0
20.833	5587.87	23.6	0.180	23.5	18.7	8.09	0.76%	Sand-Slime Tailin	0.059	119.0	1.21	0.57	0.64	1	1.23	28.892	401.60	33.72	35	0.80%	2.2	47%	1.99	0.00	1.99	0
20.997	5587.70	23.1	0.180	23.0	18.8	8.16	0.78%	Sand-Slime Tailin	0.059	119.0	1.22	0.57	0.65	1	1.23	28.155	391.36	32.87	34	0.82%	2.2	47%	2.00	0.00	2.00	0
21.161	5587.54	23.7	0.180	23.6	19.2	8.33	0.76%	Sand-Slime Tailin	0.059	119.0	1.23	0.58	0.65	1	1.22	28.695	398.86	33.50	34	0.80%	2.2	47%	2.01	0.00	2.01	0
29.990	5578.71							Sand-Slime Tailin	0.059	119.0													2.54	0.02	2.52	1

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	Idriss & Boulanger (2008) Cyclic Stress Ratio r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Cyclic Resistance Ratio Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd et al. (2001) Cyclic Stress Ratio r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
17.388	0.90	0.06	0.96	1.0	0.050	39.84	67.02	0.096	1.93	0.91	0.30	0.80	1.10	1.0	0.037	1.63	44.44	0.087	3.42	2.67	2
17.552	0.90	0.06	0.96	1.0	0.050	40.15	68.24	0.097	1.96	0.91	0.31	0.80	1.09	1.0	0.037	1.65	46.24	0.089	3.45	2.71	2
17.716	0.89	0.06	0.96	1.0	0.050	40.13	68.16	0.097	1.97	0.91	0.31	0.80	1.09	1.0	0.037	1.68	47.14	0.089	3.45	2.71	2
17.880	0.89	0.06	0.96	1.0	0.049	39.71	66.55	0.095	1.93	0.91	0.30	0.80	1.09	1.0	0.037	1.74	46.63	0.089	3.42	2.67	2
18.044	0.89	0.06	0.96	1.0	0.049	39.06	64.02	0.092	1.87	0.91	0.29	0.80	1.09	1.0	0.037	1.88	46.89	0.089	3.40	2.64	2
18.208	0.89	0.06	0.96	1.0	0.049	38.94	63.56	0.092	1.86	0.91	0.29	0.80	1.09	1.0	0.037	1.90	46.75	0.089	3.37	2.62	2
18.372	0.89	0.06	0.96	1.0	0.049	38.92	63.49	0.092	1.86	0.91	0.29	0.80	1.08	1.0	0.037	1.86	45.70	0.088	3.32	2.59	2
18.537	0.89	0.05	0.96	1.0	0.049	38.61	62.30	0.090	1.84	0.90	0.28	0.80	1.08	1.0	0.037	1.93	45.62	0.088	3.29	2.57	2
18.701	0.89	0.05	0.96	1.0	0.049	38.20	60.71	0.089	1.80	0.90	0.27	0.80	1.08	1.0	0.037	1.91	42.96	0.086	3.19	2.50	2
18.865	0.89	0.05	0.96	1.0	0.049	38.19	60.68	0.089	1.81	0.90	0.27	0.80	1.08	1.0	0.037	1.91	42.95	0.086	3.17	2.49	2
19.029	0.88	0.05	0.96	1.0	0.049	37.62	58.50	0.086	1.76	0.90	0.26	0.80	1.08	1.0	0.037	2.08	43.40	0.086	3.16	2.46	2
19.193	0.88	0.05	0.96	1.0	0.049	37.51	58.07	0.086	1.75	0.90	0.26	0.80	1.08	1.0	0.037	2.16	44.45	0.087	3.17	2.46	2
19.357	0.88	0.05	0.96	1.0	0.049	37.47	57.92	0.086	1.75	0.90	0.26	0.80	1.07	1.0	0.037	2.24	45.86	0.088	3.20	2.47	2
19.521	0.88	0.05	0.96	1.0	0.049	37.36	57.49	0.085	1.75	0.90	0.26	0.80	1.07	1.0	0.037	2.31	46.52	0.089	3.20	2.47	2
19.685	0.88	0.05	0.96	1.0	0.049	37.39	57.60	0.085	1.75	0.89	0.26	0.80	1.07	1.0	0.037	2.32	46.87	0.089	3.19	2.47	2
19.849	0.88	0.05	0.96	1.0	0.049	37.91	59.60	0.087	1.80	0.89	0.27	0.80	1.07	1.0	0.037	2.11	45.87	0.088	3.14	2.47	2
20.013	0.88	0.06	0.95	1.0	0.048	39.27	64.85	0.093	1.93	0.89	0.29	0.80	1.07	1.0	0.037	1.81	46.18	0.088	3.13	2.53	2
20.177	0.87	0.06	0.95	1.0	0.048	40.77	70.63	0.100	2.09	0.89	0.32	0.80	1.07	1.0	0.037	1.65	49.26	0.091	3.20	2.64	2
20.341	0.87	0.06	0.95	1.0	0.048	41.37	72.94	0.103	2.15	0.89	0.32	0.80	1.07	1.0	0.037	1.69	53.33	0.094	3.29	2.72	2
20.505	0.87	0.06	0.95	1.0	0.048	41.81	74.63	0.105	2.20	0.89	0.33	0.80	1.06	1.0	0.037	1.71	55.97	0.096	3.35	2.77	2
20.669	0.87	0.06	0.95	1.0	0.048	41.97	75.22	0.106	2.22	0.89	0.33	0.80	1.06	1.0	0.037	1.75	58.12	0.098	3.39	2.81	2
20.833	0.87	0.06	0.95	1.0	0.048	42.13	75.85	0.107	2.24	0.89	0.34	0.80	1.06	1.0	0.037	1.75	58.98	0.099	3.40	2.82	2
20.997	0.87	0.06	0.95	1.0	0.048	41.83	74.70	0.106	2.22	0.88	0.33	0.80	1.06	1.0	0.037	1.79	58.98	0.099	3.38	2.80	2
21.161	0.87	0.06	0.95	1.0	0.048	42.05	75.55	0.107	2.24	0.88	0.33	0.80	1.06	1.0	0.037	1.76	58.94	0.099	3.36	2.80	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.623

Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
9.76	500	1.8E-03	4.6E+02	3.8E-04	10	0.235	6362	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.96%	0.0049
9.81	500	1.8E-03	4.6E+02	3.8E-04	10	0.236	6348	0.11%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	2.99%	0.0049
9.86	500	1.8E-03	4.6E+02	3.8E-04	10	0.236	6334	0.11%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.02%	0.0050
9.91	500	1.8E-03	4.6E+02	3.8E-04	10	0.236	6319	0.11%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.05%	0.0050
9.96	500	1.8E-03	4.6E+02	3.9E-04	10	0.237	6305	0.11%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.09%	0.0051
10.01	500	1.8E-03	4.6E+02	3.9E-04	10	0.237	6291	0.12%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.12%	0.0051
10.06	500	1.8E-03	4.6E+02	3.9E-04	10	0.237	6278	0.12%	2.00	0.65	0.03%	0.021	0.34	0.079	0.765	3.15%	0.0052
10.11	500	1.8E-03	4.6E+02	3.9E-04	10	0.238	6264	0.12%	2.00	0.65	0.03%	0.021	0.34	0.079	0.765	3.18%	0.0052
10.16	500	1.8E-03	4.6E+02	3.9E-04	10	0.238	6250	0.12%	2.00	0.65	0.03%	0.021	0.34	0.079	0.765	3.21%	0.0053
10.21	500	1.8E-03	4.6E+02	4.0E-04	10	0.238	6237	0.12%	2.00	0.65	0.03%	0.021	0.34	0.079	0.765	3.24%	0.0053
10.26	500	1.8E-03	4.6E+02	4.0E-04	10	0.239	6223	0.12%	2.00	0.65	0.03%	0.021	0.34	0.079	0.765	3.28%	0.0054
10.31	500	1.8E-03	4.6E+02	4.0E-04	10	0.239	6210	0.12%	2.00	0.65	0.03%	0.022	0.34	0.079	0.765	3.31%	0.0054
10.36	500	1.8E-03	4.6E+02	4.0E-04	10	0.239	6197	0.13%	2.00	0.65	0.03%	0.022	0.34	0.079	0.765	3.34%	0.0055
10.41	500	1.8E-03	4.6E+02	4.0E-04	10	0.240	6184	0.13%	2.00	0.65	0.03%	0.022	0.34	0.079	0.765	3.37%	0.0055
10.46	538	1.8E-03	5.3E+02	3.5E-04	10	0.240	6171	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.39%	0.0039
10.51	538	1.8E-03	5.3E+02	3.5E-04	10	0.240	6158	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.41%	0.0040
10.56	538	1.8E-03	5.3E+02	3.5E-04	10	0.240	6145	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.44%	0.0040
10.61	538	1.8E-03	5.3E+02	3.6E-04	10	0.241	6132	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.46%	0.0040
10.66	538	1.8E-03	5.3E+02	3.6E-04	10	0.241	6119	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.48%	0.0041
10.71	538	1.8E-03	5.3E+02	3.6E-04	10	0.241	6107	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.51%	0.0041
10.76	538	1.8E-03	5.3E+02	3.6E-04	10	0.242	6094	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.53%	0.0042
10.81	538	1.8E-03	5.3E+02	3.6E-04	10	0.242	6082	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.56%	0.0042
10.86	538	1.8E-03	5.3E+02	3.6E-04	10	0.242	6070	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.58%	0.0042
10.91	538	1.8E-03	5.3E+02	3.7E-04	10	0.243	6057	0.10%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.61%	0.0043
13.61	594	1.8E-03	6.5E+02	3.8E-04	10	0.257	5518	0.09%	2.00	0.65	0.03%	0.017	0.34	0.079	0.765	2.54%	0.2245

Extra layer added to analyze seismic settlement of tailings below the bottom of CPT investigation.

Energy Fuels Resources (USA) Inc.
White Mesa Mill
Seismic Settlement Analyses

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-6N

Data File: 13-52106_SP3-6N-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5604.20	Water surface elevation during CPT investigation (ft amsl)
5599.16	Water surface elevation at t_0 (ft amsl)
5590.44	Water surface elevation at t_1 (ft amsl)
5585.44	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earthquake
7.51	Equiv. Number of Uniform Strain Cycles, N
5607.44	Ground Surface Elevation at time of CPT (ft amsl)
5623.62	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after plac
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
8.68	Thickness of Random/Platform Fill on top of existing interim cover (ft)
1720.10	Additional Stress due to Final Cover Placement, $\Delta\sigma_{fc}$ (psf)
5585.44	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity	Soil Density	Max Shear Strain Modulus, G_{max}	P = γ_{eff}*(G_{eff}/G_{max})	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######	5623.37	5623.12	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######	5621.37	5619.62	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######	5617.87	5616.12	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320	1.75	508	1.9E-03	4.8E+02	6.5E-05	11	0.152	12657	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######	5611.78	5607.44	8.68	0.050	101	0.861	0.643	0.00	0.00	0.861	0.643	3.61	508	1.6E-03	4.0E+02	1.6E-04	11	0.181	9468	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %
0.164	5607.28	10.8	0.029	10.8	8.7	3.75	0.27%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	18.326	254.73	21.39	1310	0.27%	0.7	51%
0.328	5607.11	17.1	0.110	17.0	4.0	1.74	0.64%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	28.968	402.66	33.69	1032	0.65%	1.1	51%
0.492	5606.95	38.1	0.119	38.1	2.8	1.21	0.31%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	64.804	900.78	75.30	1538	0.31%	0.8	51%
0.656	5606.78	56.7	0.134	56.7	2.8	1.21	0.24%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	96.339	1339.11	111.93	1714	0.24%	0.6	51%
0.820	5606.62	78.5	0.600	78.5	2.0	0.88	0.76%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	133.399	1854.25	154.96	1899	0.76%	1.1	51%
0.984	5606.46	88.8	0.411	88.8	7.3	3.17	0.46%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	150.909	2097.64	175.36	1791	0.46%	0.9	51%
1.148	5606.29	97.1	0.455	97.1	6.7	2.89	0.47%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	165.002	2293.53	191.72	1678	0.47%	0.9	51%
1.312	5606.13	120.3	0.621	120.3	5.6	2.42	0.52%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	204.459	2841.98	237.54	1819	0.52%	1.0	51%
1.476	5605.96	117.5	1.100	117.5	6.9	2.99	0.94%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	199.682	2775.58	232.00	1579	0.94%	1.2	51%
1.640	5605.80	118.4	1.817	118.4	11.4	4.95	1.53%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	201.212	2796.85	233.84	1433	1.54%	1.4	51%
1.804	5605.64	123.5	2.268	123.4	21.1	9.14	1.84%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	209.780	2915.94	243.91	1358	1.84%	1.5	51%
1.968	5605.47	160.8	1.984	160.8	3.6	1.57	1.23%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	273.394	3800.18	317.58	1621	1.23%	1.3	51%
2.133	5605.31	176.8	1.510	176.8	2.1	0.90	0.85%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	300.577	4178.02	349.13	1645	0.85%	1.2	51%
2.297	5605.14	139.6	1.524	139.5	6.6	2.87	1.09%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	236.977	3293.98	275.32	1206	1.09%	1.3	51%
2.461	5604.98	107.1	1.707	107.0	5.4	2.32	1.59%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	181.951	2529.12	211.39	863	1.60%	1.5	51%
2.625	5604.82	84.4	1.333	84.4	6.6	2.87	1.58%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.70	143.480	1994.37	166.72	638	1.58%	1.6	51%
2.789	5604.65	89.6	1.432	89.6	-4.7	-2.02	1.60%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0	1.70	152.388	2118.19	176.93	637	1.60%	1.6	51%
2.953	5604.49	77.3	1.421	77.3	-4.6	-2.00	1.84%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0	1.70	131.376	1826.13	152.53	518	1.84%	1.7	51%
3.117	5604.32	57.2	1.269	57.2	-3.2	-1.37	2.22%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0	1.70	97.240	1351.64	112.90	363	2.23%	1.8	51%
3.281	5604.16	57.1	1.231	57.1	-3.1	-1.33	2.16%	Sand-Slime Tailings	0.059	119.0	0.17	0.00	0.17	1	1.70	97.019	1348.56	112.64	344	2.16%	1.8	47%
3.445	5604.00	105.1	0.904	105.1	-2.7	-1.16	0.86%	Sand Tailings	0.062	123.5	0.18	0.01	0.17	1	1.68	177.110	2461.83	205.67	616	0.86%	1.3	18%
3.609	5603.83	60.4	0.451	60.5	-1.3	-0.55	0.75%	Sand Tailings	0.062	123.5	0.19	0.01	0.18	1	1.70	102.765	1428.43	119.34	343	0.75%	1.4	18%
3.773	5603.67	36.8	0.568	36.8	-6.9	-2.99	1.55%	Sand-Slime Tailings	0.059	119.0	0.20	0.02	0.18	1	1.70	62.560	869.58	72.57	203	1.55%	1.8	47%
3.937	5603.50	18.3	0.393	18.4	-6.8	-2.95	2.14%	Sand-Slime Tailings	0.059	119.0	0.21	0.02	0.18	1	1.70	31.246	434.32	36.21	98	2.17%	2.1	47%
4.101	5603.34	6.8	0.370	6.8	-1.7	-0.72	5.47%	Slime Tailings	0.057	113.1	0.22	0.03	0.19	1	1.70	11.526	160.21	13.37	35	5.65%	2.8	71%
4.265	5603.17	7.9	0.213	7.9	1.0	0.42	2.68%	Slime Tailings	0.057	113.1	0.23	0.03	0.19	1	1.70	13.481	187.39	15.67	40	2.76%	2.5	71%
4.429	5603.01	9.1	0.198	9.1	0.7	0.29	2.18%	Slime Tailings	0.057	113.1	0.23	0.04	0.20	1	1.70	15.436	214.56	17.94	45	2.24%	2.4	71%
4.593	5602.85	7.9	0.200	7.9	1.4	0.59	2.54%	Slime Tailings	0.057	113.1	0.24	0.04	0.20	1	1.70	13.362	185.73	15.54	38	2.62%	2.5	71%
4.757	5602.68	14.7	0.112	14.6	6.6	2.87	0.76%	Sand-Slime Tailings	0.059	119.0	0.25	0.05	0.21	1	1.70	24.837	345.23	28.93	70	0.78%	2.0	47%
4.921	5602.52	29.5	0.077	29.5	0.6	0.26	0.26%	Sand-Slime Tailings	0.059	119.0	0.26	0.05	0.21	1	1.70	50.201	697.79	58.31	139	0.26%	1.5	47%
5.085	5602.35	24.5	0.105	24.5	-1.1	-0.49	0.43%	Sand-Slime Tailings	0.059	119.0	0.27	0.06	0.22	1	1.70	41.633	578.70	48.34	112	0.43%	1.7	47%
5.249	5602.19	21.8	0.186	21.8	2.1	0.91	0.85%	Sand-Slime Tailings	0.059	119.0	0.28	0.06	0.22	1	1.70	37.094	515.61	43.11	98	0.86%	1.9	47%
5.413	5602.03	13.2	0.258	13.2	3.3	1.43	1.95%	Sand-Slime Tailings	0.059	119.0	0.29	0.07	0.22	1	1.70	22.474	312.39	26.14	58	1.99%	2.3	47%
5.577	5601.86	10.1	0.292	10.0	11.1	4.81	2.89%	Slime Tailings	0.057	113.1	0.30	0.07	0.23	1	1.70	17.068	237.25	19.96	43	2.98%	2.5	71%
5.741	5601.70	8.4	0.248	8.3	11.7	5.07	2.95%	Slime Tailings	0.057	113.1	0.31	0.08	0.23	1	1.70	14.144	196.60	16.57	35	3.07%	2.6	71%
5.905	5601.53	7.3	0.202	7.2	12.6	5.46	2.76%	Slime Tailings	0.057	113.1	0.32	0.08	0.24	1	1.70	12.308	171.08	14.45	30	2.89%	2.6	71%
6.069	5601.37	11.4	0.159	11.3	23.0	9.95	1.40%	Sand-Slime Tailings	0.059	119.0	0.33	0.09	0.24	1	1.70	19.125	265.84	22.50	46	1.44%	2.3	47%
6.234	5601.21	13.4	0.202	13.4	8.1	3.51	1.51%	Sand-Slime Tailings	0.059	119.0	0.34	0.09	0.25	1	1.70	22.712	315.70	26.48	53	1.55%	2.2	47%
6.398	5601.04	17.4	0.135	17.4	8.8	3.83	0.77%	Sand-Slime Tailings	0.059	119.0	0.35	0.10	0.25	1	1.70	29.529	410.45	34.41	68	0.79%	2.0	47%
6.562	5600.88	33.6	0.152	33.5	8.1	3.50	0.45%	Sand Tailings	0.062	123.5	0.36	0.10	0.26	1	1.70	56.967	791.84	66.26	130	0.46%	1.6	18%
6.726	5600.71	25.5	0.167	25.5	1.3	0.57	0.65%	Sand-Slime Tailings	0.059	119.0	0.37	0.11	0.26	1	1.70	43.418	603.51	50.44	97	0.66%	1.8	47%
6.890	5600.55	13.1	0.130	13.1	2.1	0.90	0.99%	Sand-Slime Tailings	0.059	119.0	0.38	0.11	0.27	1	1.70	22.287	309.79	25.91	48	1.02%	2.2	47%
7.054	5600.39	6.0	0.125	5.9	15.6	6.76	2.08%	Slime Tailings	0.057	113.1	0.39	0.12	0.27	1	1.70	10.047	139.65	11.86	21	2.22%	2.7	71%
7.218	5600.22	6.6	0.062	6.4	28.5	12.36	0.94%	Slime Tailings	0.057	113.1	0.40	0.12	0.27	1	1.70	10.914	151.70	13.03	23	1.00%	2.4	71%
7.382	5600.06	19.6	0.120	19.5	19.3	8.36	0.61%	Sand-Slime Tailings	0.059	119.0	0.41	0.13	0.28	1	1.70	33.133	460.55	38.72	69	0.62%	1.9	47%
7.546	5599.89	11.8	0.165	11.8	7.7	3.32	1.40%	Sand-Slime Tailings	0.059	119.0	0.42	0.13	0.28	1	1.70	20.009	278.13	23.33	40	1.45%	2.3	47%
7.710	5599.73	11.2	0.230	11.1	15.6	6.75	2.06%	Slime Tailings	0.057	113.1	0.43	0.14	0.29	1	1.70	18.819	261.58	22.05	37	2.14%	2.5	71%
7.874	5599.57	9.4	0.185	9.3	9.2	4.00	1.98%	Slime Tailings	0.057	113.1	0.44	0.14	0.29	1	1.70	15.810	219.76	18.48	31	2.07%	2.5	71%
8.038	5599.40	7.2	0.119	7.1	13.2	5.73	1.66%	Slime Tailings	0.057	113.1	0.45	0.15	0.30	1	1.70	12.019	167.06	14.12	23	1.77%	2.6	71%
8.202	5599.24	6.0	0.067	5.9	26.0	11.28	1.11%	Slime Tailings	0.057	113.1	0.45	0.15	0.30	1	1.70	9.962	138.47	11.89	19	1.20%	2.6	71%
8.366	5599.07	6.1	0.081	5.9	31.3	13.56	1.34%	Slime Tailings	0.057	113.1	0.46	0.16	0.30	1	1.70	9.962	138.47	11.96	18	1.45%	2.6	71%
8.530	5598.91	13.2	0.065	12.9	48.6	21.04	0.49%	Sand-Slime Tailings	0.059	119.0	0.47	0.17	0.31	1	1.70	21.981	305.54	26.13	41	0.51%	2.1	47%
8.694	5598.75	13.3	0.116	13.3	8.9	3.84	0.87%	Sand-Slime Tailings	0.059	119.0	0.48	0.17	0.31	1	1.70	22.525	313.10	26.27	41	0.90%	2.2	47%
8.858	5598.58	6.7	0.132	6.6	9.6	4.14	1.98%	Slime Tailings	0.057	113.1	0.49	0.18	0.32	1	1.70	11.254	156.43	13.19	20	2.13%	2.7	71%
9.022	5598.42	3.7	0.117	3.6	7.2	3.11	3.20%	Slime Tailings	0.057	113.1	0.50	0.18	0.32	1	1.70	6.137	85.30	7.22	10	3.71%	3.1	71%
9.186	5598.25	2.3	0.054	2.2	18.5	8.01	2.32%	Slime Tailings	0.057	113.1	0.51	0.19	0.33	1	1.70	3.757	52.22	4.59	6	2.98%	3.2	71%
9.350	5598.09	2.4	0.024	2.2	24.5	10.62	1.02%	Slime Tailings	0.057	113.1	0.52	0.19	0.33	1	1.70	3.757	52.22	4.67	6	1.30%	3.0	71%
9.514	5597.93	2.6	0.011	2.4	34.3	14.85	0.42%	Slime Tailings	0.057	113.1	0.53	0.20	0.33	1	1.70	4.080	56.71	5.16	6	0.53%	2.8	71%
9.678	5597.76	2.8	0.016	2.6	37.8	16.39	0.57%	Slime Tailings	0.057	113.1	0.54	0.20	0.34	1	1.70	4.403	61.20	5.58	7	0.70%	2.8	71%
9.842	5597.60	3.2	0.010	2.9	39.6	17.14	0.32%	Slime Tailings	0.057	113.1	0.55	0.21	0.34	1	1.70	4.947	68.76	6.23	8	0.38%	2.7	71%
10.006	5597.43	4.5	0.016	4.3	44.0	19.08	0.35%	Slime Tailings	0.057	113.1	0.56	0.21	0.35	1	1.70	7.225	100.43	8.93	11	0.40%	2.5	71%
10.170	5597.27	22.4	0.010	22.4	7.4	3.19	0.04%	Sand-Slime Tailings	0.059	119.0	0.57	0.22	0.35	1	1.70	37.995	528.13	44.22	62	0.05%	1.7	47%
10.335	5597.11	9.5	0.106	9.4	6.7	2.89	1.12%	Sand-Slime Tailings	0.059	119.0	0.58	0.22	0.36	1	1.70	15.997	222.36	18.66	25	1.19%	2.4	47%
10.499	5596.94	7.7	0.177	7.6	9.0	3.88	2.30%	Slime Tailings	0.057	113.1	0.59	0.23	0.36	1	1.70	12.971	180.30	15.18	20	2.49%	2.7	71%
10.663	5596.78	6.4	0.128	6.3	17.8	7.70	2.00%	Slime Tailings	0.057	113.1	0.60	0.23	0.36	1	1.70	10.693	148.63	12.64	16	2.20%	2.8	71%
10.827	5596.61	4.4	0.090	4.2	34.3	14.84	2.04%	Slime Tailings	0.057	113.1	0.61	0.24	0.37	1	1.70	7.123	99.01	8.70	10	2.37%	2.9	71%
10.991	5596.45	5.0	0.031	4.7	52.3	22.65	0.62%	Slime Tailings	0.057	113.1	0.61	0.24	0.37	1	1.70	7.990	111.06	9.92	12	0.70%	2.6	71%
11.155	5596.29	3.9	0.027	3.6	49.3	21.35	0.70%	Slime Tailings	0.057	113.1	0.62	0.25	0.38	1	1.70	6.052	84.12	7.64	9	0.83%	2.8	71%
11.319	5596.12	3.6	0.014	3.2	58.6	25.37	0.39%	Slime Tailings	0.057	113.1	0.63	0.25	0.38	1	1.70	5.508	76.56	7.12	8	0.47%	2.7	71%
11.483	5595.96	3.7	0.010	3.3	65.7	28.48	0.27%	Slime Tailings	0.057	113.1	0.64	0.26	0.38	1	1.70	5.610	77.98	7.33	8	0.33%	2.7	71%
11.647	5595.79	3.5	0.010	3.1	63.3	27.45	0.29%	Slime Tailings	0.057	113.1	0.65	0.26	0.39	1	1.70	5.270	73.25	6.90	7	0.35%	2.7	71%
11.811	5595.63	3.3	0.010	2.9	62.7	27.15	0.30%	Slime Tailings	0.057	113.1	0.66	0.27	0.39	1	1.70	4.862	67.58	6.46	7	0.38%	2.8	71%
11.975	5595.47	3.0	0.010	2.6	62.5	27.10	0.33%	Slime Tailings	0.057	113.1	0.67	0.27	0.40	1	1.70	4.420	61.44	5.90	6	0.43%	2.8	71%
12.139	5595.30	3.0	0.010	2.6	63.4	27.46	0.33%	Slime Tailings	0.057	113.1	0.68	0.28	0.40	1	1.70	4.420	61.44	5.91	6	0.43%	2.8	71%
12.303	5595.14	3.8	0.019	3.3	76.0	32.92	0.50%	Slime Tailings	0.057	113.1	0.69	0.28	0.41	1	1.70	5.610	77.98	7.45	8	0.62%	2.8	71%
12.467	5594.97	8.7	0.151	8.2	74.0	32.08	1.74%	Slime Tailings	0.057	113.1	0.70	0.29	0.41	1	1.70	13.957	194.00	17.12	19	1.89%	2.6	71%
12.631	5594.81	7.3	0.133	7.1	27.0	11.70	1.82%	Slime Tailings	0.057	113.1	0.71	0.29	0.41	1	1.70	12.121	168.48	14.41	16	2.02%	2.7	71%
12.795	5594.64	3.8	0.056	3.5	42.3	18.33	1.49%	Slime Tailings	0.057	113.1	0.72	0.30	0.42	1	1.70	5.950	82.71	7.43	7	1.84%	3.0	71%
12.959	5594.48	3.5	0.039	3.2	47.7	20.68	1.12%	Slime Tailings	0.057	113.1	0.73	0.30	0.42	1	1.70	5.423	75.38	6.89	7	1.41%	3.0	71%
13.123	5594.32	3.6	0.039	3.3	47.0	20.38	1.08%	Slime Tailings	0.057	113.1	0.74	0.31	0.43	1	1.70	5.627	78.22	7.12	7	1.36%	3.0	71%
13.287	5594.15	3.8	0.053	3.5	53.2	23.07	1.38%	Slime Tailings	0.057	113.1	0.75	0.31	0.43	1	1.70	5.950	82.71	7.50	7	1.73%	3.0	71%
13.451	5593.99	4.6	0.055	4.3	58.0	25.13	1.19%	Slime Tailings	0.057	113.1	0.75	0.32	0.43	1	1.70	7.259	100.90	9.15	9	1.42%	2.9	71%
13.615	5593.82	5.4	0.050	5.1	51.5	22.33	0.92%	Slime Tailings	0.057	113.1	0.76	0.32	0.44	1	1.69	8.639	120.08	10.67	11	1.07%	2.7	71%
13.779	5593.66	4.7	0.059	4.3	53.8	23.30	1.26%	Slime Tailings	0.057	113.1	0.77	0.33	0.44	1	1.68	7.298	101.44	9.13	9	1.51%	2.9	71%
13.943	5593.50	4.5	0.065	4.2	53.8	23.33	1.45%	Slime Tailings	0.057	113.1	0.78	0.33	0.45	1	1.67	6.927	96.29	8.70	8	1.75%	2.9	71%
14.107	5593.33	4.6	0.067	4.3	54.2	23.47	1.45%	Slime Tailings	0.057	113.1	0.79	0.34	0.45	1	1.67	7.093	98.59	8.89	8	1.75%	2.9	71%
14.271	5593.17	4.6	0.064	4.3	55.3	23.95	1.38%	Slime Tailings	0.057	113.1	0.80	0.34	0.46	1	1.65	7.042	97.88	8.84	8	1.67%	2.9	71%
14.436	5593.00	4.7	0.050	4.3	52.5	22.75	1.07%	Slime Tailings	0.057	113.1	0.81	0.35	0.46	1	1.65	7.009	97.43	8.80	8	1.29%	2.9	71%
14.600	5592.84	3.9	0.045	3.6	48.9	21.19	1.14%	Slime Tailings	0.057	113.1	0.81	0.35	0.46	1	1.62	5.905	82.08	7.43	7	1.44%	3.0	71%
14.764	5592.67	3.7	0.045	3.4	50.5	21.86	1.23%	Slime Tailings	0.057	113.1	0.82	0.36	0.47	1	1.61	5.477	76.13	6.91	6	1.57%	2.9	71%
14.928	5592.51	3.7	0.014	3.4	55.6	24.07	0.37%	Slime Tailings	0.057	113.1	0.83	0.36	0.47	1	1.60	5.535	76.94	6.93	6	0.48%	2.8	71%
15.092	5592.35	4.0	0.031	3.7	46.9	20.31	0.77%	Slime Tailings	0.057	113.1	0.84	0.37	0.47	1	1.59	5.911	82.16	7.40	7	0.98%	2.9	71%
15.256	5592.18	6.6	0.057	6.5	28.1	12.19	0.86%	Slime Tailings	0.057	113.1	0.85	0.37	0.48	1	1.58	10.179	141.48	12.14	12	0.99%	2.7	71%
15.420	5592.02	6.4	0.065	6.1	51.6	22.37	1.02%	Slime Tailings	0.057	113.1	0.86	0.38	0.48	1	1.57	9.515	132.25	11.64	11	1.17%	2.7	71%
15.584	5591.86	6.4	0.064	6.1	51.6	22.36	1.00%	Slime Tailings	0.057	113.1	0.87	0.38	0.49	1	1.56	9.358	130.07	11.60	11	1.15%	2.7	71%
15.748	5591.69	6.6	0.049	6.5	68.5	29.69	0.74%	Sand-Slime Tailings	0.059	119.0	0.88	0.39	0.49	1	1.55	[illegible]	[illegible]	[illegible]	[illegible]	0.85%	2.7	47%
15.912	5591.53	7.0	0.046	6.5	70.8	30.66	0.66%	Sand-Slime Tailings	0.059	119.0	0.89	0.40	0.50	1	1.53	10.004	139.05	12.41	12	0.76%	2.6	47%
16.076	5591.37	7.6	0.056	7.1	83.5	36.19	0.74%	Sand-Slime Tailings	0.059	119.0	0.90	0.40	0.50	1	1.52	10.129	140.80	12.62	13	0.85%	2.6	47%
16.240	5591.20	7.2	0.050	6.7	64.8	28.06	0.69%	Sand-Slime Tailings	0.059	119.0	0.91	0.41	0.50	1	1.51	10.072	140.00	12.67	12	0.81%	2.6	47%
16.404	5591.04	9.0	0.065	8.4	88.8	38.47	0.72%	Sand-Slime Tailings	0.059	119.0	0.92	0.42	0.51	1	1.50	12.583	174.91	15.69	16	0.76%	2.5	47%
16.568	5590.87	9.0	0.056	8.4	104.5	45.27	0.62%	Sand-Slime Tailings	0.059	119.0	0.93	0.42	0.51	1	1.49	12.495	173.68	15.56	15	0.82%	2.5	47%
16.732	5590.71	8.9	0.052	8.3	94.3	40.78	0.58%	Sand-Slime Tailings	0.059	119.0	0.94	0.42	0.52	1	1.48	12.319	171.23	15.32	15	0.65%	2.5	47%
16.896	5590.54	8.6	0.056	7.6	99.3	43.01	0.66%	Sand-Slime Tailings	0.059	119.0	0.95	0.43	0.52	1	1.47	11.855	165.84	14.07	14	0.82%	2.6	47%
17.060	5590.38	8.3	0.057	7.7	101.1	43.83	0.69%	Sand-Slime Tailings	0.059	119.0	0.96	0.44	0.53	1	1.46	11.620	156.10	14.11	14	0.66%	2.6	47%
17.224	5590.22	8.1	0.045	7.5	92.6	40.14	0.56%	Sand-Slime Tailings	0.059	119.0	0.97	0.44	0.54	1	1.45	10.878	151.21	13.61	13	0.63%	2.6	47%

Conditions at t_1 / Liquefaction Triggering Analyses

Depth at time of CPT (ft)	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	I&B (2008) r_d	C_σ	K_σ	K_α	CSR M=7.5, σ'v=1atm	Δq_{c1n}	q_{c1n-cs}	CRR M=7.5, σ'=1atm	FoS	Youd (2001) r_d	D_r	f	K_σ	K_α	CSR M=7.5, σ'v=1atm	Kc	q_{c1n-cs}	(CRR) M=7.5, σ'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
0.164	0.87	0.00	0.87	0	1.00	0.05	1.00	1.0	0.058	37.83	59.22	0.087	1.51	0.96	0.27	0.80	2.53	1.0	0.017	1.00	21.39	0.068	166.66	84.08	2
0.328	0.88	0.00	0.88	0	1.00	0.06	1.00	1.0	0.058	42.14	75.84	0.107	1.85	0.96	0.34	0.80	2.20	1.0	0.017	1.00	33.69	0.078	95.96	48.91	2
0.492	0.88	0.00	0.88	0	1.00	0.10	1.00	1.0	0.058	56.75	132.05	0.208	3.61	0.96	0.50	0.75	2.43	1.0	0.017	1.00	75.30	0.120	98.14	50.88	2
0.656	0.89	0.00	0.89	0	1.00	0.12	1.00	1.0	0.058	69.60	181.53	0.561	9.75	0.96	0.61	0.69	2.71	1.0	0.016	1.00	111.93	0.210	129.42	69.59	2
0.820	0.90	0.00	0.90	0	1.00	0.17	0.99	1.0	0.057	84.70	239.66	1.000	17.43	0.96	0.72	0.64	2.98	1.0	0.014	1.00	154.96	0.426	209.74	113.58	2
0.984	0.91	0.00	0.91	0	1.00	0.20	0.99	1.0	0.057	91.86	267.22	1.000	17.49	0.96	0.76	0.62	2.98	1.0	0.014	1.00	175.36	1.000	410.39	213.94	2
1.148	0.92	0.00	0.92	0	1.00	0.24	0.98	1.0	0.057	97.60	289.32	1.000	17.57	0.96	0.80	0.60	2.94	1.0	0.014	1.00	191.72	1.000	351.91	184.74	2
1.312	0.93	0.00	0.93	0	1.00	0.30	0.98	1.0	0.057	113.68	351.21	1.000	17.69	0.96	0.89	0.60	2.79	1.0	0.015	1.00	237.54	1.000	308.04	162.86	2
1.476	0.93	0.00	0.93	0	1.00	0.30	0.98	1.0	0.056	111.74	343.74	1.000	17.73	0.96	0.88	0.60	2.66	1.0	0.016	1.00	232.00	1.000	273.92	145.83	2
1.640	0.94	0.00	0.94	0	1.00	0.30	0.97	1.0	0.056	112.38	346.22	1.000	17.78	0.96	0.88	0.60	2.55	1.0	0.017	1.00	233.84	1.000	246.63	132.21	2
1.804	0.95	0.00	0.95	0	1.00	0.30	0.97	1.0	0.056	115.92	359.82	1.000	17.83	0.96	0.90	0.60	2.46	1.0	0.017	1.00	243.91	1.000	224.30	121.06	2
1.968	0.96	0.00	0.96	0	1.00	0.30	0.97	1.0	0.056	141.76	459.34	1.000	17.89	0.96	1.03	0.60	2.37	1.0	0.018	1.00	317.58	1.000	205.69	111.79	2
2.133	0.97	0.00	0.97	0	1.00	0.30	0.97	1.0	0.056	152.84	501.97	1.000	17.96	0.96	1.08	0.60	2.30	1.0	0.018	1.00	349.13	1.000	189.94	103.95	2
2.297	0.98	0.00	0.98	0	1.00	0.30	0.96	1.0	0.056	126.94	402.25	1.000	18.02	0.96	0.96	0.60	2.23	1.0	0.019	1.00	275.32	1.000	176.45	97.23	2
2.461	0.98	0.00	0.98	0	1.00	0.30	0.96	1.0	0.055	104.50	315.90	1.000	18.08	0.96	0.84	0.60	2.17	1.0	0.019	1.00	211.39	1.000	164.75	91.41	2
2.625	0.99	0.00	0.99	0	1.00	0.19	0.97	1.0	0.056	88.83	255.55	1.000	17.84	0.96	0.75	0.63	2.01	1.0	0.021	1.00	166.72	1.000	154.51	86.18	2
2.789	1.00	0.00	1.00	0	0.99	0.21	0.97	1.0	0.056	92.41	269.24	1.000	17.94	0.96	0.77	0.62	2.01	1.0	0.021	1.00	176.93	1.000	145.48	81.71	2
2.953	1.01	0.00	1.01	0	0.99	0.16	0.97	1.0	0.056	83.85	236.38	1.000	17.87	0.96	0.71	0.64	1.87	1.0	0.023	1.01	154.81	0.425	58.42	38.14	2
3.117	1.02	0.00	1.02	0	0.99	0.12	0.98	1.0	0.056	69.94	182.84	0.585	10.40	0.96	0.61	0.69	1.69	1.0	0.025	1.12	125.96	0.266	34.64	22.52	2
3.281	1.03	0.00	1.03	0	0.99	0.12	0.98	1.0	0.056	69.81	182.45	0.578	10.29	0.96	0.61	0.69	1.66	1.0	0.025	1.12	125.82	0.265	32.80	21.54	2
3.445	1.04	0.00	1.04	0	0.99	0.28	0.95	1.0	0.056	74.67	280.34	1.000	18.41	0.95	0.83	0.60	1.91	1.0	0.022	1.00	205.67	1.000	120.06	69.23	2
3.609	1.05	0.00	1.05	0	0.99	0.12	0.98	1.0	0.056	52.60	171.94	0.428	7.66	0.95	0.63	0.68	1.65	1.0	0.025	1.00	119.34	0.238	27.78	17.72	2
3.773	1.06	0.00	1.06	0	0.99	0.09	0.98	1.0	0.056	55.75	128.33	0.199	3.54	0.95	0.49	0.75	1.47	1.0	0.029	1.13	81.86	0.131	14.90	9.22	2
3.937	1.07	0.00	1.07	0	0.99	0.06	0.98	1.0	0.056	43.00	79.21	0.112	1.98	0.95	0.35	0.80	1.36	1.0	0.031	1.54	55.93	0.096	10.68	6.33	2
4.101	1.08	0.00	1.08	0	0.99	0.05	0.99	1.0	0.056	34.74	48.11	0.076	1.34	0.95	0.21	0.80	1.35	1.0	0.031	4.45	59.42	0.100	10.80	6.07	2
4.265	1.09	0.00	1.09	0	0.99	0.05	0.99	1.0	0.056	35.54	51.21	0.079	1.40	0.95	0.23	0.80	1.35	1.0	0.031	2.77	43.40	0.086	9.15	5.27	2
4.429	1.09	0.00	1.09	0	0.99	0.05	0.99	1.0	0.056	36.33	54.27	0.082	1.45	0.95	0.24	0.80	1.34	1.0	0.031	2.32	41.62	0.085	8.81	5.13	2
4.593	1.10	0.00	1.10	0	0.98	0.05	0.99	1.0	0.056	35.50	51.03	0.078	1.40	0.95	0.23	0.80	1.34	1.0	0.031	2.78	43.24	0.086	8.77	5.08	2
4.757	1.11	0.00	1.11	0	0.98	0.06	0.98	1.0	0.056	40.45	69.38	0.099	1.76	0.95	0.31	0.80	1.33	1.0	0.031	1.26	36.49	0.080	8.01	4.89	2
4.921	1.12	0.00	1.12	0	0.98	0.10	0.97	1.0	0.056	50.75	109.07	0.154	2.84	0.95	0.44	0.78	1.36	1.0	0.031	1.00	58.31	0.098	9.60	6.22	2
5.085	1.13	0.00	1.13	0	0.98	0.07	0.98	1.0	0.056	47.26	95.60	0.135	2.43	0.95	0.40	0.80	1.32	1.0	0.032	1.01	48.77	0.091	8.65	5.54	2
5.249	1.14	0.00	1.14	0	0.98	0.07	0.98	1.0	0.056	45.42	88.53	0.125	2.24	0.95	0.38	0.80	1.31	1.0	0.032	1.17	50.35	0.092	8.59	5.41	2
5.413	1.15	0.00	1.15	0	0.98	0.06	0.98	1.0	0.056	39.47	65.61	0.094	1.69	0.95	0.30	0.80	1.31	1.0	0.032	1.91	49.87	0.092	8.38	5.04	2
5.577	1.16	0.00	1.16	0	0.98	0.05	0.98	1.0	0.056	37.04	57.00	0.085	1.52	0.95	0.26	0.80	1.30	1.0	0.032	2.76	55.19	0.096	8.60	5.06	2
5.741	1.17	0.00	1.17	0	0.98	0.05	0.98	1.0	0.056	35.86	52.43	0.080	1.43	0.95	0.24	0.80	1.30	1.0	0.032	3.18	52.77	0.094	8.28	4.86	2
5.905	1.18	0.00	1.18	0	0.98	0.05	0.98	1.0	0.056	35.12	49.57	0.077	1.39	0.95	0.22	0.80	1.29	1.0	0.032	3.40	49.16	0.091	7.90	4.64	2
6.069	1.19	0.00	1.19	0	0.98	0.05	0.98	1.0	0.055	38.19	60.69	0.089	1.60	0.95	0.27	0.80	1.29	1.0	0.032	1.87	42.03	0.085	7.24	4.42	2
6.234	1.20	0.00	1.20	0	0.98	0.06	0.98	1.0	0.055	39.59	66.07	0.095	1.71	0.95	0.30	0.80	1.28	1.0	0.033	1.78	47.10	0.089	7.46	4.59	2
6.398	1.21	0.00	1.21	0	0.97	0.06	0.98	1.0	0.055	42.36	76.77	0.108	1.96	0.95	0.34	0.80	1.28	1.0	0.033	1.28	43.97	0.087	7.11	4.54	2
6.562	1.22	0.00	1.22	0	0.97	0.08	0.97	1.0	0.055	39.03	105.29	0.151	2.74	0.95	0.47	0.77	1.33	1.0	0.033	1.00	66.26	0.107	8.62	5.70	2
6.726	1.23	0.00	1.23	0	0.97	0.07	0.97	1.0	0.055	47.99	98.44	0.140	2.56	0.95	0.41	0.79	1.28	1.0	0.033	1.12	56.34	0.097	7.65	5.10	2
6.890	1.24	0.00	1.24	0	0.97	0.06	0.98	1.0	0.055	39.39	65.30	0.094	1.71	0.95	0.29	0.80	1.27	1.0	0.033	1.60	41.35	0.084	6.57	4.14	2
7.054	1.25	0.00	1.25	0	0.97	0.05	0.98	1.0	0.055	34.22	46.08	0.074	1.34	0.95	0.20	0.80	1.26	1.0	0.033	3.72	44.16	0.087	6.65	3.99	2
7.218	1.26	0.00	1.26	0	0.97	0.05	0.98	1.0	0.055	34.62	47.65	0.075	1.37	0.95	0.21	0.80	1.26	1.0	0.033	2.49	32.43	0.077	5.81	3.59	2
7.382	1.27	0.00	1.27	0	0.97	0.06	0.98	1.0	0.055	43.88	82.60	0.116	2.13	0.95	0.36	0.80	1.25	1.0	0.033	1.21	46.84	0.089	6.61	4.37	2
7.546	1.28	0.00	1.28	0	0.97	0.05	0.98	1.0	0.055	38.48	61.82	0.090	1.64	0.94	0.28	0.80	1.25	1.0	0.033	2.02	47.02	0.089	6.52	4.08	2
7.710	1.29	0.00	1.29	0	0.97	0.05	0.98	1.0	0.055	37.77	59.82	0.088	1.60	0.94	0.27	0.80	1.25	1.0	0.033	2.53	55.75	0.096	6.92	4.26	2
7.874	1.30	0.00	1.30	0	0.96	0.05	0.98	1.0	0.055	36.52	55.00	0.082	1.51	0.94	0.25	0.80	1.24	1.0	0.034	2.82	52.03	0.093	6.61	4.06	2
8.038	1.31	0.00	1.31	0	0.96	0.05	0.98	1.0	0.055	35.01	49.13	0.077	1.40	0.94	0.22	0.80	1.24	1.0	0.034	3.17	44.79	0.087	6.12	3.76	2
8.202	1.31	0.00	1.31	0	0.96	0.05	0.98	1.0	0.055	34.23	46.12	0.074	1.35	0.94	0.20	0.80	1.24	1.0	0.034	3.07	36.49	0.080	5.56	3.46	2
8.366	1.32	0.00	1.32	0	0.96	0.05	0.98	1.0	0.054	34.25	46.21	0.074	1.36	0.94	0.20	0.80	1.23	1.0	0.034	3.34	39.89	0.083	5.68	3.52	2
8.530	1.33	0.00	1.33	0	0.96	0.06	0.98	1.0	0.054	39.47	65.59	0.094	1.74	0.94	0.30	0.80	1.23	1.0	0.034	1.41	36.75	0.081	5.42	3.58	2
8.694	1.34	0.00	1.34	0	0.96	0.06	0.97	1.0	0.054	39.52	65.79	0.094	1.75	0.94	0.30	0.80	1.22	1.0	0.034	1.66	43.71	0.086	5.72	3.74	2
8.858	1.35	0.00	1.35	0	0.96	0.05	0.98	1.0	0.054	34.68	47.87	0.075	1.39	0.94	0.21	0.80	1.22	1.0	0.034	3.81	50.27	0.092	6.00	3.70	2
9.022	1.36	0.00	1.36	0	0.96	0.04	0.98	1.0	0.054	32.60	39.82	0.068	1.26	0.94	0.16	0.80	1.22	1.0	0.034	7.40	53.38	0.094	6.08	3.67	2
9.186	1.37	0.00	1.37	0	0.96	0.04	0.98	1.0	0.054	31.69	36.28	0.066	1.21	0.94	0.12	0.80	1.21	1.0	0.034	9.35	42.94	0.086	5.47	3.34	2
9.350	1.38	0.00	1.38	0	0.96	0.04	0.98	1.0	0.054	31.71	36.38	0.066	1.21	0.94	0.12	0.80	1.21	1.0	0.034	7.11	33.17	0.078	4.89	3.05	2
9.514	1.39	0.00	1.39	0	0.95	0.04	0.98	1.0	0.054	31.88	37.05	0.066	1.23	0.94	0.13	0.80	1.21	1.0	0.034	5.10	26.30	0.072	4.48	2.85	2
9.678	1.40	0.00	1.40	0	0.95	0.04	0.98	1.0	0.054	32.03	37.61	0.067	1.24	0.94	0.14	0.80	1.21	1.0	0.034	5.19	28.96	0.074	4.56	2.90	2
9.842	1.41	0.00	1.41	0	0.95	0.04	0.98	1.0	0.054	32.26	38.49	0.067	1.25	0.94	0.14	0.80	1.20	1.0	0.034	4.07	25.35	0.071	4.32	2.79	2
10.006	1.42	0.00	1.42	0	0.95	0.04	0.98	1.0	0.054	33.20	42.13	0.070	1.31	0.94	0.17	0.80	1.20	1.0	0.035	3.02	27.02	0.073	4.36	2.83	2
10.170	1.43	0.00	1.43	0	0.95	0.07	0.97	1.0	0.053	45.81	90.03	0.127	2.39	0.94	0.38	0.80	1.20	1.0	0.035	1.02	45.30	0.088	5.20	3.80	2
10.335	1.44	0.00	1.44	0	0.95	0.05	0.97	1.0	0.053	36.85	55.51	0.083	1.55	0.94	0.25	0.80	1.19	1.0	0.035	2.51	46.77	0.089	5.21	3.38	2
10.499	1.45	0.00	1.45	0	0.95	0.05	0.97	1.0	0.053	35.37	50.55	0.078	1.46	0.94	0.22	0.80	1.19	1.0	0.035	4.07	61.73	0.102	5.90	3.68	2
10.663	1.46	0.00	1.46	0	0.95	0.05	0.98	1.0	0.053	34.49	47.13	0.075	1.40	0.94	0.21	0.80	1.19	1.0	0.035	4.41	55.68	0.096	5.50	3.45	2
10.827	1.46	0.00	1.46	0	0.95	0.04	0.98	1.0	0.053	33.12	41.81	0.070	1.31	0.94	0.17	0.80	1.19	1.0	0.035	5.98	52.01	0.093	5.27	3.29	2
10.991	1.47	0.00	1.47	0	0.94	0.05	0.98	1.0	0.053	33.54	43.47	0.072	1.34	0.94	0.18	0.80	1.18	1.0	0.035	3.47	34.43	0.079	4.41	2.88	2
11.155	1.48	0.00	1.48	0	0.94	0.04	0.98	1.0	0.053	32.75	40.38	0.069	1.29	0.94	0.16	0.80	1.18	1.0	0.035	4.61	35.20	0.079	4.40	2.85	2
11.319	1.49	0.00	1.49	0	0.94	0.04	0.98	1.0	0.053	32.57	39.69	0.068	1.29	0.94	0.15	0.80	1.18	1.0	0.035	4.20	29.90	0.075	4.11	2.70	2
11.483	1.50	0.00	1.50	0	0.94	0.04	0.98	1.0	0.053	32.64	39.96	0.069	1.29	0.94	0.16	0.80	1.17	1.0	0.035	3.79	27.75	0.073	3.97	2.63	2
11.647	1.51	0.00	1.51	0	0.94	0.04	0.98	1.0	0.053	32.49	39.39	0.068	1.28	0.94	0.15	0.80	1.17	1.0	0.035	4.11	28.39	0.074	3.96	2.62	2
11.811	1.52	0.00	1.52	0	0.94	0.04	0.98	1.0	0.053	32.34	38.79	0.068	1.28	0.93	0.15	0.80	1.17	1.0	0.035	4.51	29.12	0.074	3.95	2.61	2
11.975	1.53	0.00	1.53	0	0.94	0.04	0.98	1.0	0.053	32.14	38.05	0.067	1.27	0.93	0.14	0.80	1.17	1.0	0.035	5.09	30.06	0.075	3.95	2.61	2
12.139	1.54	0.00	1.54	0	0.94	0.04	0.98	1.0	0.053	32.15	38.06	0.067	1.27	0.93	0.14	0.80	1.16	1.0	0.035	5.14	30.39	0.075	3.92	2.60	2
12.303	1.55	0.00	1.55	0	0.94	0.04	0.97	1.0	0.053	32.68	40.13	0.069	1.30	0.93	0.16	0.80	1.16	1.0	0.035	4.60	34.31	0.079	4.05	2.68	2
12.467	1.56	0.00	1.56	0	0.93	0.05	0.97	1.0	0.052	36.05	53.17	0.081	1.54	0.93	0.24	0.80	1.16	1.0	0.035	3.62	61.90	0.102	5.21	3.38	2
12.631	1.57	0.00	1.57	0	0.93	0.05	0.97	1.0	0.052	35.11	49.52	0.077	1.47	0.93	0.22	0.80	1.16	1.0	0.036	4.24	61.11	0.101	5.12	3.30	2
12.795	1.58	0.00	1.58	0	0.93	0.04	0.97	1.0	0.052	32.68	40.11	0.069	1.31	0.93	0.16	0.80	1.16	1.0	0.036	6.74	50.12	0.092	4.60	2.95	2
12.959	1.59	0.00	1.59	0	0.93	0.04	0.97	1.0	0.052	32.49	39.37	0.068	1.30	0.93	0.15	0.80	1.15	1.0	0.036	6.60	45.43	0.088	4.36	2.83	2
13.123	1.59	0.00	1.59	0	0.93	0.04	0.97	1.0	0.052	32.57	39.68	0.068	1.31	0.93	0.15	0.80	1.15	1.0	0.036	6.40	45.53	0.088	4.32	2.82	2
13.287	1.60	0.00	1.60	0	0.93	0.04	0.97	1.0	0.052	32.72	40.29	0.069	1.32	0.93	0.16	0.80	1.15	1.0	0.036	6.65	50.32	0.092	4.47	2.90	2
13.451	1.61	0.00	1.61	0	0.93	0.04	0.97	1.0	0.052	33.27	42.42	0.071	1.36	0.93	0.17	0.80	1.15	1.0	0.036	5.40	49.36	0.091	4.40	2.88	2
13.615	1.62	0.00	1.62	0	0.93	0.05	0.97	1.0	0.052	33.80	44.47	0.072	1.39	0.93	0.19	0.80	1.14	1.0	0.036	4.34	46.27	0.089	4.24	2.81	2
13.779	1.63	0.00	1.63	0	0.92	0.04	0.97	1.0	0.052	33.27	42.40	0.071	1.36	0.93	0.17	0.80	1.14	1.0	0.036	5.57	50.85	0.092	4.37	2.87	2
13.943	1.64	0.00	1.64	0	0.92	0.04	0.97	1.0	0.052	33.12	41.81	0.070	1.35	0.93	0.17	0.80	1.14	1.0	0.036	6.12	53.22	0.094	4.42	2.89	2
14.107	1.65	0.00	1.65	0	0.92	0.04	0.97	1.0	0.052	33.18	42.07	0.070	1.36	0.93	0.17	0.80	1.14	1.0	0.036	6.02	53.54	0.094	4.40	2.88	2
14.271	1.66	0.00	1.66	0	0.92	0.04	0.97	1.0	0.052	33.17	42.00	0.070	1.36	0.93	0.17	0.80	1.14	1.0	0.036	5.96	52.69	0.094	4.33	2.85	2
14.436	1.67	0.00	1.67	0	0.92	0.04	0.97	1.0	0.052	33.17	42.03	0.070	1.36	0.92	0.17	0.80	1.13	1.0	0.036	5.44	48.21	0.090	4.14	2.75	2
14.600	1.68	0.00	1.68	0	0.92	0.04	0.97	1.0	0.052	32.68	40.11	0.069	1.33	0.92	0.16	0.80	1.13	1.0	0.036	6.51	48.41	0.090	4.12	2.73	2
14.764	1.69	0.00	1.69	0	0.92	0.04	0.97	1.0	0.051	32.49	39.40	0.068	1.32	0.92	0.15	0.80	1.13	1.0	0.036	5.93	40.97	0.084	3.81	2.57	2
14.928	1.70	0.00	1.70	0	0.92	0.04	0.97	1.0	0.051	32.50	39.43	0.068	1.33	0.92	0.15	0.80	1.13	1.0	0.036	5.06	35.03	0.079	3.56	2.44	2
15.092	1.71	0.00	1.71	0	0.91	0.04	0.97	1.0	0.051	32.67	40.07	0.069	1.34	0.92	0.16	0.80	1.13	1.0	0.036	5.81	42.99	0.086	3.83	2.58	2
15.256	1.72	0.00	1.72	0	0.91	0.05	0.97	1.0	0.051	34.32	46.46	0.074	1.45	0.92	0.20	0.80	1.12	1.0	0.036	3.86	46.90	0.089	3.94	2.70	2
15.420	1.72	0.00	1.72	0	0.91	0.05	0.97	1.0	0.051	34.14	45.78	0.074	1.44	0.92	0.20	0.80	1.12	1.0	0.036	4.27	49.65	0.091	4.02	2.73	2
15.584	1.73	0.00	1.73	0	0.91	0.05	0.97	1.0	0.051	34.13	45.73	0.074	1.44	0.92	0.20	0.80	1.12	1.0	0.036	4.23	49.10	0.091	3.97	2.71	2
15.748	1.74	0.00	1.74	0	0.91	0.05	0.97	1.0	0.051	34.47	46.37	0.074	1.46	0.91	0.20	0.80	1.12	1.0	0.036	3.75	44.62	0.087	3.77	2.62	2
15.912	1.75	0.00	1.75	0	0.91	0.05	0.97	1.0	0.051	34.65	47.06	0.075	1.47	0.91	0.20	0.80	1.12	1.0	0.036	3.49	43.25	0.086	3.70	2.58	2
16.076	1.76	0.00	1.76	0	0.91	0.05	0.97	1.0	0.051	34.75	47.44	0.075	1.48	0.91	0.21	0.80	1.11	1.0	0.036	3.44	43.65	0.086	3.68	2.58	2
16.240	1.77	0.00	1.77	0	0.91	0.05	0.97	1.0	0.051	34.75	47.42	0.075	1.48	0.91	0.21	0.80	1.11	1.0	0.036	3.49	44.25	0.087	3.67	2.58	2
16.404	1.78	0.00	1.78	0	0.90	0.05	0.96	1.0	0.050	35.80	51.49	0.079	1.57	0.91	0.23	0.80	1.11	1.0	0.036	2.60	40.77	0.084	3.52	2.55	2
16.568	1.79	0.00	1.79	0	0.90	0.05	0.96	1.0	0.050	35.79	51.43	0.079	1.57	0.91	0.23	0.80	1.11	1.0	0.036	2.82	44.05	0.087	3.61	2.59	2
16.732	1.80	0.00	1.80	0	0.90	0.05	0.96	1.0	0.050	35.67	50.99	0.078	1.56	0.91	0.23	0.80	1.11	1.0	0.036	2.81	43.12	0.086	3.55	2.56	2
16.896	1.81	0.00	1.81	0	0.90	0.05	0.96	1.0	0.050	35.24	49.31	0.077	1.53	0.90	0.22	0.80	1.10	1.0	0.036	3.53	49.61	0.091	3.75	2.64	2
17.060	1.82	0.00	1.82	1	0.90	0.05	0.96	1.0	0.050	35.25	49.37	0.077	1.53	0.90	0.22	0.80	1.10	1.0	0.036	3.20	45.13	0.088	3.57	2.55	2
17.224	1.83	0.01	1.82	1	0.90	0.05	0.96	1.0	0.050	35.07	48.68	0.076	1.52	0.90	0.21	0.80	1.10	1.0	0.036	3.09	42.01	0.085	3.43	2.47	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.539

Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
4.98	594	1.6E-03	5.5E+02	1.5E-04	11	0.196	8357	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.03	594	1.6E-03	5.5E+02	1.5E-04	11	0.196	8324	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.08	594	1.6E-03	5.5E+02	1.6E-04	11	0.197	8291	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.13	594	1.6E-03	5.5E+02	1.6E-04	11	0.197	8260	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.18	594	1.6E-03	5.5E+02	1.6E-04	11	0.198	8228	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.23	594	1.6E-03	5.5E+02	1.6E-04	11	0.198	8197	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.28	594	1.6E-03	5.5E+02	1.6E-04	11	0.199	8166	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.33	594	1.6E-03	5.5E+02	1.6E-04	11	0.199	8136	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.38	594	1.6E-03	5.5E+02	1.7E-04	11	0.199	8106	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.43	594	1.6E-03	5.5E+02	1.7E-04	11	0.200	8076	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.48	594	1.6E-03	5.5E+02	1.7E-04	11	0.200	8047	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.53	594	1.6E-03	5.5E+02	1.7E-04	11	0.201	8018	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.58	594	1.6E-03	5.5E+02	1.7E-04	11	0.201	7990	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.63	594	1.6E-03	5.5E+02	1.7E-04	11	0.202	7962	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.68	594	1.6E-03	5.5E+02	1.7E-04	11	0.202	7934	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.73	594	1.6E-03	5.5E+02	1.8E-04	11	0.203	7906	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.78	594	1.6E-03	5.5E+02	1.8E-04	11	0.203	7879	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.83	594	1.6E-03	5.5E+02	1.8E-04	11	0.203	7852	0.03%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
5.88	495	1.6E-03	3.8E+02	2.6E-04	11	0.204	7826	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.38%	0.0023
5.93	495	1.8E-03	4.5E+02	2.2E-04	10	0.205	8004	0.04%	2.00	0.65	0.03%	0.005	0.34	0.079	0.765	0.79%	0.0013
5.98	495	1.9E-03	4.7E+02	2.2E-04	0	0.208	10054	0.05%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.07%	0.0001
6.03	495	1.9E-03	4.7E+02	2.2E-04	0	0.208	10014	0.05%	2.20	1.00	0.03%	0.000	0.34	0.079	0.765	0.07%	0.0001
6.08	495	1.8E-03	4.5E+02	2.3E-04	10	0.206	7909	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.88%	0.0015
6.13	495	1.8E-03	4.5E+02	2.3E-04	10	0.207	7879	0.04%	2.00	0.65	0.03%	0.006	0.34	0.079	0.765	0.91%	0.0015
6.18	495	1.8E-03	4.3E+02	2.4E-04	16	0.459	6462	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.35%	0.0022
6.23	495	1.8E-03	4.3E+02	2.5E-04	16	0.459	6440	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.38%	0.0023
6.28	495	1.8E-03	4.3E+02	2.5E-04	16	0.460	6417	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.40%	0.0023
6.33	495	1.8E-03	4.3E+02	2.5E-04	16	0.460	6395	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.43%	0.0024
6.38	495	1.8E-03	4.5E+02	2.4E-04	10	0.209	7739	0.05%	2.00	0.65	0.03%	0.007	0.34	0.079	0.765	1.06%	0.0017
6.43	495	1.8E-03	4.5E+02	2.4E-04	10	0.209	7711	0.05%	2.00	0.65	0.03%	0.007	0.34	0.079	0.765	1.09%	0.0018
6.48	495	1.8E-03	4.5E+02	2.4E-04	10	0.210	7684	0.05%	2.00	0.65	0.03%	0.007	0.34	0.079	0.765	1.12%	0.0018
6.53	495	1.8E-03	4.5E+02	2.5E-04	10	0.210	7657	0.05%	2.00	0.65	0.03%	0.007	0.34	0.079	0.765	1.15%	0.0019
6.58	495	1.8E-03	4.5E+02	2.5E-04	10	0.211	7630	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.17%	0.0019
6.63	495	1.8E-03	4.3E+02	2.6E-04	16	0.463	6261	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.61%	0.0026
6.68	495	1.8E-03	4.3E+02	2.7E-04	16	0.463	6241	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.64%	0.0027
6.73	495	1.8E-03	4.3E+02	2.7E-04	16	0.464	6220	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.67%	0.0027
6.78	495	1.8E-03	4.5E+02	2.6E-04	10	0.212	7529	0.05%	2.00	0.65	0.03%	0.008	0.34	0.079	0.765	1.29%	0.0021
6.83	495	1.8E-03	4.5E+02	2.6E-04	10	0.213	7503	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.31%	0.0022
6.88	495	1.8E-03	4.5E+02	2.6E-04	10	0.213	7478	0.05%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.34%	0.0022
6.93	495	1.9E-03	4.7E+02	2.5E-04	0	0.216	9406	0.07%	2.20	1.00	0.03%	0.001	0.34	0.079	0.765	0.13%	0.0002
6.98	495	1.8E-03	4.5E+02	2.6E-04	10	0.214	7428	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.40%	0.0023
7.03	495	1.8E-03	4.5E+02	2.7E-04	10	0.215	7403	0.06%	2.00	0.65	0.03%	0.009	0.34	0.079	0.765	1.43%	0.0023
7.08	495	1.8E-03	4.3E+02	2.8E-04	16	0.466	6078	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.88%	0.0031
7.13	495	1.8E-03	4.3E+02	2.8E-04	16	0.467	6060	0.07%	2.00	0.65	0.03%	0.012	0.34	0.079	0.765	1.90%	0.0031
7.18	495	1.8E-03	4.5E+02	2.7E-04	10	0.216	7334	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.51%	0.0025
7.23	495	1.8E-03	4.5E+02	2.8E-04	10	0.216	7311	0.06%	2.00	0.65	0.03%	0.010	0.34	0.079	0.765	1.54%	0.0025
7.28	495	1.8E-03	4.3E+02	2.9E-04	16	0.468	6004	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	1.99%	0.0033
7.33	495	1.8E-03	4.3E+02	2.9E-04	16	0.468	5986	0.07%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.02%	0.0033
7.38	495	1.8E-03	4.3E+02	3.0E-04	16	0.469	5968	0.08%	2.00	0.65	0.03%	0.013	0.34	0.079	0.765	2.05%	0.0034
7.43	495	1.8E-03	4.3E+02	3.0E-04	16	0.469	5951	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.08%	0.0034
7.48	495	1.8E-03	4.3E+02	3.0E-04	16	0.470	5934	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.11%	0.0035
7.53	495	1.8E-03	4.5E+02	2.9E-04	10	0.219	7182	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.71%	0.0028
7.58	495	1.8E-03	4.5E+02	2.9E-04	10	0.219	7160	0.06%	2.00	0.65	0.03%	0.011	0.34	0.079	0.765	1.73%	0.0028
7.63	495	1.8E-03	4.3E+02	3.1E-04	16	0.471	5881	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.19%	0.0036
7.68	495	1.8E-03	4.3E+02	3.1E-04	16	0.471	5865	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.22%	0.0036
7.73	495	1.8E-03	4.3E+02	3.1E-04	16	0.471	5849	0.08%	2.00	0.65	0.03%	0.015	0.34	0.079	0.765	2.25%	0.0037
7.78	460	1.8E-03	3.7E+02	3.6E-04	16	0.472	5832	0.12%	2.00	0.65	0.03%	0.021	0.34	0.079	0.765	3.22%	0.0053
7.83	460	1.8E-03	3.7E+02	3.6E-04	16	0.472	5816	0.12%	2.00	0.65	0.03%	0.021	0.34	0.079	0.765	3.25%	0.0053
7.88	460	1.8E-03	3.7E+02	3.7E-04	16	0.473	5800	0.12%	2.00	0.65	0.03%	0.022	0.34	0.079	0.765	3.29%	0.0054
7.93	460	1.8E-03	3.7E+02	3.7E-04	16	0.473	5785	0.13%	2.00	0.65	0.03%	0.022	0.34	0.079	0.765	3.33%	0.0055
7.98	460	1.8E-03	3.7E+02	3.7E-04	16	0.473	5769	0.13%	2.00	0.65	0.03%	0.022	0.34	0.079	0.765	3.37%	0.0055
8.03	460	1.8E-03	3.9E+02	3.6E-04	10	0.222	6982	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.89%	0.0047
8.08	460	1.8E-03	3.9E+02	3.6E-04	10	0.223	6963	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.93%	0.0048
8.13	460	1.8E-03	3.7E+02	3.8E-04	16	0.474	5722	0.13%	2.00	0.65	0.03%	0.023	0.34	0.079	0.765	3.49%	0.0057
8.18	460	1.8E-03	3.7E+02	3.8E-04	16	0.475	5707	0.13%	2.00	0.65	0.03%	0.023	0.34	0.079	0.765	3.53%	0.0058
8.23	460	1.8E-03	3.7E+02	3.8E-04	16	0.475	5692	0.14%	2.00	0.65	0.03%	0.023	0.34	0.079	0.765	3.57%	0.0059
8.28	460	1.8E-03	3.7E+02	3.9E-04	16	0.475	5677	0.14%	2.00	0.65	0.03%	0.024	0.34	0.079	0.765	3.61%	0.0059
8.33	460	1.8E-03	3.7E+02	3.9E-04	16	0.476	5662	0.14%	2.00	0.65	0.03%	0.024	0.34	0.079	0.765	3.65%	0.0060
8.38	460	1.8E-03	3.7E+02	3.9E-04	16	0.476	5648	0.14%	2.00	0.65	0.03%	0.024	0.34	0.079	0.765	3.69%	0.0061
8.43	460	1.8E-03	3.7E+02	3.9E-04	16	0.476	5633	0.14%	2.00	0.65	0.03%	0.024	0.34	0.079	0.765	3.73%	0.0061
8.48	460	1.8E-03	3.7E+02	4.0E-04	16	0.477	5619	0.15%	2.00	0.65	0.03%	0.025	0.34	0.079	0.765	3.77%	0.0062
8.53	460	1.8E-03	3.7E+02	4.0E-04	16	0.477	5605	0.15%	2.00	0.65	0.03%	0.025	0.34	0.079	0.765	3.81%	0.0063
8.58	460	1.8E-03	3.7E+02	4.0E-04	16	0.478	5591	0.15%	2.00	0.65	0.03%	0.025	0.34	0.079	0.765	3.85%	0.0063
8.63	460	1.8E-03	3.7E+02	4.0E-04	16	0.478	5577	0.15%	2.00	0.65	0.03%	0.025	0.34	0.079	0.765	3.89%	0.0064
8.68	460	1.8E-03	3.7E+02	4.1E-04	16	0.478	5563	0.15%	2.00	0.65	0.03%	0.026	0.34	0.079	0.765	3.93%	0.0065
8.73	460	1.8E-03	3.7E+02	4.1E-04	16	0.479	5550	0.16%	2.00	0.65	0.03%	0.026	0.34	0.079	0.765	3.97%	0.0065
8.78	460	1.8E-03	3.7E+02	4.1E-04	16	0.479	5536	0.16%	2.00	0.65	0.03%	0.026	0.34	0.079	0.765	4.01%	0.0066
8.83	460	1.8E-03	3.7E+02	4.1E-04	16	0.479	5523	0.16%	2.00	0.65	0.03%	0.027	0.34	0.079	0.765	4.06%	0.0067
8.88	460	1.8E-03	3.7E+02	4.2E-04	16	0.480	5510	0.16%	2.00	0.65	0.03%	0.027	0.34	0.079	0.765	4.10%	0.0067
8.93	460	1.8E-03	3.7E+02	4.2E-04	16	0.480	5496	0.16%	2.00	0.65	0.03%	0.027	0.34	0.079	0.765	4.14%	0.0068
8.98	460	1.8E-03	3.7E+02	4.2E-04	16	0.480	5483	0.17%	2.00	0.65	0.03%	0.027	0.34	0.079	0.765	4.18%	0.0069
9.03	460	1.8E-03	3.7E+02	4.2E-04	16	0.481	5470	0.17%	2.00	0.65	0.03%	0.028	0.34	0.079	0.765	4.22%	0.0069
9.08	460	1.8E-03	3.7E+02	4.3E-04	16	0.481	5457	0.17%	2.00	0.65	0.03%	0.028	0.34	0.079	0.765	4.27%	0.0070
9.13	460	1.8E-03	3.7E+02	4.3E-04	16	0.481	5445	0.17%	2.00	0.65	0.03%	0.028	0.34	0.079	0.765	4.31%	0.0071
9.18	460	1.8E-03	3.7E+02	4.3E-04	16	0.481	5432	0.17%	2.00	0.65	0.03%	0.028	0.34	0.079	0.765	4.35%	0.0071
9.23	460	1.8E-03	3.7E+02	4.3E-04	16	0.482	5419	0.18%	2.00	0.65	0.03%	0.029	0.34	0.079	0.765	4.39%	0.0072
9.28	460	1.8E-03	3.7E+02	4.4E-04	16	0.482	5407	0.18%	2.00	0.65	0.03%	0.029	0.34	0.079	0.765	4.44%	0.0073
9.33	460	1.8E-03	3.7E+02	4.4E-04	16	0.482	5395	0.18%	2.00	0.65	0.03%	0.029	0.34	0.079	0.765	4.48%	0.0073
9.38	500	1.8E-03	4.4E+02	3.7E-04	16	0.483	5382	0.12%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.09%	0.0051
9.43	500	1.8E-03	4.4E+02	3.7E-04	16	0.483	5370	0.12%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.12%	0.0051
9.48	500	1.8E-03	4.4E+02	3.8E-04	16	0.483	5358	0.12%	2.00	0.65	0.03%	0.021	0.34	0.079	0.765	3.15%	0.0052
9.53	500	1.8E-03	4.4E+02	3.8E-04	16	0.484	5346	0.12%	2.00	0.65	0.03%	0.021	0.34	0.079	0.765	3.18%	0.0052
9.58	500	1.8E-03	4.4E+02	3.8E-04	16	0.484	5334	0.12%	2.00	0.65	0.03%	0.021	0.34	0.079	0.765	3.21%	0.0053
9.63	500	1.8E-03	4.4E+02	3.8E-04	16	0.484	5322	0.12%	2.00	0.65	0.03%	0.021	0.34	0.079	0.765	3.24%	0.0053
9.68	500	1.8E-03	4.4E+02	3.8E-04	16	0.485	5311	0.12%	2.00	0.65	0.03%	0.021	0.34	0.079	0.765	3.27%	0.0054
9.73	500	1.8E-03	4.6E+02	3.7E-04	10	0.234	6426	0.10%	2.00	0.65	0.03%	0.018	0.34	0.079	0.765	2.83%	0.0046
9.78	500	1.8E-03	4.6E+02	3.7E-04	10	0.234	6411	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.86%	0.0047
9.83	500	1.8E-03	4.6E+02	3.7E-04	10	0.235	6396	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.89%	0.0047
9.88	500	1.8E-03	4.6E+02	3.7E-04	10	0.235	6382	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.92%	0.0048
9.93	500	1.8E-03	4.6E+02	3.8E-04	10	0.235	6367	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.95%	0.0048
9.98	500	1.8E-03	4.6E+02	3.8E-04	10	0.236	6353	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.98%	0.0049
10.03	500	1.8E-03	4.6E+02	3.8E-04	10	0.236	6339	0.11%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.01%	0.0049
10.08	500	1.8E-03	4.6E+02	3.8E-04	10	0.236	6324	0.11%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.04%	0.0050
10.13	500	1.8E-03	4.6E+02	3.8E-04	10	0.237	6313	0.11%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.08%	0.0050
10.18	500	1.8E-03	4.6E+02	3.9E-04	10	0.237	6306	0.12%	2.00	0.65	0.03%	0.020	0.34	0.079	0.765	3.11%	0.0051

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-6N

Data File: 13-52106_SP3-6N-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Dat

Legend
Tailings Sands
Tailings Sand-Slimes
Tailings Slimes
Interim Cover
Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5604.20	Water surface elevation during CPT investigation (ft ar
5599.16	Water surface elevation at t_0 (ft amsl)
5590.44	Water surface elevation at t_1 (ft amsl)
5585.44	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earthq
7.51	Equiv. Number of Uniform Strain Cycles, N

Value	Parameter
5607.44	Ground Surface Elevation at time of CPT (ft amsl)
5623.62	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after plac
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
8.68	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1720.10	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5585.44	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer
Erosion Protection Layer	######	5623.37	5623.12	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
Water Storage/Rooting Zone Layer	######	5621.37	5619.62	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5617.87	5616.12	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320
Platform/Random Fill Layer	######	5611.78	5607.44	8.68	0.050	101	0.861	0.643	0.00	0.00	0.861	0.643

Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
1.75	508	1.9E-03	4.8E+02	6.5E-05	11	0.152	12657	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
3.61	508	1.6E-03	4.0E+02	1.6E-04	11	0.181	9468	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No
17.388	5590.05	6.7	0.047	6.0	104.9	45.45	0.70%	Sand-Slime Tailin	0.059	119.0	0.98	0.44	0.54	1
17.552	5589.89	6.6	0.046	6.0	96.3	41.71	0.70%	Sand-Slime Tailin	0.059	119.0	0.99	0.45	0.54	1
17.716	5589.72	6.0	0.052	5.5	92.4	40.06	0.86%	Slime Tailings	0.057	113.1	1.00	0.45	0.55	1
17.880	5589.56	5.7	0.042	5.2	93.9	40.69	0.73%	Slime Tailings	0.057	113.1	1.01	0.46	0.55	1
18.044	5589.40	6.1	0.034	5.6	77.5	33.57	0.56%	Slime Tailings	0.057	113.1	1.02	0.46	0.56	1
18.208	5589.23	5.2	0.036	4.7	84.2	36.50	0.69%	Slime Tailings	0.057	113.1	1.03	0.47	0.56	1
18.372	5589.07	5.4	0.036	4.9	84.8	36.76	0.66%	Slime Tailings	0.057	113.1	1.04	0.47	0.57	1
18.537	5588.90	6.0	0.036	5.4	86.7	37.59	0.60%	Slime Tailings	0.057	113.1	1.05	0.48	0.57	1
22.000	5585.44							Slime Tailings	0.057	113.1				

CPT Data Interpretations (cont.) / Conditions at t_1

Depth at time of CPT (ft)	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
17.388	1.44	8.687	120.75	11.19	11	0.82%	2.7	47%	1.84	0.01	1.83	1
17.552	1.43	8.544	118.76	10.92	10	0.82%	2.7	47%	1.85	0.02	1.83	1
17.716	1.42	7.782	108.16	9.99	9	1.03%	2.8	71%	1.86	0.02	1.84	1
17.880	1.41	7.283	101.24	9.42	9	0.89%	2.8	71%	1.87	0.03	1.84	1
18.044	1.41	7.873	109.44	9.93	9	0.67%	2.7	71%	1.88	0.03	1.85	1
18.208	1.40	6.570	91.32	8.48	7	0.86%	2.8	71%	1.89	0.04	1.85	1
18.372	1.39	6.824	94.85	8.78	8	0.82%	2.8	71%	1.90	0.04	1.85	1
18.537	1.38	7.489	104.10	9.57	9	0.73%	2.8	71%	1.91	0.05	1.86	1
22.000									2.10	0.10	2.00	1

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	Idriss & Boulanger (2008) Cyclic Stress Ratio r_d	C_σ	K_σ	K_a	CSR M=7.5, s'v=1atm	Cyclic Resistance Ratio Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd et al. (2001) Cyclic Stress Ratio r_d	D_r	f	K_σ	K_a	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
17.388	0.90	0.05	0.97	1.0	0.050	34.22	45.41	0.073	1.45	0.90	0.19	0.80	1.10	1.0	0.036	3.97	44.45	0.087	3.47	2.46	2
17.552	0.90	0.05	0.97	1.0	0.050	34.13	45.05	0.073	1.45	0.90	0.19	0.80	1.10	1.0	0.037	4.06	44.36	0.087	3.44	2.44	2
17.716	0.89	0.05	0.97	1.0	0.051	33.57	43.56	0.072	1.42	0.90	0.18	0.80	1.09	1.0	0.037	4.73	47.21	0.089	3.50	2.46	2
17.880	0.89	0.04	0.97	1.0	0.051	33.37	42.79	0.071	1.40	0.90	0.18	0.80	1.09	1.0	0.037	4.73	44.60	0.087	3.38	2.39	2
18.044	0.89	0.05	0.97	1.0	0.051	33.55	43.48	0.072	1.41	0.90	0.18	0.80	1.09	1.0	0.037	4.15	41.21	0.084	3.25	2.33	2
18.208	0.89	0.04	0.97	1.0	0.051	33.04	41.53	0.070	1.38	0.89	0.17	0.80	1.09	1.0	0.037	5.14	43.60	0.086	3.29	2.33	2
18.372	0.89	0.04	0.97	1.0	0.051	33.15	41.93	0.070	1.38	0.89	0.17	0.80	1.09	1.0	0.037	4.92	43.24	0.086	3.25	2.32	2
18.537	0.89	0.04	0.97	1.0	0.051	33.42	42.99	0.071	1.40	0.89	0.18	0.80	1.09	1.0	0.037	4.42	42.33	0.085	3.20	2.30	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.539

Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
10.23	500	1.8E-03	4.6E+02	3.9E-04	10	0.237	6300	0.12%	2.00	0.65	0.03%	0.021	0.34	0.079	0.765	3.15%	0.0052
10.28	500	1.8E-03	4.6E+02	3.9E-04	10	0.237	6293	0.12%	2.00	0.65	0.03%	0.021	0.34	0.079	0.765	3.18%	0.0052
10.33	500	1.8E-03	4.4E+02	4.1E-04	16	0.488	5185	0.14%	2.00	0.65	0.03%	0.024	0.34	0.079	0.765	3.72%	0.0061
10.38	500	1.8E-03	4.4E+02	4.2E-04	16	0.488	5180	0.14%	2.00	0.65	0.03%	0.025	0.34	0.079	0.765	3.75%	0.0062
10.43	500	1.8E-03	4.4E+02	4.2E-04	16	0.488	5175	0.15%	2.00	0.65	0.03%	0.025	0.34	0.079	0.765	3.79%	0.0062
10.48	500	1.8E-03	4.4E+02	4.2E-04	16	0.488	5171	0.15%	2.00	0.65	0.03%	0.025	0.34	0.079	0.765	3.83%	0.0063
10.53	500	1.8E-03	4.4E+02	4.2E-04	16	0.489	5166	0.15%	2.00	0.65	0.03%	0.025	0.34	0.079	0.765	3.87%	0.0063
10.58	500	1.8E-03	4.4E+02	4.2E-04	16	0.489	5161	0.15%	2.00	0.65	0.03%	0.026	0.34	0.079	0.765	3.90%	0.0064
11.64	538	1.8E-03	5.1E+02	4.0E-04	16	0.493	5008	0.13%	2.00	0.65	0.03%	0.022	0.34	0.079	0.765	3.37%	0.1167

Extra layer added to analyze seismic settlement of tailings below the bottom of CPT investigation.

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-8N

Data File: 13-52106_SP3-8N-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3 Field Data\2013 Field Investigation\Conetec Dat

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5604.90	Water surface elevation during CPT investigation (ft amsl)
5600.09	Water surface elevation at t_1 (ft amsl)
5595.24	Water surface elevation at t_2 (ft amsl)
5590.24	Water surface elevation at t_3 (ft amsl)
1.44	Scaling Factor for stress ratio, r_α
0.47	Volumetric Strain Ratio for Site-Specific Design Earthquake
7.51	Equiv. Number of Uniform Strain Cycles, N

5608.37	Ground Surface Elevation at time of CPT (ft amsl)
5623.82	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
7.95	Thickness of Random/Platform Fill on top of existing interim cover (ft)
1646.57	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5590.24	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer
Erosion Protection Layer	######	5623.57	5623.32	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
Water Storage/Rooting Zone Layer	######	5621.57	5619.82	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5618.07	5616.32	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320
Platform/Random Fill Layer	######	5612.35	5608.37	7.95	0.050	101	0.825	0.624	0.00	0.00	0.825	0.624

2013 CPT Data from ConeTec

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)
0.164	5608.21	4.6	0.040	4.6	1.7	0.73	0.87%	Interim Cover
0.328	5608.04	22.0	0.044	22.0	2.8	1.22	0.20%	Interim Cover
0.492	5607.88	41.2	0.114	41.1	4.2	1.81	0.28%	Interim Cover
0.656	5607.71	59.5	0.362	59.4	4.7	2.05	0.61%	Interim Cover
0.820	5607.55	65.8	0.430	65.7	4.5	1.93	0.65%	Interim Cover
0.984	5607.39	69.7	0.402	69.6	3.8	1.66	0.58%	Interim Cover
1.148	5607.22	68.4	0.655	68.4	3.8	1.64	0.96%	Interim Cover
1.312	5607.06	77.9	0.651	77.9	3.0	1.29	0.84%	Interim Cover
1.476	5606.89	71.1	0.676	71.0	6.8	2.96	0.95%	Interim Cover
1.640	5606.73	61.8	0.871	61.7	6.0	2.61	1.41%	Interim Cover
1.804	5606.57	70.3	1.290	70.3	5.1	2.22	1.83%	Interim Cover
1.968	5606.40	106.9	2.471	106.9	8.4	3.62	2.31%	Interim Cover
2.133	5606.24	99.5	2.832	99.4	11.5	4.99	2.85%	Interim Cover
2.297	5606.07	93.6	3.017	93.6	6.8	2.93	3.22%	Interim Cover
2.461	5605.91	68.6	2.531	68.6	1.4	0.62	3.69%	Interim Cover
2.625	5605.75	95.3	2.541	95.3	9.0	3.88	2.67%	Interim Cover
2.789	5605.58	99.4	3.003	99.4	5.2	2.27	3.02%	Interim Cover
2.953	5605.42	96.2	3.312	96.2	12.2	5.30	3.44%	Interim Cover
3.117	5605.25	92.1	3.557	92.0	12.7	5.51	3.86%	Interim Cover
3.281	5605.09	80.8	3.387	80.6	37.5	16.27	4.19%	Slime Tailings
3.445	5604.93	122.2	2.584	121.9	40.5	17.53	2.12%	Sand Tailings
3.609	5604.76	107.6	2.292	107.6	12.0	5.18	2.13%	Sand-Slime Tailing
3.773	5604.60	78.1	1.653	78.1	6.0	2.59	2.12%	Sand-Slime Tailing
3.937	5604.43	66.3	1.592	66.2	9.0	3.89	2.40%	Sand-Slime Tailing
4.101	5604.27	57.7	1.714	57.7	8.7	3.75	2.97%	Sand-Slime Tailing
4.265	5604.10	99.5	1.694	99.3	20.2	8.74	1.70%	Sand Tailings
4.429	5603.94	96.3	1.854	96.2	10.5	4.55	1.93%	Sand Tailings
4.593	5603.78	87.1	1.742	87.0	10.5	4.55	2.00%	Sand-Slime Tailing
4.757	5603.61	81.0	1.555	81.0	10.4	4.50	1.92%	Sand-Slime Tailing
4.921	5603.45	82.4	1.088	82.4	10.5	4.56	1.32%	Sand Tailings
5.085	5603.28	81.0	1.231	80.9	13.0	5.62	1.52%	Sand Tailings
5.249	5603.12	70.7	1.164	70.7	9.2	3.98	1.65%	Sand Tailings
5.413	5602.96	85.1	0.966	85.1	8.1	3.51	1.14%	Sand Tailings
5.577	5602.79	64.0	0.689	64.0	6.3	2.74	1.08%	Sand Tailings
5.741	5602.63	47.9	0.475	47.9	3.6	1.57	0.99%	Sand Tailings
5.905	5602.46	40.9	0.332	40.9	2.7	1.18	0.81%	Sand Tailings
6.069	5602.30	39.0	0.287	39.0	2.6	1.11	0.74%	Sand Tailings
6.234	5602.14	40.0	0.341	40.0	2.0	0.85	0.85%	Sand Tailings
6.398	5601.97	40.0	0.355	40.0	2.8	1.20	0.89%	Sand Tailings
6.562	5601.81	40.0	0.387	40.0	3.0	1.30	0.97%	Sand Tailings
6.726	5601.64	43.0	0.411	42.9	3.4	1.47	0.96%	Sand Tailings
6.890	5601.48	43.2	0.434	43.2	4.0	1.72	1.00%	Sand Tailings
7.054	5601.32	39.0	0.417	39.0	3.6	1.56	1.07%	Sand-Slime Tailing
7.218	5601.15	35.2	0.330	35.2	3.4	1.46	0.94%	Sand-Slime Tailing
7.382	5600.99	32.9	0.239	32.9	3.5	1.53	0.73%	Sand-Slime Tailing
7.546	5600.82	30.1	0.219	30.0	3.5	1.51	0.73%	Sand-Slime Tailing
7.710	5600.66	27.5	0.248	27.5	4.2	1.82	0.90%	Sand-Slime Tailing
7.874	5600.50	19.6	0.239	19.6	6.2	2.68	1.22%	Sand-Slime Tailing
8.038	5600.33	18.1	0.197	18.0	10.3	4.48	1.09%	Sand-Slime Tailing
8.202	5600.17	23.6	0.205	23.5	21.5	9.32	0.87%	Sand-Slime Tailing
8.366	5600.00	25.6	0.288	25.5	14.2	6.17	1.13%	Sand-Slime Tailing
8.530	5599.84	29.3	0.323	29.2	8.4	3.65	1.10%	Sand-Slime Tailing
8.694	5599.68	30.7	0.209	30.7	6.5	2.83	0.68%	Sand-Slime Tailing
8.858	5599.51	33.0	0.238	32.9	7.2	3.11	0.72%	Sand-Slime Tailing
9.022	5599.35	32.8	0.289	32.7	11.2	4.85	0.88%	Sand-Slime Tailing
9.186	5599.18	31.3	0.342	31.3	6.6	2.86	1.09%	Sand-Slime Tailing
9.350	5599.02	29.8	0.381	29.8	8.8	3.81	1.28%	Sand-Slime Tailing
9.514	5598.86	25.7	0.381	25.6	10.2	4.40	1.48%	Sand-Slime Tailing
9.678	5598.69	21.5	0.318	21.5	11.1	4.80	1.48%	Sand-Slime Tailing
9.842	5598.53	16.4	0.157	16.3	10.5	4.54	0.96%	Sand-Slime Tailing
10.006	5598.36	14.2	0.105	14.1	11.9	5.14	0.74%	Sand-Slime Tailing
10.170	5598.20	15.4	0.103	15.4	7.0	3.05	0.67%	Sand-Slime Tailing
10.335	5598.04	16.1	0.128	16.1	4.8	2.09	0.79%	Sand-Slime Tailing
10.499	5597.87	14.5	0.162	14.4	6.6	2.86	1.12%	Sand-Slime Tailing
10.663	5597.71	14.4	0.178	14.4	8.8	3.80	1.23%	Sand-Slime Tailing
10.827	5597.54	16.9	0.242	16.8	10.1	4.39	1.44%	Sand-Slime Tailing
10.991	5597.38	15.0	0.248	14.9	10.7	4.62	1.66%	Sand-Slime Tailing
11.155	5597.22	12.9	0.198	12.8	12.5	5.43	1.54%	Sand-Slime Tailing
11.319	5597.05	11.6	0.168	11.5	17.1	7.40	1.45%	Sand-Slime Tailing
11.483	5596.89	11.7	0.133	11.5	23.8	10.31	1.14%	Sand-Slime Tailing
11.647	5596.72	12.6	0.172	12.4	30.6	13.24	1.37%	Sand-Slime Tailing
11.811	5596.56	15.5	0.198	15.4	20.6	8.94	1.28%	Sand-Slime Tailing
11.975	5596.40	18.6	0.272	18.5	20.1	8.70	1.46%	Sand-Slime Tailing
12.139	5596.23	20.8	0.332	20.7	20.6	8.93	1.59%	Sand-Slime Tailing
12.303	5596.07	20.6	0.354	20.4	21.5	9.33	1.72%	Sand-Slime Tailing
12.467	5595.90	21.7	0.293	21.6	21.5	9.33	1.35%	Sand-Slime Tailing
12.631	5595.74	19.6	0.242	19.4	23.8	10.31	1.24%	Sand-Slime Tailing
12.795	5595.57	25.2	0.298	25.1	16.3	7.06	1.18%	Sand-Slime Tailing
12.959	5595.41	21.9	0.407	21.8	10.3	4.45	1.86%	Sand-Slime Tailing
13.123	5595.25	15.7	0.413	15.6	13.9	6.04	2.63%	Slime Tailings
13.287	5595.08	12.5	0.244	12.3	29.1	12.59	1.95%	Sand-Slime Tailing
13.451	5594.92	23.9	0.277	23.7	39.2	16.99	1.16%	Sand-Slime Tailing
13.615	5594.75	17.1	0.257	16.9	21.6	9.34	1.51%	Sand-Slime Tailing
13.779	5594.59	13.5	0.216	13.4	24.5	10.62	1.60%	Sand-Slime Tailing
13.943	5594.43	12.3	0.109	12.1	31.7	13.73	0.89%	Sand-Slime Tailing
14.107	5594.26	13.7	0.109	13.5	35.9	15.56	0.80%	Sand-Slime Tailing
14.271	5594.10	14.3	0.105	14.1	40.0	17.33	0.73%	Sand-Slime Tailing
14.436	5593.93	15.6	0.141	15.4	38.1	16.50	0.90%	Sand-Slime Tailing
14.600	5593.77	13.6	0.133	13.4	36.6	15.87	0.98%	Sand-Slime Tailing
14.764	5593.61	12.7	0.142	12.5	36.6	15.85	1.11%	Sand-Slime Tailing
14.928	5593.44	11.6	0.159	11.4	38.9	16.85	1.37%	Sand-Slime Tailing
15.092	5593.28	12.1	0.159	11.8	38.7	16.79	1.32%	Sand-Slime Tailing
15.256	5593.11	18.8	0.159	18.6	31.2	13.52	0.85%	Sand-Slime Tailing
18.130	5590.24							Sand-Slime Tailing

Extra layer added to analyze seismic settlement of tailings below the bottom of CPT investigation.

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-8S

Data File: 13-52106_SP3-8S-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Dat

Legend
Tailings Sands
Tailings Sand-Slimes
Tailings Slimes
Interim Cover
Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5603.50	Water surface elevation during CPT investigation (ft a
5600.42	Water surface elevation at t_0 (ft amsl)
5590.63	Water surface elevation at t_1 (ft amsl)
5585.63	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earth
7.51	Equiv. Number of Uniform Strain Cycles, N

Value	Parameter
5608.70	Ground Surface Elevation at time of CPT (ft amsl)
5620.45	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
4.25	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1273.89	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5585.63	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)		Elev. At Midpoint of Layer (ft)	Elev. At Bottom of Layer	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at Bottom of Layer	Total Stress at Midpoint of Layer	Equil Pore Pressure at Bottom of Layer	Equil Pore Pressure at Midpoint of Layer (tsf)	Effective Stress at Bottom of Layer	Effective Stress at Midpoint of Layer	Midpoint Depth at t_1, z_1	Shear Wave Velocity, V_s	Soil Density, ρ (tcf)	Max Shear Strain Modulus, G_{max} (tsf)	P = γ_{eff}*(G_{eff}/G_{max}) (tsf)	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
Erosion Protection Layer	######		5620.2	5619.95	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014	0.08	508	1.7E-03	4.4E+02	3.0E-06	11	0.068	46696	0.00%	1.20	0.80	0.04%	0.000	0.32	0.133	0.778	0.00%	0.0000
Water Storage/Rooting Zone Layer	######		5618.2	5616.45	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121	0.69	508	1.7E-03	4.3E+02	2.8E-05	11	0.118	18930	0.00%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
High Compaction Layer	######		5614.7	5612.95	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320	1.75	508	1.9E-03	4.8E+02	6.5E-05	11	0.152	12657	0.01%	0.65	0.75	0.02%	0.000	0.34	0.079	0.765	0.00%	0.0000
Platform/Random Fill Layer	######		5610.83	5608.70	4.25	0.050	101	0.638	0.531	0.00	0.00	0.638	0.531	2.93	508	1.6E-03	4.0E+02	1.3E-04	11	0.173	10248	0.02%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
0.164	5608.54	17.2	0.175	17.2	1.2	0.54	1.02%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	29.240	406.44	33.98	2082	1.02%	1.2	51%	0.65	0.00	0.65	0

Liquefaction Triggering Analyses

Idriss & Boulanger (2008) Cyclic Stress Ratio: r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Cyclic Resistance Ratio: Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd et al. (2001) Cyclic Stress Ratio: r_d	D_r	f	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
1.00	0.06	1.02	1.0	0.059	42.24	76.22	0.108	1.83	0.97	0.34	0.80	0.80	2.53	1.0	0.017	1.00	33.98	0.078	190.38	96.10	2

Seismic Settlement Analysis - Stewart et al (2004)

TOTAL SEISMIC SETTLEMENT (FT): 0.354

Depth at t_1, z_1 m	Shear Wave Velocity, V_s (ft/sec)	Soil Density, ρ (tcf)	Maximum Shear Strain Modulus, G_{max} tsf	P = γ_{eff}*(G_{eff}/G_{max}) tsf	Plasticity Index, PI	g_1	g_2	Shear Strain, γ (%)	a	b	Threshhold Shear Strain, γ_{tv} (%)	Volumetric Strain at 15 Cycles, ε_{c-15} (%)	R	c	C_N	Volumetric Strain for Design Event, ε_v (%)	Incremental Consolidation (ft)
3.63	594	1.6E-03	5.5E+02	1.1E-04	11	0.181	9453	0.01%	2.00	0.65	0.03%	0.000	0.34	0.079	0.765	0.00%	0.0000
7.78	460	1.8E-03	3.9E+02	3.5E-04	10	0.222	7001	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.86%	0.0047
7.83	460	1.8E-03	3.7E+02	3.7E-04	16	0.474	5753	0.13%	2.00	0.65	0.03%	0.022	0.34	0.079	0.765	3.41%	0.0056
7.88	460	1.8E-03	3.9E+02	3.6E-04	10	0.223	6962	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.93%	0.0048
7.93	460	1.8E-03	3.9E+02	3.6E-04	10	0.223	6943	0.11%	2.00	0.65	0.03%	0.019	0.34	0.079	0.765	2.97%	0.0049
7.98	460	1.8E-03	3.7E+02	3.8E-04	16	0.475	5706	0.13%	2.00	0.65	0.03%	0.023	0.34	0.079	0.765	3.53%	0.0058
8.03	500	1.8E-03	4.4E+02	3.3E-04	16	0.475	5691	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.43%	0.0040
8.08	500	1.8E-03	4.4E+02	3.3E-04	16	0.475	5676	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.46%	0.0040
8.13	500	1.8E-03	4.4E+02	3.3E-04	16	0.476	5661	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.49%	0.0041
8.18	500	1.8E-03	4.6E+02	3.2E-04	10	0.225	6852	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.07%	0.0034
8.23	500	1.8E-03	4.6E+02	3.2E-04	10	0.225	6833	0.08%	2.00	0.65	0.03%	0.014	0.34	0.079	0.765	2.10%	0.0034
10.61	538	1.8E-03	5.3E+02	3.6E-04	10	0.240	6155	0.09%	2.00	0.65	0.03%	0.016	0.34	0.079	0.765	2.52%	0.1971

Extra layer added to analyze seismic settlement of tailings below the bottom of CPT investigation.

ATTACHMENT F.4

LIQUEFACTION CALCULATIONS

Notes

t_0 corresponds to beginning of final cover placement — Assumes 99% of consolidation due to existing stress conditions has taken place

t_1 corresponds to dewatering of the tailings to a level 5 feet above the liner

t_2 corresponds to completion of dewatering

SOIL PROPERTIES

TAILINGS

Specific Gravity, G_s		
2.70	Specific gravity of tailing sands, $G_{s\text{-}TSand}$	Based on testing performed on other uranium tailings and presented in Keshian and Rager (1988)
2.80	Specific gravity of tailing sand-slimes, $G_{s\text{-}TS\text{-}S}$	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
2.86	Specific gravity of tailing slimes, $G_{s\text{-}TSlime}$	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
Fines Content		
18%	Fines content of tailings sands (%)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
47%	Fines content of tailings sand-slimes (%)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
71%	Fines content of tailings slimes (%)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
Dry Unit Weight, γ_d		
97	In-situ dry unit weight of tailings sands at t_0, $\gamma_{d0\text{-}Tsand}$ (pcf)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
88	In-situ dry unit weight of tailings sand-slimes at t_0, $\gamma_{d0\text{-}TS\text{-}S}$ (pcf)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
78	In-situ dry unit weight of tailings slimes at t_0, $\gamma_{d0\text{-}Tslime}$ (pcf)	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
Saturated Unit Weight, γ_{sat}		
123	In-situ saturated unit weight of tailings sands at t_0, $\gamma_{sat0\text{-}Tsand}$ (pcf)	Calculated
119	In-situ saturated unit weight of tailings sand-slimes at t_0, $\gamma_{sat0\text{-}TS\text{-}S}$ (pcf)	Calculated
113	In-situ saturated unit weight of tailings slimes at t_0, $\gamma_{sat0\text{-}Tslime}$ (pcf)	Calculated
Moist Unit Weight, γ_m		
103	Moist unit weight of tailings sands, $\gamma_{m\text{-}Tsand}$ (pcf)	Calculated, assuming long-term water content from laboratory testing (Tailings Data Analysis Report. MWH, 2015b)
93	Moist unit weight of tailings sand-slimes, $\gamma_{m\text{-}TS\text{-}S}$ (pcf)	Calculated, assuming long-term water content from laboratory testing (Tailings Data Analysis Report. MWH, 2015b)
83	Moist unit weight of tailings slimes, $\gamma_{m\text{-}Tslime}$ (pcf)	Calculated, assuming long-term water content from laboratory testing (Tailings Data Analysis Report. MWH, 2015b)
Void Ratio, e		
0.74	Void ratio of tailing sands at t_0, $e_{0\text{-}TSand}$	Calculated
0.99	Void ratio of tailing sand-slimes at t_0, $e_{0\text{-}TS\text{-}S}$	Calculated
1.29	Void ratio of tailing slimes at t_0, $e_{0\text{-}TSlime}$	Calculated
Saturated Water Content, w_{Sat}		
27%	Saturated water content of tailings sands at t_0, $w_{sat0\text{-}TSand}$ (%)	Calculated
35%	Saturated water content of tailings sand-slimes at t_0, $w_{sat0\text{-}TS\text{-}S}$ (%)	Calculated
45%	Saturated water content of tailings slimes at t_0, $w_{sat0\text{-}TSlime}$ (%)	Calculated
Water Content of Moist Tailings, $w_{m\text{-}T}$		
6%	Water content of moist tailings sands, $w_{m\text{-}TSand}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
6%	Water content of moist tailings sand-slimes, $w_{m\text{-}TS\text{-}S}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
6%	Water content of moist tailings slimes, $w_{m\text{-}TSlime}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
Plasticity Index, PI		
0	Plasticity index of tailings sands, PI_{TSand}	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
10	Plasticity index of tailings sand-slimes, $PI_{TS\text{-}S}$	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
16	Plasticity index of tailings slimes, PI_{TSlime}	Average value from lab testing of samples obtained on-site (Tailings Data Analysis Report. MWH, 2015b)
Seismic Settlement Coefficients		
2.2	Coefficient "a" of Unsaturated Sand Tailings	From Stewart, et al (2004), page 86, Figure 6.5
5.0	Coefficient "a" of Saturated Sand Tailings	From Stewart, et al (2004), page 86, Figure 6.5
2.0	Coefficient "a" of Sand-Slime Tailings	From Stewart, et al (2004), page 89, Figure 6.7
2.0	Coefficient "a" of Slime Tailings	From Stewart, et al (2004), page 89, Figure 6.7
1.00	Coefficient "b" of Sand Tailings	From Stewart, et al (2004), page 86, Figure 6.5
0.65	Coefficient "b" of Sand-Slime Tailings	From Stewart, et al (2004), page 89, Figure 6.7
0.65	Coefficient "b" of Slime Tailings	From Stewart, et al (2004), page 89, Figure 6.7
0.01%	Strain threshold value of Sand Tailings, γtv	From Stewart, et al (2004), page 86, Figure 6.5
0.03%	Strain threshold value of Sand-Slime Tailings, γtv	From Stewart, et al (2004), page 89, Figure 6.7
0.03%	Strain threshold value of Slime Tailings, γtv	From Stewart, et al (2004), page 89, Figure 6.7
0.36	Coefficient "R" of Sand Tailings	From Stewart, et al (2004), page 86, for soils with non-plastic fines
0.34	Coefficient "R" of Sand-Slime Tailings	From Stewart, et al (2004), page 89, for soils with medium plasticity fines
0.34	Coefficient "R" of Slime Tailings	From Stewart, et al (2004), page 89, for soils with medium plasticity fines

Other

5.0	Height of water table above liner at t_1, H_{sat-1} (ft)	Assumed for end of active maintenance
0.0	Height of water table above liner at t_2, H_{sat-2} (ft)	
6.0%	Long-term moisture content of tailings, $w_{tailings}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
508	Shear Wave Velocity of Tailings, V_s (ft/sec)	Conservatively assumed to be the average of the shear wave velocities measured in Cell 2 tailings

COVER SOIL

Specific Gravity, G_s

2.61	Specific gravity of topsoil, $G_{s\text{-Topsoil}}$	From Attachment H - Radon Emanation Modeling including with this submittal
2.62	Specific gravity of rock mulch, $G_{s\text{-mulch}}$	From Attachment H - Radon Emanation Modeling including with this submittal
2.63	Specific gravity of cover soil, $G_{s\text{-cover}}$	From Attachment H - Radon Emanation Modeling including with this submittal

Unit Weight, γ

118.0	Maximum dry unit weight of cover soil $\gamma_{cover\text{-}max}$ (pcf)	Average calculated from laboratory testing results (UWM, 2012)
100.7	Moist unit weight of cover soil at 80% relative compaction, $\gamma_{cover80}$ (pcf)	Calculated
107.0	Moist unit weight of cover soil at 85% relative compaction, $\gamma_{cover85}$ (pcf)	Calculated
119.6	Moist unit weight of cover soil at 95% relative compaction, $\gamma_{cover95}$ (pcf)	Calculated
100	Dry unit weight of topsoil layer at 85% relative compaction, $\gamma_{topsoil5}$ (pcf)	From Attachment H - Radon Emanation Modeling including with this submittal
105	Moist unit weight of topsoil layer at 85% relative compaction, $\gamma_{topsoil5}$ (pcf)	Calculated
106	Dry unit weight of rock mulch layer at 85% relative compaction, $\gamma_{mulch85}$ (pcf)	Calculated
110	Moist unit weight of rock mulch layer at 85% relative compaction, $\gamma_{mulch85}$ (pcf)	From Attachment H - Radon Emanation Modeling including with this submittal

Void Ratio, e

0.74	Void Ratio of cover soil at 80% relative compaction, $e_{cover80}$	Calculated
0.64	Void Ratio of cover soil at 85% relative compaction, $e_{cover85}$	Calculated
0.46	Void Ratio of cover soil at 95% relative compaction, $e_{cover95}$	Calculated
0.61	Void Ratio of topsoil at 85% relative compaction, $e_{topsoil85}$	Calculated from porosity presented in Attachment H - Radon Emanation Modeling including with this submittal
0.54	Void Ratio of rock mulch at 85% relative compaction, $e_{mulch85}$	Calculated from porosity presented in Attachment H - Radon Emanation Modeling including with this submittal

Seismic Settlement Coefficients

1.2	Coefficient "a" of Erosion Protection/Topsoil Cover	From Stewart, et al (2004), page 88, Figure 6.6
2.0	Coefficient "a" of General Cover Soil	From Stewart, et al (2004), page 89, Figure 6.7
0.65	Coefficient "a" of High-Compaction Layer	From Stewart, et al (2004), page 89, Figure 6.7
0.80	Coefficient "b" of Erosion Protection/Topsoil Cover	From Stewart, et al (2004), page 88, Figure 6.6
0.65	Coefficient "b" of General Cover Soil	From Stewart, et al (2004), page 89, Figure 6.7
0.75	Coefficient "b" of High-Compaction Layer	From Stewart, et al (2004), page 89, Figure 6.7
0.04%	Strain threshold value of Erosion Protection/Topsoil Cover, γtv	From Stewart, et al (2004), page 88, Figure 6.6
0.03%	Strain threshold value of General Cover Soil, γtv	From Stewart, et al (2004), page 89, Figure 6.7
0.02%	Strain threshold value of High-Compaction Layer, γtv	From Stewart, et al (2004), page 89, Figure 6.7
0.32	Coefficient "R" of Erosion Protection/Topsoil Cover	From Stewart, et al (2004), page 88, for soils with low plasticity fines
0.34	Coefficient "R" of General Cover Soil	From Stewart, et al (2004), page 89, for soils with medium plasticity fines
0.34	Coefficient "R" of High-Compaction Layer	From Stewart, et al (2004), page 89, for soils with medium plasticity fines

Other

6.7%	Long-term moisture content of cover soil, w_{cover} (%)	Estimated based on measured 15bar water content. (UWM, 2012)
5.2%	Long-term moisture content of topsoil, $w_{topsoil}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
4.0%	Long-term moisture content of rock mulch, $w_{rockmulch}$ (%)	From Attachment H - Radon Emanation Modeling including with this submittal
0.14	Compression index of cover soil, $C_{c\text{-cover}}$	Calculated from empirical equation presented in Holtz and Kovacs, 1981. Page 341. $C_c = 0.30*(e_0\text{-}0.27)$
51%	Fines content of cover soil (%)	Mean value from laboratory analyses presented in previous response to interrogatories (EFRI, 2012)
11	Plasticity Index of cover soil, PI	Weighted Average from 2010 and 2012 laboratory testing (laboratory results presented in EFRI, 2012)
508	Shear Wave Velocity of Cover Soil, V_s (ft/sec)	Conservatively assumed to be the average of the shear wave velocities measured in Cell 2 tailings

SEISMIC PARAMETERS

0.15	Maximum horizontal acceleration at the ground surface, a_{max}/g	From Probabilistic Seismic Hazard Analysis (MWH, 2015a)
5.5	Magnitude of Design Event, M	From Probabilistic Seismic Hazard Analysis (MWH, 2015a)
20	Site-Source Distance, r (km)	From Probabilistic Seismic Hazard Analysis (MWH, 2015a)
1.00	Stress reduction factor, r_d	Conservatively assumed.
7.51	Equiv. Number of Uniform Strain Cycles, N	Calculated from Stewart, et al (2004), Equation 6.11, page 79, S parameter =0 since shallow soil and rock underlie the tailings (<20m) below tailings
594	Average shear wave velocity for cover, Vs (ft/s)	Conservatively estimated as upper bound average Vs for tailings in Cell 2 in October 2013 (Tailings Data Analysis Report. MWH, 2015b)
495	Average shear wave velocity for tailings (3' - 9.4'), Vs (ft/s)	Conservatively estimated as average Vs over depth range for tailings in Cell 2 in October 2013 (Tailings Data Analysis Report. MWH, 2015b)
460	Average shear wave velocity for tailings (9.4' - 14.4'), Vs (ft/s)	Conservatively estimated as average Vs over depth range for tailings in Cell 2 in October 2013 (Tailings Data Analysis Report. MWH, 2015b)
500	Average shear wave velocity for tailings (14.4' - 19.6'), Vs (ft/s)	Conservatively estimated as average Vs over depth range for tailings in Cell 2 in October 2013 (Tailings Data Analysis Report. MWH, 2015b)
538	Average shear wave velocity for tailings (19.6' - 24.7'), Vs (ft/s)	Conservatively estimated as average Vs over depth range for tailings in Cell 2 in October 2013 (Tailings Data Analysis Report. MWH, 2015b)
594	Average shear wave velocity for tailings (24.7' - liner), Vs (ft/s)	Conservatively estimated as average Vs over depth range for tailings in Cell 2 in October 2013 (Tailings Data Analysis Report. MWH, 2015b)

MISCELLANEOUS PARAMETERS

62.4	Unit Weight of Water, γ_W	
82.4	Atmospheric Pressure, P_a (kPa)	Calculated assuming elev=5600' amsl. http://www.engineeringtoolbox.com/air-altitude-pressure-d_462.html
1722.0	Atmospheric Pressure, P_a (psf)	Unit conversion calculation

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WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W2

Data File: 13-52106_SP2W2-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3 Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5613.10	Water surface elevation during CPT investigation (ft
5607.57	Water surface elevation at t_0 (ft amsl)
5598.51	Water surface elevation at t_1 (ft amsl)
5593.51	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Eartl
7.51	Equiv. Number of Uniform Strain Cycles, N
5615.85	Ground Surface Elevation at time of CPT (ft amsl)
5625.87	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
2.02	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1111.60	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5593.51	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5625.62	5625.37	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5623.62	5621.87	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5619.87	5617.87	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	######	5616.86	5615.85	2.02	0.050	101	0.556	0.505	0.00	0.00	0.556	0.505

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No
0.164	5615.69	19.0	0.292	19.0	2.8	1.22	1.53%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0
0.328	5615.52	27.6	0.767	27.6	3.0	1.32	2.78%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0
0.492	5615.36	63.0	1.250	63.0	2.6	1.13	1.98%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0
0.656	5615.19	130.6	1.407	130.6	1.2	0.53	1.08%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0
0.820	5615.03	202.3	0.922	202.3	2.2	0.96	0.46%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0
0.984	5614.87	189.1	1.391	189.0	4.1	1.77	0.74%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0
1.148	5614.70	207.8	1.514	207.8	0.1	0.04	0.73%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0
1.312	5614.54	81.3	1.745	81.3	0.7	0.29	2.15%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0
1.476	5614.37	52.5	1.382	52.5	-0.3	-0.14	2.63%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0
1.640	5614.21	40.7	1.041	40.7	0.1	0.02	2.56%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0
1.804	5614.05	34.3	0.916	34.3	-0.7	-0.29	2.67%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0
1.968	5613.88	64.5	1.005	64.5	0.8	0.33	1.56%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0
2.133	5613.72	88.7	1.082	88.7	0.0	0.00	1.22%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0
2.297	5613.55	88.1	1.355	88.1	0.0	0.00	1.54%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0
2.461	5613.39	81.2	1.017	81.2	0.2	0.08	1.25%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0
2.625	5613.23	71.1	0.910	71.1	0.7	0.32	1.28%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0
2.789	5613.06	61.0	0.753	61.0	-0.9	-0.37	1.24%	Interim Cover	0.050	100.7	0.14	0.00	0.14	1
2.953	5612.90	57.1	0.690	57.1	-0.9	-0.37	1.21%	Interim Cover	0.050	100.7	0.15	0.01	0.14	1
3.117	5612.73	50.5	0.655	50.5	-0.1	-0.05	1.30%	Interim Cover	0.050	100.7	0.16	0.01	0.15	1
3.281	5612.57	52.1	0.800	52.1	-0.1	-0.06	1.53%	Sand-Slime Tailing	0.059	119.0	0.17	0.02	0.15	1
3.445	5612.41	55.0	0.793	55.0	0.1	0.03	1.44%	Sand-Slime Tailing	0.059	119.0	0.18	0.02	0.15	1
3.609	5612.24	40.3	0.780	40.3	-1.0	-0.44	1.93%	Sand-Slime Tailing	0.059	119.0	0.19	0.03	0.16	1
3.773	5612.08	31.5	0.543	31.5	0.5	0.23	1.72%	Sand-Slime Tailing	0.059	119.0	0.20	0.03	0.16	1
3.937	5611.91	30.6	0.621	30.6	-0.2	-0.08	2.03%	Sand-Slime Tailing	0.059	119.0	0.21	0.04	0.17	1
4.101	5611.75	25.9	0.747	25.9	1.3	0.55	2.89%	Sand-Slime Tailing	0.059	119.0	0.22	0.04	0.17	1
4.265	5611.58	25.9	0.883	25.9	7.3	3.14	3.41%	Slime Tailings	0.057	113.1	0.22	0.05	0.18	1
4.429	5611.42	89.9	1.190	89.6	44.0	19.08	1.32%	Sand Tailings	0.062	123.5	0.23	0.05	0.18	1
4.593	5611.26	84.3	1.536	84.2	21.1	9.16	1.82%	Sand Tailings	0.062	123.5	0.25	0.06	0.19	1
4.757	5611.09	45.9	1.208	45.9	6.9	3.00	2.63%	Sand-Slime Tailing	0.059	119.0	0.25	0.06	0.19	1
4.921	5610.93	20.0	0.909	20.0	1.7	0.72	4.54%	Slime Tailings	0.057	113.1	0.26	0.07	0.20	1
5.085	5610.76	10.4	0.273	10.4	2.2	0.96	2.62%	Slime Tailings	0.057	113.1	0.27	0.07	0.20	1
5.249	5610.60	7.0	0.186	7.0	4.3	1.87	2.65%	Slime Tailings	0.057	113.1	0.28	0.08	0.20	1
5.413	5610.44	5.8	0.170	5.8	4.1	1.77	2.93%	Slime Tailings	0.057	113.1	0.29	0.08	0.21	1
5.577	5610.27	5.5	0.100	5.5	4.8	2.09	1.81%	Slime Tailings	0.057	113.1	0.30	0.09	0.21	1
5.741	5610.11	10.8	0.134	10.8	6.8	2.96	1.24%	Sand-Slime Tailing	0.059	119.0	0.31	0.09	0.22	1
5.905	5609.94	7.7	0.162	7.6	3.3	1.43	2.12%	Slime Tailings	0.057	113.1	0.32	0.10	0.22	1
6.069	5609.78	6.6	0.117	6.6	3.7	1.61	1.76%	Slime Tailings	0.057	113.1	0.33	0.10	0.23	1
6.234	5609.62	7.5	0.098	7.5	4.8	2.07	1.30%	Slime Tailings	0.057	113.1	0.34	0.11	0.23	1
6.398	5609.45	8.5	0.058	8.5	5.5	2.39	0.68%	Sand-Slime Tailing	0.059	119.0	0.35	0.11	0.23	1
6.562	5609.29	11.8	0.109	11.7	5.3	2.29	0.93%	Sand-Slime Tailing	0.059	119.0	0.36	0.12	0.24	1
6.726	5609.12	9.5	0.147	9.5	5.2	2.27	1.54%	Sand-Slime Tailing	0.059	119.0	0.37	0.12	0.24	1
6.890	5608.96	7.6	0.165	7.5	7.0	3.04	2.18%	Slime Tailings	0.057	113.1	0.38	0.13	0.25	1
7.054	5608.80	5.6	0.138	5.5	9.3	4.03	2.48%	Slime Tailings	0.057	113.1	0.39	0.13	0.25	1
7.218	5608.63	5.1	0.118	5.0	12.3	5.33	2.33%	Slime Tailings	0.057	113.1	0.40	0.14	0.26	1
7.382	5608.47	4.8	0.099	4.7	14.7	6.38	2.05%	Slime Tailings	0.057	113.1	0.41	0.14	0.26	1
7.546	5608.30	4.8	0.131	4.7	16.7	7.23	2.74%	Slime Tailings	0.057	113.1	0.41	0.15	0.26	1
7.710	5608.14	5.1	0.119	5.0	19.0	8.22	2.35%	Slime Tailings	0.057	113.1	0.42	0.15	0.27	1
7.874	5607.98	6.7	0.130	6.5	20.7	8.95	1.95%	Slime Tailings	0.057	113.1	0.43	0.16	0.27	1
8.038	5607.81	7.3	0.077	7.3	16.0	6.91	1.05%	Sand-Slime Tailing	0.059	119.0	0.44	0.16	0.28	1
8.202	5607.65	8.5	0.080	8.4	14.3	6.19	0.94%	Sand-Slime Tailing	0.059	119.0	0.45	0.17	0.28	1
8.366	5607.48	6.1	0.091	6.1	11.4	4.95	1.49%	Slime Tailings	0.057	113.1	0.46	0.18	0.29	1
8.530	5607.32	4.7	0.067	4.7	13.0	5.62	1.41%	Slime Tailings	0.057	113.1	0.47	0.18	0.29	1
8.694	5607.16	5.0	0.101	4.9	16.1	6.98	2.04%	Slime Tailings	0.057	113.1	0.48	0.19	0.29	1
8.858	5606.99	5.0	0.075	4.9	20.4	8.84	1.49%	Slime Tailings	0.057	113.1	0.49	0.19	0.30	1
9.022	5606.83	7.8	0.111	7.7	23.6	10.24	1.42%	Slime Tailings	0.057	113.1	0.50	0.20	0.30	1
9.186	5606.66	8.8	0.109	8.7	14.2	6.17	1.24%	Sand-Slime Tailing	0.059	119.0	0.51	0.20	0.31	1
9.350	5606.50	11.9	0.108	11.8	12.8	5.55	0.91%	Sand-Slime Tailing	0.059	119.0	0.52	0.21	0.31	1
9.514	5606.34	10.3	0.138	10.2	9.1	3.92	1.35%	Sand-Slime Tailing	0.059	119.0	0.53	0.21	0.32	1
9.678	5606.17	8.8	0.125	8.7	12.4	5.39	1.42%	Sand-Slime Tailing	0.059	119.0	0.54	0.22	0.32	1
9.842	5606.01	7.8	0.130	7.7	15.8	6.85	1.68%	Slime Tailings	0.057	113.1	0.55	0.22	0.33	1
10.006	5605.84	5.8	0.162	5.7	21.9	9.49	2.79%	Slime Tailings	0.057	113.1	0.56	0.23	0.33	1
10.170	5605.68	6.7	0.084	6.5	21.8	9.43	1.26%	Slime Tailings	0.057	113.1	0.57	0.23	0.33	1
10.335	5605.52	10.0	0.096	9.8	21.2	9.19	0.96%	Sand-Slime Tailing	0.059	119.0	0.58	0.24	0.34	1
10.499	5605.35	8.9	0.103	8.8	20.2	8.74	1.16%	Sand-Slime Tailing	0.059	119.0	0.59	0.24	0.34	1
10.663	5605.19	7.0	0.126	6.9	26.1	11.32	1.79%	Slime Tailings	0.057	113.1	0.59	0.25	0.35	1
10.827	5605.02	7.3	0.113	7.1	29.0	12.55	1.55%	Slime Tailings	0.057	113.1	0.60	0.25	0.35	1
10.991	5604.86	8.8	0.076	8.6	29.8	12.92	0.87%	Sand-Slime Tailing	0.059	119.0	0.61	0.26	0.36	1
11.155	5604.70	10.2	0.109	10.0	19.3	8.38	1.07%	Sand-Slime Tailing	0.059	119.0	0.62	0.26	0.36	1
11.319	5604.53	8.3	0.156	8.2	20.1	8.71	1.87%	Slime Tailings	0.057	113.1	0.63	0.27	0.37	1
11.483	5604.37	7.8	0.195	7.6	32.3	13.99	2.49%	Slime Tailings	0.057	113.1	0.64	0.27	0.37	1
11.647	5604.20	8.0	0.126	7.8	34.4	14.89	1.57%	Slime Tailings	0.057	113.1	0.65	0.28	0.37	1
11.811	5604.04	9.1	0.108	8.9	32.1	13.92	1.19%	Sand-Slime Tailing	0.059	119.0	0.66	0.28	0.38	1
11.975	5603.88	8.0	0.097	7.8	31.7	13.74	1.21%	Sand-Slime Tailing	0.059	119.0	0.67	0.29	0.38	1

CPT Data Interpretations (continued) / Conditions at t_1

Depth (ft)	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
0.164	1.70	32.317	449.21	37.57	2302	1.54%	1.4	51%	0.56	0.00	0.56	0
0.328	1.70	46.937	652.42	54.55	1671	2.78%	1.7	51%	0.57	0.00	0.57	0
0.492	1.70	107.100	######	124.42	2542	1.98%	1.5	51%	0.58	0.00	0.58	0
0.656	1.70	221.952	######	257.80	3950	1.08%	1.3	51%	0.59	0.00	0.59	0
0.820	1.70	343.859	######	399.40	4896	0.46%	0.9	51%	0.60	0.00	0.60	0
0.984	1.70	321.351	######	373.28	3813	0.74%	1.1	51%	0.61	0.00	0.61	0
1.148	1.70	353.311	######	410.35	3593	0.73%	1.1	51%	0.61	0.00	0.61	0
1.312	1.70	138.142	######	160.45	1229	2.15%	1.6	51%	0.62	0.00	0.62	0
1.476	1.70	89.284	######	103.69	705	2.64%	1.8	51%	0.63	0.00	0.63	0
1.640	1.70	69.241	962.45	80.42	492	2.56%	1.8	51%	0.64	0.00	0.64	0
1.804	1.70	58.310	810.51	67.72	376	2.68%	1.9	51%	0.65	0.00	0.65	0
1.968	1.70	109.582	######	127.28	649	1.56%	1.6	51%	0.65	0.00	0.65	0
2.133	1.70	150.858	######	175.21	825	1.22%	1.4	51%	0.66	0.00	0.66	0
2.297	1.70	149.685	######	173.85	760	1.54%	1.5	51%	0.67	0.00	0.67	0
2.461	1.70	138.091	######	160.39	655	1.25%	1.5	51%	0.68	0.00	0.68	0
2.625	1.70	120.887	######	140.41	537	1.28%	1.5	51%	0.69	0.00	0.69	0
2.789	1.70	103.632	######	120.35	437	1.24%	1.6	51%	0.70	0.00	0.70	0
2.953	1.70	97.036	######	112.69	400	1.21%	1.6	51%	0.70	0.00	0.70	0
3.117	1.70	85.782	######	99.63	346	1.30%	1.6	51%	0.71	0.00	0.71	0
3.281	1.70	88.604	######	102.91	346	1.54%	1.7	47%	0.72	0.00	0.72	0
3.445	1.70	93.449	######	108.54	354	1.45%	1.7	47%	0.73	0.00	0.73	0
3.609	1.70	68.544	952.76	79.60	252	1.94%	1.8	47%	0.74	0.00	0.74	0
3.773	1.70	53.584	744.82	62.24	191	1.73%	1.9	47%	0.75	0.00	0.75	0
3.937	1.70	52.088	724.02	60.49	180	2.04%	2.0	47%	0.76	0.00	0.76	0
4.101	1.70	43.962	611.07	51.07	148	2.91%	2.1	47%	0.77	0.00	0.77	0
4.265	1.70	43.979	611.31	51.17	145	3.44%	2.2	71%	0.78	0.00	0.78	0
4.429	1.70	152.354	######	177.49	491	1.33%	1.6	18%	0.79	0.00	0.79	0
4.593	1.70	143.140	######	166.51	448	1.83%	1.7	18%	0.80	0.00	0.80	0
4.757	1.70	78.030	######	90.71	238	2.64%	2.0	47%	0.81	0.00	0.81	0
4.921	1.70	34.051	473.31	39.57	101	4.60%	2.4	71%	0.82	0.00	0.82	0
5.085	1.70	17.697	245.99	20.58	51	2.69%	2.4	71%	0.83	0.00	0.83	0
5.249	1.70	11.866	164.94	13.83	33	2.77%	2.6	71%	0.84	0.00	0.84	0
5.413	1.70	9.809	136.35	11.44	26	3.09%	2.7	71%	0.85	0.00	0.85	0
5.577	1.70	9.367	130.20	10.94	25	1.91%	2.6	71%	0.86	0.00	0.86	0
5.741	1.70	18.360	255.20	21.41	48	1.27%	2.2	47%	0.87	0.00	0.87	0
5.905	1.70	12.971	180.30	15.11	33	2.21%	2.5	71%	0.88	0.00	0.88	0
6.069	1.70	11.254	156.43	13.12	28	1.85%	2.5	71%	0.89	0.00	0.89	0
6.234	1.70	12.767	177.46	14.89	31	1.36%	2.4	71%	0.89	0.00	0.89	0
6.398	1.70	14.399	200.15	16.79	35	0.71%	2.2	47%	0.90	0.00	0.90	0
6.562	1.70	19.941	277.18	23.23	48	0.96%	2.2	47%	0.91	0.00	0.91	0
6.726	1.70	16.150	224.49	18.82	38	1.60%	2.4	47%	0.92	0.00	0.92	0
6.890	1.70	12.801	177.93	14.95	29	2.29%	2.6	71%	0.93	0.00	0.93	0
7.054	1.70	9.350	129.97	10.97	20	2.67%	2.7	71%	0.94	0.00	0.94	0
7.218	1.70	8.483	117.91	10.00	18	2.53%	2.7	71%	0.95	0.00	0.95	0
7.382	1.70	8.058	112.01	9.54	17	2.24%	2.7	71%	0.96	0.00	0.96	0
7.546	1.70	7.956	110.59	9.45	16	3.00%	2.8	71%	0.97	0.00	0.97	0
7.710	1.70	8.415	116.97	10.01	17	2.56%	2.8	71%	0.98	0.00	0.98	0
7.874	1.70	11.118	154.54	13.17	23	2.08%	2.6	71%	0.99	0.00	0.99	0
8.038	1.70	12.325	171.32	14.51	25	1.11%	2.4	47%	1.00	0.00	1.00	0
8.202	1.70	14.297	198.73	16.78	28	0.99%	2.4	47%	1.01	0.00	1.01	0
8.366	1.70	10.285	142.96	12.09	20	1.61%	2.6	71%	1.02	0.00	1.02	0
8.530	1.70	7.922	110.12	9.36	15	1.57%	2.7	71%	1.03	0.00	1.03	0
8.694	1.70	8.245	114.61	9.77	15	2.26%	2.8	71%	1.04	0.00	1.04	0
8.858	1.70	8.364	116.26	9.97	15	1.65%	2.7	71%	1.05	0.00	1.05	0
9.022	1.70	13.022	181.01	15.42	24	1.52%	2.5	71%	1.05	0.00	1.05	0
9.186	1.70	14.739	204.87	17.29	27	1.32%	2.4	47%	1.06	0.00	1.06	0
9.350	1.70	20.043	278.60	23.44	36	0.95%	2.3	47%	1.07	0.00	1.07	0
9.514	1.70	17.340	241.03	20.25	31	1.42%	2.4	47%	1.08	0.00	1.08	0
9.678	1.70	14.858	206.53	17.41	26	1.51%	2.5	47%	1.09	0.00	1.09	0
9.842	1.70	13.022	181.01	15.32	22	1.80%	2.6	71%	1.10	0.00	1.10	0
10.006	1.70	9.656	134.22	11.48	16	3.08%	2.8	71%	1.11	0.00	1.11	0
10.170	1.70	11.101	154.30	13.16	18	1.38%	2.6	71%	1.12	0.00	1.12	0
10.335	1.70	16.728	232.52	19.69	28	1.02%	2.4	47%	1.13	0.00	1.13	0
10.499	1.70	14.892	207.00	17.54	24	1.24%	2.5	47%	1.14	0.00	1.14	0
10.663	1.70	11.662	162.10	13.87	18	1.96%	2.7	71%	1.15	0.00	1.15	0
10.827	1.70	12.087	168.01	14.40	19	1.69%	2.6	71%	1.16	0.00	1.16	0
10.991	1.70	14.586	202.75	17.31	23	0.93%	2.4	47%	1.17	0.00	1.17	0
11.155	1.70	17.068	237.25	20.06	26	1.14%	2.4	47%	1.18	0.00	1.18	0
11.319	1.70	13.940	193.77	16.44	21	2.03%	2.6	71%	1.19	0.00	1.19	0
11.483	1.70	12.971	180.30	15.46	19	2.71%	2.7	71%	1.20	0.00	1.20	0
11.647	1.70	13.311	185.02	15.88	20	1.70%	2.6	71%	1.21	0.00	1.21	0
11.811	1.70	15.045	209.13	17.87	22	1.29%	2.5	47%	1.22	0.00	1.22	0
11.975	1.70	13.311	185.02	15.85	19	1.32%	2.6	47%	1.23	0.00	1.23	0

Liquefaction Triggering Analyses — Idriss & Boulanger (2008)

Depth (ft)	r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS
0.164	1.00	0.06	1.03	1.0	0.059	43.50	81.07	0.114	1.92
0.328	1.00	0.07	1.03	1.0	0.060	49.46	104.02	0.149	2.51
0.492	1.00	0.13	1.05	1.0	0.061	73.98	198.41	1.000	16.46
0.656	1.00	0.30	1.10	1.0	0.064	120.79	378.59	1.000	15.73
0.820	1.00	0.30	1.10	1.0	0.064	170.48	569.88	1.000	15.73
0.984	1.00	0.30	1.10	1.0	0.064	161.32	534.60	1.000	15.73
1.148	1.00	0.30	1.10	1.0	0.064	174.33	584.68	1.000	15.73
1.312	1.00	0.18	1.06	1.0	0.061	86.53	247.08	1.000	16.36
1.476	1.00	0.11	1.03	1.0	0.060	66.71	170.40	0.412	6.88
1.640	1.00	0.09	1.03	1.0	0.059	58.54	138.96	0.229	3.86
1.804	1.00	0.08	1.02	1.0	0.059	54.08	121.80	0.183	3.10
1.968	1.00	0.13	1.04	1.0	0.060	74.99	202.27	1.000	16.71
2.133	1.00	0.20	1.05	1.0	0.061	91.81	267.02	1.000	16.46
2.297	1.00	0.20	1.05	1.0	0.061	91.33	265.18	1.000	16.52
2.461	1.00	0.18	1.04	1.0	0.060	86.61	246.99	1.000	16.67
2.625	1.00	0.15	1.03	1.0	0.059	79.60	220.01	1.000	16.82
2.789	0.99	0.12	1.03	1.0	0.059	72.56	192.91	0.840	14.23
2.953	0.99	0.12	1.02	1.0	0.059	69.87	182.56	0.580	9.86
3.117	0.99	0.11	1.02	1.0	0.059	65.28	164.91	0.362	6.18
3.281	0.99	0.11	1.02	1.0	0.058	66.39	169.30	0.401	6.85
3.445	0.99	0.11	1.02	1.0	0.058	68.37	176.90	0.489	8.38
3.609	0.99	0.09	1.01	1.0	0.058	58.22	137.81	0.225	3.88
3.773	0.99	0.08	1.01	1.0	0.058	52.13	114.37	0.168	2.91
3.937	0.99	0.08	1.01	1.0	0.058	51.52	112.01	0.164	2.84
4.101	0.99	0.07	1.01	1.0	0.058	48.21	99.29	0.141	2.46
4.265	0.99	0.07	1.01	1.0	0.057	47.91	99.07	0.141	2.45
4.429	0.99	0.21	1.02	1.0	0.058	67.47	244.96	1.000	17.24
4.593	0.98	0.19	1.01	1.0	0.058	64.66	231.17	1.000	17.33
4.757	0.98	0.10	1.01	1.0	0.057	62.12	152.83	0.285	4.98
4.921	0.98	0.06	1.00	1.0	0.057	43.87	83.44	0.117	2.06
5.085	0.98	0.05	1.00	1.0	0.057	37.25	57.84	0.085	1.50
5.249	0.98	0.05	1.00	1.0	0.057	34.91	48.74	0.076	1.34
5.413	0.98	0.05	1.00	1.0	0.057	34.07	45.52	0.073	1.29
5.577	0.98	0.05	1.00	1.0	0.057	33.90	44.84	0.073	1.28
5.741	0.98	0.05	1.00	1.0	0.057	37.81	59.22	0.087	1.54
5.905	0.98	0.05	1.00	1.0	0.056	35.35	50.45	0.078	1.38
6.069	0.98	0.05	1.00	1.0	0.056	34.66	47.77	0.075	1.34
6.234	0.98	0.05	1.00	1.0	0.056	35.27	50.16	0.078	1.38
6.398	0.97	0.05	1.00	1.0	0.056	36.19	52.98	0.080	1.43
6.562	0.97	0.05	1.00	1.0	0.056	38.45	61.67	0.090	1.60
6.726	0.97	0.05	1.00	1.0	0.056	36.90	55.72	0.083	1.49
6.890	0.97	0.05	1.00	1.0	0.056	35.30	50.25	0.078	1.39
7.054	0.97	0.05	1.00	1.0	0.056	33.91	44.88	0.073	1.30
7.218	0.97	0.05	1.00	1.0	0.056	33.57	43.58	0.072	1.28
7.382	0.97	0.04	1.00	1.0	0.056	33.41	42.95	0.071	1.28
7.546	0.97	0.04	0.99	1.0	0.056	33.38	42.82	0.071	1.28
7.710	0.97	0.05	0.99	1.0	0.056	33.57	43.58	0.072	1.29
7.874	0.96	0.05	0.99	1.0	0.055	34.67	47.84	0.075	1.36
8.038	0.96	0.05	0.99	1.0	0.055	35.39	49.90	0.077	1.40
8.202	0.96	0.05	0.99	1.0	0.055	36.19	52.97	0.080	1.46
8.366	0.96	0.05	0.99	1.0	0.055	34.30	46.38	0.074	1.34
8.530	0.96	0.04	0.99	1.0	0.055	33.35	42.71	0.071	1.29
8.694	0.96	0.05	0.99	1.0	0.055	33.49	43.27	0.071	1.30
8.858	0.96	0.05	0.99	1.0	0.055	33.56	43.52	0.072	1.30
9.022	0.96	0.05	0.99	1.0	0.055	35.46	50.87	0.078	1.43
9.186	0.96	0.05	0.99	1.0	0.055	36.37	53.66	0.081	1.48
9.350	0.96	0.05	0.99	1.0	0.055	38.52	61.96	0.090	1.65
9.514	0.95	0.05	0.99	1.0	0.054	37.40	57.65	0.085	1.57
9.678	0.95	0.05	0.99	1.0	0.054	36.41	53.82	0.081	1.49
9.842	0.95	0.05	0.99	1.0	0.054	35.42	50.74	0.078	1.44
10.006	0.95	0.05	0.99	1.0	0.054	34.09	45.57	0.073	1.35
10.170	0.95	0.05	0.99	1.0	0.054	34.67	47.83	0.075	1.39
10.335	0.95	0.05	0.99	1.0	0.054	37.21	56.90	0.084	1.56
10.499	0.95	0.05	0.99	1.0	0.054	36.45	54.00	0.081	1.51
10.663	0.95	0.05	0.99	1.0	0.054	34.92	48.78	0.076	1.41
10.827	0.95	0.05	0.99	1.0	0.054	35.10	49.50	0.077	1.43
10.991	0.94	0.05	0.98	1.0	0.054	36.37	53.68	0.081	1.51
11.155	0.94	0.05	0.98	1.0	0.054	37.34	57.40	0.085	1.59
11.319	0.94	0.05	0.98	1.0	0.054	35.81	52.25	0.080	1.49
11.483	0.94	0.05	0.98	1.0	0.054	35.47	50.94	0.078	1.47
11.647	0.94	0.05	0.98	1.0	0.053	35.62	51.50	0.079	1.48
11.811	0.94	0.05	0.98	1.0	0.053	36.57	54.44	0.082	1.54
11.975	0.94	0.05	0.98	1.0	0.053	35.86	51.71	0.079	1.49

Liquefaction Triggering Analyses — Youd et al. (2001)

Depth (ft)	r_d	D_r	f	K_σ	K_a	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
0.164	0.98	0.35	0.80	2.53	1.0	0.017	1.00	37.57	0.081	196.84	99.38	2
0.328	0.98	0.43	0.79	2.32	1.0	0.019	1.03	55.95	0.096	116.62	59.56	2
0.492	0.98	0.64	0.68	3.13	1.0	0.014	1.00	124.42	0.259	209.31	112.89	2
0.656	0.98	0.93	0.60	3.68	1.0	0.012	1.00	257.80	1.000	606.04	310.88	2
0.820	0.97	1.15	0.60	3.37	1.0	0.013	1.00	399.40	1.000	485.02	250.37	2
0.984	0.97	1.12	0.60	3.13	1.0	0.014	1.00	373.28	1.000	404.34	210.03	2
1.148	0.97	1.17	0.60	2.95	1.0	0.015	1.00	410.35	1.000	346.72	181.22	2
1.312	0.97	0.73	0.63	2.56	1.0	0.017	1.00	160.45	1.000	303.50	159.93	2
1.476	0.97	0.59	0.71	2.05	1.0	0.021	1.07	111.44	0.209	56.33	31.61	2
1.640	0.97	0.52	0.74	1.83	1.0	0.023	1.11	89.28	0.146	35.52	19.69	2
1.804	0.97	0.48	0.76	1.71	1.0	0.025	1.17	78.96	0.126	27.80	15.45	2
1.968	0.97	0.65	0.67	2.02	1.0	0.021	1.00	127.28	0.272	55.07	35.89	2
2.133	0.97	0.76	0.62	2.22	1.0	0.019	1.00	175.21	1.000	187.13	101.80	2
2.297	0.97	0.76	0.62	2.15	1.0	0.020	1.00	173.85	1.000	173.84	95.18	2
2.461	0.97	0.73	0.63	2.03	1.0	0.021	1.00	160.39	1.000	162.31	89.49	2
2.625	0.97	0.68	0.66	1.90	1.0	0.023	1.00	140.41	0.337	51.37	34.09	2
2.789	0.97	0.63	0.68	1.78	1.0	0.024	1.00	120.35	0.242	35.00	24.61	2
2.953	0.97	0.61	0.69	1.74	1.0	0.025	1.00	112.69	0.213	30.14	20.00	2
3.117	0.97	0.58	0.71	1.67	1.0	0.026	1.00	99.63	0.172	23.81	14.99	2
3.281	0.97	0.59	0.71	1.67	1.0	0.026	1.03	105.93	0.191	25.57	16.21	2
3.445	0.97	0.60	0.70	1.68	1.0	0.025	1.01	109.63	0.203	26.38	17.38	2
3.609	0.97	0.52	0.74	1.54	1.0	0.028	1.14	91.09	0.150	19.01	11.45	2
3.773	0.97	0.46	0.77	1.46	1.0	0.029	1.17	72.98	0.116	14.28	8.59	2
3.937	0.97	0.45	0.78	1.44	1.0	0.030	1.24	75.19	0.120	14.30	8.57	2
4.101	0.97	0.41	0.79	1.39	1.0	0.031	1.51	76.95	0.122	14.26	8.36	2
4.265	0.97	0.41	0.79	1.39	1.0	0.031	1.64	84.13	0.135	15.41	8.93	2
4.429	0.97	0.77	0.62	1.82	1.0	0.023	1.00	177.49	1.000	110.72	63.98	2
4.593	0.97	0.75	0.63	1.76	1.0	0.024	1.03	171.98	1.000	107.80	62.57	2
4.757	0.97	0.55	0.73	1.51	1.0	0.028	1.27	114.89	0.221	23.26	14.12	2
4.921	0.97	0.36	0.80	1.34	1.0	0.032	2.26	89.35	0.146	15.08	8.57	2
5.085	0.96	0.26	0.80	1.34	1.0	0.032	2.38	48.99	0.091	9.17	5.34	2
5.249	0.96	0.21	0.80	1.33	1.0	0.032	3.12	43.13	0.086	8.50	4.92	2
5.413	0.96	0.20	0.80	1.33	1.0	0.032	3.77	43.19	0.086	8.34	4.82	2
5.577	0.96	0.19	0.80	1.32	1.0	0.032	3.11	34.07	0.078	7.46	4.37	2
5.741	0.96	0.27	0.80	1.32	1.0	0.032	1.72	36.93	0.081	7.52	4.53	2
5.905	0.96	0.22	0.80	1.31	1.0	0.032	2.77	41.86	0.085	7.76	4.57	2
6.069	0.96	0.21	0.80	1.31	1.0	0.032	2.83	37.11	0.081	7.27	4.30	2
6.234	0.96	0.22	0.80	1.30	1.0	0.033	2.29	34.07	0.078	6.91	4.15	2
6.398	0.96	0.24	0.80	1.30	1.0	0.033	1.68	28.28	0.074	6.36	3.90	2
6.562	0.96	0.28	0.80	1.29	1.0	0.033	1.57	36.41	0.080	6.82	4.21	2
6.726	0.96	0.25	0.80	1.29	1.0	0.033	2.20	41.40	0.084	7.04	4.26	2
6.890	0.96	0.22	0.80	1.28	1.0	0.033	3.06	45.80	0.088	7.22	4.31	2
7.054	0.96	0.19	0.80	1.28	1.0	0.033	4.10	45.03	0.088	7.05	4.18	2
7.218	0.96	0.18	0.80	1.27	1.0	0.033	4.31	43.09	0.086	6.81	4.05	2
7.382	0.96	0.18	0.80	1.27	1.0	0.033	4.26	40.64	0.084	6.55	3.91	2
7.546	0.96	0.18	0.80	1.27	1.0	0.033	4.96	46.83	0.089	6.84	4.06	2
7.710	0.96	0.18	0.80	1.26	1.0	0.033	4.48	44.87	0.087	6.62	3.95	2
7.874	0.96	0.21	0.80	1.26	1.0	0.034	3.41	44.85	0.087	6.52	3.94	2
8.038	0.96	0.22	0.80	1.25	1.0	0.034	2.44	35.45	0.080	5.84	3.62	2
8.202	0.96	0.24	0.80	1.25	1.0	0.034	2.14	35.85	0.080	5.77	3.61	2
8.366	0.96	0.20	0.80	1.25	1.0	0.034	3.33	40.24	0.084	5.95	3.64	2
8.530	0.96	0.18	0.80	1.24	1.0	0.034	4.02	37.64	0.081	5.71	3.50	2
8.694	0.96	0.18	0.80	1.24	1.0	0.034	4.60	44.99	0.087	6.06	3.68	2
8.858	0.96	0.18	0.80	1.24	1.0	0.034	4.00	39.87	0.083	5.68	3.49	2
9.022	0.96	0.23	0.80	1.23	1.0	0.034	2.84	43.84	0.087	5.83	3.63	2
9.186	0.96	0.24	0.80	1.23	1.0	0.034	2.50	43.16	0.086	5.71	3.60	2
9.350	0.95	0.28	0.80	1.22	1.0	0.034	1.81	42.45	0.085	5.59	3.62	2
9.514	0.95	0.26	0.80	1.22	1.0	0.034	2.36	47.79	0.090	5.79	3.68	2
9.678	0.95	0.24	0.80	1.22	1.0	0.035	2.72	47.30	0.089	5.69	3.59	2
9.842	0.95	0.23	0.80	1.21	1.0	0.035	3.25	49.79	0.091	5.75	3.59	2
10.006	0.95	0.20	0.80	1.21	1.0	0.035	5.13	58.89	0.099	6.14	3.75	2
10.170	0.95	0.21	0.80	1.21	1.0	0.035	3.29	43.25	0.086	5.27	3.33	2
10.335	0.95	0.26	0.80	1.20	1.0	0.035	2.20	43.26	0.086	5.20	3.38	2
10.499	0.95	0.24	0.80	1.20	1.0	0.035	2.60	45.66	0.088	5.26	3.38	2
10.663	0.95	0.21	0.80	1.20	1.0	0.035	3.80	52.67	0.094	5.52	3.47	2
10.827	0.95	0.22	0.80	1.20	1.0	0.035	3.49	50.26	0.092	5.36	3.39	2
10.991	0.95	0.24	0.80	1.19	1.0	0.035	2.41	41.68	0.085	4.88	3.19	2
11.155	0.95	0.26	0.80	1.19	1.0	0.035	2.37	47.58	0.090	5.10	3.34	2
11.319	0.95	0.23	0.80	1.19	1.0	0.035	3.54	58.25	0.098	5.53	3.51	2
11.483	0.95	0.23	0.80	1.18	1.0	0.035	4.27	66.05	0.107	5.94	3.70	2
11.647	0.95	0.23	0.80	1.18	1.0	0.035	3.41	54.19	0.095	5.22	3.35	2
11.811	0.95	0.24	0.80	1.18	1.0	0.035	2.80	50.01	0.092	4.98	3.26	2
11.975	0.95	0.23	0.80	1.18	1.0	0.036	3.12	49.38	0.091	4.90	3.19	2

Idriss & Boulanger (2008)

Depth (ft)	CN	qc1 TSF	qc1 MPa	qc1N
0.164	1.7	32.347	3.0969	37.569
0.328	1.7	46.969	4.4968	54.552
0.492	1.7	107.13	10.256	124.422
0.656	1.7	221.97	21.251	257.799
0.820	1.7	343.88	32.923	399.399
0.984	1.7	321.39	30.77	373.280
1.148	1.7	353.31	33.826	410.351
1.312	1.7	138.15	13.226	160.452
1.476	1.7	89.281	8.5477	103.694
1.640	1.7	69.242	6.6292	80.420
1.804	1.7	58.303	5.5819	67.715
1.968	1.7	109.59	10.492	127.282
2.133	1.7	150.86	14.443	175.213
2.297	1.7	149.69	14.331	173.850
2.461	1.7	138.09	13.221	160.387
2.625	1.7	120.89	11.574	140.412
2.789	1.7	103.62	9.9209	120.352
2.953	1.7	97.027	9.2894	112.691
3.117	1.7	85.781	8.2126	99.629
3.281	1.7	88.603	8.4828	102.907
3.445	1.7	93.45	8.9469	108.536
3.609	1.7	68.533	6.5614	79.597
3.773	1.7	53.59	5.1307	62.241
3.937	1.7	52.086	4.9867	60.495
4.101	1.7	43.975	4.2102	51.075
4.265	1.7	44.056	4.2179	51.168
4.429	1.7	152.82	14.631	177.493
4.593	1.7	143.36	13.726	166.509
4.757	1.7	78.104	7.4776	90.713
4.921	1.7	34.069	3.2617	39.569
5.085	1.7	17.721	1.6966	20.581
5.249	1.7	11.912	1.1404	13.835
5.413	1.7	9.8523	0.9433	11.443
5.577	1.7	9.4182	0.9017	10.939
5.741	1.7	18.432	1.7647	21.408
5.905	1.7	13.006	1.2452	15.106
6.069	1.7	11.293	1.0812	13.117
6.234	1.7	12.818	1.2272	14.887
6.398	1.7	14.458	1.3842	16.792
6.562	1.7	19.997	1.9145	23.225
6.726	1.7	16.206	1.5515	18.822
6.890	1.7	12.875	1.2327	14.954
7.054	1.7	9.4487	0.9046	10.974
7.218	1.7	8.6134	0.8246	10.004
7.382	1.7	8.2142	0.7864	9.540
7.546	1.7	8.133	0.7787	9.446
7.710	1.7	8.6163	0.8249	10.007
7.874	1.7	11.337	1.0854	13.167
8.038	1.7	12.494	1.1962	14.511
8.202	1.7	14.449	1.3833	16.781
8.366	1.7	10.406	0.9963	12.086
8.530	1.7	8.0596	0.7716	9.361
8.694	1.7	8.4159	0.8057	9.775
8.858	1.7	8.5806	0.8215	9.966
9.022	1.7	13.273	1.2707	15.416
9.186	1.7	14.89	1.4256	17.294
9.350	1.7	20.179	1.9319	23.437
9.514	1.7	17.436	1.6693	20.251
9.678	1.7	14.99	1.4351	17.410
9.842	1.7	13.19	1.2628	15.319
10.006	1.7	9.8884	0.9467	11.485
10.170	1.7	11.332	1.0849	13.161
10.335	1.7	16.953	1.6231	19.690
10.499	1.7	15.106	1.4462	17.545
10.663	1.7	11.939	1.1431	13.867
10.827	1.7	12.394	1.1866	14.395
10.991	1.7	14.902	1.4268	17.308
11.155	1.7	17.273	1.6537	20.062
11.319	1.7	14.153	1.355	16.438
11.483	1.7	13.314	1.2747	15.463
11.647	1.7	13.676	1.3093	15.883
11.811	1.7	15.386	1.4731	17.870
11.975	1.7	13.648	1.3066	15.851

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W2

Data File: 13-52106_SP2W2-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend
Tailings Sands
Tailings Sand-Slimes
Tailings Slimes
Interim Cover
Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69

Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5613.10	Water surface elevation during CPT investigation (ft
5607.57	Water surface elevation at t_0 (ft amsl)
5598.51	Water surface elevation at t_1 (ft amsl)
5593.51	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Eartl
7.51	Equiv. Number of Uniform Strain Cycles, N

Value	Parameter
5615.85	Ground Surface Elevation at time of CPT (ft amsl)
5625.87	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
2.02	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1111.60	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5593.51	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5625.62	5625.37	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5623.62	5621.87	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5619.87	5617.87	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	######	5616.86	5615.85	2.02	0.050	101	0.556	0.505	0.00	0.00	0.556	0.505

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
12.139	5603.71	7.7	0.106	7.5	40.4	17.50	1.37%	Slime Tailings	0.057	113.1	0.68	0.29	0.39	1	1.70	12.682	176.28	15.23	18	1.51%	2.6	71%	1.24	0.00	1.24	0
12.303	5603.55	7.1	0.110	6.8	39.6	17.17	1.56%	Slime Tailings	0.057	113.1	0.69	0.30	0.39	1	1.70	11.594	161.16	13.95	16	1.72%	2.7	71%	1.25	0.00	1.25	0
12.467	5603.38	6.8	0.107	6.6	37.4	16.22	1.57%	Slime Tailings	0.057	113.1	0.70	0.30	0.40	1	1.70	11.169	155.25	13.43	15	1.75%	2.7	71%	1.25	0.00	1.25	0
12.631	5603.22	7.0	0.092	6.8	30.6	13.25	1.32%	Slime Tailings	0.057	113.1	0.71	0.31	0.40	1	1.70	11.543	160.45	13.78	16	1.47%	2.7	71%	1.26	0.00	1.26	0
12.795	5603.05	6.2	0.105	6.0	36.6	15.85	1.68%	Slime Tailings	0.057	113.1	0.72	0.31	0.40	1	1.70	10.234	142.25	12.34	14	1.90%	2.8	71%	1.27	0.00	1.27	0
12.959	5602.89	7.8	0.124	7.5	43.8	18.98	1.60%	Slime Tailings	0.057	113.1	0.73	0.32	0.41	1	1.70	12.733	176.99	15.33	17	1.76%	2.7	71%	1.28	0.00	1.28	0
13.123	5602.73	10.5	0.147	10.3	32.1	13.89	1.40%	Sand-Slime Tailing	0.059	119.0	0.74	0.32	0.41	1	1.70	17.493	243.15	20.71	24	1.51%	2.5	47%	1.29	0.00	1.29	0
13.287	5602.56	8.1	0.177	8.0	30.0	13.02	2.18%	Slime Tailings	0.057	113.1	0.75	0.33	0.42	1	1.70	13.515	187.86	16.07	18	2.39%	2.7	71%	1.30	0.00	1.30	0
13.451	5602.40	6.8	0.135	6.6	34.3	14.86	1.98%	Slime Tailings	0.057	113.1	0.75	0.33	0.42	1	1.70	11.237	156.19	13.47	14	2.22%	2.8	71%	1.31	0.00	1.31	0
13.615	5602.23	7.9	0.138	7.7	36.4	15.78	1.74%	Slime Tailings	0.057	113.1	0.76	0.34	0.43	1	1.70	13.073	181.71	15.63	17	1.93%	2.7	71%	1.32	0.00	1.32	0
13.779	5602.07	6.3	0.125	6.2	26.0	11.28	1.97%	Slime Tailings	0.057	113.1	0.77	0.34	0.43	1	1.70	10.489	145.80	12.50	13	2.25%	2.8	71%	1.33	0.00	1.33	0
13.943	5601.91	8.1	0.120	7.9	29.9	12.95	1.49%	Slime Tailings	0.057	113.1	0.78	0.35	0.43	1	1.70	13.413	186.44	15.95	17	1.65%	2.7	71%	1.34	0.00	1.34	0
14.107	5601.74	16.0	0.167	16.0	7.3	3.14	1.04%	Sand-Slime Tailing	0.059	119.0	0.79	0.35	0.44	1	1.63	26.112	362.96	30.41	35	1.09%	2.3	47%	1.35	0.00	1.35	0
14.271	5601.58	12.3	0.154	12.2	9.6	4.16	1.25%	Sand-Slime Tailing	0.059	119.0	0.80	0.36	0.44	1	1.66	20.342	282.76	23.74	26	1.34%	2.5	47%	1.36	0.00	1.36	0
14.436	5601.41	9.4	0.143	9.3	15.0	6.48	1.52%	Sand-Slime Tailing	0.059	119.0	0.81	0.36	0.45	1	1.67	15.535	215.94	18.22	19	1.66%	2.6	47%	1.37	0.00	1.37	0
14.600	5601.25	7.8	0.109	7.7	29.2	12.64	1.39%	Slime Tailings	0.057	113.1	0.82	0.37	0.45	1	1.66	12.673	176.16	15.07	16	1.55%	2.7	71%	1.38	0.00	1.38	0
14.764	5601.09	7.9	0.092	7.6	52.5	22.75	1.16%	Sand-Slime Tailing	0.059	119.0	0.83	0.37	0.46	1	1.64	12.474	173.39	15.11	16	1.30%	2.6	47%	1.39	0.00	1.39	0
14.928	5600.92	7.5	0.153	7.1	63.0	27.30	2.03%	Slime Tailings	0.057	113.1	0.84	0.38	0.46	1	1.63	11.651	161.95	14.28	15	2.29%	2.8	71%	1.40	0.00	1.40	0
15.092	5600.76	7.7	0.237	7.3	69.8	30.26	3.08%	Slime Tailings	0.057	113.1	0.85	0.39	0.46	1	1.62	11.780	163.74	14.50	15	3.46%	2.9	71%	1.41	0.00	1.41	0
15.256	5600.59	9.1	0.255	9.0	23.2	10.06	2.79%	Slime Tailings	0.057	113.1	0.86	0.39	0.47	1	1.61	14.482	201.30	17.09	18	3.08%	2.8	71%	1.41	0.00	1.41	0
15.420	5600.43	10.0	0.246	9.8	31.0	13.41	2.45%	Slime Tailings	0.057	113.1	0.87	0.40	0.47	1	1.60	15.709	218.35	18.60	19	2.69%	2.7	71%	1.42	0.00	1.42	0
15.584	5600.27	9.3	0.199	9.1	28.5	12.35	2.14%	Slime Tailings	0.057	113.1	0.88	0.40	0.48	1	1.59	14.475	201.20	17.14	18	2.36%	2.7	71%	1.43	0.00	1.43	0
15.748	5600.10	9.5	0.138	9.2	48.8	21.16	1.45%	Sand-Slime Tailing	0.059	119.0	0.89	0.41	0.48	1	1.58	14.476	201.21	17.37	18	1.60%	2.6	47%	1.44	0.00	1.44	0
15.912	5599.94	9.5	0.075	9.3	47.2	20.47	0.79%	Sand-Slime Tailing	0.059	119.0	0.90	0.41	0.49	1	1.56	14.461	201.01	17.33	18	0.87%	2.5	47%	1.45	0.00	1.45	0
16.076	5599.77	10.5	0.072	10.3	43.2	18.73	0.68%	Sand-Slime Tailing	0.059	119.0	0.91	0.42	0.49	1	1.55	15.937	221.53	19.00	20	0.75%	2.4	47%	1.46	0.00	1.46	0
16.240	5599.61	29.3	0.191	29.0	50.3	21.81	0.65%	Sand-Slime Tailing	0.059	119.0	0.92	0.42	0.50	1	1.43	41.329	574.48	48.52	57	0.67%	2.0	47%	1.47	0.00	1.47	0
16.404	5599.45	22.6	0.359	22.6	8.2	3.54	1.59%	Sand-Slime Tailing	0.059	119.0	0.93	0.43	0.50	1	1.45	32.779	455.63	38.16	43	1.65%	2.3	47%	1.48	0.00	1.48	0
16.568	5599.28	14.1	0.339	14.0	14.0	6.07	2.40%	Slime Tailings	0.057	113.1	0.94	0.43	0.50	1	1.50	21.048	292.57	24.60	26	2.57%	2.6	71%	1.49	0.00	1.49	0
16.732	5599.12	8.8	0.276	8.7	23.2	10.05	3.13%	Slime Tailings	0.057	113.1	0.94	0.44	0.51	1	1.51	13.104	182.14	15.47	16	3.50%	2.9	71%	1.50	0.00	1.50	0
16.896	5598.95	8.5	0.184	8.2	42.7	18.51	2.17%	Slime Tailings	0.057	113.1	0.95	0.44	0.51	1	1.50	12.346	171.60	14.80	15	2.44%	2.8	71%	1.51	0.00	1.51	0
17.060	5598.79	8.5	0.183	8.2	54.7	23.72	2.15%	Slime Tailings	0.057	113.1	0.96	0.45	0.52	1	1.49	12.178	169.28	14.74	15	2.42%	2.8	71%	1.52	0.00	1.52	0
17.224	5598.63	8.3	0.174	7.9	66.5	28.82	2.09%	Slime Tailings	0.057	113.1	0.97	0.45	0.52	1	1.48	11.717	162.87	14.32	14	2.37%	2.8	71%	1.53	0.00	1.53	0
17.388	5598.46	9.6	0.196	9.2	57.7	25.02	2.05%	Slime Tailings	0.057	113.1	0.98	0.46	0.53	1	1.47	13.529	188.05	16.33	16	2.29%	2.8	71%	1.54	0.00	1.54	1
17.552	5598.30	8.9	0.209	8.4	74.2	32.14	2.35%	Slime Tailings	0.057	113.1	0.99	0.46	0.53	1	1.46	12.319	171.23	15.09	15	2.65%	2.8	71%	1.55	0.01	1.54	1
17.716	5598.13	9.1	0.199	8.7	67.5	29.25	2.19%	Slime Tailings	0.057	113.1	1.00	0.47	0.53	1	1.45	12.622	175.44	15.37	15	2.46%	2.8	71%	1.56	0.01	1.54	1
17.880	5597.97	9.1	0.170	8.7	60.5	26.22	1.88%	Slime Tailings	0.057	113.1	1.01	0.47	0.54	1	1.45	12.545	174.38	15.20	15	2.11%	2.8	71%	1.57	0.02	1.55	1
18.044	5597.81	9.4	0.142	9.0	57.5	24.92	1.52%	Sand-Slime Tailing	0.059	119.0	1.02	0.48	0.54	1	1.44	12.921	179.60	15.61	15	1.70%	2.7	47%	1.58	0.02	1.55	1
18.208	5597.64	8.7	0.209	8.3	57.7	25.02	2.41%	Slime Tailings	0.057	113.1	1.03	0.48	0.55	1	1.43	11.845	164.64	14.35	14	2.74%	2.9	71%	1.58	0.03	1.56	1
18.372	5597.48	10.0	0.260	9.5	72.0	31.20	2.61%	Slime Tailings	0.057	113.1	1.04	0.49	0.55	1	1.42	13.491	187.53	16.41	16	2.91%	2.8	71%	1.59	0.03	1.56	1
18.537	5597.31	10.6	0.320	10.3	54.3	23.51	3.02%	Slime Tailings	0.057	113.1	1.05	0.49	0.55	1	1.41	14.484	201.33	17.38	17	3.35%	2.8	71%	1.60	0.04	1.57	1
18.701	5597.15	12.3	0.297	12.1	37.1	16.09	2.42%	Slime Tailings	0.057	113.1	1.06	0.50	0.56	1	1.40	16.910	235.04	20.02	20	2.64%	2.7	71%	1.61	0.04	1.57	1
18.865	5596.99	17.2	0.199	17.1	20.4	8.85	1.16%	Sand-Slime Tailing	0.059	119.0	1.07	0.50	0.56	1	1.37	23.404	325.31	27.38	29	1.23%	2.4	47%	1.62	0.05	1.57	1
19.029	5596.82	16.8	0.219	16.7	20.1	8.71	1.31%	Sand-Slime Tailing	0.059	119.0	1.08	0.51	0.57	1	1.36	22.707	315.63	26.57	28	1.39%	2.4	47%	1.63	0.05	1.58	1
19.193	5596.66	15.5	0.212	15.4	19.4	8.42	1.37%	Sand-Slime Tailing	0.059	119.0	1.09	0.51	0.57	1	1.36	20.954	291.26	24.53	25	1.47%	2.5	47%	1.64	0.06	1.58	1
19.357	5596.49	11.9	0.188	11.8	28.4	12.32	1.58%	Sand-Slime Tailing	0.059	119.0	1.10	0.52	0.58	1	1.37	16.059	223.22	18.93	19	1.74%	2.6	47%	1.65	0.06	1.59	1
19.521	5596.33	10.5	0.213	10.3	42.0	18.18	2.02%	Slime Tailings	0.057	113.1	1.10	0.52	0.58	1	1.36	13.972	194.20	16.64	16	2.26%	2.8	71%	1.66	0.07	1.59	1
19.685	5596.17	10.7	0.236	10.3	60.5	26.21	2.21%	Slime Tailings	0.057	113.1	1.11	0.53	0.59	1	1.35	13.907	193.31	16.75	16	2.47%	2.8	71%	1.67	0.07	1.60	1
19.849	5596.00	13.4	0.216	13.1	40.2	17.42	1.62%	Sand-Slime Tailing	0.059	119.0	1.12	0.53	0.59	1	1.34	17.596	244.59	20.83	21	1.77%	2.6	47%	1.68	0.08	1.60	1
20.013	5595.84	12.8	0.185	12.6	40.5	17.54	1.44%	Sand-Slime Tailing	0.059	119.0	1.13	0.54	0.59	1	1.34	16.808	233.63	19.91	20	1.58%	2.6	47%	1.69	0.08	1.61	1
20.177	5595.67	14.7	0.185	14.4	48.7	21.12	1.26%	Sand-Slime Tailing	0.059	119.0	1.14	0.54	0.60	1	1.32	18.997	264.05	22.53	23	1.37%	2.5	47%	1.70	0.09	1.61	1
20.341	5595.51	13.5	0.185	13.4	28.8	12.46	1.37%	Sand-Slime Tailing	0.059	119.0	1.15	0.55	0.60	1	1.32	17.608	244.76	20.73	20	1.49%	2.6	47%	1.71	0.09	1.62	1

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	Idriss & Boulanger (2008) Cyclic Stress Ratio r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Cyclic Resistance Ratio Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd et al. (2001) Cyclic Stress Ratio r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	Idriss & Boulanger (2008) CN	qc1 TSF	qc1 MPa	qc1N
12.139	0.94	0.05	0.98	1.0	0.053	35.39	50.62	0.078	1.47	0.95	0.23	0.80	1.17	1.0	0.036	3.42	52.15	0.093	4.96	3.21	2	1.7	13.111	1.2552	15.227
12.303	0.94	0.05	0.98	1.0	0.053	34.95	48.90	0.076	1.44	0.95	0.22	0.80	1.17	1.0	0.036	3.90	54.45	0.095	5.00	3.22	2	1.7	12.015	1.1503	13.954
12.467	0.93	0.05	0.98	1.0	0.053	34.77	48.20	0.076	1.43	0.95	0.21	0.80	1.17	1.0	0.036	4.07	54.72	0.095	4.96	3.20	2	1.7	11.566	1.1073	13.433
12.631	0.93	0.05	0.98	1.0	0.053	34.89	48.67	0.076	1.44	0.95	0.21	0.80	1.17	1.0	0.036	3.74	51.51	0.093	4.78	3.11	2	1.7	11.867	1.1362	13.783
12.795	0.93	0.05	0.98	1.0	0.053	34.38	46.72	0.074	1.41	0.95	0.20	0.80	1.16	1.0	0.036	4.56	56.24	0.097	4.93	3.17	2	1.7	10.622	1.017	12.337
12.959	0.93	0.05	0.98	1.0	0.053	35.43	50.75	0.078	1.48	0.95	0.23	0.80	1.16	1.0	0.036	3.79	58.13	0.098	4.97	3.23	2	1.7	13.198	1.2636	15.328
13.123	0.93	0.05	0.98	1.0	0.053	37.57	58.28	0.086	1.64	0.95	0.26	0.80	1.16	1.0	0.036	2.87	59.45	0.100	4.98	3.31	2	1.7	17.833	1.7073	20.712
13.287	0.93	0.05	0.98	1.0	0.053	35.68	51.75	0.079	1.51	0.95	0.23	0.80	1.16	1.0	0.036	4.27	68.65	0.110	5.46	3.48	2	1.7	13.834	1.3244	16.067
13.451	0.93	0.05	0.98	1.0	0.052	34.78	48.25	0.076	1.44	0.95	0.21	0.80	1.15	1.0	0.036	4.72	63.58	0.104	5.10	3.27	2	1.7	11.601	1.1107	13.474
13.615	0.93	0.05	0.98	1.0	0.052	35.53	51.16	0.079	1.50	0.94	0.23	0.80	1.15	1.0	0.036	4.01	62.70	0.103	5.01	3.25	2	1.7	13.459	1.2886	15.632
13.779	0.92	0.05	0.98	1.0	0.052	34.44	46.95	0.075	1.43	0.94	0.20	0.80	1.15	1.0	0.036	5.08	63.48	0.104	5.00	3.21	2	1.7	10.765	1.0307	12.503
13.943	0.92	0.05	0.98	1.0	0.052	35.64	51.59	0.079	1.51	0.94	0.23	0.80	1.15	1.0	0.036	3.74	59.68	0.100	4.76	3.14	2	1.7	13.73	1.3145	15.947
14.107	0.92	0.06	0.97	1.0	0.052	40.97	71.38	0.101	1.95	0.94	0.32	0.80	1.14	1.0	0.036	1.96	59.56	0.100	4.71	3.33	2	1.632	26.186	2.507	30.413
14.271	0.92	0.05	0.97	1.0	0.052	38.63	62.37	0.091	1.74	0.94	0.28	0.80	1.14	1.0	0.036	2.56	60.83	0.101	4.72	3.23	2	1.661961	20.442	1.9571	23.742
14.436	0.92	0.05	0.98	1.0	0.052	36.69	54.92	0.082	1.59	0.94	0.25	0.80	1.14	1.0	0.036	3.44	62.76	0.103	4.77	3.18	2	1.668682	15.691	1.5023	18.224
14.600	0.92	0.05	0.98	1.0	0.052	35.34	50.41	0.078	1.50	0.94	0.22	0.80	1.14	1.0	0.037	3.86	58.13	0.098	4.51	3.01	2	1.656647	12.975	1.2422	15.070
14.764	0.92	0.05	0.98	1.0	0.052	35.60	50.72	0.078	1.51	0.94	0.22	0.80	1.14	1.0	0.037	3.58	54.12	0.095	4.31	2.91	2	1.643455	13.012	1.2458	15.113
14.928	0.92	0.05	0.98	1.0	0.052	35.06	49.34	0.077	1.49	0.94	0.22	0.80	1.13	1.0	0.037	4.75	67.81	0.109	4.91	3.20	2	1.631828	12.293	1.1769	14.278
15.092	0.91	0.05	0.98	1.0	0.052	35.14	49.64	0.077	1.49	0.94	0.22	0.80	1.13	1.0	0.037	5.66	82.06	0.131	5.87	3.68	2	1.620387	12.486	1.1955	14.502
15.256	0.91	0.05	0.97	1.0	0.051	36.04	53.13	0.081	1.57	0.94	0.24	0.80	1.13	1.0	0.037	4.81	82.21	0.132	5.83	3.70	2	1.609127	14.715	1.4088	17.091
15.420	0.91	0.05	0.97	1.0	0.051	36.57	55.17	0.083	1.61	0.94	0.25	0.80	1.13	1.0	0.037	4.26	79.34	0.126	5.55	3.58	2	1.598044	16.018	1.5335	18.603
15.584	0.91	0.05	0.97	1.0	0.051	36.06	53.20	0.081	1.57	0.94	0.24	0.80	1.13	1.0	0.037	4.26	73.00	0.116	5.06	3.32	2	1.587134	14.757	1.4128	17.139
15.748	0.91	0.05	0.97	1.0	0.051	36.39	53.76	0.081	1.59	0.94	0.24	0.80	1.12	1.0	0.037	3.55	61.75	0.102	4.40	2.99	2	1.575164	14.956	1.4319	17.370
15.912	0.91	0.05	0.97	1.0	0.051	36.38	53.71	0.081	1.59	0.94	0.24	0.80	1.12	1.0	0.037	2.79	48.31	0.090	3.86	2.72	2	1.563399	14.922	1.4287	17.331
16.076	0.91	0.05	0.97	1.0	0.051	36.96	55.96	0.083	1.64	0.94	0.25	0.80	1.12	1.0	0.037	2.47	46.86	0.089	3.77	2.70	2	1.551831	16.356	1.5659	18.997
16.240	0.91	0.07	0.96	1.0	0.050	47.32	95.84	0.136	2.70	0.94	0.40	0.80	1.12	1.0	0.037	1.31	63.59	0.104	4.36	3.53	2	1.427613	41.778	3.9998	48.522
16.404	0.90	0.06	0.97	1.0	0.050	43.68	81.84	0.115	2.28	0.94	0.36	0.80	1.11	1.0	0.037	2.05	78.17	0.124	5.18	3.73	2	1.452341	32.853	3.1454	38.157
16.568	0.90	0.06	0.97	1.0	0.051	38.65	63.25	0.092	1.81	0.94	0.29	0.80	1.11	1.0	0.037	3.46	85.09	0.137	5.67	3.74	2	1.500236	21.179	2.0277	24.599
16.732	0.90	0.05	0.97	1.0	0.051	35.48	50.95	0.078	1.55	0.94	0.23	0.80	1.11	1.0	0.037	5.53	85.58	0.138	5.67	3.61	2	1.509668	13.323	1.2755	15.473
16.896	0.90	0.05	0.97	1.0	0.051	35.24	50.05	0.078	1.53	0.94	0.22	0.80	1.11	1.0	0.037	4.85	71.80	0.114	4.65	3.09	2	1.500079	12.746	1.2203	14.803
17.060	0.90	0.05	0.97	1.0	0.051	35.22	49.96	0.077	1.53	0.94	0.22	0.80	1.11	1.0	0.037	4.86	71.61	0.114	4.61	3.07	2	1.490627	12.688	1.2147	14.736
17.224	0.90	0.05	0.97	1.0	0.050	35.08	49.40	0.077	1.52	0.94	0.22	0.80	1.11	1.0	0.037	4.91	70.38	0.112	4.50	3.01	2	1.481311	12.332	1.1807	14.323
17.388	0.90	0.05	0.97	1.0	0.050	35.77	52.10	0.080	1.58	0.94	0.23	0.80	1.10	1.0	0.037	4.41	72.07	0.115	4.56	3.07	2	1.472126	14.059	1.346	16.329
17.552	0.90	0.05	0.97	1.0	0.051	35.34	50.44	0.078	1.54	0.94	0.22	0.80	1.10	1.0	0.038	4.99	75.30	0.120	4.70	3.12	2	1.463069	12.996	1.2443	15.095
17.716	0.89	0.05	0.97	1.0	0.051	35.44	50.81	0.078	1.55	0.94	0.23	0.80	1.10	1.0	0.038	4.77	73.31	0.117	4.53	3.04	2	1.454139	13.235	1.2671	15.371
17.880	0.89	0.05	0.97	1.0	0.051	35.38	50.59	0.078	1.54	0.93	0.23	0.80	1.10	1.0	0.038	4.50	68.48	0.110	4.22	2.88	2	1.445332	13.091	1.2534	15.205
18.044	0.89	0.05	0.97	1.0	0.051	35.77	51.38	0.079	1.55	0.93	0.23	0.80	1.10	1.0	0.038	4.03	62.94	0.103	3.92	2.74	2	1.435653	13.436	1.2864	15.605
18.208	0.89	0.05	0.97	1.0	0.051	35.09	49.44	0.077	1.51	0.93	0.22	0.80	1.10	1.0	0.038	5.27	75.69	0.120	4.53	3.02	2	1.427098	12.359	1.1833	14.354
18.372	0.89	0.05	0.97	1.0	0.051	35.80	52.21	0.080	1.56	0.93	0.23	0.80	1.09	1.0	0.038	4.95	81.19	0.130	4.83	3.20	2	1.418658	14.129	1.3527	16.410
18.537	0.89	0.05	0.97	1.0	0.051	36.14	53.52	0.081	1.59	0.93	0.24	0.80	1.09	1.0	0.039	5.08	88.30	0.144	5.31	3.45	2	1.410331	14.962	1.4324	17.377
18.701	0.89	0.05	0.97	1.0	0.051	37.06	57.08	0.085	1.66	0.93	0.26	0.80	1.09	1.0	0.039	4.13	82.75	0.133	4.84	3.25	2	1.402115	17.235	1.65	20.017
18.865	0.89	0.06	0.97	1.0	0.051	39.91	67.29	0.096	1.89	0.93	0.30	0.80	1.09	1.0	0.039	2.32	63.52	0.104	3.75	2.82	2	1.369428	23.578	2.2574	27.385
19.029	0.88	0.06	0.97	1.0	0.051	39.62	66.19	0.095	1.86	0.93	0.30	0.80	1.09	1.0	0.039	2.50	66.55	0.107	3.83	2.85	2	1.363804	22.878	2.1904	26.572
19.193	0.88	0.06	0.97	1.0	0.051	38.90	63.43	0.092	1.79	0.93	0.29	0.80	1.08	1.0	0.039	2.72	66.83	0.108	3.80	2.80	2	1.362408	21.119	2.0219	24.528
19.357	0.88	0.05	0.97	1.0	0.051	36.94	55.88	0.083	1.63	0.93	0.25	0.80	1.08	1.0	0.039	3.56	67.47	0.109	3.79	2.71	2	1.366753	16.302	1.5607	18.934
19.521	0.88	0.05	0.97	1.0	0.051	35.88	52.52	0.080	1.56	0.93	0.24	0.80	1.08	1.0	0.040	4.40	73.27	0.117	4.03	2.79	2	1.359102	14.327	1.3717	16.641
19.685	0.88	0.05	0.97	1.0	0.051	35.92	52.66	0.080	1.56	0.93	0.24	0.80	1.08	1.0	0.040	4.57	76.54	0.122	4.17	2.86	2	1.351548	14.418	1.3804	16.745
19.849	0.88	0.05	0.97	1.0	0.051	37.61	58.44	0.086	1.67	0.93	0.26	0.80	1.08	1.0	0.040	3.36	70.06	0.112	3.80	2.74	2	1.343236	17.933	1.717	20.829
20.013	0.88	0.05	0.97	1.0	0.052	37.29	57.20	0.085	1.65	0.93	0.26	0.80	1.08	1.0	0.040	3.31	65.95	0.107	3.58	2.61	2	1.335039	17.146	1.6415	19.913
20.177	0.87	0.05	0.97	1.0	0.052	38.20	60.73	0.089	1.72	0.93	0.27	0.80	1.08	1.0	0.040	2.84	63.94	0.104	3.47	2.59	2	1.321958	19.399	1.8572	22.531
20.341	0.87	0.05	0.97	1.0	0.052	37.57	58.30	0.086	1.66	0.93	0.26	0.80	1.07	1.0	0.040	3.15	65.23	0.106	3.49	2.58	2	1.318983	17.845	1.7085	20.726

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W3

Data File: 13-52106_SP2W3-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend:
- Tailings Sands
- Tailings Sand-Slimes
- Tailings Slimes
- Interim Cover
- Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69

Youd, et al (2001)		
Max. Horiz. Acceleration, Amax/g:	0.15	
Earthquake Moment Magnitude, M:	5.5	
Magnitude Scaling Factor, MSF:	2.21	2.21

5613.80	Water surface elevation during CPT investigation (f
5607.44	Water surface elevation at t_0 (ft amsl)
5597.74	Water surface elevation at t_1 (ft amsl)
5592.74	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ea
7.51	Equiv. Number of Uniform Strain Cycles, N

5615.72	Ground Surface Elevation at time of CPT (ft amsl)
5626.27	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
2.55	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1164.98	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5592.74	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5626.02	5625.77	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5624.02	5622.27	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5620.27	5618.27	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	######	5617	5615.72	2.55	0.050	101	0.582	0.518	0.00	0.00	0.582	0.518

2013 CPT Data from ConeTec / Material / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
0.164	5615.56	7.7	0.125	7.7	1.9	0.82	1.62%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	13.124	182.42	15.27	935	1.62%	1.5	51%	0.59	0.00	0.59	0
0.328	5615.39	34.3	0.207	34.2	7.6	3.28	0.60%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	58.208	809.09	67.70	2074	0.60%	1.0	51%	0.60	0.00	0.60	0
0.492	5615.23	60.2	0.548	60.2	5.7	2.48	0.91%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	102.306	######	118.89	2429	0.91%	1.2	51%	0.61	0.00	0.61	0
0.656	5615.06	93.8	1.118	93.8	6.5	2.81	1.19%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	159.409	######	185.22	2838	1.19%	1.3	51%	0.62	0.00	0.62	0
0.820	5614.90	158.1	1.774	158.0	7.2	3.13	1.12%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	268.634	######	312.09	3826	1.12%	1.3	51%	0.62	0.00	0.62	0
0.984	5614.74	233.5	2.580	233.4	9.6	4.17	1.11%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	396.814	######	460.99	4709	1.11%	1.3	51%	0.63	0.00	0.63	0
1.148	5614.57	321.1	3.237	321.1	4.7	2.05	1.01%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	545.819	######	633.99	5551	1.01%	1.3	51%	0.64	0.00	0.64	0
1.312	5614.41	348.1	3.834	348.0	7.5	3.25	1.10%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	591.651	######	687.26	5266	1.10%	1.3	51%	0.65	0.00	0.65	0
1.476	5614.24	325.9	3.960	325.9	6.7	2.88	1.22%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	553.945	######	643.46	4382	1.22%	1.3	51%	0.66	0.00	0.66	0
1.640	5614.08	280.6	3.998	280.6	6.9	3.01	1.42%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	477.020	######	554.12	3396	1.43%	1.4	51%	0.67	0.00	0.67	0
1.804	5613.92	244.2	3.918	244.1	3.6	1.54	1.60%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	415.038	######	482.09	2686	1.61%	1.4	51%	0.67	0.00	0.67	0
1.968	5613.75	208.3	4.496	208.3	3.0	1.30	2.16%	Interim Cover	0.050	100.7	0.10	0.00	0.10	1	1.70	354.025	######	411.22	2132	2.16%	1.6	51%	0.68	0.00	0.68	0
2.133	5613.59	171.3	4.306	171.3	1.4	0.62	2.51%	Interim Cover	0.050	100.7	0.11	0.01	0.10	1	1.70	291.278	######	338.32	1699	2.51%	1.6	51%	0.69	0.00	0.69	0
2.297	5613.42	146.4	3.625	146.4	0.5	0.21	2.48%	Interim Cover	0.050	100.7	0.12	0.01	0.10	1	1.70	248.795	######	288.97	1407	2.48%	1.6	51%	0.70	0.00	0.70	0
2.461	5613.26	130.5	2.022	130.5	-0.0	-0.01	1.55%	Interim Cover	0.050	100.7	0.12	0.02	0.11	1	1.70	221.918	######	257.74	1218	1.55%	1.5	51%	0.71	0.00	0.71	0
2.625	5613.10	117.5	1.895	117.5	0.5	0.22	1.61%	Interim Cover	0.050	100.7	0.13	0.02	0.11	1	1.70	199.801	######	232.06	1065	1.61%	1.5	51%	0.71	0.00	0.71	0
2.789	5612.93	87.2	1.616	87.2	-0.2	-0.08	1.85%	Interim Cover	0.050	100.7	0.14	0.03	0.11	1	1.70	148.240	######	172.17	768	1.86%	1.6	51%	0.72	0.00	0.72	0
2.953	5612.77	56.6	1.213	56.6	-0.3	-0.11	2.14%	Interim Cover	0.050	100.7	0.15	0.03	0.12	1	1.70	96.186	######	111.71	484	2.15%	1.7	51%	0.73	0.00	0.73	0
3.117	5612.60	41.8	0.990	41.8	-0.7	-0.32	2.37%	Interim Cover	0.050	100.7	0.16	0.04	0.12	1	1.70	71.043	987.50	82.50	348	2.38%	1.8	51%	0.74	0.00	0.74	0
3.281	5612.44	29.4	0.781	29.4	-1.4	-0.59	2.66%	Sand-Slime Tailing	0.059	119.0	0.17	0.04	0.12	1	1.70	49.980	694.72	58.03	235	2.67%	2.0	47%	0.75	0.00	0.75	0
3.445	5612.28	24.9	0.524	24.9	-1.2	-0.53	2.10%	Sand-Slime Tailing	0.059	119.0	0.18	0.05	0.13	1	1.70	42.364	588.86	49.19	192	2.12%	1.9	47%	0.76	0.00	0.76	0
3.609	5612.11	21.4	0.387	21.4	-1.7	-0.72	1.81%	Sand-Slime Tailing	0.059	119.0	0.19	0.05	0.13	1	1.70	36.363	505.45	42.21	159	1.83%	2.0	47%	0.77	0.00	0.77	0
3.773	5611.95	13.1	0.327	13.2	-2.1	-0.91	2.49%	Slime Tailings	0.057	113.1	0.20	0.06	0.14	1	1.70	22.355	310.73	25.94	94	2.53%	2.2	71%	0.78	0.00	0.78	0
3.937	5611.78	9.9	0.171	10.0	-1.5	-0.64	1.72%	Sand-Slime Tailing	0.059	119.0	0.21	0.06	0.14	1	1.70	16.915	235.12	19.63	68	1.76%	2.2	47%	0.79	0.00	0.79	0
4.101	5611.62	9.9	0.106	9.9	1.7	0.74	1.07%	Sand-Slime Tailing	0.059	119.0	0.22	0.07	0.15	1	1.70	16.881	234.65	19.63	66	1.09%	2.1	47%	0.80	0.00	0.80	0
4.265	5611.45	13.3	0.031	13.3	3.7	1.60	0.23%	Sand-Slime Tailing	0.059	119.0	0.22	0.07	0.15	1	1.70	22.593	314.04	26.29	86	0.24%	1.6	47%	0.81	0.00	0.81	0
4.429	5611.29	10.7	0.042	10.7	2.1	0.90	0.39%	Sand-Slime Tailing	0.059	119.0	0.23	0.08	0.16	1	1.70	18.241	253.55	21.21	67	0.40%	1.8	47%	0.82	0.00	0.82	0
4.593	5611.13	8.5	0.048	8.4	6.1	2.62	0.57%	Sand-Slime Tailing	0.059	119.0	0.24	0.08	0.16	1	1.70	14.314	198.96	16.70	51	0.58%	2.0	47%	0.83	0.00	0.83	0
4.757	5610.96	7.9	0.031	7.8	13.0	5.65	0.39%	Sand-Slime Tailing	0.059	119.0	0.25	0.09	0.17	1	1.70	13.311	185.02	15.62	46	0.40%	2.0	47%	0.84	0.00	0.84	0
4.921	5610.80	7.2	0.093	7.1	20.3	8.78	1.30%	Slime Tailings	0.057	113.1	0.26	0.09	0.17	1	1.70	11.985	166.59	14.17	41	1.35%	2.3	71%	0.85	0.00	0.85	0
5.085	5610.63	7.1	0.130	7.0	25.9	11.21	1.82%	Slime Tailings	0.057	113.1	0.27	0.10	0.17	1	1.70	11.866	164.94	14.10	40	1.89%	2.4	71%	0.86	0.00	0.86	0
5.249	5610.47	8.4	0.108	8.2	23.7	10.28	1.29%	Sand-Slime Tailing	0.059	119.0	0.28	0.10	0.18	1	1.70	14.008	194.71	16.56	45	1.33%	2.3	47%	0.86	0.00	0.86	0
5.413	5610.31	18.2	0.125	18.1	15.6	6.76	0.69%	Sand-Slime Tailing	0.059	119.0	0.29	0.11	0.18	1	1.70	30.804	428.18	35.97	98	0.70%	1.8	47%	0.87	0.00	0.87	0
5.577	5610.14	20.7	0.144	20.7	2.2	0.94	0.69%	Sand-Slime Tailing	0.059	119.0	0.30	0.11	0.19	1	1.70	35.241	489.85	40.96	109	0.70%	1.8	47%	0.88	0.00	0.88	0
5.741	5609.98	20.9	0.185	20.9	1.2	0.52	0.89%	Sand-Slime Tailing	0.059	119.0	0.31	0.12	0.19	1	1.70	35.462	492.92	41.20	107	0.90%	1.9	47%	0.89	0.00	0.89	0
5.905	5609.81	17.0	0.216	17.0	-0.2	-0.07	1.27%	Sand-Slime Tailing	0.059	119.0	0.32	0.12	0.20	1	1.70	28.849	401.00	33.50	84	1.30%	2.0	47%	0.90	0.00	0.90	0
6.069	5609.65	16.4	0.222	16.4	0.0	0.01	1.35%	Sand-Slime Tailing	0.059	119.0	0.33	0.13	0.20	1	1.70	27.880	387.53	32.38	80	1.38%	2.1	47%	0.91	0.00	0.91	0
6.234	5609.49	12.5	0.167	12.5	0.5	0.23	1.33%	Sand-Slime Tailing	0.059	119.0	0.34	0.13	0.21	1	1.70	21.267	295.61	24.71	59	1.37%	2.2	47%	0.92	0.00	0.92	0
6.398	5609.32	11.4	0.156	11.4	5.1	2.22	1.37%	Sand-Slime Tailing	0.059	119.0	0.35	0.14	0.21	1	1.70	19.312	268.44	22.49	52	1.41%	2.2	47%	0.93	0.00	0.93	0
6.562	5609.16	8.9	0.092	8.8	14.8	6.41	1.03%	Sand-Slime Tailing	0.059	119.0	0.36	0.14	0.22	1	1.70	14.977	208.18	17.58	40	1.08%	2.3	47%	0.94	0.00	0.94	0
6.726	5608.99	7.1	0.054	7.0	16.9	7.31	0.76%	Sand-Slime Tailing	0.059	119.0	0.37	0.15	0.22	1	1.70	11.832	164.46	13.95	30	0.81%	2.3	47%	0.95	0.00	0.95	0
6.890	5608.83	6.9	0.094	6.8	23.9	10.34	1.36%	Slime Tailings	0.057	113.1	0.38	0.16	0.22	1	1.70	11.509	159.98	13.66	29	1.44%	2.4	71%	0.96	0.00	0.96	0
7.054	5608.67	6.6	0.021	6.4	33.6	14.56	0.32%	Sand-Slime Tailing	0.059	119.0	0.39	0.16	0.23	1	1.70	10.880	151.23	13.05	27	0.34%	2.2	47%	0.97	0.00	0.97	0
7.218	5608.50	8.6	0.044	8.4	29.9	12.94	0.51%	Sand-Slime Tailing	0.059	119.0	0.40	0.17	0.23	1	1.70	14.246	198.02	16.91	35	0.54%	2.1	47%	0.98	0.00	0.98	0
7.382	5608.34	6.9	0.052	6.7	30.0	13.02	0.75%	Sand-Slime Tailing	0.059	119.0	0.41	0.17	0.24	1	1.70	11.424	158.79	13.64	27	0.80%	2.3	47%	0.99	0.00	0.99	0
7.546	5608.17	6.5	0.057	6.3	35.9	15.54	0.88%	Slime Tailings	0.057	113.1	0.42	0.18	0.24	1	1.70	10.659	148.16	12.82	25	0.94%	2.4	71%	1.00	0.00	1.00	0
7.710	5608.01	7.0	0.066	6.9	29.2	12.65	0.94%	Sand-Slime Tailing	0.059	119.0	0.43	0.18	0.25	1	1.70	11.645	161.87	13.88	27	1.00%	2.4	47%	1.01	0.00	1.01	0
7.874	5607.85	6.7	0.068	6.5	36.4	15.76	1.02%	Slime Tailings	0.057	113.1	0.44	0.19	0.25	1	1.70	10.982	152.65	13.20	25	1.09%	2.4	71%	1.02	0.00	1.02	0
8.038	5607.68	7.0	0.101	6.8	40.6	17.55	1.44%	Slime Tailings	0.057	113.1	0.45	0.19	0.26	1	1.70	11.526	160.21	13.89	26	1.53%	2.5	71%	1.03	0.00	1.03	0
8.202	5607.52	7.2	0.053	7.0	32.9	14.27	0.74%	Sand-Slime Tailing	0.059	119.0	0.46	0.20	0.26	1	1.70	11.866	164.94	14.19	26	0.79%	2.3	47%	1.04	0.00	1.04	0
8.366	5607.35	8.3	0.060	8.1	33.6	14.56	0.72%	Sand-Slime Tailing	0.059	119.0	0.47	0.20	0.26	1	1.70	13.719	190.69	16.35	30	0.77%	2.3	47%	1.05	0.00	1.05	0
8.530	5607.19	8.4	0.039	8.2	29.3	12.71	0.47%	Sand-Slime Tailing	0.059	119.0	0.48	0.21	0.27	1	1.70	13.923	193.53	16.53	29	0.49%	2.2	47%	1.06	0.00	1.06	0
8.694	5607.03	9.0	0.046	8.9	16.0	6.93	0.51%	Sand-Slime Tailing	0.059	119.0	0.49	0.21	0.27	1	1.70	15.130	210.31	17.77	31	0.54%	2.2	47%	1.07	0.00	1.07	0
8.858	5606.86	8.9	0.043	8.8	19.3	8.37	0.48%	Sand-Slime Tailing	0.059	119.0	0.50	0.22	0.28	1	1.70	14.909	207.24	17.55	30	0.51%	2.2	47%	1.08	0.00	1.08	0
9.022	5606.70	9.0	0.081	8.9	11.3	4.91	0.90%	Sand-Slime Tailing	0.059	119.0	0.50	0.22	0.28	1	1.70	15.130	210.31	17.71	30	0.96%	2.3	47%	1.09	0.00	1.09	0
9.186	5606.53	10.5	0.074	10.5	12.7	5.50	0.70%	Sand-Slime Tailing	0.059	119.0	0.51	0.23	0.29	1	1.70	17.782	247.17	20.81	35	0.74%	2.2	47%	1.10	0.00	1.10	0
9.350	5606.37	8.8	0.087	8.8	6.6	2.84	0.98%	Sand-Slime Tailing	0.059	119.0	0.52	0.23	0.29	1	1.70	14.960	207.94	17.46	28	1.05%	2.4	47%	1.11	0.00	1.11	0
9.514	5606.21	6.8	0.122	6.7	23.8	10.30	1.78%	Slime Tailings	0.057	113.1	0.53	0.24	0.30	1	1.70	11.390	158.32	13.52	21	1.93%	2.6	71%	1.12	0.00	1.12	0
9.678	5606.04	8.3	0.124	8.0	40.2	17.44	1.50%	Slime Tailings	0.057	113.1	0.54	0.24	0.30	1	1.70	13.668	189.99	16.37	26	1.60%	2.5	71%	1.13	0.00	1.13	0
9.842	5605.88	13.0	0.032	12.8	32.9	14.24	0.25%	Sand-Slime Tailing	0.059	119.0	0.55	0.25	0.31	1	1.70	21.794	302.94	25.72	41	0.26%	2.0	47%	1.14	0.00	1.14	0
10.006	5605.71	14.0	0.141	13.9	7.1	3.09	1.01%	Sand-Slime Tailing	0.059	119.0	0.56	0.25	0.31	1	1.70	23.647	328.69	27.50	43	1.05%	2.2	47%	1.14	0.00	1.14	0
10.170	5605.55	8.3	0.114	8.2	6.4	2.78	1.38%	Sand-Slime Tailing	0.059	119.0	0.57	0.26	0.31	1	1.70	13.957	194.00	16.29	24	1.48%	2.5	47%	1.15	0.00	1.15	0
10.335	5605.39	8.7	0.102	8.7	10.1	4.39	1.17%	Sand-Slime Tailing	0.059	119.0	0.58	0.26	0.32	1	1.70	14.722	204.64	17.22	25	1.25%	2.4	47%	1.16	0.00	1.16	0
10.499	5605.22	23.1	0.120	23.1	9.6	4.17	0.52%	Sand-Slime Tailing	0.059	119.0	0.59	0.27	0.32	1	1.70	39.219	545.14	45.67	70	0.53%	1.9	47%	1.17	0.00	1.17	0
10.663	5605.06	24.0	0.124	23.9	8.7	3.75	0.52%	Sand-Slime Tailing	0.059	119.0	0.60	0.27	0.33	1	1.70	40.647	564.99	47.32	71	0.53%	1.9	47%	1.18	0.00	1.18	0
10.827	5604.89	25.3	0.175	25.3	8.6	3.72	0.69%	Sand-Slime Tailing	0.059	119.0	0.61	0.28	0.33	1	1.70	42.925	596.66	49.96	74	0.71%	1.9	47%	1.19	0.00	1.19	0
10.991	5604.73	28.0	0.202	28.0	8.4	3.62	0.72%	Sand-Slime Tailing	0.059	119.0	0.62	0.28	0.34	1	1.70	47.583	661.40	55.37	81	0.74%	1.9	47%	1.20	0.00	1.20	0
11.155	5604.57	24.5	0.216	24.4	7.8	3.38	0.88%	Sand-Slime Tailing	0.059	119.0	0.63	0.29	0.34	1	1.70	41.514	577.04	48.31	70	0.91%	2.0	47%	1.21	0.00	1.21	0
11.319	5604.40	20.2	0.227	20.2	7.1	3.09	1.12%	Sand-Slime Tailing	0.059	119.0	0.64	0.29	0.35	1	1.70	34.272	476.38	39.89	56	1.16%	2.1	47%	1.22	0.00	1.22	0
11.483	5604.24	17.7	0.281	17.6	7.2	3.11	1.59%	Sand-Slime Tailing	0.059	119.0	0.65	0.30	0.35	1	1.70	29.937	416.12	34.86	48	1.65%	2.3	47%	1.23	0.00	1.23	0
11.647	5604.07	17.7	0.326	17.7	8.6	3.74	1.84%	Sand-Slime Tailing	0.059	119.0	0.66	0.30	0.36	1	1.70	30.039	417.54	34.99	48	1.91%	2.3	47%	1.24	0.00	1.24	0
11.811	5603.91	20.4	0.539	20.3	13.1	5.69	2.65%	Sand-Slime Tailing	0.059	119.0	0.67	0.31	0.36	1	1.70	34.493	479.45	40.22	55	2.74%	2.4	47%	1.25	0.00	1.25	0
11.975	5603.75	17.7	0.579	17.6	13.2	5.71	3.27%	Slime Tailings	0.057	113.1	0.68	0.31	0.37	1	1.70	29.937	416.12	34.93	47	3.40%	2.5	71%	1.26	0.00	1.26	0

Liquefaction Triggering Analyses (Idriss & Boulanger (2008); Youd et al. (2001)) and Idriss & Boulanger (2008)

Depth at time of CPT (ft)	I&B CSR: r_d	C_σ	K_σ	K_a	CSR M=7.5, s'v=1atm	I&B CRR: Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd CSR: r_d	D_r	f	K_σ	K_a	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	CN	qc1 TSF	qc1 MPa	qc1N
0.164	1.00	0.05	1.02	1.0	0.059	35.68	50.94	0.078	1.33	0.98	0.23	0.80	2.53	1.0	0.017	1.00	15.27	0.063	152.05	76.69	2	1.7	13.144	1.2584	15.266
0.328	1.00	0.08	1.03	1.0	0.060	54.08	121.78	0.183	3.08	0.97	0.48	0.76	2.56	1.0	0.017	1.00	67.70	0.109	132.00	67.54	2	1.7	58.288	5.5805	67.698
0.492	1.00	0.12	1.04	1.0	0.060	72.04	190.94	0.778	12.90	0.97	0.63	0.69	3.05	1.0	0.014	1.00	118.89	0.236	191.11	102.00	2	1.7	102.37	9.8006	118.893
0.656	1.00	0.22	1.07	1.0	0.062	95.32	280.55	1.000	16.09	0.97	0.79	0.61	3.60	1.0	0.012	1.00	185.22	1.000	606.81	311.45	2	1.7	159.48	15.268	185.224
0.820	1.00	0.30	1.10	1.0	0.063	139.84	451.93	1.000	15.77	0.97	1.02	0.60	3.37	1.0	0.013	1.00	312.09	1.000	485.64	250.71	2	1.7	268.71	25.726	312.091
0.984	1.00	0.30	1.09	1.0	0.063	192.10	653.09	1.000	15.83	0.97	1.24	0.60	3.13	1.0	0.014	1.00	460.99	1.000	404.86	210.34	2	1.7	396.92	38.001	460.994
1.148	1.00	0.30	1.09	1.0	0.063	252.81	886.80	1.000	15.89	0.97	1.45	0.60	2.95	1.0	0.015	1.00	633.99	1.000	347.16	181.52	2	1.7	545.87	52.262	633.994
1.312	1.00	0.30	1.08	1.0	0.063	271.50	958.76	1.000	15.94	0.97	1.51	0.60	2.79	1.0	0.015	1.00	687.26	1.000	303.88	159.91	2	1.7	591.73	56.652	687.259
1.476	1.00	0.30	1.08	1.0	0.063	256.13	899.58	1.000	16.00	0.97	1.46	0.60	2.66	1.0	0.016	1.00	643.46	1.000	270.22	143.11	2	1.7	554.02	53.041	643.456
1.640	1.00	0.30	1.08	1.0	0.062	224.78	778.89	1.000	16.06	0.97	1.36	0.60	2.55	1.0	0.017	1.00	554.12	1.000	243.30	129.68	2	1.7	477.09	45.677	554.115
1.804	1.00	0.30	1.07	1.0	0.062	199.50	681.58	1.000	16.11	0.97	1.27	0.60	2.46	1.0	0.017	1.00	482.09	1.000	221.27	118.69	2	1.7	415.08	39.739	482.085
1.968	1.00	0.30	1.07	1.0	0.062	174.63	585.84	1.000	16.18	0.97	1.17	0.60	2.39	1.0	0.018	1.00	411.22	1.000	206.05	111.11	2	1.7	354.06	33.897	411.216
2.133	1.00	0.30	1.07	1.0	0.062	149.05	487.37	1.000	16.25	0.97	1.06	0.60	2.36	1.0	0.018	1.00	338.32	1.000	199.70	107.97	2	1.7	291.29	27.888	338.319
2.297	1.00	0.30	1.06	1.0	0.061	131.73	420.69	1.000	16.32	0.97	0.98	0.60	2.33	1.0	0.018	1.00	289.10	1.000	193.74	105.03	2	1.7	248.8	23.82	288.966
2.461	1.00	0.30	1.06	1.0	0.061	120.77	378.52	1.000	16.38	0.97	0.93	0.60	2.30	1.0	0.019	1.00	257.74	1.000	188.12	102.25	2	1.7	221.92	21.246	257.744
2.625	1.00	0.30	1.06	1.0	0.061	111.76	343.82	1.000	16.45	0.97	0.88	0.60	2.28	1.0	0.019	1.00	232.06	1.000	182.83	99.64	2	1.7	199.81	19.129	232.063
2.789	0.99	0.20	1.03	1.0	0.059	90.74	262.91	1.000	16.81	0.97	0.76	0.62	2.16	1.0	0.020	1.00	172.17	1.000	177.83	97.32	2	1.7	148.24	14.192	172.170
2.953	0.99	0.12	1.02	1.0	0.059	69.52	181.23	0.556	9.50	0.97	0.61	0.69	1.84	1.0	0.023	1.06	118.91	0.236	40.91	25.21	2	1.7	96.183	9.2086	111.711
3.117	0.99	0.09	1.01	1.0	0.058	59.27	141.78	0.238	4.10	0.97	0.52	0.74	1.68	1.0	0.025	1.14	94.25	0.158	26.62	15.36	2	1.7	71.035	6.8009	82.503
3.281	0.99	0.08	1.01	1.0	0.058	50.65	108.69	0.157	2.72	0.97	0.44	0.78	1.53	1.0	0.028	1.27	73.95	0.118	19.10	10.91	2	1.7	49.966	4.7837	58.032
3.445	0.99	0.07	1.01	1.0	0.058	47.55	96.74	0.137	2.37	0.97	0.40	0.80	1.47	1.0	0.029	1.24	60.94	0.101	15.82	9.10	2	1.7	42.351	4.0547	49.188
3.609	0.99	0.07	1.01	1.0	0.058	45.11	87.32	0.123	2.13	0.97	0.38	0.80	1.45	1.0	0.029	1.24	52.38	0.093	14.12	8.13	2	1.7	36.345	3.4797	42.213
3.773	0.99	0.06	1.01	1.0	0.058	39.12	65.06	0.094	1.63	0.97	0.29	0.80	1.44	1.0	0.030	1.69	43.72	0.086	12.68	7.15	2	1.7	22.333	2.1381	25.938
3.937	0.99	0.05	1.00	1.0	0.057	37.19	56.81	0.084	1.47	0.97	0.26	0.80	1.43	1.0	0.030	1.65	32.48	0.077	10.94	6.21	2	1.7	16.899	1.6179	19.628
4.101	0.99	0.05	1.00	1.0	0.057	37.19	56.81	0.084	1.47	0.97	0.26	0.80	1.42	1.0	0.030	1.41	27.67	0.073	10.05	5.76	2	1.7	16.899	1.6179	19.627
4.265	0.99	0.06	1.00	1.0	0.057	39.52	65.81	0.095	1.65	0.97	0.30	0.80	1.42	1.0	0.030	1.00	26.28	0.072	9.59	5.62	2	1.7	22.632	2.1668	26.286
4.429	0.99	0.05	1.00	1.0	0.057	37.74	58.95	0.087	1.52	0.97	0.27	0.80	1.41	1.0	0.030	1.13	24.06	0.070	9.07	5.29	2	1.7	18.263	1.7485	21.211
4.593	0.98	0.05	1.00	1.0	0.057	36.16	52.86	0.080	1.41	0.96	0.24	0.80	1.40	1.0	0.030	1.33	22.15	0.068	8.61	5.01	2	1.7	14.378	1.3766	16.699
4.757	0.98	0.05	1.00	1.0	0.057	35.78	51.40	0.079	1.38	0.96	0.23	0.80	1.39	1.0	0.031	1.28	20.02	0.067	8.16	4.77	2	1.7	13.449	1.2876	15.621
4.921	0.98	0.05	1.00	1.0	0.057	35.02	49.19	0.077	1.35	0.96	0.22	0.80	1.38	1.0	0.031	1.94	27.50	0.073	8.70	5.03	2	1.7	12.2	1.168	14.170
5.085	0.98	0.05	1.00	1.0	0.057	35.00	49.10	0.077	1.35	0.96	0.22	0.80	1.38	1.0	0.031	2.30	32.49	0.077	8.98	5.17	2	1.7	12.141	1.1623	14.101
5.249	0.98	0.05	1.00	1.0	0.057	36.11	52.67	0.080	1.41	0.96	0.23	0.80	1.37	1.0	0.031	1.82	30.12	0.075	8.53	4.97	2	1.7	14.26	1.3652	16.562
5.413	0.98	0.06	1.00	1.0	0.057	42.92	78.89	0.111	1.96	0.96	0.35	0.80	1.36	1.0	0.031	1.12	40.39	0.084	9.26	5.61	2	1.7	30.97	2.965	35.969
5.577	0.98	0.07	1.00	1.0	0.057	44.67	85.62	0.121	2.13	0.96	0.37	0.80	1.36	1.0	0.031	1.10	44.95	0.087	9.45	5.79	2	1.7	35.264	3.3762	40.957
5.741	0.98	0.07	1.00	1.0	0.056	44.75	85.95	0.121	2.14	0.96	0.37	0.80	1.35	1.0	0.031	1.15	47.49	0.090	9.45	5.80	2	1.7	35.475	3.3964	41.202
5.905	0.98	0.06	1.00	1.0	0.056	42.05	75.56	0.107	1.89	0.96	0.33	0.80	1.34	1.0	0.032	1.35	45.39	0.088	9.05	5.47	2	1.7	28.847	2.7618	33.504
6.069	0.98	0.06	1.00	1.0	0.056	41.66	74.04	0.105	1.86	0.96	0.33	0.80	1.34	1.0	0.032	1.41	45.77	0.088	8.88	5.37	2	1.7	27.88	2.6693	32.381
6.234	0.98	0.06	1.00	1.0	0.056	38.97	63.67	0.092	1.64	0.96	0.29	0.80	1.33	1.0	0.032	1.61	39.71	0.083	8.18	4.91	2	1.7	21.273	2.0366	24.707
6.398	0.97	0.05	1.00	1.0	0.056	38.19	60.68	0.089	1.58	0.96	0.27	0.80	1.32	1.0	0.032	1.73	38.83	0.082	7.94	4.76	2	1.7	19.366	1.8541	22.493
6.562	0.97	0.05	1.00	1.0	0.056	36.47	54.04	0.082	1.46	0.96	0.24	0.80	1.32	1.0	0.032	1.80	31.72	0.076	7.21	4.33	2	1.7	15.134	1.4489	17.577
6.726	0.97	0.05	1.00	1.0	0.056	35.19	49.14	0.077	1.37	0.96	0.22	0.80	1.31	1.0	0.032	1.90	26.50	0.072	6.66	4.01	2	1.7	12.011	1.1499	13.950
6.890	0.97	0.05	0.99	1.0	0.056	34.84	48.51	0.076	1.36	0.96	0.21	0.80	1.31	1.0	0.032	2.45	33.50	0.078	7.07	4.21	2	1.7	11.762	1.1261	13.661
7.054	0.97	0.05	0.99	1.0	0.056	34.88	47.93	0.076	1.35	0.96	0.21	0.80	1.30	1.0	0.032	1.59	20.81	0.067	5.99	3.67	2	1.7	11.237	1.0758	13.051
7.218	0.97	0.05	0.99	1.0	0.056	36.23	53.15	0.081	1.45	0.96	0.24	0.80	1.30	1.0	0.033	1.55	26.22	0.072	6.26	3.86	2	1.7	14.563	1.3942	16.914
7.382	0.97	0.05	0.99	1.0	0.056	35.08	48.72	0.076	1.37	0.96	0.21	0.80	1.29	1.0	0.033	2.03	27.65	0.073	6.25	3.81	2	1.7	11.743	1.1243	13.639
7.546	0.97	0.05	0.99	1.0	0.056	34.55	47.37	0.075	1.35	0.96	0.21	0.80	1.29	1.0	0.033	2.27	29.12	0.074	6.24	3.80	2	1.7	11.04	1.0569	12.822
7.710	0.97	0.05	0.99	1.0	0.055	35.17	49.06	0.077	1.38	0.96	0.22	0.80	1.28	1.0	0.033	2.23	30.97	0.076	6.26	3.82	2	1.7	11.955	1.1446	13.885
7.874	0.96	0.05	0.99	1.0	0.055	34.69	47.89	0.075	1.36	0.96	0.21	0.80	1.28	1.0	0.033	2.42	31.93	0.077	6.22	3.79	2	1.7	11.368	1.0884	13.203
8.038	0.96	0.05	0.99	1.0	0.055	34.92	48.81	0.076	1.38	0.96	0.22	0.80	1.28	1.0	0.033	2.73	37.94	0.082	6.52	3.95	2	1.7	11.956	1.1446	13.886
8.202	0.96	0.05	0.99	1.0	0.055	35.28	49.47	0.077	1.40	0.96	0.22	0.80	1.27	1.0	0.033	2.09	29.59	0.075	5.86	3.63	2	1.7	12.216	1.1695	14.188
8.366	0.96	0.05	0.99	1.0	0.055	36.04	52.38	0.080	1.45	0.96	0.23	0.80	1.27	1.0	0.033	1.90	31.09	0.076	5.86	3.65	2	1.7	14.076	1.3476	16.348
8.530	0.96	0.05	0.99	1.0	0.055	36.10	52.63	0.080	1.46	0.96	0.23	0.80	1.26	1.0	0.033	1.67	27.61	0.073	5.54	3.50	2	1.7	14.234	1.3628	16.532
8.694	0.96	0.05	0.99	1.0	0.055	36.53	54.30	0.082	1.49	0.96	0.24	0.80	1.26	1.0	0.033	1.65	29.41	0.074	5.56	3.52	2	1.7	15.3	1.4648	17.770
8.858	0.96	0.05	0.99	1.0	0.055	36.46	54.01	0.081	1.49	0.95	0.24	0.80	1.25	1.0	0.034	1.66	29.14	0.074	5.45	3.47	2	1.7	15.114	1.447	17.554
9.022	0.96	0.05	0.99	1.0	0.055	36.51	54.23	0.082	1.49	0.95	0.24	0.80	1.25	1.0	0.034	2.04	36.18	0.080	5.79	3.64	2	1.7	15.25	1.4601	17.712
9.186	0.96	0.05	0.99	1.0	0.055	37.60	58.41	0.086	1.58	0.95	0.26	0.80	1.24	1.0	0.034	1.70	35.42	0.080	5.65	3.61	2	1.7	17.917	1.7154	20.809
9.350	0.96	0.05	0.99	1.0	0.055	36.42	53.88	0.081	1.49	0.95	0.24	0.80	1.24	1.0	0.034	2.18	38.09	0.082	5.72	3.61	2	1.7	15.03	1.4389	17.456
9.514	0.95	0.05	0.99	1.0	0.054	34.80	48.32	0.076	1.39	0.95	0.21	0.80	1.24	1.0	0.034	3.44	46.54	0.089	6.13	3.76	2	1.7	11.642	1.1146	13.522
9.678	0.95	0.05	0.99	1.0	0.054	35.79	52.16	0.080	1.46	0.95	0.23	0.80	1.23	1.0	0.034	2.79	45.63	0.088	5.99	3.73	2	1.7	14.095	1.3495	16.371
9.842	0.95	0.06	0.98	1.0	0.054	39.32	65.04	0.094	1.73	0.95	0.29	0.80	1.23	1.0	0.034	1.25	32.26	0.077	5.16	3.44	2	1.7	22.143	2.1199	25.717
10.006	0.95	0.06	0.98	1.0	0.054	39.96	67.52	0.097	1.79	0.95	0.30	0.80	1.23	1.0	0.034	1.71	47.02	0.089	5.90	3.84	2	1.7	23.723	2.2712	27.553
10.170	0.95	0.05	0.99	1.0	0.054	36.01	52.30	0.080	1.47	0.95	0.23	0.80	1.22	1.0	0.034	2.79	45.51	0.088	5.73	3.60	2	1.7	14.025	1.3428	16.289
10.335	0.95	0.05	0.99	1.0	0.054	36.34	53.57	0.081	1.50	0.95	0.24	0.80	1.22	1.0	0.034	2.52	43.44	0.086	5.54	3.52	2	1.7	14.829	1.4198	17.223
10.499	0.95	0.07	0.98	1.0	0.054	45.99	91.66	0.130	2.42	0.95	0.39	0.80	1.22	1.0	0.034	1.17	53.57	0.094	5.98	4.20	2	1.7	39.321	3.7646	45.669
10.663	0.95	0.07	0.98	1.0	0.054	46.90	94.21	0.133	2.49	0.95	0.40	0.80	1.21	1.0	0.035	1.17	55.14	0.096	5.97	4.23	2	1.7	40.739	3.9003	47.316
10.827	0.95	0.07	0.98	1.0	0.053	47.82	97.78	0.139	2.60	0.95	0.41	0.80	1.21	1.0	0.035	1.21	60.64	0.101	6.21	4.41	2	1.7	43.016	4.1184	49.961
10.991	0.94	0.07	0.98	1.0	0.053	49.72	105.09	0.151	2.84	0.95	0.43	0.79	1.22	1.0	0.034	1.19	65.94	0.107	6.49	4.66	2	1.7	47.672	4.5641	55.368
11.155	0.94	0.07	0.98	1.0	0.053	47.25	95.56	0.135	2.54	0.95	0.40	0.80	1.20	1.0	0.035	1.31	63.36	0.104	6.22	4.38	2	1.7	41.597	3.9825	48.312
11.319	0.94	0.06	0.98	1.0	0.053	44.29	84.19	0.118	2.23	0.95	0.36	0.80	1.20	1.0	0.035	1.54	61.62	0.102	6.03	4.13	2	1.7	34.348	3.2884	39.893
11.483	0.94	0.06	0.98	1.0	0.053	42.53	77.39	0.109	2.05	0.95	0.34	0.80	1.20	1.0	0.035	1.93	67.15	0.108	6.33	4.19	2	1.7	30.013	2.8735	34.858
11.647	0.94	0.06	0.98	1.0	0.053	42.57	77.57	0.109	2.06	0.95	0.34	0.80	1.19	1.0	0.035	2.07	72.45	0.115	6.66	4.36	2	1.7	30.131	2.8847	34.995
11.811	0.94	0.07	0.98	1.0	0.053	44.41	84.63	0.119	2.25	0.95	0.37	0.80	1.19	1.0	0.035	2.30	92.67	0.154	8.78	5.52	2	1.7	34.632	3.3157	40.223
11.975	0.94	0.06	0.98	1.0	0.053	42.25	77.18	0.109	2.06	0.95	0.34	0.80	1.19	1.0	0.035	2.84	99.07	0.170	9.61	5.84	2	1.7	30.077	2.8795	34.932

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W3

Data File: 13-52106_SP2W3-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend:
- Tailings Sands
- Tailings Sand-Slimes
- Tailings Slimes
- Interim Cover
- Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5613.80	Water surface elevation during CPT investigation (f
5607.44	Water surface elevation at t_0 (ft amsl)
5597.74	Water surface elevation at t_1 (ft amsl)
5592.74	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ea
7.51	Equiv. Number of Uniform Strain Cycles, N

5615.72	Ground Surface Elevation at time of CPT (ft amsl)
5626.27	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
2.55	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1164.98	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5592.74	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5626.02	5625.77	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5624.02	5622.27	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5620.27	5618.27	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	######	5617	5615.72	2.55	0.050	101	0.582	0.518	0.00	0.00	0.582	0.518

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
12.139	5603.58	11.5	0.499	11.4	15.5	6.73	4.33%	Slime Tailings	0.057	113.1	0.69	0.32	0.37	1	1.70	19.448	270.33	22.78	29	4.60%	2.7	71%	1.27	0.00	1.27	0
12.303	5603.42	10.9	0.321	10.7	30.3	13.15	2.94%	Slime Tailings	0.057	113.1	0.70	0.32	0.37	1	1.70	18.258	253.79	21.58	27	3.14%	2.7	71%	1.28	0.00	1.28	0
12.467	5603.25	10.3	0.339	10.0	56.2	24.35	3.28%	Slime Tailings	0.057	113.1	0.71	0.33	0.38	1	1.70	16.949	235.59	20.38	25	3.53%	2.7	71%	1.29	0.00	1.29	0
12.631	5603.09	8.7	0.195	8.6	16.5	7.14	2.25%	Slime Tailings	0.057	113.1	0.72	0.33	0.38	1	1.70	14.586	202.75	17.14	21	2.45%	2.7	71%	1.30	0.00	1.30	0
12.795	5602.92	9.5	0.203	9.3	29.1	12.59	2.13%	Slime Tailings	0.057	113.1	0.73	0.34	0.39	1	1.70	15.878	220.70	18.80	23	2.31%	2.6	71%	1.31	0.00	1.31	0
12.959	5602.76	8.1	0.206	7.9	33.3	14.44	2.53%	Slime Tailings	0.057	113.1	0.73	0.34	0.39	1	1.70	13.498	187.62	16.09	19	2.78%	2.8	71%	1.32	0.00	1.32	0
13.123	5602.60	7.2	0.183	6.9	46.1	19.99	2.54%	Slime Tailings	0.057	113.1	0.74	0.35	0.39	1	1.70	11.764	163.52	14.23	16	2.83%	2.8	71%	1.33	0.00	1.33	0
13.287	5602.43	10.7	0.106	10.4	37.6	16.29	0.99%	Sand-Slime Tailin	0.059	119.0	0.75	0.35	0.40	1	1.70	17.731	246.46	21.06	25	1.07%	2.4	47%	1.34	0.00	1.34	0
13.451	5602.27	16.7	0.102	16.7	10.8	4.70	0.61%	Sand-Slime Tailin	0.059	119.0	0.76	0.36	0.40	1	1.70	28.339	393.91	33.05	40	0.64%	2.1	47%	1.35	0.00	1.35	0
13.615	5602.10	17.2	0.121	17.1	10.8	4.69	0.70%	Sand-Slime Tailin	0.059	119.0	0.77	0.36	0.41	1	1.69	29.024	403.44	33.84	40	0.74%	2.2	47%	1.36	0.00	1.36	0
13.779	5601.94	17.2	0.165	17.1	13.8	5.99	0.96%	Sand-Slime Tailin	0.059	119.0	0.78	0.37	0.41	1	1.68	28.815	400.53	33.64	40	1.00%	2.2	47%	1.37	0.00	1.37	0
13.943	5601.78	17.7	0.203	17.6	15.3	6.65	1.15%	Sand-Slime Tailin	0.059	119.0	0.79	0.38	0.42	1	1.67	29.281	407.00	34.19	40	1.20%	2.3	47%	1.38	0.00	1.38	0
14.107	5601.61	19.0	0.286	18.9	16.8	7.30	1.50%	Sand-Slime Tailin	0.059	119.0	0.80	0.38	0.42	1	1.64	31.034	431.37	36.24	43	1.57%	2.3	47%	1.39	0.00	1.39	0
14.271	5601.45	18.8	0.300	18.7	17.6	7.62	1.59%	Sand-Slime Tailin	0.059	119.0	0.81	0.39	0.43	1	1.63	30.546	424.59	35.69	42	1.67%	2.3	47%	1.39	0.00	1.39	0
14.436	5601.28	21.0	0.318	20.9	18.2	7.88	1.51%	Sand-Slime Tailin	0.059	119.0	0.82	0.39	0.43	1	1.60	33.469	465.22	39.08	47	1.58%	2.3	47%	1.40	0.00	1.40	0
14.600	5601.12	18.5	0.163	18.5	9.1	3.93	0.88%	Sand-Slime Tailin	0.059	119.0	0.83	0.40	0.44	1	1.61	29.799	414.21	34.72	41	0.92%	2.2	47%	1.41	0.00	1.41	0
14.764	5600.96	15.4	0.117	15.4	3.3	1.43	0.76%	Sand-Slime Tailin	0.059	119.0	0.84	0.40	0.44	1	1.63	25.149	349.57	29.25	33	0.80%	2.3	47%	1.42	0.00	1.42	0
14.928	5600.79	12.2	0.162	12.2	9.3	4.03	1.32%	Sand-Slime Tailin	0.059	119.0	0.85	0.41	0.45	1	1.66	20.144	280.00	23.51	26	1.42%	2.5	47%	1.43	0.00	1.43	0
15.092	5600.63	11.5	0.194	11.3	27.6	11.96	1.69%	Sand-Slime Tailin	0.059	119.0	0.86	0.41	0.45	1	1.65	18.644	259.15	21.98	24	1.83%	2.6	47%	1.44	0.00	1.44	0
15.256	5600.46	10.0	0.206	9.9	14.5	6.29	2.06%	Slime Tailings	0.057	113.1	0.87	0.42	0.45	1	1.65	16.317	226.81	19.13	20	2.26%	2.7	71%	1.45	0.00	1.45	0
15.420	5600.30	8.6	0.137	8.4	31.8	13.77	1.60%	Slime Tailings	0.057	113.1	0.88	0.42	0.46	1	1.64	13.698	190.40	16.29	17	1.78%	2.7	71%	1.46	0.00	1.46	0
15.584	5600.14	9.3	0.108	9.1	29.9	12.95	1.16%	Sand-Slime Tailin	0.059	119.0	0.89	0.43	0.46	1	1.62	14.841	206.28	17.59	18	1.28%	2.6	47%	1.47	0.00	1.47	0
15.748	5599.97	8.4	0.114	8.2	29.4	12.75	1.36%	Sand-Slime Tailin	0.059	119.0	0.90	0.43	0.47	1	1.61	13.195	183.41	15.67	16	1.53%	2.7	47%	1.48	0.00	1.48	0
15.912	5599.81	7.3	0.150	7.0	43.6	18.89	2.07%	Slime Tailings	0.057	113.1	0.91	0.44	0.47	1	1.60	11.168	155.23	13.48	13	2.36%	2.8	71%	1.49	0.00	1.49	0
16.076	5599.64	6.8	0.155	6.5	59.5	25.76	2.27%	Slime Tailings	0.057	113.1	0.92	0.44	0.48	1	1.59	10.281	142.91	12.63	12	2.62%	2.9	71%	1.50	0.00	1.50	0
16.240	5599.48	6.4	0.150	6.0	55.9	24.23	2.36%	Slime Tailings	0.057	113.1	0.93	0.45	0.48	1	1.58	9.501	132.07	11.67	11	2.76%	2.9	71%	1.51	0.00	1.51	0
16.404	5599.32	6.2	0.155	5.8	62.4	27.06	2.49%	Slime Tailings	0.057	113.1	0.94	0.45	0.48	1	1.57	9.139	127.04	11.32	11	2.93%	3.0	71%	1.52	0.00	1.52	0
16.568	5599.15	6.4	0.156	6.0	61.6	26.67	2.43%	Slime Tailings	0.057	113.1	0.95	0.46	0.49	1	1.56	9.390	130.52	11.60	11	2.85%	2.9	71%	1.53	0.00	1.53	0
16.732	5598.99	6.5	0.127	6.1	59.1	25.59	1.96%	Slime Tailings	0.057	113.1	0.95	0.46	0.49	1	1.55	9.436	131.16	11.62	11	2.30%	2.9	71%	1.54	0.00	1.54	0
16.896	5598.82	6.4	0.116	6.1	51.0	22.11	1.81%	Slime Tailings	0.057	113.1	0.96	0.47	0.50	1	1.54	9.374	130.30	11.46	11	2.13%	2.9	71%	1.55	0.00	1.55	0
17.060	5598.66	5.5	0.121	5.1	60.9	26.40	2.22%	Slime Tailings	0.057	113.1	0.97	0.47	0.50	1	1.53	7.756	107.81	9.68	9	2.70%	3.0	71%	1.56	0.00	1.56	0
17.224	5598.50	5.3	0.143	4.9	60.8	26.34	2.71%	Slime Tailings	0.057	113.1	0.98	0.48	0.51	1	1.52	7.433	103.32	9.30	9	3.33%	3.1	71%	1.57	0.00	1.57	0
17.388	5598.33	5.4	0.167	5.0	60.4	26.17	3.09%	Slime Tailings	0.057	113.1	0.99	0.48	0.51	1	1.51	7.567	105.17	9.45	9	3.79%	3.1	71%	1.57	0.00	1.57	0
17.552	5598.17	8.1	0.153	7.8	49.8	21.59	1.90%	Slime Tailings	0.057	113.1	1.00	0.49	0.51	1	1.50	11.622	161.55	14.04	14	2.16%	2.8	71%	1.58	0.00	1.58	0
17.716	5598.00	12.1	0.146	11.9	23.4	10.13	1.21%	Sand-Slime Tailin	0.059	119.0	1.01	0.49	0.52	1	1.49	17.713	246.21	20.82	21	1.32%	2.5	47%	1.59	0.00	1.59	0
17.880	5597.84	14.1	0.132	14.0	21.9	9.47	0.94%	Sand-Slime Tailin	0.059	119.0	1.02	0.50	0.52	1	1.46	20.417	283.79	23.94	25	1.01%	2.4	47%	1.60	0.00	1.60	0
18.044	5597.68	14.0	0.074	13.9	17.3	7.51	0.53%	Sand-Slime Tailin	0.059	119.0	1.03	0.50	0.53	1	1.45	20.197	280.74	23.64	25	0.57%	2.3	47%	1.61	0.00	1.61	1
18.208	5597.51	11.8	0.070	11.7	17.2	7.43	0.59%	Sand-Slime Tailin	0.059	119.0	1.04	0.51	0.53	1	1.46	16.985	236.10	19.91	20	0.65%	2.4	47%	1.62	0.01	1.62	1
18.372	5597.35	9.1	0.178	8.9	23.4	10.12	1.96%	Slime Tailings	0.057	113.1	1.05	0.51	0.54	1	1.45	12.930	179.72	15.26	15	2.22%	2.8	71%	1.63	0.01	1.62	1
18.537	5597.18	6.8	0.214	6.6	44.6	19.31	3.12%	Slime Tailings	0.057	113.1	1.06	0.52	0.54	1	1.44	9.455	131.43	11.45	11	3.70%	3.0	71%	1.64	0.02	1.62	1
18.701	5597.02	12.2	0.207	12.1	17.2	7.44	1.70%	Sand-Slime Tailin	0.059	119.0	1.07	0.52	0.55	1	1.43	17.226	239.45	20.19	20	1.87%	2.6	47%	1.65	0.02	1.63	1
18.865	5596.86	12.4	0.172	12.2	21.3	9.23	1.39%	Sand-Slime Tailin	0.059	119.0	1.08	0.53	0.55	1	1.42	17.382	241.62	20.41	21	1.52%	2.6	47%	1.66	0.03	1.63	1
19.029	5596.69	14.4	0.138	14.3	22.3	9.64	0.96%	Sand-Slime Tailin	0.059	119.0	1.09	0.53	0.56	1	1.40	20.001	278.01	23.46	24	1.04%	2.4	47%	1.67	0.03	1.64	1
19.193	5596.53	15.7	0.130	15.6	20.8	8.99	0.83%	Sand-Slime Tailin	0.059	119.0	1.10	0.54	0.56	1	1.39	21.538	299.38	25.22	26	0.89%	2.4	47%	1.68	0.04	1.64	1
19.357	5596.36	16.7	0.123	16.5	23.1	9.99	0.74%	Sand-Slime Tailin	0.059	119.0	1.11	0.54	0.56	1	1.37	22.650	314.83	26.54	28	0.79%	2.3	47%	1.69	0.04	1.65	1
19.521	5596.20	16.7	0.112	16.5	24.3	10.52	0.67%	Sand-Slime Tailin	0.059	119.0	1.12	0.55	0.57	1	1.36	22.519	313.02	26.39	27	0.72%	2.3	47%	1.70	0.05	1.65	1
19.685	5596.04	16.2	0.142	16.1	26.1	11.31	0.88%	Sand-Slime Tailin	0.059	119.0	1.13	0.55	0.57	1	1.36	21.815	303.23	25.59	26	0.94%	2.4	47%	1.71	0.05	1.66	1
19.849	5595.87	13.7	0.203	13.5	30.3	13.14	1.48%	Sand-Slime Tailin	0.059	119.0	1.14	0.56	0.58	1	1.36	18.424	256.09	21.70	22	1.62%	2.6	47%	1.72	0.06	1.66	1
20.013	5595.71	9.9	0.190	9.6	41.6	18.02	1.92%	Slime Tailings	0.057	113.1	1.15	0.56	0.58	1	1.36	13.071	181.68	15.59	15	2.18%	2.8	71%	1.73	0.06	1.67	1
20.177	5595.54	8.7	0.172	8.3	65.6	28.43	1.98%	Slime Tailings	0.057	113.1	1.16	0.57	0.59	1	1.35	11.187	155.51	13.64	13	2.28%	2.8	71%	1.74	0.07	1.67	1
20.341	5595.38	8.9	0.207	8.5	67.9	29.41	2.32%	Slime Tailings	0.057	113.1	1.16	0.57	0.59	1	1.34	11.394	158.38	13.90	13	2.67%	2.9	71%	1.75	0.07	1.67	1
20.505	5595.22	9.3	0.168	8.9	65.7	28.45	1.81%	Slime Tailings	0.057	113.1	1.17	0.58	0.59	1	1.34	11.840	164.57	14.39	14	2.08%	2.8	71%	1.76	0.08	1.68	1
20.669	5595.05	12.9	0.090	12.6	43.1	18.67	0.70%	Sand-Slime Tailin	0.059	119.0	1.18	0.58	0.60	1	1.33	16.762	232.99	19.88	20	0.77%	2.4	47%	1.77	0.08	1.68	1
20.833	5594.89	13.2	0.156	13.1	27.5	11.92	1.18%	Sand-Slime Tailin	0.059	119.0	1.19	0.59	0.60	1	1.32	17.242	239.67	20.29	20	1.30%	2.5	47%	1.78	0.09	1.69	1
20.997	5594.72	9.7	0.180	9.2	68.8	29.83	1.86%	Slime Tailings	0.057	113.1	1.20	0.60	0.61	1	1.31	12.134	168.66	14.75	14	2.13%	2.8	71%	1.79	0.09	1.69	1
21.161	5594.56	9.1	0.158	8.5	91.2	39.53	1.73%	Slime Tailings	0.057	113.1	1.21	0.60	0.61	1	1.31	11.155	155.05	13.82	13	2.00%	2.8	71%	1.79	0.10	1.70	1
21.325	5594.39	9.1	0.173	8.5	87.2	37.78	1.90%	Slime Tailings	0.057	113.1	1.22	0.61	0.62	1	1.30	11.096	154.23	13.71	13	2.20%	2.8	71%	1.80	0.10	1.70	1
21.489	5594.23	10.0	0.173	9.4	103.1	44.66	1.73%	Sand-Slime Tailin	0.059	119.0	1.23	0.61	0.62	1	1.29	12.116	168.41	15.04	14	1.97%	2.8	47%	1.81	0.11	1.70	1
21.653	5594.07	11.1	0.173	10.5	102.2	44.29	1.56%	Sand-Slime Tailin	0.059	119.0	1.24	0.62	0.63	1	1.28	13.420	186.53	16.54	16	1.76%	2.7	47%	1.82	0.11	1.71	1

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	Idriss & Boulanger (2008) Cyclic Stress Ratio r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Cyclic Resistance Ratio Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd et al. (2001) Cyclic Stress Ratio r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	Idriss & Boulanger (2008) CN	qc1 TSF	qc1 MPa	qc1N
12.139	0.94	0.05	0.98	1.0	0.053	38.02	60.80	0.089	1.68	0.95	0.28	0.80	1.18	1.0	0.035	4.36	99.37	0.171	9.56	5.62	2	1.7	19.613	1.8777	22.779
12.303	0.94	0.05	0.98	1.0	0.053	37.60	59.18	0.087	1.64	0.95	0.27	0.80	1.18	1.0	0.035	3.72	80.22	0.128	7.07	4.35	2	1.7	18.58	1.7788	21.580
12.467	0.93	0.05	0.98	1.0	0.053	37.18	57.56	0.085	1.61	0.95	0.26	0.80	1.18	1.0	0.035	4.13	84.08	0.135	7.39	4.50	2	1.7	17.545	1.6798	20.378
12.631	0.93	0.05	0.98	1.0	0.053	36.06	53.20	0.081	1.53	0.95	0.24	0.80	1.18	1.0	0.035	3.89	66.77	0.108	5.82	3.67	2	1.7	14.761	1.4132	17.144
12.795	0.93	0.05	0.98	1.0	0.053	36.63	55.43	0.083	1.57	0.95	0.25	0.80	1.17	1.0	0.036	3.58	67.31	0.108	5.79	3.68	2	1.7	16.186	1.5497	18.799
12.959	0.93	0.05	0.98	1.0	0.053	35.69	51.78	0.079	1.51	0.95	0.23	0.80	1.17	1.0	0.036	4.39	70.58	0.113	5.96	3.73	2	1.7	13.852	1.3262	16.088
13.123	0.93	0.05	0.98	1.0	0.053	35.04	49.28	0.077	1.46	0.94	0.22	0.80	1.17	1.0	0.036	4.85	69.02	0.111	5.79	3.63	2	1.7	12.254	1.1732	14.232
13.287	0.93	0.05	0.98	1.0	0.052	37.69	58.74	0.086	1.65	0.94	0.26	0.80	1.17	1.0	0.036	2.40	50.63	0.092	4.77	3.21	2	1.7	18.13	1.7358	21.057
13.451	0.93	0.06	0.97	1.0	0.052	41.89	74.94	0.106	2.03	0.94	0.33	0.80	1.16	1.0	0.036	1.52	50.29	0.092	4.70	3.37	2	1.7	28.454	2.7242	33.048
13.615	0.93	0.06	0.97	1.0	0.052	42.17	76.01	0.107	2.06	0.94	0.34	0.80	1.16	1.0	0.036	1.57	53.23	0.094	4.76	3.41	2	1.694353	29.139	2.7898	33.843
13.779	0.92	0.06	0.97	1.0	0.052	42.10	75.73	0.107	2.06	0.94	0.33	0.80	1.16	1.0	0.036	1.75	59.00	0.099	4.97	3.51	2	1.682138	28.96	2.7727	33.636
13.943	0.92	0.06	0.97	1.0	0.052	42.29	76.49	0.108	2.08	0.94	0.34	0.80	1.16	1.0	0.036	1.86	63.68	0.104	5.16	3.62	2	1.66558	29.44	2.8186	34.193
14.107	0.92	0.06	0.97	1.0	0.052	43.01	79.26	0.112	2.16	0.94	0.35	0.80	1.15	1.0	0.036	2.01	72.78	0.116	5.68	3.92	2	1.64115	31.207	2.9877	36.245
14.271	0.92	0.06	0.97	1.0	0.052	42.82	78.50	0.111	2.14	0.94	0.34	0.80	1.15	1.0	0.036	2.09	74.50	0.118	5.75	3.95	2	1.631735	30.725	2.9416	35.685
14.436	0.92	0.06	0.97	1.0	0.051	44.01	83.09	0.117	2.27	0.94	0.36	0.80	1.15	1.0	0.036	1.92	75.08	0.119	5.73	4.00	2	1.60217	33.651	3.2218	39.084
14.600	0.92	0.06	0.97	1.0	0.051	42.48	77.19	0.109	2.12	0.94	0.34	0.80	1.15	1.0	0.036	1.68	58.41	0.099	4.69	3.40	2	1.612498	29.89	2.8617	34.716
14.764	0.92	0.06	0.97	1.0	0.051	40.56	69.81	0.099	1.93	0.94	0.31	0.80	1.14	1.0	0.036	1.80	52.65	0.094	4.40	3.17	2	1.630934	25.183	2.411	29.248
14.928	0.92	0.05	0.97	1.0	0.051	38.55	62.05	0.090	1.75	0.94	0.28	0.80	1.14	1.0	0.036	2.66	62.56	0.103	4.79	3.27	2	1.655194	20.24	1.9378	23.507
15.092	0.91	0.05	0.97	1.0	0.051	38.01	60.00	0.088	1.71	0.94	0.27	0.80	1.14	1.0	0.036	3.15	69.15	0.111	5.11	3.41	2	1.652854	18.929	1.8123	21.985
15.256	0.91	0.05	0.97	1.0	0.051	36.75	55.87	0.083	1.62	0.94	0.25	0.80	1.14	1.0	0.036	3.84	73.49	0.117	5.35	3.49	2	1.648232	16.467	1.5765	19.125
15.420	0.91	0.05	0.97	1.0	0.051	35.76	52.05	0.079	1.55	0.94	0.23	0.80	1.13	1.0	0.037	3.88	63.25	0.104	4.69	3.12	2	1.636528	14.022	1.3425	16.286
15.584	0.91	0.05	0.97	1.0	0.051	36.47	54.06	0.082	1.59	0.94	0.24	0.80	1.13	1.0	0.037	3.19	56.14	0.096	4.33	2.96	2	1.623697	15.144	1.4498	17.588
15.748	0.91	0.05	0.97	1.0	0.051	35.80	51.47	0.079	1.54	0.94	0.23	0.80	1.13	1.0	0.037	3.75	58.82	0.099	4.40	2.97	2	1.611093	13.491	1.2916	15.669
15.912	0.91	0.05	0.97	1.0	0.051	34.78	48.26	0.076	1.48	0.94	0.21	0.80	1.13	1.0	0.037	5.07	68.29	0.110	4.83	3.16	2	1.599979	11.603	1.1109	13.476
16.076	0.91	0.05	0.97	1.0	0.051	34.48	47.11	0.075	1.46	0.94	0.21	0.80	1.13	1.0	0.037	5.55	70.12	0.112	4.90	3.18	2	1.589039	10.871	1.0408	12.626
16.240	0.91	0.05	0.97	1.0	0.051	34.15	45.83	0.074	1.44	0.94	0.20	0.80	1.12	1.0	0.037	6.01	70.18	0.112	4.86	3.15	2	1.578267	10.052	0.9624	11.675
16.404	0.90	0.05	0.97	1.0	0.051	34.03	45.36	0.073	1.44	0.94	0.19	0.80	1.12	1.0	0.037	6.31	71.49	0.114	4.90	3.17	2	1.56766	9.7505	0.9335	11.325
16.568	0.90	0.05	0.97	1.0	0.051	34.13	45.73	0.074	1.45	0.94	0.20	0.80	1.12	1.0	0.037	6.14	71.27	0.114	4.85	3.15	2	1.557215	9.9883	0.9563	11.601
16.732	0.90	0.05	0.97	1.0	0.051	34.13	45.76	0.074	1.45	0.94	0.20	0.80	1.12	1.0	0.037	5.62	65.37	0.106	4.49	2.97	2	1.546927	10.006	0.958	11.622
16.896	0.90	0.05	0.97	1.0	0.051	34.08	45.53	0.073	1.45	0.94	0.20	0.80	1.12	1.0	0.037	5.51	63.14	0.103	4.34	2.89	2	1.536792	9.864	0.9444	11.456
17.060	0.90	0.04	0.97	1.0	0.051	33.46	43.14	0.071	1.41	0.94	0.18	0.80	1.11	1.0	0.037	6.87	66.48	0.107	4.47	2.94	2	1.526807	8.3369	0.7982	9.683
17.224	0.90	0.04	0.97	1.0	0.051	33.33	42.63	0.071	1.40	0.94	0.18	0.80	1.11	1.0	0.037	7.68	71.47	0.114	4.71	3.05	2	1.516969	8.0087	0.7668	9.302
17.388	0.90	0.04	0.97	1.0	0.050	33.38	42.83	0.071	1.41	0.93	0.18	0.80	1.11	1.0	0.037	8.01	75.70	0.120	4.93	3.17	2	1.507275	8.1349	0.7788	9.448
17.552	0.90	0.05	0.97	1.0	0.050	34.98	49.02	0.077	1.52	0.93	0.22	0.80	1.11	1.0	0.037	4.80	67.46	0.109	4.42	2.97	2	1.49772	12.088	1.1573	14.040
17.716	0.89	0.05	0.97	1.0	0.050	37.61	58.43	0.086	1.72	0.93	0.26	0.80	1.11	1.0	0.037	2.91	60.54	0.101	4.06	2.89	2	1.487226	17.93	1.7166	20.824
17.880	0.89	0.06	0.97	1.0	0.050	38.70	62.64	0.091	1.82	0.93	0.28	0.80	1.10	1.0	0.037	2.34	56.01	0.096	3.85	2.84	2	1.462524	20.616	1.9738	23.945
18.044	0.89	0.05	0.97	1.0	0.050	38.59	62.23	0.090	1.81	0.93	0.28	0.80	1.10	1.0	0.037	1.94	45.86	0.088	3.49	2.65	2	1.454089	20.355	1.9488	23.641
18.208	0.89	0.05	0.97	1.0	0.050	37.28	57.19	0.085	1.70	0.93	0.26	0.80	1.10	1.0	0.038	2.31	46.04	0.088	3.46	2.58	2	1.456726	17.141	1.6411	19.909
18.372	0.89	0.05	0.97	1.0	0.050	35.40	50.66	0.078	1.56	0.93	0.23	0.80	1.10	1.0	0.038	4.60	70.24	0.112	4.35	2.95	2	1.447882	13.141	1.2581	15.262
18.537	0.89	0.05	0.97	1.0	0.050	34.07	45.52	0.073	1.46	0.93	0.20	0.80	1.10	1.0	0.038	7.03	80.43	0.128	4.92	3.19	2	1.439161	9.8555	0.9436	11.447
18.701	0.89	0.05	0.97	1.0	0.050	37.38	57.57	0.085	1.70	0.93	0.26	0.80	1.10	1.0	0.038	3.49	70.44	0.113	4.27	2.98	2	1.429575	17.38	1.6639	20.185
18.865	0.89	0.05	0.97	1.0	0.050	37.46	57.87	0.086	1.70	0.93	0.26	0.80	1.09	1.0	0.038	3.17	64.62	0.105	3.94	2.82	2	1.420133	17.571	1.6823	20.408
19.029	0.88	0.05	0.96	1.0	0.050	38.53	61.98	0.090	1.79	0.93	0.28	0.80	1.09	1.0	0.038	2.42	56.88	0.097	3.60	2.70	2	1.400632	20.196	1.9335	23.456
19.193	0.88	0.06	0.96	1.0	0.050	39.15	64.37	0.093	1.84	0.93	0.29	0.80	1.09	1.0	0.039	2.17	54.73	0.095	3.49	2.67	2	1.385076	21.717	2.0792	25.223
19.357	0.88	0.06	0.96	1.0	0.050	39.61	66.14	0.095	1.88	0.93	0.30	0.80	1.09	1.0	0.039	2.00	53.20	0.094	3.41	2.65	2	1.371886	22.847	2.1874	26.536
19.521	0.88	0.06	0.96	1.0	0.050	39.56	65.95	0.095	1.88	0.93	0.30	0.80	1.09	1.0	0.039	1.95	51.52	0.093	3.33	2.60	2	1.363988	22.726	2.1758	26.395
19.685	0.88	0.06	0.96	1.0	0.051	39.28	64.87	0.093	1.85	0.93	0.29	0.80	1.08	1.0	0.039	2.20	56.30	0.097	3.44	2.64	2	1.358371	22.037	2.1098	25.594
19.849	0.88	0.05	0.96	1.0	0.051	37.91	59.61	0.087	1.73	0.93	0.27	0.80	1.08	1.0	0.039	3.13	67.89	0.109	3.85	2.79	2	1.363705	18.682	1.7886	21.698
20.013	0.88	0.05	0.97	1.0	0.051	35.52	51.11	0.079	1.54	0.93	0.23	0.80	1.08	1.0	0.039	4.55	71.01	0.113	3.96	2.75	2	1.358687	13.423	1.2851	15.590
20.177	0.87	0.05	0.97	1.0	0.051	34.84	48.47	0.076	1.49	0.92	0.21	0.80	1.08	1.0	0.039	5.13	70.00	0.112	3.88	2.68	2	1.351138	11.741	1.1241	13.636
20.341	0.87	0.05	0.97	1.0	0.051	34.93	48.82	0.076	1.50	0.92	0.22	0.80	1.08	1.0	0.039	5.43	75.40	0.120	4.12	2.81	2	1.343684	11.964	1.1454	13.895
20.505	0.87	0.05	0.97	1.0	0.051	35.10	49.49	0.077	1.51	0.92	0.22	0.80	1.08	1.0	0.039	4.75	68.35	0.110	3.74	2.62	2	1.336323	12.388	1.186	14.387
20.669	0.87	0.05	0.96	1.0	0.051	37.27	57.16	0.085	1.66	0.92	0.26	0.80	1.08	1.0	0.040	2.50	49.68	0.091	3.09	2.37	2	1.328222	17.019	1.639	19.883
20.833	0.87	0.05	0.96	1.0	0.051	37.42	57.71	0.085	1.67	0.92	0.26	0.80	1.07	1.0	0.040	3.02	61.18	0.101	3.39	2.53	2	1.320232	17.469	1.6725	20.289
20.997	0.87	0.05	0.97	1.0	0.051	35.22	49.97	0.077	1.51	0.92	0.22	0.80	1.07	1.0	0.040	4.73	69.77	0.112	3.70	2.61	2	1.31316	12.698	1.2157	14.748
21.161	0.87	0.05	0.97	1.0	0.051	34.90	48.72	0.076	1.49	0.92	0.21	0.80	1.07	1.0	0.040	4.84	66.95	0.108	3.55	2.52	2	1.306174	11.899	1.1392	13.820
21.325	0.87	0.05	0.97	1.0	0.051	34.86	48.57	0.076	1.48	0.91	0.21	0.80	1.07	1.0	0.040	5.08	69.61	0.111	3.64	2.56	2	1.299271	11.803	1.13	13.708
21.489	0.86	0.05	0.97	1.0	0.051	35.58	50.61	0.078	1.52	0.91	0.22	0.80	1.07	1.0	0.040	4.53	68.09	0.109	3.54	2.53	2	1.291671	12.947	1.2395	15.037
21.653	0.86	0.05	0.97	1.0	0.051	36.10	52.64	0.080	1.56	0.91	0.23	0.80	1.07	1.0	0.040	4.02	66.55	0.107	3.45	2.50	2	1.284172	14.239	1.3632	16.538

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W4-C

Data File:	13-52106_SP2W4-C-BSC-CPT
Location:	White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da	
Tailings Sands	
Tailings Sand-Slimes	
Tailings Slimes	
Interim Cover	
Cells Requiring User Input/Manipulation	

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5611.20	Water surface elevation during CPT investigation (ft a
5607.96	Water surface elevation at t_0 (ft amsl)
5593.50	Water surface elevation at t_1 (ft amsl)
5588.50	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earth
7.51	Equiv. Number of Uniform Strain Cycles, N

5616.24	Ground Surface Elevation at time of CPT (ft amsl)
5626.19	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
1.95	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1104.55	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5588.50	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	5626.19	5625.94	5625.69	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	5625.69	5623.94	5622.19	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	5622.19	5620.19	5618.19	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	5618.19	5617.22	5616.24	1.95	0.050	101	0.552	0.503	0.00	0.00	0.552	0.503

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
0.164	5616.08	20.1	0.057	20.0	8.1	3.50	0.28%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	34.068	473.55	39.67	2431	0.28%	0.7	51%	0.56	0.00	0.56	0
0.328	5615.91	44.3	0.080	44.3	3.0	1.28	0.18%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	75.242	1045.86	87.43	2679	0.18%	0.5	51%	0.57	0.00	0.57	0
0.492	5615.75	56.7	0.160	56.7	4.6	1.97	0.28%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	96.373	1339.58	111.99	2287	0.28%	0.7	51%	0.58	0.00	0.58	0
0.656	5615.58	59.2	0.227	59.2	1.6	0.69	0.38%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	100.708	1399.84	116.99	1792	0.38%	0.8	51%	0.59	0.00	0.59	0
0.820	5615.42	57.7	0.368	57.7	1.8	0.79	0.64%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	98.107	1363.69	113.97	1396	0.64%	1.1	51%	0.59	0.00	0.59	0
0.984	5615.26	76.8	0.959	76.8	3.0	1.30	1.25%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	130.509	1814.08	151.62	1548	1.25%	1.3	51%	0.60	0.00	0.60	0
1.148	5615.09	85.7	0.894	85.6	3.7	1.58	1.04%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	145.571	2023.44	169.12	1480	1.04%	1.3	51%	0.61	0.00	0.61	0
1.312	5614.93	82.5	0.999	82.4	17.4	7.54	1.21%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	140.046	1946.64	162.87	1247	1.21%	1.4	51%	0.62	0.00	0.62	0
1.476	5614.76	93.6	0.450	93.6	0.8	0.34	0.48%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	159.120	2211.77	184.82	1258	0.48%	1.0	51%	0.63	0.00	0.63	0
1.640	5614.60	40.2	0.533	40.2	-0.8	-0.35	1.33%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	68.306	949.45	79.32	485	1.33%	1.6	51%	0.63	0.00	0.63	0
1.804	5614.44	69.8	0.650	69.8	3.2	1.40	0.93%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	118.609	1648.67	137.80	767	0.93%	1.3	51%	0.64	0.00	0.64	0
1.968	5614.27	139.8	1.194	139.8	6.7	2.90	0.85%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	237.575	3302.29	276.01	1409	0.85%	1.2	51%	0.65	0.00	0.65	0
2.133	5614.11	222.3	2.152	222.2	6.7	2.90	0.97%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	377.791	5251.29	438.86	2069	0.97%	1.2	51%	0.66	0.00	0.66	0
2.297	5613.94	246.8	3.608	246.8	4.8	2.07	1.46%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	419.082	5825.24	486.80	2133	1.46%	1.4	51%	0.67	0.00	0.67	0
2.461	5613.78	219.5	4.267	219.4	6.7	2.90	1.94%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.67	365.913	5086.19	425.07	1770	1.95%	1.5	51%	0.68	0.00	0.68	0
2.625	5613.62	178.9	4.079	179.0	-0.1	-0.03	2.28%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.64	293.386	4078.06	340.75	1353	2.28%	1.6	51%	0.68	0.00	0.68	0
2.789	5613.45	149.3	2.666	149.3	0.3	0.12	1.79%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0	1.61	240.810	3347.26	279.69	1062	1.79%	1.5	51%	0.69	0.00	0.69	0
2.953	5613.29	132.8	2.041	132.8	-0.3	-0.15	1.54%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0	1.61	213.554	2968.40	248.03	892	1.54%	1.5	51%	0.70	0.00	0.70	0
3.117	5613.12	92.1	1.817	92.1	2.6	1.12	1.97%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0	1.70	156.604	2176.80	181.92	586	1.98%	1.7	51%	0.71	0.00	0.71	0
3.281	5612.96	80.8	1.379	80.8	2.1	0.89	1.71%	Sand Tailings	0.051	102.8	0.17	0.00	0.17	0	1.70	137.326	1908.83	159.52	487	1.71%	1.7	18%	0.72	0.00	0.72	0
3.445	5612.80	68.7	1.150	68.7	0.4	0.18	1.67%	Sand-Slime Tailings	0.047	93.3	0.17	0.00	0.17	0	1.70	116.722	1622.44	135.57	396	1.68%	1.7	47%	0.73	0.00	0.73	0
3.609	5612.63	56.4	0.959	56.4	-0.5	-0.20	1.70%	Sand-Slime Tailings	0.047	93.3	0.18	0.00	0.18	0	1.70	95.897	1332.97	111.37	311	1.71%	1.8	47%	0.73	0.00	0.73	0
3.773	5612.47	53.4	0.881	53.4	-0.6	-0.27	1.65%	Sand-Slime Tailings	0.047	93.3	0.19	0.00	0.19	0	1.70	90.797	1262.08	105.45	283	1.66%	1.8	47%	0.74	0.00	0.74	0
3.937	5612.30	48.2	0.768	48.2	-0.6	-0.27	1.59%	Sand-Slime Tailings	0.047	93.3	0.20	0.00	0.20	0	1.70	81.991	1139.67	95.22	245	1.60%	1.8	47%	0.75	0.00	0.75	0
4.101	5612.14	42.9	0.667	42.9	-0.7	-0.29	1.56%	Sand-Slime Tailings	0.047	93.3	0.20	0.00	0.20	0	1.70	72.879	1013.02	84.64	209	1.56%	1.8	47%	0.76	0.00	0.76	0
4.265	5611.97	37.5	0.582	37.5	-0.0	-0.01	1.55%	Sand-Slime Tailings	0.047	93.3	0.21	0.00	0.21	0	1.70	63.767	886.36	74.06	177	1.56%	1.9	47%	0.76	0.00	0.76	0
4.429	5611.81	34.9	0.521	35.0	-0.6	-0.25	1.49%	Sand-Slime Tailings	0.047	93.3	0.22	0.00	0.22	0	1.70	59.415	825.87	69.00	159	1.50%	1.9	47%	0.77	0.00	0.77	0
4.593	5611.65	33.0	0.469	33.0	-0.6	-0.26	1.42%	Sand-Slime Tailings	0.047	93.3	0.23	0.00	0.23	0	1.70	56.049	779.08	65.09	144	1.43%	1.9	47%	0.78	0.00	0.78	0
4.757	5611.48	30.9	0.492	30.9	-0.7	-0.32	1.59%	Sand-Slime Tailings	0.047	93.3	0.23	0.00	0.23	0	1.70	52.462	729.22	60.92	131	1.61%	2.0	47%	0.79	0.00	0.79	0
4.921	5611.32	29.7	0.432	29.7	-1.3	-0.55	1.45%	Sand-Slime Tailings	0.047	93.3	0.24	0.00	0.24	0	1.70	50.490	701.81	58.63	122	1.47%	2.0	47%	0.79	0.00	0.79	0
5.085	5611.15	26.8	0.410	26.8	-1.5	-0.67	1.53%	Sand-Slime Tailings	0.059	119.0	0.25	0.00	0.25	1	1.70	45.594	633.76	52.94	106	1.54%	2.0	47%	0.80	0.00	0.80	0
5.249	5610.99	24.8	0.386	24.8	-0.4	-0.16	1.56%	Sand-Slime Tailings	0.059	119.0	0.26	0.01	0.25	1	1.70	42.143	585.79	48.94	96	1.57%	2.1	47%	0.81	0.00	0.81	0
5.413	5610.83	26.0	0.371	26.0	-0.4	-0.17	1.43%	Sand-Slime Tailings	0.059	119.0	0.27	0.01	0.26	1	1.70	44.200	614.38	51.33	99	1.44%	2.0	47%	0.82	0.00	0.82	0
5.577	5610.66	24.7	0.321	24.7	-0.3	-0.13	1.30%	Sand-Slime Tailings	0.059	119.0	0.28	0.02	0.26	1	1.70	41.922	582.72	48.69	92	1.32%	2.0	47%	0.83	0.00	0.83	0
5.741	5610.50	27.7	0.310	27.7	-0.3	-0.13	1.12%	Sand-Slime Tailings	0.059	119.0	0.29	0.02	0.27	1	1.70	47.022	653.61	54.61	102	1.13%	1.9	47%	0.84	0.00	0.84	0
5.905	5610.33	28.1	0.321	28.1	-0.4	-0.16	1.14%	Sand-Slime Tailings	0.059	119.0	0.30	0.03	0.27	1	1.70	47.770	664.00	55.48	102	1.15%	1.9	47%	0.85	0.00	0.85	0
6.069	5610.17	23.8	0.368	23.8	-0.4	-0.17	1.54%	Sand-Slime Tailings	0.059	119.0	0.31	0.03	0.28	1	1.70	40.511	563.10	47.05	85	1.56%	2.1	47%	0.86	0.00	0.86	0
6.234	5610.01	18.4	0.319	18.4	-0.5	-0.20	1.73%	Sand-Slime Tailings	0.059	119.0	0.32	0.04	0.28	1	1.70	31.297	435.03	36.34	64	1.76%	2.2	47%	0.87	0.00	0.87	0
6.398	5609.84	20.4	0.332	20.5	-0.3	-0.14	1.62%	Sand-Slime Tailings	0.059	119.0	0.33	0.04	0.29	1	1.70	34.765	483.23	40.37	70	1.65%	2.2	47%	0.88	0.00	0.88	0
6.562	5609.68	17.3	0.407	17.3	-0.4	-0.16	2.35%	Sand-Slime Tailings	0.059	119.0	0.34	0.05	0.29	1	1.70	29.461	409.51	34.21	58	2.40%	2.3	47%	0.89	0.00	0.89	0
6.726	5609.51	11.3	0.330	11.4	-0.5	-0.20	2.91%	Slime Tailings	0.057	113.1	0.35	0.05	0.30	1	1.70	19.295	268.20	22.40	37	3.00%	2.5	71%	0.90	0.00	0.90	0
6.890	5609.35	13.4	0.217	13.4	1.7	0.72	1.62%	Sand-Slime Tailings	0.059	119.0	0.36	0.06	0.30	1	1.70	22.763	316.41	26.46	43	1.66%	2.3	47%	0.91	0.00	0.91	0
7.054	5609.19	20.5	0.195	20.5	1.9	0.83	0.95%	Sand-Slime Tailings	0.059	119.0	0.37	0.06	0.31	1	1.70	34.782	483.47	40.42	66	0.97%	2.0	47%	0.92	0.00	0.92	0
7.218	5609.02	20.5	0.217	20.5	0.3	0.14	1.06%	Sand-Slime Tailings	0.059	119.0	0.38	0.07	0.31	1	1.70	34.782	483.47	40.40	65	1.08%	2.1	47%	0.93	0.00	0.93	0
7.382	5608.86	18.7	0.284	18.7	-0.3	-0.14	1.52%	Sand-Slime Tailings	0.059	119.0	0.39	0.07	0.31	1	1.70	31.756	441.41	36.88	58	1.55%	2.2	47%	0.94	0.00	0.94	0
7.546	5608.69	13.6	0.275	13.6	-0.3	-0.14	2.03%	Sand-Slime Tailings	0.059	119.0	0.40	0.08	0.32	1	1.70	23.086	320.90	26.81	41	2.09%	2.4	47%	0.95	0.00	0.95	0
7.710	5608.53	17.2	0.252	17.2	0.6	0.24	1.46%	Sand-Slime Tailings	0.059	119.0	0.41	0.08	0.32	1	1.70	29.257	406.67	33.99	52	1.50%	2.2	47%	0.96	0.00	0.96	0
7.874	5608.37	19.5	0.259	19.5	0.3	0.14	1.33%	Sand-Slime Tailings	0.059	119.0	0.42	0.09	0.33	1	1.70	33.184	461.26	38.55	58	1.36%	2.2	47%	0.97	0.00	0.97	0
8.038	5608.20	17.5	0.270	17.5	-0.4	-0.19	1.54%	Sand-Slime Tailings	0.059	119.0	0.43	0.09	0.33	1	1.70	29.716	413.05	34.51	51	1.58%	2.3	47%	0.98	0.00	0.98	0
8.202	5608.04	20.8	0.275	20.8	-0.3	-0.15	1.32%	Sand-Slime Tailings	0.059	119.0	0.44	0.10	0.34	1	1.70	35.343	491.27	41.04	60	1.35%	2.2	47%	0.99	0.00	0.99	0
8.366	5607.87	29.7	0.344	29.7	-0.3	-0.13	1.16%	Sand-Slime Tailings	0.059	119.0	0.45	0.10	0.34	1	1.70	50.524	702.28	58.68	85	1.18%	2.0	47%	1.00	0.00	1.00	0
8.530	5607.71	27.7	0.473	27.7	-0.4	-0.17	1.71%	Sand-Slime Tailings	0.059	119.0	0.46	0.11	0.35	1	1.70	47.056	654.08	54.65	78	1.74%	2.1	47%	1.01	0.00	1.01	0
8.694	5607.55	17.5	0.350	17.5	-0.4	-0.18	2.00%	Sand-Slime Tailings	0.059	119.0	0.47	0.11	0.35	1	1.70	29.733	413.29	34.53	48	2.06%	2.4	47%	1.02	0.00	1.02	0
8.858	5607.38	14.1	0.266	14.1	0.3	0.13	1.88%	Sand-Slime Tailings	0.059	119.0	0.48	0.12	0.36	1	1.70	23.987	333.42	27.86	38	1.95%	2.4	47%	1.03	0.00	1.03	0
9.022	5607.22	12.6	0.246	12.4	27.0	11.71	1.96%	Sand-Slime Tailings	0.059	119.0	0.49	0.12	0.36	1	1.70	21.080	293.01	24.82	33	2.04%	2.5	47%	1.04	0.00	1.04	0
9.186	5607.05	14.1	0.209	14.0	21.8	9.43	1.48%	Sand-Slime Tailings	0.059	119.0	0.50	0.13	0.37	1	1.70	23.783	330.58	27.89	37	1.53%	2.4	47%	1.05	0.00	1.05	0
9.350	5606.89	11.2	0.245	11.2	5.5	2.40	2.18%	Slime Tailings	0.057	113.1	0.50	0.13	0.37	1	1.70	19.023	264.42	22.16	29	2.29%	2.6	71%	1.06	0.00	1.06	0
9.514	5606.73	8.4	0.166	8.3	7.5	3.23	1.98%	Slime Tailings	0.057	113.1	0.51	0.14	0.37	1	1.70	14.144	196.60	16.52	21	2.11%	2.6	71%	1.07	0.00	1.07	0
9.678	5606.56	9.2	0.101	9.1	11.5	4.97	1.10%	Sand-Slime Tailings	0.059	119.0	0.52	0.14	0.38	1	1.70	15.470	215.03	18.11	23	1.17%	2.5	47%	1.08	0.00	1.08	0
9.842	5606.40	8.9	0.136	8.8	15.6	6.76	1.53%	Sand-Slime Tailings	0.059	119.0	0.53	0.15	0.38	1	1.70	14.926	207.47	17.53	22	1.63%	2.6	47%	1.09	0.00	1.09	0
10.006	5606.23	7.4	0.138	7.3	21.3	9.25	1.87%	Slime Tailings	0.057	113.1	0.54	0.15	0.39	1	1.70	12.325	171.32	14.58	18	2.02%	2.7	71%	1.09	0.00	1.09	0
10.170	5606.07	10.2	0.164	10.2	-1.3	-0.56	1.60%	Sand-Slime Tailings	0.059	119.0	0.55	0.16	0.39	1	1.70	17.408	241.97	20.20	25	1.69%	2.5	47%	1.10	0.00	1.10	0
10.335	5605.91	11.2	0.177	11.1	9.8	4.26	1.58%	Sand-Slime Tailings	0.059	119.0	0.56	0.17	0.40	1	1.70	18.921	263.00	22.10	27	1.67%	2.5	47%	1.11	0.00	1.11	0
10.499	5605.74	10.6	0.158	10.5	14.1	6.11	1.49%	Sand-Slime Tailings	0.059	119.0	0.57	0.17	0.40	1	1.70	17.833	247.88	20.89	25	1.58%	2.5	47%	1.12	0.00	1.12	0
10.663	5605.58	11.5	0.125	11.4	10.9	4.70	1.09%	Sand-Slime Tailings	0.059	119.0	0.58	0.18	0.41	1	1.70	19.380	269.38	22.64	27	1.15%	2.4	47%	1.13	0.00	1.13	0
10.827	5605.41	11.2	0.137	11.1	7.2	3.12	1.22%	Sand-Slime Tailings	0.059	119.0	0.59	0.18	0.41	1	1.70	18.938	263.24	22.08	26	1.29%	2.5	47%	1.14	0.00	1.14	0
10.991	5605.25	11.3	0.125	11.2	15.6	6.77	1.11%	Sand-Slime Tailings	0.059	119.0	0.60	0.19	0.42	1	1.70	19.057	264.89	22.33	26	1.17%	2.4	47%	1.15	0.00	1.15	0
11.155	5605.09	12.7	0.188	12.6	14.5	6.28	1.48%	Sand-Slime Tailings	0.059	119.0	0.61	0.19	0.42	1	1.70	21.437	297.97	25.08	29	1.56%	2.5	47%	1.16	0.00	1.16	0
11.319	5604.92	10.6	0.193	10.5	12.0	5.18	1.82%	Sand-Slime Tailings	0.059	119.0	0.62	0.20	0.42	1	1.70	17.867	248.35	20.90	23	1.94%	2.6	47%	1.17	0.00	1.17	0
11.483	5604.76	10.1	0.128	10.0	15.4	6.66	1.27%	Sand-Slime Tailings	0.059	119.0	0.63	0.20	0.43	1	1.70	17.000	236.30	19.93	22	1.35%	2.5	47%	1.18	0.00	1.18	0
11.647	5604.59	9.6	0.155	9.5	10.4	4.52	1.62%	Sand-Slime Tailings	0.059	119.0	0.64	0.21	0.43	1	1.70	16.150	224.49	18.89	21	1.74%	2.6	47%	1.19	0.00	1.19	0
11.811	5604.43	7.6	0.132	7.4	26.7	11.58	1.74%	Slime Tailings	0.057	113.1	0.65	0.21	0.44	1	1.70	12.549	174.44	14.90	16	1.91%	2.7	71%	1.20	0.00	1.20	0
11.975	5604.27	7.8	0.081	7.7	21.2	9.18	1.04%	Sand-Slime Tailings	0.059	119.0	0.66	0.22	0.44	1	1.68	12.884	179.08	15.22	16	1.14%	2.6	47%	1.21	0.00	1.21	0

Liquefaction Triggering Analyses

Depth (ft)	Idriss & Boulanger (2008) Cyclic Stress Ratio r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Cyclic Resistance Ratio Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd et al. (2001) Cyclic Stress Ratio r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
0.164	1.00	0.06	1.03	1.0	0.059	44.24	83.91	0.118	1.99	0.98	0.36	0.80	2.53	1.0	0.017	1.00	39.67	0.083	201.04	101.51	2
0.328	1.00	0.10	1.04	1.0	0.060	61.00	148.43	0.264	4.40	0.98	0.54	0.73	2.91	1.0	0.015	1.00	87.43	0.142	172.13	88.26	2
0.492	1.00	0.12	1.05	1.0	0.061	69.62	181.61	0.563	9.30	0.98	0.61	0.69	2.96	1.0	0.015	1.00	111.99	0.211	170.09	89.70	2
0.656	1.00	0.12	1.05	1.0	0.061	71.37	188.36	0.707	11.68	0.98	0.62	0.69	2.77	1.0	0.016	1.00	116.99	0.229	138.70	75.19	2
0.820	1.00	0.12	1.04	1.0	0.060	70.32	184.28	0.614	10.17	0.97	0.62	0.69	2.55	1.0	0.017	1.00	113.97	0.218	105.56	57.86	2
0.984	1.00	0.16	1.06	1.0	0.061	83.53	235.14	1.000	16.35	0.97	0.71	0.64	2.76	1.0	0.016	1.00	151.62	0.404	163.38	89.86	2
1.148	1.00	0.19	1.07	1.0	0.062	89.67	258.79	1.000	16.23	0.97	0.75	0.62	2.76	1.0	0.016	1.00	169.12	1.000	346.66	181.45	2
1.312	1.00	0.18	1.06	1.0	0.061	87.48	250.35	1.000	16.33	0.97	0.74	0.63	2.57	1.0	0.017	1.00	162.87	1.000	303.45	159.89	2
1.476	1.00	0.22	1.07	1.0	0.062	95.18	280.00	1.000	16.16	0.97	0.78	0.61	2.61	1.0	0.016	1.00	184.82	1.000	269.84	143.00	2
1.640	1.00	0.09	1.03	1.0	0.059	58.16	137.48	0.224	3.78	0.97	0.51	0.74	1.83	1.0	0.023	1.00	79.32	0.126	30.71	17.24	2
1.804	1.00	0.14	1.04	1.0	0.060	78.68	216.47	1.000	16.60	0.97	0.68	0.66	2.14	1.0	0.020	1.00	137.80	0.323	71.44	44.02	2
1.968	1.00	0.30	1.08	1.0	0.063	127.18	403.19	1.000	15.98	0.97	0.96	0.60	2.37	1.0	0.018	1.00	276.01	1.000	202.62	109.30	2
2.133	1.00	0.30	1.08	1.0	0.062	184.33	623.20	1.000	16.05	0.97	1.21	0.60	2.30	1.0	0.019	1.00	438.86	1.000	187.10	101.57	2
2.297	1.00	0.30	1.08	1.0	0.062	201.15	687.95	1.000	16.11	0.97	1.27	0.60	2.23	1.0	0.019	1.00	486.80	1.000	173.81	94.96	2
2.461	1.00	0.30	1.07	1.0	0.062	179.49	604.56	1.000	16.18	0.97	1.19	0.60	2.17	1.0	0.020	1.00	425.07	1.000	162.28	89.23	2
2.625	1.00	0.30	1.07	1.0	0.062	149.90	490.65	1.000	16.25	0.97	1.07	0.60	2.12	1.0	0.020	1.00	340.75	1.000	152.20	84.23	2
2.789	0.99	0.30	1.07	1.0	0.061	128.47	408.16	1.000	16.32	0.97	0.97	0.60	2.07	1.0	0.021	1.00	279.69	1.000	143.30	79.81	2
2.953	0.99	0.30	1.06	1.0	0.061	117.36	365.39	1.000	16.39	0.97	0.91	0.60	2.02	1.0	0.021	1.00	248.03	1.000	135.40	75.89	2
3.117	0.99	0.22	1.04	1.0	0.060	94.16	276.08	1.000	16.72	0.97	0.78	0.61	1.94	1.0	0.022	1.02	185.13	1.000	128.32	72.52	2
3.281	0.99	0.17	1.03	1.0	0.059	62.87	222.39	1.000	16.90	0.97	0.73	0.64	1.82	1.0	0.023	1.00	160.07	1.000	121.83	69.36	2
3.445	0.99	0.14	1.02	1.0	0.059	77.85	213.42	1.000	17.04	0.97	0.67	0.66	1.71	1.0	0.025	1.03	139.61	0.333	38.80	27.92	2
3.609	0.99	0.12	1.02	1.0	0.058	69.36	180.73	0.548	9.39	0.97	0.61	0.70	1.61	1.0	0.027	1.07	119.35	0.238	26.57	17.98	2
3.773	0.99	0.11	1.02	1.0	0.058	67.28	172.73	0.437	7.51	0.97	0.59	0.70	1.57	1.0	0.027	1.08	113.95	0.218	23.31	15.41	2
3.937	0.99	0.10	1.01	1.0	0.058	63.70	158.92	0.319	5.50	0.97	0.56	0.72	1.52	1.0	0.028	1.10	104.52	0.186	19.17	12.34	2
4.101	0.99	0.09	1.01	1.0	0.058	59.98	144.62	0.249	4.31	0.97	0.53	0.73	1.47	1.0	0.029	1.12	95.05	0.160	15.85	10.08	2
4.265	0.99	0.09	1.01	1.0	0.058	56.28	130.34	0.204	3.54	0.97	0.50	0.75	1.42	1.0	0.030	1.16	85.99	0.139	13.30	8.42	2
4.429	0.99	0.08	1.01	1.0	0.058	54.50	123.50	0.187	3.26	0.97	0.48	0.76	1.39	1.0	0.031	1.18	81.21	0.130	11.98	7.62	2
4.593	0.98	0.08	1.01	1.0	0.057	53.13	118.22	0.176	3.06	0.97	0.47	0.77	1.36	1.0	0.031	1.19	77.39	0.123	10.98	7.02	2
4.757	0.98	0.08	1.01	1.0	0.057	51.67	112.59	0.165	2.87	0.97	0.45	0.77	1.34	1.0	0.032	1.26	76.65	0.122	10.52	6.70	2
4.921	0.98	0.08	1.01	1.0	0.057	50.86	109.49	0.159	2.78	0.97	0.44	0.78	1.32	1.0	0.032	1.25	73.30	0.117	9.75	6.27	2
5.085	0.98	0.07	1.00	1.0	0.057	48.87	101.80	0.146	2.55	0.96	0.42	0.79	1.30	1.0	0.033	1.32	70.05	0.112	9.05	5.80	2
5.249	0.98	0.07	1.00	1.0	0.057	47.47	96.41	0.137	2.40	0.96	0.40	0.80	1.28	1.0	0.033	1.38	67.39	0.108	8.62	5.51	2
5.413	0.98	0.07	1.00	1.0	0.057	48.30	99.63	0.142	2.50	0.96	0.41	0.79	1.28	1.0	0.033	1.32	68.00	0.109	8.53	5.51	2
5.577	0.98	0.07	1.00	1.0	0.057	47.38	96.06	0.136	2.40	0.96	0.40	0.80	1.27	1.0	0.033	1.32	64.25	0.105	8.03	5.21	2
5.741	0.98	0.07	1.00	1.0	0.057	49.45	104.06	0.149	2.64	0.96	0.43	0.79	1.28	1.0	0.033	1.23	67.08	0.108	8.15	5.39	2
5.905	0.98	0.07	1.00	1.0	0.057	49.76	105.24	0.151	2.68	0.96	0.43	0.78	1.28	1.0	0.033	1.23	68.51	0.110	8.15	5.41	2
6.069	0.98	0.07	1.00	1.0	0.056	46.80	93.85	0.133	2.35	0.96	0.40	0.80	1.25	1.0	0.034	1.44	67.86	0.109	7.96	5.15	2
6.234	0.98	0.06	1.00	1.0	0.056	43.05	79.39	0.112	1.98	0.96	0.35	0.80	1.25	1.0	0.034	1.71	62.22	0.102	7.35	4.67	2
6.398	0.97	0.07	1.00	1.0	0.056	44.46	84.83	0.119	2.12	0.96	0.37	0.80	1.25	1.0	0.034	1.60	64.41	0.105	7.41	4.77	2
6.562	0.97	0.06	1.00	1.0	0.056	42.30	76.51	0.108	1.92	0.96	0.34	0.80	1.24	1.0	0.034	2.08	71.05	0.113	7.88	4.90	2
6.726	0.97	0.05	1.00	1.0	0.056	37.89	60.29	0.088	1.57	0.96	0.27	0.80	1.24	1.0	0.034	3.02	67.71	0.109	7.47	4.52	2
6.890	0.97	0.06	1.00	1.0	0.056	39.58	66.04	0.095	1.69	0.96	0.30	0.80	1.23	1.0	0.034	2.05	54.36	0.095	6.42	4.05	2
7.054	0.97	0.07	1.00	1.0	0.056	44.48	84.90	0.119	2.14	0.96	0.37	0.80	1.23	1.0	0.034	1.36	55.14	0.096	6.36	4.25	2
7.218	0.97	0.07	0.99	1.0	0.056	44.47	84.87	0.119	2.14	0.96	0.37	0.80	1.23	1.0	0.035	1.42	57.29	0.097	6.40	4.27	2
7.382	0.97	0.06	0.99	1.0	0.056	43.24	80.11	0.113	2.03	0.96	0.35	0.80	1.22	1.0	0.035	1.70	62.74	0.103	6.66	4.34	2
7.546	0.97	0.06	0.99	1.0	0.056	39.70	66.51	0.095	1.72	0.96	0.30	0.80	1.22	1.0	0.035	2.35	63.11	0.103	6.59	4.15	2
7.710	0.97	0.06	0.99	1.0	0.055	42.22	76.21	0.108	1.94	0.96	0.34	0.80	1.22	1.0	0.035	1.78	60.41	0.101	6.32	4.13	2
7.874	0.96	0.06	0.99	1.0	0.055	43.82	82.37	0.116	2.09	0.96	0.36	0.80	1.21	1.0	0.035	1.61	62.11	0.102	6.34	4.22	2
8.038	0.96	0.06	0.99	1.0	0.055	42.40	76.91	0.108	1.96	0.96	0.34	0.80	1.21	1.0	0.035	1.83	63.24	0.104	6.33	4.15	2
8.202	0.96	0.07	0.99	1.0	0.055	44.70	85.74	0.121	2.19	0.96	0.37	0.80	1.21	1.0	0.035	1.58	64.94	0.105	6.36	4.28	2
8.366	0.96	0.08	0.99	1.0	0.055	50.88	109.56	0.159	2.89	0.96	0.44	0.78	1.23	1.0	0.034	1.31	76.88	0.122	7.28	5.09	2
8.530	0.96	0.07	0.99	1.0	0.055	49.47	104.12	0.149	2.72	0.96	0.43	0.79	1.21	1.0	0.035	1.55	84.64	0.136	8.02	5.37	2
8.694	0.96	0.06	0.99	1.0	0.055	42.41	76.94	0.109	1.98	0.96	0.34	0.80	1.20	1.0	0.035	2.13	73.60	0.117	6.79	4.38	2
8.858	0.96	0.06	0.99	1.0	0.055	40.07	67.94	0.097	1.77	0.96	0.30	0.80	1.19	1.0	0.035	2.38	66.42	0.107	6.14	3.96	2
9.022	0.96	0.06	0.99	1.0	0.055	39.01	63.82	0.092	1.68	0.96	0.29	0.80	1.19	1.0	0.035	2.64	65.56	0.106	6.01	3.85	2
9.186	0.96	0.06	0.99	1.0	0.055	40.08	67.97	0.097	1.78	0.96	0.30	0.80	1.19	1.0	0.035	2.17	60.39	0.100	5.62	3.70	2
9.350	0.96	0.05	0.99	1.0	0.055	37.81	59.97	0.088	1.61	0.95	0.27	0.80	1.18	1.0	0.036	3.06	67.79	0.109	6.02	3.82	2
9.514	0.95	0.05	0.99	1.0	0.055	35.84	52.36	0.080	1.46	0.95	0.23	0.80	1.18	1.0	0.036	3.62	59.80	0.100	5.46	3.46	2
9.678	0.95	0.05	0.99	1.0	0.054	36.65	54.76	0.082	1.51	0.95	0.25	0.80	1.18	1.0	0.036	2.64	47.72	0.090	4.85	3.18	2
9.842	0.95	0.05	0.99	1.0	0.054	36.45	53.98	0.081	1.50	0.95	0.24	0.80	1.18	1.0	0.036	3.14	55.03	0.095	5.10	3.30	2
10.006	0.95	0.05	0.99	1.0	0.054	35.16	49.74	0.077	1.42	0.95	0.22	0.80	1.17	1.0	0.036	3.97	57.82	0.098	5.18	3.30	2
10.170	0.95	0.05	0.99	1.0	0.054	37.39	57.59	0.085	1.57	0.95	0.26	0.80	1.17	1.0	0.036	2.94	59.41	0.100	5.20	3.39	2
10.335	0.95	0.05	0.99	1.0	0.054	38.05	60.15	0.088	1.63	0.95	0.27	0.80	1.17	1.0	0.036	2.77	61.13	0.101	5.23	3.43	2
10.499	0.95	0.05	0.99	1.0	0.054	37.63	58.51	0.086	1.60	0.95	0.26	0.80	1.16	1.0	0.036	2.83	59.12	0.099	5.07	3.33	2
10.663	0.95	0.05	0.99	1.0	0.054	38.24	60.89	0.089	1.65	0.95	0.27	0.80	1.16	1.0	0.036	2.35	53.28	0.094	4.75	3.20	2
10.827	0.95	0.05	0.98	1.0	0.054	38.05	60.13	0.088	1.64	0.95	0.27	0.80	1.16	1.0	0.036	2.54	56.01	0.096	4.81	3.22	2
10.991	0.94	0.05	0.98	1.0	0.054	38.13	60.46	0.088	1.64	0.95	0.27	0.80	1.16	1.0	0.036	2.43	54.27	0.095	4.69	3.17	2
11.155	0.94	0.06	0.98	1.0	0.054	39.10	64.17	0.093	1.73	0.95	0.29	0.80	1.15	1.0	0.036	2.56	64.20	0.105	5.12	3.42	2
11.319	0.94	0.05	0.98	1.0	0.054	37.63	58.53	0.086	1.61	0.95	0.26	0.80	1.15	1.0	0.036	3.23	67.57	0.109	5.26	3.43	2
11.483	0.94	0.05	0.98	1.0	0.053	37.29	57.23	0.085	1.59	0.95	0.26	0.80	1.15	1.0	0.036	2.87	57.19	0.097	4.66	3.12	2
11.647	0.94	0.05	0.98	1.0	0.053	36.93	55.81	0.083	1.56	0.95	0.25	0.80	1.15	1.0	0.037	3.35	63.33	0.104	4.91	3.24	2
11.811	0.94	0.05	0.98	1.0	0.053	35.28	50.18	0.078	1.46	0.95	0.22	0.80	1.14	1.0	0.037	4.16	62.05	0.102	4.80	3.13	2
11.975	0.94	0.05	0.98	1.0	0.053	35.64	50.86	0.078	1.47	0.95	0.23	0.80	1.14	1.0	0.037	3.31	50.40	0.092	4.27	2.87	2

Idriss & Boulanger (2008)

Depth (ft)	CN	qc1 TSF	qc1 MPa	qc1N
0.164	1.7	34.154	3.2699	39.667
0.328	1.7	75.273	7.2067	87.425
0.492	1.7	96.421	9.2314	111.988
0.656	1.7	100.72	9.6434	116.986
0.820	1.7	98.126	9.3946	113.968
0.984	1.7	130.54	12.498	151.615
1.148	1.7	145.61	13.941	169.117
1.312	1.7	140.23	13.426	162.870
1.476	1.7	159.13	15.235	184.818
1.640	1.7	68.297	6.5388	79.323
1.804	1.7	118.64	11.359	137.797
1.968	1.7	237.65	22.752	276.012
2.133	1.7	377.86	36.177	438.864
2.297	1.69827	419.13	40.128	486.797
2.461	1.667638	365.98	35.039	425.067
2.625	1.639484	293.39	28.089	340.749
2.789	1.61347	240.81	23.055	279.690
2.953	1.608211	213.55	20.445	248.026
3.117	1.7	156.63	14.996	181.918
3.281	1.7	137.35	13.15	159.521
3.445	1.7	116.73	11.175	135.571
3.609	1.7	95.892	9.1807	111.373
3.773	1.7	90.79	8.6923	105.447
3.937	1.7	81.984	7.8492	95.220
4.101	1.7	72.872	6.9768	84.636
4.265	1.7	63.767	6.105	74.061
4.429	1.7	59.409	5.6878	69.000
4.593	1.7	56.043	5.3655	65.090
4.757	1.7	52.454	5.022	60.922
4.921	1.7	50.477	4.8326	58.625
5.085	1.7	45.578	4.3636	52.936
5.249	1.7	42.139	4.0344	48.942
5.413	1.7	44.196	4.2313	51.331
5.577	1.7	41.919	4.0133	48.686
5.741	1.7	47.019	4.5016	54.609
5.905	1.7	47.766	4.5731	55.478
6.069	1.7	40.507	3.8781	47.046
6.234	1.7	31.292	2.9959	36.344
6.398	1.7	34.762	3.3281	40.374
6.562	1.7	29.457	2.8202	34.213
6.726	1.7	19.29	1.8468	22.404
6.890	1.7	22.781	2.181	26.458
7.054	1.7	34.802	3.332	40.421
7.218	1.7	34.786	3.3304	40.401
7.382	1.7	31.752	3.04	36.879
7.546	1.7	23.082	2.2099	26.809
7.710	1.7	29.263	2.8016	33.987
7.874	1.7	33.187	3.1774	38.545
8.038	1.7	29.711	2.8446	34.508
8.202	1.7	35.339	3.3834	41.045
8.366	1.7	50.521	4.8369	58.677
8.530	1.7	47.052	4.5047	54.648
8.694	1.7	29.729	2.8462	34.528
8.858	1.7	23.99	2.2968	27.863
9.022	1.7	21.367	2.0457	24.816
9.186	1.7	24.014	2.2991	27.891
9.350	1.7	19.082	1.8269	22.162
9.514	1.7	14.223	1.3617	16.519
9.678	1.7	15.592	1.4928	18.109
9.842	1.7	15.092	1.4449	17.528
10.006	1.7	12.551	1.2017	14.578
10.170	1.7	17.394	1.6653	20.202
10.335	1.7	19.025	1.8215	22.097
10.499	1.7	17.983	1.7216	20.886
10.663	1.7	19.495	1.8665	22.642
10.827	1.7	19.014	1.8204	22.084
10.991	1.7	19.223	1.8404	22.326
11.155	1.7	21.591	2.0671	25.077
11.319	1.7	17.994	1.7227	20.899
11.483	1.7	17.163	1.6432	19.934
11.647	1.7	16.261	1.5568	18.886
11.811	1.695868	12.832	1.2286	14.904
11.975	1.681958	13.106	1.2548	15.222

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W4-C

Data File:	13-52106_SP2W4-C-BSC-CPT
Location:	White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da	

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5611.20	Water surface elevation during CPT investigation (ft a
5607.96	Water surface elevation at t_0 (ft amsl)
5593.50	Water surface elevation at t_1 (ft amsl)
5588.50	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earth
7.51	Equiv. Number of Uniform Strain Cycles, N
5616.24	Ground Surface Elevation at time of CPT (ft amsl)
5626.19	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
1.95	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1104.55	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5588.50	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	5626.19	5625.94	5625.69	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	5625.69	5623.94	5622.19	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	5622.19	5620.19	5618.19	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	5618.19	5617.22	5616.24	1.95	0.050	101	0.552	0.503	0.00	0.00	0.552	0.503

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
12.139	5604.10	8.6	0.080	8.5	21.2	9.20	0.93%	Sand-Slime Tailings	0.059	119.0	0.67	0.22	0.45	1	1.67	14.147	196.65	16.69	18	1.01%	2.5	47%	1.22	0.00	1.22	0
12.303	5603.94	7.4	0.144	7.2	28.9	12.53	1.95%	Slime Tailings	0.057	113.1	0.68	0.23	0.45	1	1.66	11.958	166.22	14.24	15	2.14%	2.8	71%	1.23	0.00	1.23	0
12.467	5603.77	6.6	0.098	6.4	31.0	13.42	1.49%	Slime Tailings	0.057	113.1	0.69	0.23	0.46	1	1.64	10.508	146.06	12.57	13	1.66%	2.8	71%	1.24	0.00	1.24	0
12.631	5603.61	10.5	0.114	10.4	20.4	8.82	1.08%	Sand-Slime Tailings	0.059	119.0	0.70	0.24	0.46	1	1.63	16.984	236.07	19.97	21	1.16%	2.5	47%	1.25	0.00	1.25	0
12.795	5603.44	13.7	0.097	13.6	15.2	6.59	0.71%	Sand-Slime Tailings	0.059	119.0	0.71	0.24	0.46	1	1.59	21.666	301.16	25.34	28	0.75%	2.3	47%	1.26	0.00	1.26	0
12.959	5603.28	16.5	0.105	16.4	9.8	4.23	0.64%	Sand-Slime Tailings	0.059	119.0	0.72	0.25	0.47	1	1.55	25.544	355.07	29.78	34	0.67%	2.2	47%	1.27	0.00	1.27	0
13.123	5603.12	21.7	0.122	21.7	9.2	4.00	0.56%	Sand-Slime Tailings	0.059	119.0	0.73	0.25	0.47	1	1.51	32.623	453.45	37.99	44	0.58%	2.1	47%	1.28	0.00	1.28	0
13.287	5602.95	18.8	0.157	18.7	5.8	2.52	0.84%	Sand-Slime Tailings	0.059	119.0	0.74	0.26	0.48	1	1.52	28.407	394.86	33.06	38	0.87%	2.2	47%	1.29	0.00	1.29	0
13.451	5602.79	19.3	0.227	19.2	9.2	4.00	1.18%	Sand-Slime Tailings	0.059	119.0	0.75	0.26	0.48	1	1.50	28.942	402.30	33.72	38	1.22%	2.3	47%	1.30	0.00	1.30	0
13.615	5602.62	15.8	0.262	15.7	7.7	3.33	1.66%	Sand-Slime Tailings	0.059	119.0	0.76	0.27	0.49	1	1.52	23.933	332.67	27.88	31	1.74%	2.5	47%	1.31	0.00	1.31	0
13.779	5602.46	12.7	0.218	12.6	16.1	6.99	1.72%	Sand-Slime Tailings	0.059	119.0	0.77	0.27	0.49	1	1.54	19.381	269.39	22.69	24	1.83%	2.6	47%	1.32	0.00	1.32	0
13.943	5602.30	10.1	0.175	9.9	22.6	9.81	1.74%	Sand-Slime Tailings	0.059	119.0	0.78	0.28	0.50	1	1.54	15.263	212.15	17.98	19	1.88%	2.7	47%	1.33	0.00	1.33	0
14.107	5602.13	9.1	0.134	8.8	44.4	19.24	1.48%	Sand-Slime Tailings	0.059	119.0	0.79	0.28	0.50	1	1.52	13.415	186.46	16.07	17	1.62%	2.7	47%	1.34	0.00	1.34	0
14.271	5601.97	13.3	0.135	13.2	23.4	10.14	1.01%	Sand-Slime Tailings	0.059	119.0	0.79	0.29	0.51	1	1.50	19.817	275.45	23.27	25	1.08%	2.4	47%	1.35	0.00	1.35	0
14.436	5601.80	11.8	0.101	11.7	21.6	9.38	0.86%	Sand-Slime Tailings	0.059	119.0	0.80	0.29	0.51	1	1.50	17.537	243.76	20.60	22	0.92%	2.4	47%	1.36	0.00	1.36	0
14.600	5601.64	11.3	0.117	11.2	20.4	8.83	1.03%	Sand-Slime Tailings	0.059	119.0	0.81	0.30	0.52	1	1.49	16.742	232.71	19.67	20	1.11%	2.5	47%	1.37	0.00	1.37	0
14.764	5601.48	10.3	0.048	10.1	26.4	11.43	0.47%	Sand-Slime Tailings	0.059	119.0	0.82	0.30	0.52	1	1.48	15.025	208.85	17.73	18	0.51%	2.4	47%	1.38	0.00	1.38	0
14.928	5601.31	10.3	0.125	10.2	18.1	7.85	1.21%	Sand-Slime Tailings	0.059	119.0	0.83	0.31	0.53	1	1.47	15.024	208.83	17.64	18	1.32%	2.6	47%	1.39	0.00	1.39	0
15.092	5601.15	9.7	0.124	9.5	36.6	15.86	1.28%	Sand-Slime Tailings	0.059	119.0	0.84	0.31	0.53	1	1.46	13.810	191.97	16.43	17	1.40%	2.6	47%	1.40	0.00	1.40	0
15.256	5600.98	10.1	0.123	10.0	14.9	6.47	1.22%	Sand-Slime Tailings	0.059	119.0	0.85	0.32	0.53	1	1.45	14.471	201.15	16.96	17	1.34%	2.6	47%	1.41	0.00	1.41	0
15.420	5600.82	8.8	0.119	8.6	32.5	14.09	1.36%	Sand-Slime Tailings	0.059	119.0	0.86	0.32	0.54	1	1.44	12.356	171.74	14.69	15	1.50%	2.7	47%	1.42	0.00	1.42	0
15.584	5600.66	9.0	0.124	8.6	54.7	23.71	1.38%	Sand-Slime Tailings	0.059	119.0	0.87	0.33	0.54	1	1.43	12.359	171.79	14.92	15	1.53%	2.7	47%	1.43	0.00	1.43	0
15.748	5600.49	9.1	0.139	8.8	60.7	26.31	1.52%	Sand-Slime Tailings	0.059	119.0	0.88	0.33	0.55	1	1.42	12.476	173.42	15.12	15	1.68%	2.7	47%	1.43	0.00	1.43	0
15.912	5600.33	8.8	0.135	8.4	58.5	25.37	1.54%	Sand-Slime Tailings	0.059	119.0	0.89	0.34	0.55	1	1.41	11.857	164.82	14.37	14	1.72%	2.7	47%	1.44	0.00	1.44	0
16.076	5600.16	8.0	0.083	7.6	54.0	23.40	1.04%	Sand-Slime Tailings	0.059	119.0	0.90	0.34	0.56	1	1.40	10.699	148.72	12.98	13	1.18%	2.7	47%	1.45	0.00	1.45	0
16.240	5600.00	7.9	0.083	7.6	49.3	21.36	1.05%	Sand-Slime Tailings	0.059	119.0	0.91	0.35	0.56	1	1.40	10.560	146.79	12.76	12	1.19%	2.7	47%	1.46	0.00	1.46	0
16.404	5599.84	7.2	0.093	6.8	64.6	27.99	1.29%	Slime Tailings	0.057	113.1	0.92	0.35	0.57	1	1.39	9.446	131.29	11.62	11	1.48%	2.8	71%	1.47	0.00	1.47	0
16.568	5599.67	7.6	0.134	7.3	52.4	22.70	1.75%	Slime Tailings	0.057	113.1	0.93	0.36	0.57	1	1.38	10.095	140.32	12.25	12	2.00%	2.8	71%	1.48	0.00	1.48	0
16.732	5599.51	6.9	0.131	6.6	54.4	23.55	1.89%	Slime Tailings	0.057	113.1	0.94	0.36	0.57	1	1.37	9.064	125.99	11.07	10	2.18%	2.9	71%	1.49	0.00	1.49	0
16.896	5599.34	8.8	0.147	8.5	39.7	17.21	1.67%	Slime Tailings	0.057	113.1	0.95	0.37	0.58	1	1.36	11.645	161.86	13.92	14	1.88%	2.8	71%	1.50	0.00	1.50	0
17.060	5599.18	7.0	0.190	6.8	39.7	17.19	2.72%	Slime Tailings	0.057	113.1	0.96	0.38	0.58	1	1.36	9.153	127.22	11.02	10	3.15%	3.0	71%	1.51	0.00	1.51	0
17.224	5599.02	6.5	0.176	6.2	52.9	22.94	2.70%	Slime Tailings	0.057	113.1	0.97	0.38	0.59	1	1.35	8.333	115.83	10.20	9	3.18%	3.0	71%	1.52	0.00	1.52	0
17.388	5598.85	7.9	0.164	7.7	33.1	14.33	2.07%	Slime Tailings	0.057	113.1	0.98	0.39	0.59	1	1.34	10.339	143.72	12.33	12	2.36%	2.9	71%	1.53	0.00	1.53	0
17.552	5598.69	11.4	0.123	11.3	9.0	3.89	1.08%	Sand-Slime Tailings	0.059	119.0	0.99	0.39	0.60	1	1.33	15.075	209.54	17.60	17	1.19%	2.6	47%	1.54	0.00	1.54	0
17.716	5598.52	11.9	0.100	11.9	9.2	3.97	0.84%	Sand-Slime Tailings	0.059	119.0	1.00	0.40	0.60	1	1.32	15.752	218.95	18.38	18	0.91%	2.5	47%	1.55	0.00	1.55	0
17.880	5598.36	13.3	0.080	13.2	10.8	4.68	0.60%	Sand-Slime Tailings	0.059	119.0	1.01	0.40	0.61	1	1.32	17.409	241.99	20.32	20	0.65%	2.4	47%	1.56	0.00	1.56	0
18.044	5598.20	11.4	0.112	11.3	11.6	5.01	0.98%	Sand-Slime Tailings	0.059	119.0	1.02	0.41	0.61	1	1.31	14.805	205.79	17.31	17	1.08%	2.6	47%	1.57	0.00	1.57	0
18.208	5598.03	9.8	0.153	9.6	32.4	14.04	1.56%	Sand-Slime Tailings	0.059	119.0	1.03	0.41	0.61	1	1.30	12.479	173.46	14.80	14	1.75%	2.7	47%	1.58	0.00	1.58	0
18.372	5597.87	8.7	0.140	8.4	48.2	20.90	1.61%	Slime Tailings	0.057	113.1	1.03	0.42	0.62	1	1.29	10.848	150.78	13.05	12	1.83%	2.8	71%	1.59	0.00	1.59	0
18.537	5597.70	13.2	0.140	13.0	34.0	14.71	1.06%	Sand-Slime Tailings	0.059	119.0	1.04	0.42	0.62	1	1.29	16.691	232.01	19.70	19	1.15%	2.5	47%	1.60	0.00	1.60	0
18.701	5597.54	16.6	0.192	16.5	16.7	7.23	1.15%	Sand-Slime Tailings	0.059	119.0	1.05	0.43	0.63	1	1.27	21.007	292.00	24.55	25	1.23%	2.5	47%	1.61	0.00	1.61	0
18.865	5597.38	18.6	0.304	18.5	20.3	8.79	1.64%	Sand-Slime Tailings	0.059	119.0	1.06	0.43	0.63	1	1.26	23.192	322.37	27.12	28	1.74%	2.5	47%	1.62	0.00	1.62	0
19.029	5597.21	12.1	0.344	12.0	21.5	9.30	2.85%	Slime Tailings	0.057	113.1	1.07	0.44	0.64	1	1.27	15.124	210.23	17.76	17	3.12%	2.8	71%	1.63	0.00	1.63	0
19.193	5597.05	10.5	0.228	10.4	14.6	6.31	2.17%	Slime Tailings	0.057	113.1	1.08	0.44	0.64	1	1.26	13.121	182.38	15.37	15	2.42%	2.8	71%	1.63	0.00	1.63	0
19.357	5596.88	14.9	0.247	14.8	23.9	10.36	1.66%	Sand-Slime Tailings	0.059	119.0	1.09	0.45	0.65	1	1.25	18.446	256.39	21.64	21	1.79%	2.6	47%	1.64	0.00	1.64	0
19.521	5596.72	13.9	0.205	13.8	21.2	9.20	1.47%	Sand-Slime Tailings	0.059	119.0	1.10	0.45	0.65	1	1.25	17.183	238.84	20.15	20	1.60%	2.6	47%	1.65	0.00	1.65	0
19.685	5596.56	13.2	0.218	13.1	22.9	9.93	1.65%	Sand-Slime Tailings	0.059	119.0	1.11	0.46	0.66	1	1.24	16.221	225.47	19.05	19	1.80%	2.7	47%	1.66	0.00	1.66	0
19.849	5596.39	13.5	0.200	13.2	37.2	16.11	1.49%	Sand-Slime Tailings	0.059	119.0	1.12	0.46	0.66	1	1.23	16.280	226.29	19.24	19	1.62%	2.6	47%	1.67	0.00	1.67	0
20.013	5596.23	12.3	0.225	12.1	40.5	17.56	1.82%	Sand-Slime Tailings	0.059	119.0	1.13	0.47	0.66	1	1.22	14.794	205.64	17.54	17	2.01%	2.7	47%	1.68	0.00	1.68	0
20.177	5596.06	11.2	0.272	11.1	13.6	5.88	2.44%	Slime Tailings	0.057	113.1	1.14	0.47	0.67	1	1.22	13.492	187.53	15.79	15	2.72%	2.8	71%	1.69	0.00	1.69	0
20.341	5595.90	8.2	0.252	7.9	49.1	21.27	3.08%	Slime Tailings	0.057	113.1	1.15	0.48	0.67	1	1.21	9.557	132.85	11.53	10	3.58%	3.0	71%	1.70	0.00	1.70	0
20.505	5595.74	9.4	0.193	9.0	75.9	32.90	2.05%	Slime Tailings	0.057	113.1	1.16	0.48	0.68	1	1.21	10.815	150.33	13.23	12	2.33%	2.9	71%	1.71	0.00	1.71	0
20.669	5595.57	9.3	0.202	9.0	52.0	22.51	2.18%	Slime Tailings	0.057	113.1	1.17	0.49	0.68	1	1.20	10.763	149.61	12.95	12	2.49%	2.9	71%	1.72	0.00	1.72	0
20.833	5595.41	8.3	0.219	7.8	73.7	31.95	2.64%	Slime Tailings	0.057	113.1	1.18	0.49	0.69	1	1.20	9.349	129.95	11.50	10	3.08%	3.0	71%	1.73	0.00	1.73	0
20.997	5595.24	12.0	0.180	11.6	62.5	27.06	1.50%	Sand-Slime Tailings	0.059	119.0	1.19	0.50	0.69	1	1.19	13.843	192.42	16.62	16	1.66%	2.7	47%	1.74	0.00	1.74	0
21.161	5595.08	19.0	0.205	19.0	5.5	2.37	1.08%	Sand-Slime Tailings	0.059	119.0	1.20	0.50	0.69	1	1.17	22.300	309.97	25.95	26	1.15%	2.4	47%	1.75	0.00	1.75	0
21.325	5594.91	17.5	0.316	17.4	19.7	8.54	1.80%	Sand-Slime Tailings	0.059	119.0	1.21	0.51	0.70	1	1.17	20.385	283.36	23.84	23	1.94%	2.6	47%	1.76	0.00	1.76	0
21.489	5594.75	17.3	0.420	17.1	33.3	14.41	2.43%	Sand-Slime Tailings	0.059	119.0	1.22	0.51	0.70	1	1.17	19.921	276.90	23.42	23	2.62%	2.7	47%	1.77	0.00	1.77	0
21.653	5594.59	15.7	0.502	15.4	48.2	20.90	3.21%	Slime Tailings	0.057	113.1	1.23	0.52	0.71	1	1.17	17.885	248.60	21.18	20	3.48%	2.8	71%	1.78	0.00	1.78	0
21.817	5594.42	15.8	0.368	15.7	17.6	7.63	2.33%	Sand-Slime Tailings	0.059	119.0	1.24	0.52	0.71	1	1.16	18.175	252.63	21.26	20	2.53%	2.7	47%	1.79	0.00	1.79	0
21.981	5594.26	15.2	0.338	15.1	19.9	8.62	2.23%	Sand-Slime Tailings	0.059	119.0	1.25	0.53	0.72	1	1.15	17.362	241.33	20.33	19	2.43%	2.7	47%	1.80	0.00	1.80	0
22.145	5594.09	12.0	0.255	11.8	32.8	14.22	2.12%	Slime Tailings	0.057	113.1	1.25	0.53	0.72	1	1.15	13.551	188.36	16.01	15	2.37%	2.8	71%	1.81	0.00	1.81	0
22.309	5593.93	8.6	0.140	8.2	71.6	31.03	1.62%	Slime Tailings	0.057	113.1	1.26	0.54	0.73	1	1.14	9.341	129.83	11.44	10	1.90%	2.9	71%	1.82	0.00	1.82	0
22.473	5593.77	9.5	0.099	9.0	82.5	35.75	1.04%	Sand-Slime Tailings	0.059	119.0	1.27	0.54	0.73	1	1.14	10.238	142.31	12.57	11	1.20%	2.7	47%	1.83	0.00	1.83	0
22.638	5593.60	10.4	0.096	9.8	94.2	40.81	0.93%	Sand-Slime Tailings	0.059	119.0	1.28	0.55	0.73	1	1.13	11.059	153.72	13.62	12	1.06%	2.7	47%	1.84	0.00	1.84	0
22.802	5593.44	9.9	0.099	9.3	99.2	43.00	1.00%	Sand-Slime Tailings	0.059	119.0	1.29	0.55	0.74	1	1.13	10.431	144.98	12.92	12	1.15%	2.7	47%	1.85	0.00	1.84	1
22.966	5593.27	10.2	0.107	9.5	106.1	45.99	1.05%	Sand-Slime Tailings	0.059	119.0	1.30	0.56	0.74	1	1.12	10.660	148.17	13.24	12	1.21%	2.7	47%	1.86	0.01	1.85	1
23.130	5593.11	10.7	0.153	10.0	111.1	48.14	1.44%	Sand-Slime Tailings	0.059	119.0	1.31	0.56	0.75	1	1.12	11.110	154.43	13.80	12	1.64%	2.8	47%	1.87	0.01	1.85	1
23.294	5592.95	12.8	0.177	12.1	112.8	48.88	1.39%	Sand-Slime Tailings	0.059	119.0	1.32	0.57	0.75	1	1.11	13.388	186.09	16.46	15	1.55%	2.7	47%	1.88	0.02	1.86	1
23.458	5592.78	14.7	0.172	14.3	63.4	27.46	1.17%	Sand-Slime Tailings	0.059	119.0	1.33	0.57	0.76	1	1.10	15.787	219.45	18.84	18	1.29%	2.6	47%	1.88	0.02	1.86	1
23.622	5592.62	13.1	0.169	12.7	73.0	31.63	1.29%	Sand-Slime Tailings	0.059	119.0	1.34	0.58	0.76	1	1.10	13.909	193.34	16.74	15	1.44%	2.7	47%	1.89	0.03	1.87	1
23.786	5592.45	13.9	0.141	13.4	84.0	36.41	1.02%	Sand-Slime Tailings	0.059	119.0	1.35	0.58	0.77	1	1.09	14.609	203.07	17.63	16	1.13%	2.6	47%	1.90	0.03	1.87	1
23.950	5592.29	12.4	0.180	12.0	69.1	29.93	1.45%	Sand-Slime Tailings	0.059	119.0	1.36	0.59	0.77	1	1.09	13.081	181.83	15.74	14	1.62%	2.7	47%	1.91	0.04	1.88	1

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	I&B (2008) CSR: r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	I&B (2008) CRR: Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd et al. (2001) CSR: r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	Idriss & Boulanger (2008): CN	qc1 TSF	qc1 MPa	qc1N
12.139	0.94	0.05	0.98	1.0	0.053	36.15	52.84	0.080	1.51	0.95	0.24	0.80	1.14	1.0	0.037	2.95	49.28	0.091	4.19	2.85	2	1.668305	14.368	1.3756	16.688
12.303	0.94	0.05	0.98	1.0	0.053	35.05	49.28	0.077	1.45	0.95	0.22	0.80	1.14	1.0	0.037	4.55	64.75	0.105	4.80	3.12	2	1.656275	12.257	1.1735	14.236
12.467	0.93	0.05	0.98	1.0	0.053	34.47	47.04	0.075	1.41	0.95	0.20	0.80	1.14	1.0	0.037	4.48	56.35	0.097	4.37	2.89	2	1.644442	10.826	1.0365	12.574
12.631	0.93	0.05	0.98	1.0	0.053	37.30	57.27	0.085	1.61	0.95	0.26	0.80	1.13	1.0	0.037	2.75	54.84	0.095	4.27	2.94	2	1.631469	17.191	1.6459	19.966
12.795	0.93	0.06	0.98	1.0	0.053	39.19	64.53	0.093	1.76	0.95	0.29	0.80	1.13	1.0	0.037	1.95	49.33	0.091	4.04	2.90	2	1.59077	21.817	2.0888	25.339
12.959	0.93	0.06	0.98	1.0	0.053	40.75	70.52	0.100	1.91	0.95	0.32	0.80	1.13	1.0	0.037	1.68	50.08	0.092	4.03	2.97	2	1.554744	25.639	2.4547	29.778
13.123	0.93	0.06	0.97	1.0	0.052	43.63	81.62	0.115	2.19	0.95	0.36	0.80	1.13	1.0	0.037	1.41	53.48	0.094	4.10	3.15	2	1.506814	32.709	3.1316	37.990
13.287	0.93	0.06	0.98	1.0	0.052	41.90	74.95	0.106	2.02	0.95	0.33	0.80	1.12	1.0	0.037	1.72	56.89	0.097	4.19	3.11	2	1.517492	28.462	2.725	33.057
13.451	0.93	0.06	0.97	1.0	0.052	42.13	75.84	0.107	2.05	0.95	0.34	0.80	1.12	1.0	0.037	1.93	65.17	0.106	4.52	3.28	2	1.504284	29.029	2.7792	33.715
13.615	0.93	0.06	0.98	1.0	0.052	40.08	67.96	0.097	1.86	0.95	0.30	0.80	1.12	1.0	0.037	2.58	72.05	0.115	4.86	3.36	2	1.520523	24.006	2.2983	27.881
13.779	0.92	0.05	0.98	1.0	0.052	38.26	60.95	0.089	1.70	0.94	0.28	0.80	1.12	1.0	0.037	3.08	69.87	0.112	4.69	3.19	2	1.536918	19.535	1.8703	22.689
13.943	0.92	0.05	0.98	1.0	0.052	36.61	54.59	0.082	1.57	0.94	0.24	0.80	1.12	1.0	0.037	3.70	66.52	0.107	4.46	3.02	2	1.5355	15.48	1.482	17.979
14.107	0.92	0.05	0.98	1.0	0.052	35.94	52.01	0.079	1.52	0.94	0.23	0.80	1.11	1.0	0.037	3.76	60.46	0.101	4.14	2.83	2	1.524396	13.837	1.3248	16.071
14.271	0.92	0.05	0.98	1.0	0.052	38.46	61.73	0.090	1.73	0.94	0.28	0.80	1.11	1.0	0.037	2.41	56.17	0.096	3.94	2.84	2	1.501262	20.036	1.9182	23.270
14.436	0.92	0.05	0.98	1.0	0.052	37.53	58.13	0.086	1.65	0.94	0.26	0.80	1.11	1.0	0.037	2.50	51.42	0.093	3.75	2.70	2	1.502727	17.74	1.6984	20.604
14.600	0.92	0.05	0.98	1.0	0.052	37.20	56.86	0.084	1.63	0.94	0.26	0.80	1.11	1.0	0.038	2.79	54.80	0.095	3.83	2.73	2	1.492153	16.932	1.621	19.665
14.764	0.92	0.05	0.98	1.0	0.052	36.52	54.25	0.082	1.58	0.94	0.24	0.80	1.11	1.0	0.038	2.29	40.67	0.084	3.34	2.46	2	1.481748	15.269	1.4618	17.734
14.928	0.92	0.05	0.98	1.0	0.052	36.49	54.13	0.082	1.58	0.94	0.24	0.80	1.10	1.0	0.038	3.25	57.31	0.098	3.85	2.71	2	1.471506	15.19	1.4543	17.643
15.092	0.91	0.05	0.98	1.0	0.052	36.06	52.49	0.080	1.55	0.94	0.23	0.80	1.10	1.0	0.038	3.52	57.87	0.098	3.84	2.69	2	1.461424	14.144	1.3542	16.428
15.256	0.91	0.05	0.98	1.0	0.051	36.25	53.22	0.081	1.57	0.94	0.24	0.80	1.10	1.0	0.038	3.37	57.25	0.097	3.78	2.67	2	1.451498	14.607	1.3984	16.965
15.420	0.91	0.05	0.98	1.0	0.051	35.45	50.14	0.078	1.51	0.94	0.22	0.80	1.10	1.0	0.038	3.95	58.10	0.098	3.78	2.65	2	1.441725	12.648	1.2109	14.690
15.584	0.91	0.05	0.98	1.0	0.051	35.54	50.46	0.078	1.52	0.94	0.22	0.80	1.10	1.0	0.038	3.94	58.84	0.099	3.78	2.65	2	1.4321	12.848	1.2301	14.922
15.748	0.91	0.05	0.97	1.0	0.051	35.60	50.72	0.078	1.53	0.94	0.22	0.80	1.09	1.0	0.038	4.07	61.49	0.102	3.85	2.69	2	1.42262	13.016	1.2461	15.117
15.912	0.91	0.05	0.97	1.0	0.051	35.34	49.71	0.077	1.51	0.94	0.22	0.80	1.09	1.0	0.038	4.27	61.31	0.101	3.81	2.66	2	1.413283	12.374	1.1847	14.372
16.076	0.91	0.05	0.98	1.0	0.051	34.85	47.83	0.075	1.48	0.94	0.21	0.80	1.09	1.0	0.038	3.97	51.55	0.093	3.46	2.47	2	1.404084	11.172	1.0696	12.976
16.240	0.91	0.05	0.97	1.0	0.051	34.78	47.54	0.075	1.47	0.94	0.21	0.80	1.09	1.0	0.038	4.05	51.70	0.093	3.43	2.45	2	1.39502	10.99	1.0521	12.764
16.404	0.90	0.05	0.98	1.0	0.051	34.13	45.75	0.074	1.44	0.94	0.20	0.80	1.09	1.0	0.038	4.74	55.05	0.096	3.51	2.47	2	1.387005	10.005	0.9579	11.620
16.568	0.90	0.05	0.97	1.0	0.051	34.35	46.60	0.074	1.46	0.94	0.20	0.80	1.09	1.0	0.038	5.14	62.91	0.103	3.76	2.61	2	1.379094	10.546	1.0097	12.249
16.732	0.90	0.05	0.97	1.0	0.051	33.94	45.01	0.073	1.43	0.94	0.19	0.80	1.08	1.0	0.038	5.74	63.53	0.104	3.76	2.60	2	1.371285	9.5295	0.9124	11.068
16.896	0.90	0.05	0.97	1.0	0.051	34.93	48.85	0.076	1.51	0.94	0.22	0.80	1.08	1.0	0.038	4.57	63.62	0.104	3.74	2.62	2	1.363577	11.983	1.1472	13.918
17.060	0.90	0.05	0.97	1.0	0.051	33.93	44.95	0.073	1.44	0.94	0.19	0.80	1.08	1.0	0.038	6.70	73.85	0.117	4.20	2.82	2	1.355966	9.4885	0.9084	11.020
17.224	0.90	0.05	0.97	1.0	0.051	33.64	43.83	0.072	1.42	0.94	0.18	0.80	1.08	1.0	0.038	7.10	72.42	0.115	4.09	2.76	2	1.348452	8.779	0.8405	10.196
17.388	0.90	0.05	0.97	1.0	0.050	34.38	46.71	0.074	1.47	0.94	0.20	0.80	1.08	1.0	0.038	5.52	68.04	0.109	3.85	2.66	2	1.341031	10.616	1.0164	12.330
17.552	0.90	0.05	0.97	1.0	0.050	36.47	54.07	0.082	1.62	0.94	0.24	0.80	1.08	1.0	0.038	3.19	56.15	0.096	3.38	2.50	2	1.332865	15.149	1.4504	17.595
17.716	0.89	0.05	0.97	1.0	0.050	36.75	55.13	0.083	1.65	0.94	0.25	0.80	1.07	1.0	0.038	2.79	51.35	0.093	3.22	2.43	2	1.324812	15.828	1.5154	18.383
17.880	0.89	0.05	0.97	1.0	0.050	37.43	57.75	0.085	1.71	0.94	0.26	0.80	1.07	1.0	0.038	2.30	46.76	0.089	3.07	2.39	2	1.316868	17.498	1.6752	20.323
18.044	0.89	0.05	0.97	1.0	0.050	36.37	53.68	0.081	1.62	0.93	0.24	0.80	1.07	1.0	0.038	3.13	54.15	0.095	3.25	2.43	2	1.309032	14.9	1.4265	17.305
18.208	0.89	0.05	0.97	1.0	0.050	35.49	50.29	0.078	1.56	0.93	0.22	0.80	1.07	1.0	0.039	4.29	63.44	0.104	3.53	2.54	2	1.301302	12.743	1.22	14.800
18.372	0.89	0.05	0.97	1.0	0.050	34.63	47.68	0.075	1.51	0.93	0.21	0.80	1.07	1.0	0.039	4.81	62.72	0.103	3.48	2.49	2	1.294458	11.237	1.0759	13.051
18.537	0.89	0.05	0.97	1.0	0.050	37.21	56.91	0.085	1.70	0.93	0.26	0.80	1.07	1.0	0.039	2.92	57.59	0.098	3.28	2.49	2	1.286921	16.964	1.6241	19.703
18.701	0.89	0.06	0.97	1.0	0.049	38.91	63.46	0.092	1.85	0.93	0.29	0.80	1.07	1.0	0.039	2.55	62.56	0.103	3.42	2.64	2	1.270069	21.139	2.0239	24.552
18.865	0.89	0.06	0.96	1.0	0.049	39.81	66.93	0.096	1.94	0.93	0.30	0.80	1.06	1.0	0.039	2.76	74.88	0.119	3.94	2.94	2	1.257014	23.351	2.2356	27.121
19.029	0.88	0.05	0.97	1.0	0.049	36.27	54.04	0.081	1.65	0.93	0.24	0.80	1.06	1.0	0.039	4.91	87.26	0.142	4.66	3.15	2	1.265644	15.294	1.4643	17.763
19.193	0.88	0.05	0.97	1.0	0.049	35.44	50.81	0.078	1.58	0.93	0.23	0.80	1.06	1.0	0.039	4.83	74.31	0.118	3.86	2.72	2	1.259219	13.236	1.2672	15.372
19.357	0.88	0.05	0.97	1.0	0.049	37.89	59.53	0.087	1.78	0.93	0.27	0.80	1.06	1.0	0.039	3.31	71.69	0.114	3.71	2.74	2	1.250547	18.632	1.7838	21.640
19.521	0.88	0.05	0.97	1.0	0.049	37.37	57.52	0.085	1.73	0.93	0.26	0.80	1.06	1.0	0.039	3.32	66.95	0.108	3.48	2.61	2	1.245152	17.348	1.6609	20.149
19.685	0.88	0.05	0.97	1.0	0.049	36.98	56.03	0.084	1.70	0.93	0.25	0.80	1.06	1.0	0.039	3.65	69.51	0.111	3.56	2.63	2	1.238251	16.398	1.57	19.046
19.849	0.88	0.05	0.97	1.0	0.049	37.05	56.29	0.084	1.71	0.93	0.25	0.80	1.05	1.0	0.039	3.47	66.72	0.108	3.42	2.57	2	1.231438	16.565	1.586	19.240
20.013	0.88	0.05	0.97	1.0	0.049	36.45	54.00	0.081	1.66	0.93	0.24	0.80	1.05	1.0	0.039	4.08	71.55	0.114	3.60	2.63	2	1.224709	15.104	1.4461	17.543
20.177	0.87	0.05	0.97	1.0	0.049	35.59	51.38	0.079	1.61	0.93	0.23	0.80	1.05	1.0	0.039	5.03	79.45	0.127	3.98	2.80	2	1.218746	13.595	1.3016	15.789
20.341	0.87	0.05	0.97	1.0	0.049	34.10	45.64	0.073	1.50	0.93	0.20	0.80	1.05	1.0	0.039	7.03	81.06	0.130	4.05	2.78	2	1.212849	9.9289	0.9506	11.532
20.505	0.87	0.05	0.97	1.0	0.049	34.69	47.92	0.076	1.55	0.93	0.21	0.80	1.05	1.0	0.039	5.35	70.73	0.113	3.52	2.53	2	1.207016	11.387	1.0902	13.225
20.669	0.87	0.05	0.97	1.0	0.049	34.60	47.55	0.075	1.54	0.92	0.21	0.80	1.05	1.0	0.039	5.58	72.33	0.115	3.57	2.56	2	1.201248	11.153	1.0678	12.953
20.833	0.87	0.05	0.97	1.0	0.049	34.09	45.59	0.073	1.51	0.92	0.20	0.80	1.05	1.0	0.039	6.64	76.37	0.121	3.75	2.63	2	1.195541	9.8993	0.9478	11.497
20.997	0.87	0.05	0.96	1.0	0.048	36.13	52.75	0.080	1.66	0.92	0.24	0.80	1.05	1.0	0.039	3.93	65.36	0.106	3.25	2.45	2	1.18925	14.307	1.3697	16.616
21.161	0.87	0.06	0.96	1.0	0.048	39.40	65.35	0.094	1.95	0.92	0.29	0.80	1.04	1.0	0.039	2.42	62.89	0.103	3.15	2.55	2	1.174935	22.34	2.1389	25.947
21.325	0.87	0.05	0.96	1.0	0.048	38.66	62.51	0.091	1.89	0.92	0.28	0.80	1.04	1.0	0.039	3.25	77.41	0.123	3.74	2.81	2	1.172249	20.53	1.9655	23.844
21.489	0.86	0.05	0.96	1.0	0.048	38.51	61.93	0.090	1.88	0.92	0.28	0.80	1.04	1.0	0.039	3.80	88.94	0.145	4.40	3.14	2	1.166991	20.163	1.9304	23.418
21.653	0.86	0.05	0.96	1.0	0.048	37.46	58.64	0.086	1.80	0.92	0.27	0.80	1.04	1.0	0.039	4.68	99.17	0.171	5.14	3.47	2	1.16515	18.236	1.7459	21.180
21.817	0.86	0.05	0.96	1.0	0.048	37.76	59.01	0.087	1.81	0.92	0.27	0.80	1.04	1.0	0.039	4.01	85.19	0.137	4.12	2.96	2	1.159106	18.302	1.7523	21.257
21.981	0.86	0.05	0.96	1.0	0.048	37.43	57.76	0.085	1.79	0.91	0.26	0.80	1.04	1.0	0.039	4.06	82.51	0.132	3.94	2.86	2	1.15363	17.505	1.676	20.332
22.145	0.86	0.05	0.96	1.0	0.048	35.66	51.68	0.079	1.65	0.91	0.23	0.80	1.04	1.0	0.039	4.75	76.11	0.121	3.59	2.62	2	1.148424	13.787	1.3199	16.012
22.309	0.86	0.05	0.97	1.0	0.048	34.07	45.51	0.073	1.53	0.91	0.20	0.80	1.03	1.0	0.039	5.55	63.50	0.104	3.07	2.30	2	1.143272	9.8516	0.9432	11.442
22.473	0.86	0.05	0.96	1.0	0.048	34.71	47.28	0.075	1.57	0.91	0.20	0.80	1.03	1.0	0.039	4.33	54.47	0.095	2.79	2.18	2	1.137588	10.824	1.0363	12.572
22.638	0.85	0.05	0.96	1.0	0.048	35.08	48.70	0.076	1.60	0.91	0.21	0.80	1.03	1.0	0.039	3.88	52.88	0.094	2.74	2.17	2	1.131968	11.725	1.1225	13.618
22.802	0.85	0.05	0.96	1.0	0.048	34.83	47.76	0.075	1.58	0.91	0.21	0.80	1.03	1.0	0.039	4.18	54.08	0.095	2.75	2.17	2	1.126411	11.128	1.0654	12.925
22.966	0.85	0.05	0.96	1.0	0.048	34.95	48.19	0.076	1.59	0.91	0.21	0.80	1.03	1.0	0.039	4.18	55.34	0.096	2.76	2.18	2	1.120916	11.403	1.0917	13.243
23.130	0.85	0.05	0.96	1.0	0.048	35.14	48.94	0.076	1.60	0.90	0.21	0.80	1.03	1.0	0.039	4.56	63.00	0.103	2.96	2.28	2	1.115481	11.884	1.1378	13.802
23.294	0.85	0.05	0.96	1.0	0.048	36.07	52.53	0.080	1.68	0.90	0.23	0.80	1.03	1.0	0.039	3.91	64.31	0.105	2.98	2.33	2	1.110106	14.17	1.3566	16.457
23.458	0.85	0.05	0.96	1.0	0.048	36.91	55.75	0.083	1.75	0.90	0.25	0.80	1.03	1.0	0.039	3.27	61.70	0.102	2.87	2.31	2	1.10479	16.225	1.5533	18.844
23.622	0.85	0.05	0.96	1.0	0.048	36.17	52.91	0.080	1.68	0.90	0.24	0.80	1.02	1.0	0.039	3.75	62.77	0.103	2.89	2.28	2	1.099532	14.41	1.3796	16.737
23.786	0.85	0.05	0.96	1.0	0.048	36.49	54.12	0.082	1.71	0.90	0.24	0.80	1.02	1.0	0.039	3.27	57.67	0.098	2.72	2.21	2	1.09433	15.183	1.4537	17.635
23.950	0.84	0.05	0.96	1.0	0.048	35.82	51.56	0.079	1.65	0.90	0.23	0.80	1.02	1.0	0.040	4.14	65.19	0.106	2.92	2.29	2	1.089184	13.551	1.2973	15.738

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W4-C

Data File: 13-52106_SP2W4-C-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5611.20	Water surface elevation during CPT investigation (ft a
5607.96	Water surface elevation at t_0 (ft amsl)
5593.50	Water surface elevation at t_1 (ft amsl)
5588.50	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earth
7.51	Equiv. Number of Uniform Strain Cycles, N
5616.24	Ground Surface Elevation at time of CPT (ft amsl)
5626.19	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
1.95	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1104.55	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5588.50	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	5626.19	5625.94	5625.69	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	5625.69	5623.94	5622.19	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	5622.19	5620.19	5618.19	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	5618.19	5617.22	5616.24	1.95	0.050	101	0.552	0.503	0.00	0.00	0.552	0.503

2013 CPT Data from ConeTec									CPT Data Interpretations													
Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %
24.114	5592.13	12.8	0.188	11.8	149.2	64.65	1.47%	Sand-Slime Tailing	0.059	119.0	1.37	0.60	0.78	1	1.08	12.814	178.11	16.06	15	1.65%	2.7	47%
24.278	5591.96	13.0	0.159	12.1	152.5	66.07	1.22%	Sand-Slime Tailing	0.059	119.0	1.38	0.60	0.78	1	1.08	13.024	181.04	16.32	15	1.37%	2.7	47%
24.442	5591.80	13.9	0.175	13.0	152.5	66.07	1.26%	Sand-Slime Tailing	0.059	119.0	1.39	0.61	0.79	1	1.07	13.931	193.64	17.37	16	1.40%	2.6	47%
24.606	5591.63	14.2	0.192	13.3	152.9	66.26	1.35%	Sand-Slime Tailing	0.059	119.0	1.40	0.61	0.79	1	1.07	14.198	197.35	17.68	16	1.50%	2.7	47%
24.770	5591.47	13.7	0.186	12.8	151.0	65.42	1.36%	Sand-Slime Tailing	0.059	119.0	1.41	0.62	0.80	1	1.06	13.601	189.06	16.96	15	1.51%	2.7	47%
24.934	5591.31	12.8	0.197	12.0	120.3	52.12	1.54%	Sand-Slime Tailing	0.059	119.0	1.42	0.62	0.80	1	1.06	12.734	177.01	15.71	14	1.74%	2.7	47%
25.098	5591.14	11.7	0.209	10.9	127.8	55.38	1.79%	Sand-Slime Tailing	0.059	119.0	1.43	0.63	0.80	1	1.05	11.464	159.35	14.29	13	2.04%	2.8	47%
25.262	5590.98	11.2	0.195	10.6	97.8	42.36	1.74%	Sand-Slime Tailing	0.059	119.0	1.44	0.63	0.81	1	1.05	11.150	154.99	13.69	12	1.99%	2.8	47%
25.426	5590.81	11.4	0.160	10.8	101.4	43.94	1.41%	Sand-Slime Tailing	0.059	119.0	1.45	0.64	0.81	1	1.05	11.236	156.18	13.82	12	1.61%	2.8	47%
25.590	5590.65	11.2	0.149	10.6	105.8	45.83	1.33%	Sand-Slime Tailing	0.059	119.0	1.46	0.64	0.82	1	1.04	10.978	152.60	13.55	12	1.53%	2.8	47%
25.754	5590.49	11.6	0.159	11.1	86.4	37.44	1.37%	Sand-Slime Tailing	0.059	119.0	1.47	0.65	0.82	1	1.04	11.458	159.27	13.96	12	1.57%	2.8	47%
25.918	5590.32	11.7	0.182	11.0	108.2	46.89	1.56%	Sand-Slime Tailing	0.059	119.0	1.48	0.65	0.83	1	1.03	11.356	157.85	14.00	12	1.78%	2.8	47%
26.082	5590.16	11.7	0.204	11.1	102.1	44.24	1.74%	Sand-Slime Tailing	0.059	119.0	1.49	0.66	0.83	1	1.03	11.368	158.02	13.96	12	2.00%	2.8	47%
26.246	5589.99	11.8	0.197	11.1	100.4	43.51	1.67%	Sand-Slime Tailing	0.059	119.0	1.50	0.66	0.84	1	1.02	11.391	158.33	13.97	12	1.92%	2.8	47%
26.410	5589.83	11.4	0.197	10.8	88.6	38.40	1.73%	Sand-Slime Tailing	0.059	119.0	1.51	0.67	0.84	1	1.02	11.016	153.12	13.45	12	2.00%	2.8	47%
26.574	5589.67	10.5	0.197	10.0	88.3	38.26	1.87%	Sand-Slime Tailing	0.059	119.0	1.52	0.67	0.85	1	1.01	10.127	140.77	12.41	11	2.18%	2.9	47%

	Conditions at t_1				Liquefaction Triggering Analyses – Idriss & Boulanger (2008): Cyclic Stress Ratio					Cyclic Resistance Ratio			
Depth at time of CPT (ft)	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	r_d	C_σ	K_σ	K_a	CSR M=7.5, s'v=1atm	Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS
24.114	1.92	0.04	1.88	1	0.84	0.05	0.96	1.0	0.048	35.93	51.99	0.079	1.66
24.278	1.93	0.05	1.89	1	0.84	0.05	0.96	1.0	0.048	36.03	52.34	0.080	1.67
24.442	1.94	0.05	1.89	1	0.84	0.05	0.96	1.0	0.048	36.39	53.76	0.081	1.69
24.606	1.95	0.06	1.89	1	0.84	0.05	0.96	1.0	0.048	36.50	54.18	0.082	1.70
24.770	1.96	0.06	1.90	1	0.84	0.05	0.96	1.0	0.048	36.25	53.21	0.081	1.68
24.934	1.97	0.07	1.90	1	0.84	0.05	0.96	1.0	0.048	35.81	51.53	0.079	1.64
25.098	1.98	0.07	1.91	1	0.83	0.05	0.96	1.0	0.048	35.31	49.61	0.077	1.60
25.262	1.99	0.08	1.91	1	0.83	0.05	0.96	1.0	0.048	35.10	48.80	0.076	1.58
25.426	2.00	0.08	1.92	1	0.83	0.05	0.96	1.0	0.048	35.15	48.97	0.077	1.59
25.590	2.01	0.09	1.92	1	0.83	0.05	0.96	1.0	0.048	35.05	48.60	0.076	1.58
25.754	2.02	0.09	1.93	1	0.83	0.05	0.96	1.0	0.048	35.20	49.15	0.077	1.59
25.918	2.03	0.10	1.93	1	0.83	0.05	0.96	1.0	0.048	35.21	49.21	0.077	1.59
26.082	2.04	0.10	1.94	1	0.83	0.05	0.96	1.0	0.048	35.20	49.16	0.077	1.59
26.246	2.05	0.11	1.94	1	0.82	0.05	0.96	1.0	0.048	35.20	49.18	0.077	1.58
26.410	2.06	0.11	1.95	1	0.82	0.05	0.96	1.0	0.048	35.02	48.47	0.076	1.57
26.574	2.07	0.12	1.95	1	0.82	0.05	0.96	1.0	0.048	34.65	47.07	0.075	1.54

	Youd et al. (2001): Cyclic Stress Ratio											
Depth at time of CPT (ft)	r_d	D_r	f	K_σ	K_a	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
24.114	0.90	0.23	0.80	1.02	1.0	0.040	4.11	66.05	0.107	2.93	2.29	2
24.278	0.90	0.23	0.80	1.02	1.0	0.040	3.76	61.39	0.102	2.76	2.21	2
24.442	0.89	0.24	0.80	1.02	1.0	0.040	3.62	62.94	0.103	2.79	2.24	2
24.606	0.89	0.24	0.80	1.02	1.0	0.040	3.68	65.11	0.106	2.84	2.27	2
24.770	0.89	0.24	0.80	1.02	1.0	0.040	3.82	64.78	0.105	2.81	2.24	2
24.934	0.89	0.23	0.80	1.01	1.0	0.040	4.29	67.41	0.108	2.87	2.26	2
25.098	0.89	0.22	0.80	1.01	1.0	0.040	4.93	70.46	0.113	2.96	2.28	2
25.262	0.89	0.21	0.80	1.01	1.0	0.040	5.04	69.04	0.111	2.89	2.24	2
25.426	0.89	0.21	0.80	1.01	1.0	0.040	4.60	63.56	0.104	2.70	2.14	2
25.590	0.88	0.21	0.80	1.01	1.0	0.040	4.58	62.02	0.102	2.63	2.11	2
25.754	0.88	0.22	0.80	1.01	1.0	0.040	4.53	63.18	0.103	2.65	2.12	2
25.918	0.88	0.22	0.80	1.01	1.0	0.041	4.76	66.63	0.108	2.74	2.16	2
26.082	0.88	0.22	0.80	1.01	1.0	0.041	5.00	69.81	0.112	2.82	2.20	2
26.246	0.88	0.22	0.80	1.01	1.0	0.041	4.92	68.75	0.110	2.77	2.18	2
26.410	0.88	0.21	0.80	1.00	1.0	0.041	5.15	69.27	0.111	2.77	2.17	2
26.574	0.88	0.20	0.80	1.00	1.0	0.041	5.67	70.40	0.112	2.79	2.16	2

Idriss & Boulanger (2008)			
CN	qc1 TSF	qc1 MPa	qc1N
1.084092	13.824	1.3235	16.055
1.079055	14.051	1.3453	16.320
1.074071	14.953	1.4316	17.367
1.069139	15.219	1.457	17.676
1.064258	14.604	1.3982	16.962
1.059427	13.53	1.2953	15.714
1.054647	12.305	1.1781	14.292
1.049915	11.791	1.1288	13.694
1.045231	11.898	1.1391	13.819
1.040595	11.665	1.1168	13.549
1.036005	12.017	1.1505	13.957
1.031462	12.053	1.154	13.999
1.026963	12.023	1.1511	13.964
1.022509	12.032	1.1519	13.974
1.018098	11.579	1.1086	13.448
1.013731	10.686	1.0231	12.411

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W5-C

Data File: 13-52106_SP2W5-C-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\.\6.2.3_Field Data\2013 Field Investigation\Conetec Da

- Tailings Sands
- Tailings Sand-Slimes
- Tailings Slimes
- Interim Cover
- Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5604.20	Water surface elevation during CPT investigation (ft
5604.20	Water surface elevation at t_0 (ft amsl)
5589.01	Water surface elevation at t_1 (ft amsl)
5584.01	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ear
7.51	Equiv. Number of Uniform Strain Cycles, N

Value	Parameter
5615.86	Ground Surface Elevation at time of CPT (ft amsl)
5626.28	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
2.42	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1151.89	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5584.01	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5626.03	5625.78	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5624.03	5622.28	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5620.28	5618.28	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	######	5617.07	5615.86	2.42	0.050	101	0.576	0.515	0.00	0.00	0.576	0.515

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
0.164	5615.70	4.8	0.029	4.8	1.1	0.49	0.60%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	8.143	113.19	9.47	580	0.61%	1.2	51%	0.58	0.00	0.58	0
0.328	5615.53	11.7	0.170	11.6	8.2	3.56	1.46%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	19.737	274.34	23.02	705	1.46%	1.5	51%	0.59	0.00	0.59	0
0.492	5615.37	34.1	0.408	34.1	8.9	3.84	1.20%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	57.885	804.60	67.34	1375	1.20%	1.3	51%	0.60	0.00	0.60	0
0.656	5615.20	51.6	0.661	51.6	1.4	0.59	1.28%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	87.686	1218.84	101.86	1560	1.28%	1.4	51%	0.61	0.00	0.61	0
0.820	5615.04	73.2	1.112	73.1	6.6	2.84	1.52%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	124.304	1727.83	144.45	1770	1.52%	1.4	51%	0.62	0.00	0.62	0
0.984	5614.88	89.2	1.392	89.2	-0.9	-0.37	1.56%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	151.606	2107.32	176.07	1798	1.56%	1.4	51%	0.63	0.00	0.63	0
1.148	5614.71	116.0	1.613	115.8	37.9	16.43	1.39%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	196.792	2735.41	229.03	2005	1.39%	1.4	51%	0.63	0.00	0.63	0
1.312	5614.55	135.8	1.481	135.7	12.6	5.44	1.09%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	230.724	3207.06	268.13	2054	1.09%	1.3	51%	0.64	0.00	0.64	0
1.476	5614.38	141.1	2.556	141.0	16.3	7.07	1.81%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	239.717	3332.07	278.62	1897	1.81%	1.5	51%	0.65	0.00	0.65	0
1.640	5614.22	158.3	2.323	158.2	7.6	3.31	1.47%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	268.974	3738.74	312.49	1915	1.47%	1.4	51%	0.66	0.00	0.66	0
1.804	5614.06	219.1	2.632	219.1	7.2	3.12	1.20%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	372.453	5177.10	432.67	2410	1.20%	1.3	51%	0.67	0.00	0.67	0
1.968	5613.89	216.1	2.814	216.0	10.4	4.50	1.30%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	367.251	5104.79	426.67	2179	1.30%	1.3	51%	0.68	0.00	0.68	0
2.133	5613.73	184.6	2.875	184.5	8.4	3.65	1.56%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	313.718	4360.68	364.47	1718	1.56%	1.4	51%	0.68	0.00	0.68	0
2.297	5613.56	191.7	3.125	191.7	11.1	4.81	1.63%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	325.524	4524.79	378.21	1657	1.63%	1.5	51%	0.69	0.00	0.69	0
2.461	5613.40	166.4	3.732	166.3	8.8	3.82	2.24%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.67	277.345	3855.09	322.23	1342	2.24%	1.6	51%	0.70	0.00	0.70	0
2.625	5613.24	152.8	3.596	152.7	5.5	2.40	2.35%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.64	250.398	3480.54	290.89	1155	2.36%	1.6	51%	0.71	0.00	0.71	0
2.789	5613.07	141.7	3.046	141.7	2.9	1.26	2.15%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0	1.61	228.613	3177.71	265.55	1008	2.15%	1.6	51%	0.72	0.00	0.72	0
2.953	5612.91	135.3	2.327	135.3	3.0	1.28	1.72%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0	1.60	216.180	3004.91	251.11	909	1.72%	1.5	51%	0.72	0.00	0.72	0
3.117	5612.74	130.1	2.548	130.1	2.3	0.98	1.96%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0	1.60	208.503	2898.19	242.19	828	1.96%	1.6	51%	0.73	0.00	0.73	0
3.281	5612.58	111.7	2.753	111.7	2.9	1.27	2.46%	Sand-Slime Tailin	0.047	93.3	0.16	0.00	0.16	0	1.67	186.121	2587.09	216.20	678	2.47%	1.7	47%	0.74	0.00	0.74	0
3.445	5612.42	108.0	2.637	108.0	2.3	1.00	2.44%	Sand-Slime Tailin	0.047	93.3	0.17	0.00	0.17	0	1.67	180.028	2502.39	209.12	626	2.45%	1.7	47%	0.75	0.00	0.75	0
3.609	5612.25	115.0	1.758	115.0	1.5	0.66	1.53%	Sand Tailings	0.051	102.8	0.18	0.00	0.18	0	1.62	186.160	2587.62	216.23	635	1.53%	1.6	18%	0.76	0.00	0.76	0
3.773	5612.09	130.6	2.562	130.6	2.0	0.88	1.96%	Sand Tailings	0.051	102.8	0.19	0.00	0.19	0	1.54	201.640	2802.79	234.22	690	1.96%	1.6	18%	0.77	0.00	0.77	0
3.937	5611.92	134.1	2.416	134.1	2.0	0.88	1.80%	Sand Tailings	0.051	102.8	0.20	0.00	0.20	0	1.52	203.635	2830.52	236.53	678	1.80%	1.6	18%	0.77	0.00	0.77	0
4.101	5611.76	107.5	2.141	107.5	1.8	0.76	1.99%	Sand Tailings	0.051	102.8	0.21	0.00	0.21	0	1.60	172.196	2393.53	200.02	521	2.00%	1.7	18%	0.78	0.00	0.78	0
4.265	5611.59	96.2	1.939	96.1	5.9	2.54	2.02%	Sand-Slime Tailin	0.047	93.3	0.21	0.00	0.21	0	1.64	157.282	2186.22	182.74	449	2.02%	1.7	47%	0.79	0.00	0.79	0
4.429	5611.43	67.8	1.878	67.8	0.9	0.39	2.77%	Sand-Slime Tailin	0.047	93.3	0.22	0.00	0.22	0	1.70	115.175	1600.93	133.78	305	2.78%	1.9	47%	0.80	0.00	0.80	0
4.593	5611.27	82.0	1.346	81.9	5.5	2.36	1.64%	Sand Tailings	0.051	102.8	0.23	0.00	0.23	0	1.67	136.924	1903.24	159.09	356	1.65%	1.7	18%	0.81	0.00	0.81	0
4.757	5611.10	80.0	1.313	80.0	1.7	0.75	1.64%	Sand Tailings	0.051	102.8	0.24	0.00	0.24	0	1.66	133.066	1849.61	154.57	335	1.65%	1.7	18%	0.81	0.00	0.81	0
4.921	5610.94	93.3	1.401	93.3	3.1	1.33	1.50%	Sand Tailings	0.051	102.8	0.25	0.00	0.25	0	1.59	147.935	2056.29	171.85	377	1.51%	1.7	18%	0.82	0.00	0.82	0
5.085	5610.77	97.4	1.343	97.4	3.2	1.40	1.38%	Sand Tailings	0.051	102.8	0.26	0.00	0.26	0	1.56	151.462	2105.33	175.95	381	1.38%	1.6	18%	0.83	0.00	0.83	0
5.249	5610.61	63.5	1.284	63.5	0.9	0.40	2.02%	Sand-Slime Tailin	0.047	93.3	0.26	0.00	0.26	0	1.70	107.951	1500.52	125.39	241	2.03%	1.9	47%	0.84	0.00	0.84	0
5.413	5610.45	54.2	0.816	54.2	-0.6	-0.24	1.51%	Sand-Slime Tailin	0.047	93.3	0.27	0.00	0.27	0	1.70	92.072	1279.80	106.93	199	1.51%	1.8	47%	0.85	0.00	0.85	0
5.577	5610.28	38.7	0.729	38.7	-0.7	-0.30	1.88%	Sand-Slime Tailin	0.047	93.3	0.28	0.00	0.28	0	1.70	65.841	915.19	76.46	138	1.90%	2.0	47%	0.85	0.00	0.85	0
5.741	5610.12	35.6	0.520	35.6	0.1	0.04	1.46%	Sand-Slime Tailin	0.047	93.3	0.29	0.00	0.29	0	1.70	60.520	841.23	70.29	124	1.47%	2.0	47%	0.86	0.00	0.86	0
5.905	5609.95	32.6	0.386	32.6	-0.6	-0.28	1.18%	Sand-Slime Tailin	0.047	93.3	0.29	0.00	0.29	0	1.70	55.420	770.34	64.36	110	1.19%	1.9	47%	0.87	0.00	0.87	0
6.069	5609.79	31.4	0.323	31.4	-0.6	-0.25	1.03%	Sand-Slime Tailin	0.047	93.3	0.30	0.00	0.30	0	1.70	53.346	741.51	61.95	103	1.04%	1.9	47%	0.88	0.00	0.88	0
6.234	5609.63	27.6	0.437	27.6	-0.4	-0.19	1.59%	Sand-Slime Tailin	0.047	93.3	0.31	0.00	0.31	0	1.70	46.852	651.24	54.41	88	1.60%	2.1	47%	0.88	0.00	0.88	0
6.398	5609.46	19.4	0.406	19.4	-0.6	-0.24	2.09%	Sand-Slime Tailin	0.047	93.3	0.32	0.00	0.32	0	1.70	32.963	458.19	38.28	60	2.13%	2.3	47%	0.89	0.00	0.89	0
6.562	5609.30	22.0	0.353	22.0	0.9	0.39	1.60%	Sand-Slime Tailin	0.047	93.3	0.32	0.00	0.32	0	1.70	37.400	519.86	43.45	67	1.63%	2.2	47%	0.90	0.00	0.90	0
6.726	5609.13	32.3	0.314	32.3	1.2	0.51	0.97%	Sand-Slime Tailin	0.047	93.3	0.33	0.00	0.33	0	1.70	54.961	763.96	63.85	97	0.98%	1.9	47%	0.91	0.00	0.91	0
6.890	5608.97	36.5	0.296	36.5	0.3	0.11	0.81%	Sand Tailings	0.051	102.8	0.34	0.00	0.34	0	1.70	61.932	860.85	71.93	106	0.82%	1.8	18%	0.92	0.00	0.92	0
7.054	5608.81	37.5	0.279	37.5	0.2	0.10	0.74%	Sand Tailings	0.051	102.8	0.35	0.00	0.35	0	1.67	62.634	870.61	72.75	107	0.75%	1.8	18%	0.92	0.00	0.92	0
7.218	5608.64	38.6	0.335	38.6	0.2	0.10	0.87%	Sand Tailings	0.051	102.8	0.36	0.00	0.36	0	1.64	63.426	881.62	73.67	107	0.88%	1.9	18%	0.93	0.00	0.93	0
7.382	5608.48	38.6	0.379	38.6	0.0	0.02	0.98%	Sand-Slime Tailin	0.047	93.3	0.36	0.00	0.36	0	1.63	62.785	872.71	72.92	105	0.99%	1.9	47%	0.94	0.00	0.94	0
7.546	5608.31	38.2	0.414	38.2	-0.4	-0.19	1.08%	Sand-Slime Tailin	0.047	93.3	0.37	0.00	0.37	0	1.61	61.540	855.40	71.47	102	1.10%	1.9	47%	0.95	0.00	0.95	0
7.710	5608.15	37.4	0.416	37.4	-0.5	-0.20	1.11%	Sand-Slime Tailin	0.047	93.3	0.38	0.00	0.38	0	1.60	59.889	832.45	69.55	97	1.12%	2.0	47%	0.96	0.00	0.96	0
7.874	5607.99	36.6	0.415	36.6	-0.5	-0.20	1.13%	Sand-Slime Tailin	0.047	93.3	0.39	0.00	0.39	0	1.59	58.233	809.43	67.63	94	1.15%	2.0	47%	0.96	0.00	0.96	0
8.038	5607.82	34.6	0.402	34.6	-0.5	-0.22	1.16%	Sand-Slime Tailin	0.047	93.3	0.40	0.00	0.40	0	1.59	54.871	762.70	63.72	87	1.18%	2.0	47%	0.97	0.00	0.97	0
8.202	5607.66	33.4	0.283	33.5	-0.5	-0.20	0.85%	Sand-Slime Tailin	0.047	93.3	0.40	0.00	0.40	0	1.58	52.769	733.49	61.28	82	0.86%	1.9	47%	0.98	0.00	0.98	0
8.366	5607.49	34.9	0.300	34.9	-0.5	-0.22	0.86%	Sand-Slime Tailin	0.047	93.3	0.41	0.00	0.41	0	1.55	54.238	753.90	62.99	84	0.87%	1.9	47%	0.99	0.00	0.99	0
8.530	5607.33	35.7	0.323	35.7	1.0	0.45	0.91%	Sand-Slime Tailin	0.047	93.3	0.42	0.00	0.42	0	1.53	54.753	761.06	63.60	84	0.92%	1.9	47%	0.99	0.00	0.99	0
8.694	5607.17	37.7	0.356	37.7	0.3	0.14	0.95%	Sand-Slime Tailin	0.047	93.3	0.43	0.00	0.43	0	1.51	56.872	790.53	66.06	87	0.96%	1.9	47%	1.00	0.00	1.00	0
8.858	5607.00	39.5	0.390	39.5	0.3	0.12	0.99%	Sand-Slime Tailin	0.047	93.3	0.43	0.00	0.43	0	1.49	58.703	815.97	68.18	90	1.00%	1.9	47%	1.01	0.00	1.01	0
9.022	5606.84	40.6	0.422	40.6	0.3	0.12	1.04%	Sand-Slime Tailin	0.047	93.3	0.44	0.00	0.44	0	1.47	59.660	829.28	69.29	91	1.05%	2.0	47%	1.02	0.00	1.02	0
9.186	5606.67	38.9	0.458	38.9	0.2	0.10	1.18%	Sand-Slime Tailin	0.047	93.3	0.45	0.00	0.45	0	1.46	57.008	792.41	66.21	86	1.19%	2.0	47%	1.02	0.00	1.02	0
9.350	5606.51	35.6	0.461	35.6	0.2	0.10	1.30%	Sand-Slime Tailin	0.047	93.3	0.46	0.00	0.46	0	1.47	52.127	724.56	60.54	77	1.31%	2.1	47%	1.03	0.00	1.03	0
9.514	5606.35	32.5	0.457	32.5	-0.1	-0.05	1.41%	Sand-Slime Tailin	0.047	93.3	0.46	0.00	0.46	0	1.47	47.683	662.79	55.38	69	1.43%	2.1	47%	1.04	0.00	1.04	0
9.678	5606.18	26.9	0.454	26.9	-0.5	-0.21	1.69%	Sand-Slime Tailin	0.047	93.3	0.47	0.00	0.47	0	1.48	39.847	553.87	46.27	56	1.72%	2.3	47%	1.05	0.00	1.05	0
9.842	5606.02	18.0	0.256	18.0	-0.5	-0.21	1.42%	Sand-Slime Tailin	0.047	93.3	0.48	0.00	0.48	0	1.52	27.373	380.49	31.79	37	1.46%	2.4	47%	1.06	0.00	1.06	0
10.006	5605.85	15.0	0.216	15.1	-0.5	-0.21	1.44%	Sand-Slime Tailin	0.047	93.3	0.49	0.00	0.49	0	1.53	23.015	319.91	26.73	30	1.48%	2.4	47%	1.06	0.00	1.06	0
10.170	5605.69	15.7	0.118	15.7	0.9	0.39	0.75%	Sand-Slime Tailin	0.047	93.3	0.49	0.00	0.49	0	1.51	23.659	328.86	27.49	31	0.78%	2.3	47%	1.07	0.00	1.07	0
10.335	5605.53	12.4	0.142	12.4	0.4	0.18	1.15%	Sand-Slime Tailin	0.047	93.3	0.50	0.00	0.50	0	1.52	18.795	261.25	21.83	24	1.20%	2.5	47%	1.08	0.00	1.08	0
10.499	5605.36	10.8	0.099	10.7	4.9	2.13	0.92%	Sand-Slime Tailin	0.047	93.3	0.51	0.00	0.51	0	1.51	16.147	224.44	18.81	20	0.97%	2.5	47%	1.09	0.00	1.09	0
10.663	5605.20	14.4	0.173	14.4	9.8	4.23	1.20%	Sand-Slime Tailin	0.047	93.3	0.52	0.00	0.52	0	1.47	21.120	293.57	24.63	27	1.24%	2.4	47%	1.09	0.00	1.09	0
10.827	5605.03	12.7	0.151	12.7	5.4	2.33	1.19%	Sand-Slime Tailin	0.047	93.3	0.53	0.00	0.53	0	1.47	18.646	259.18	21.71	23	1.24%	2.5	47%	1.10	0.00	1.10	0
10.991	5604.87	19.4	0.189	19.4	5.3	2.31	0.97%	Sand-Slime Tailin	0.047	93.3	0.53	0.00	0.53	0	1.41	27.383	380.62	31.86	35	1.00%	2.3	47%	1.11	0.00	1.11	0
11.155	5604.71	14.8	0.188	14.8	2.4	1.02	1.27%	Sand-Slime Tailin	0.047	93.3	0.54	0.00	0.54	0	1.42	21.005	291.97	24.42	26	1.32%	2.4	47%	1.12	0.00	1.12	0
11.319	5604.54	12.2	0.105	12.1	2.4	1.02	0.86%	Sand-Slime Tailin	0.047	93.3	0.55	0.00	0.55	0	1.42	17.280	240.19	20.09	21	0.90%	2.4	47%	1.12	0.00	1.12	0
11.483	5604.38	10.1	0.138	10.1	3.1	1.34	1.37%	Sand-Slime Tailin	0.047	93.3	0.56	0.00	0.56	0	1.41	14.151	196.70	16.47	17	1.45%	2.6	47%	1.13	0.00	1.13	0
11.647	5604.21	14.6	0.228	14.6	2.1	0.91	1.56%	Sand-Slime Tailin	0.047	93.3	0.56	0.00	0.56	0	1.38	20.144	280.00	23.42	25	1.63%	2.5	47%	1.14	0.00	1.14	0
11.811	5604.05	12.5	0.140	12.5	3.1	1.35	1.12%	Sand-Slime Tailin	0.059	119.0	0.57	0.00	0.57	1	1.38	17.237	239.60	20.05	21	1.18%	2.5	47%	1.15	0.00	1.15	0
11.975	5603.89	12.6	0.058	12.6	2.8	1.22	0.46%	Sand-Slime Tailin	0.059	119.0	0.58	0.01	0.57	1	1.37	17.307	240.56	20.13	21	0.48%	2.3	47%	1.16	0.00	1.16	0

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	Idriss & Boulanger (2008) Cyclic Stress Ratio r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Cyclic Resistance Ratio Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd et al. (2001) Cyclic Stress Ratio r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	Idriss & Boulanger (2008) CN	qc1 TSF	qc1 MPa	qc1N
0.164	1.00	0.04	1.02	1.0	0.059	33.64	43.12	0.071	1.21	0.98	0.18	0.80	2.53	1.0	0.017	1.00	9.47	0.058	4.26	2.74	2	1.7	8.155	0.7808	9.472
0.328	1.00	0.05	1.02	1.0	0.059	38.40	61.43	0.089	1.52	0.97	0.28	0.80	2.20	1.0	0.019	1.00	23.02	0.069	4.34	2.93	2	1.7	19.824	1.898	23.025
0.492	1.00	0.08	1.03	1.0	0.060	53.95	121.29	0.182	3.06	0.97	0.47	0.76	2.32	1.0	0.019	1.00	67.34	0.108	6.40	4.73	2	1.7	57.979	5.5509	67.339
0.656	1.00	0.11	1.04	1.0	0.060	66.07	167.92	0.388	6.46	0.97	0.58	0.71	2.59	1.0	0.017	1.00	101.86	0.178	11.62	9.04	2	1.7	87.7	8.3964	101.859
0.820	1.00	0.15	1.05	1.0	0.061	81.01	225.47	1.000	16.46	0.97	0.69	0.65	2.87	1.0	0.015	1.00	144.45	0.360	23.84	20.15	2	1.7	124.37	11.908	144.452
0.984	1.00	0.20	1.07	1.0	0.062	92.11	268.18	1.000	16.24	0.97	0.77	0.62	2.98	1.0	0.014	1.00	176.07	1.000	62.26	39.25	2	1.7	151.6	14.514	176.071
1.148	1.00	0.30	1.09	1.0	0.063	110.69	339.72	1.000	15.84	0.97	0.87	0.60	2.95	1.0	0.015	1.00	229.03	1.000	54.71	35.28	2	1.7	197.19	18.879	229.029
1.312	1.00	0.30	1.09	1.0	0.063	124.41	392.54	1.000	15.90	0.97	0.95	0.60	2.79	1.0	0.015	1.00	268.13	1.000	65.11	40.50	2	1.7	230.86	22.102	268.127
1.476	1.00	0.30	1.08	1.0	0.063	128.10	406.71	1.000	15.95	0.97	0.96	0.60	2.66	1.0	0.016	1.00	278.62	1.000	62.14	39.05	2	1.7	239.89	22.967	278.618
1.640	1.00	0.30	1.08	1.0	0.062	139.98	452.47	1.000	16.01	0.97	1.02	0.60	2.55	1.0	0.017	1.00	312.49	1.000	243.22	129.62	2	1.7	269.05	25.759	312.491
1.804	1.00	0.30	1.08	1.0	0.062	182.16	614.83	1.000	16.07	0.97	1.20	0.60	2.46	1.0	0.017	1.00	432.67	1.000	221.20	118.63	2	1.7	372.53	35.666	432.671
1.968	1.00	0.30	1.07	1.0	0.062	180.05	606.72	1.000	16.13	0.97	1.19	0.60	2.37	1.0	0.018	1.00	426.67	1.000	202.84	109.49	2	1.7	367.36	35.171	426.668
2.133	1.00	0.30	1.07	1.0	0.062	158.22	522.69	1.000	16.20	0.97	1.10	0.60	2.30	1.0	0.019	1.00	364.47	1.000	187.31	101.76	2	1.7	313.81	30.044	364.468
2.297	1.00	0.30	1.07	1.0	0.061	163.05	541.26	1.000	16.27	0.97	1.12	0.60	2.23	1.0	0.019	1.00	378.21	1.000	174.00	95.14	2	1.69827	325.64	31.177	378.214
2.461	1.00	0.30	1.06	1.0	0.061	143.40	465.63	1.000	16.34	0.97	1.04	0.60	2.17	1.0	0.020	1.00	322.23	1.000	162.47	89.40	2	1.667638	277.44	26.562	322.226
2.625	1.00	0.30	1.06	1.0	0.061	132.40	423.29	1.000	16.41	0.97	0.98	0.60	2.12	1.0	0.020	1.00	290.50	1.000	152.37	84.39	2	1.639484	250.45	23.979	290.888
2.789	0.99	0.30	1.06	1.0	0.061	123.51	389.07	1.000	16.48	0.97	0.94	0.60	2.07	1.0	0.021	1.00	265.55	1.000	143.47	79.97	2	1.61347	228.64	21.89	265.554
2.953	0.99	0.30	1.05	1.0	0.060	118.44	369.56	1.000	16.55	0.97	0.91	0.60	2.02	1.0	0.021	1.00	251.11	1.000	135.55	76.05	2	1.598376	216.21	20.7	251.115
3.117	0.99	0.30	1.05	1.0	0.060	115.31	357.50	1.000	16.62	0.97	0.90	0.60	1.98	1.0	0.022	1.00	242.19	1.000	128.47	72.54	2	1.603006	208.53	19.964	242.190
3.281	0.99	0.30	1.05	1.0	0.060	106.13	322.33	1.000	16.68	0.97	0.85	0.60	1.94	1.0	0.022	1.06	229.38	1.000	122.54	69.61	2	1.666111	186.15	17.822	216.204
3.445	0.99	0.29	1.04	1.0	0.060	103.64	312.76	1.000	16.76	0.97	0.83	0.60	1.90	1.0	0.022	1.07	223.18	1.000	117.15	66.95	2	1.666926	180.05	17.238	209.119
3.609	0.99	0.30	1.04	1.0	0.059	77.37	293.60	1.000	16.81	0.97	0.85	0.60	1.87	1.0	0.023	1.00	216.23	1.000	111.72	64.27	2	1.618783	186.18	17.824	216.231
3.773	0.99	0.30	1.04	1.0	0.059	81.97	316.18	1.000	16.88	0.97	0.88	0.60	1.83	1.0	0.023	1.00	234.22	1.000	106.79	61.83	2	1.54395	201.66	19.307	234.215
3.937	0.99	0.30	1.03	1.0	0.059	82.56	319.09	1.000	16.95	0.97	0.89	0.60	1.80	1.0	0.024	1.00	236.53	1.000	102.27	59.61	2	1.518641	203.65	19.498	236.532
4.101	0.99	0.26	1.03	1.0	0.059	73.22	273.24	1.000	17.08	0.97	0.82	0.60	1.77	1.0	0.024	1.04	207.11	1.000	98.12	57.60	2	1.601976	172.21	16.488	200.016
4.265	0.99	0.22	1.02	1.0	0.058	94.39	277.14	1.000	17.21	0.97	0.78	0.61	1.72	1.0	0.025	1.06	193.46	1.000	94.64	55.92	2	1.636141	157.34	15.064	182.743
4.429	0.99	0.14	1.01	1.0	0.058	77.22	211.00	1.000	17.36	0.97	0.67	0.67	1.57	1.0	0.027	1.22	163.57	1.000	91.41	54.38	2	1.7	115.18	11.028	133.780
4.593	0.98	0.17	1.01	1.0	0.058	62.76	221.86	1.000	17.36	0.96	0.73	0.64	1.62	1.0	0.026	1.04	165.68	1.000	88.09	52.73	2	1.671027	136.98	13.115	159.095
4.757	0.98	0.17	1.01	1.0	0.057	61.60	216.17	1.000	17.42	0.96	0.72	0.64	1.59	1.0	0.027	1.05	162.43	1.000	85.00	51.21	2	1.663111	133.08	12.741	154.568
4.921	0.98	0.20	1.01	1.0	0.057	66.02	237.88	1.000	17.44	0.96	0.76	0.62	1.61	1.0	0.026	1.01	173.52	1.000	82.13	49.78	2	1.58643	147.96	14.166	171.852
5.085	0.98	0.20	1.01	1.0	0.057	67.07	243.02	1.000	17.49	0.96	0.77	0.62	1.59	1.0	0.027	1.00	175.95	1.000	79.44	48.47	2	1.555375	151.49	14.504	175.951
5.249	0.98	0.13	1.00	1.0	0.057	74.28	199.67	1.000	17.57	0.96	0.65	0.68	1.47	1.0	0.029	1.17	146.26	0.371	28.62	23.10	2	1.698942	107.96	10.336	125.390
5.413	0.98	0.11	1.00	1.0	0.057	67.80	174.73	0.460	8.11	0.96	0.60	0.70	1.41	1.0	0.030	1.13	120.33	0.242	18.15	13.13	2	1.7	92.066	8.8144	106.929
5.577	0.98	0.09	1.00	1.0	0.057	57.12	133.58	0.213	3.75	0.96	0.50	0.75	1.33	1.0	0.032	1.30	99.66	0.172	12.55	8.15	2	1.7	65.834	6.3029	76.462
5.741	0.98	0.08	1.00	1.0	0.057	54.95	125.25	0.191	3.38	0.96	0.48	0.76	1.31	1.0	0.032	1.25	87.61	0.143	10.13	6.75	2	1.7	60.521	5.7943	70.292
5.905	0.98	0.08	1.00	1.0	0.056	52.87	117.23	0.174	3.08	0.96	0.46	0.77	1.28	1.0	0.033	1.22	78.38	0.125	8.64	5.86	2	1.7	55.413	5.3053	64.359
6.069	0.98	0.08	1.00	1.0	0.056	52.03	113.98	0.167	2.97	0.96	0.45	0.77	1.27	1.0	0.033	1.20	74.27	0.118	7.97	5.47	2	1.7	53.34	5.1068	61.951
6.234	0.98	0.07	1.00	1.0	0.056	49.38	103.79	0.149	2.65	0.96	0.43	0.79	1.24	1.0	0.034	1.43	77.86	0.124	8.16	5.40	2	1.7	46.847	4.4852	54.410
6.398	0.97	0.06	1.00	1.0	0.056	43.73	82.00	0.115	2.05	0.96	0.36	0.80	1.22	1.0	0.035	1.92	73.58	0.117	7.52	4.79	2	1.7	32.957	3.1553	38.278
6.562	0.97	0.07	1.00	1.0	0.056	45.54	88.99	0.125	2.24	0.96	0.38	0.80	1.22	1.0	0.035	1.62	70.38	0.112	7.06	4.65	2	1.7	37.41	3.5816	43.449
6.726	0.97	0.08	1.00	1.0	0.056	52.69	116.54	0.172	3.08	0.96	0.46	0.77	1.25	1.0	0.034	1.21	76.95	0.122	7.51	5.29	2	1.7	54.974	5.2632	63.848
6.890	0.97	0.09	0.99	1.0	0.056	40.48	112.41	0.164	2.94	0.96	0.49	0.76	1.26	1.0	0.034	1.13	81.47	0.130	7.80	5.37	2	1.69536	61.934	5.9296	71.933
7.054	0.97	0.09	0.99	1.0	0.056	40.69	113.44	0.166	2.98	0.96	0.49	0.75	1.25	1.0	0.034	1.11	81.07	0.130	7.57	5.28	2	1.668458	62.636	5.9968	72.748
7.218	0.97	0.09	0.99	1.0	0.056	40.92	114.59	0.169	3.03	0.96	0.50	0.75	1.24	1.0	0.034	1.15	84.37	0.136	7.75	5.39	2	1.642315	63.428	6.0726	73.668
7.382	0.97	0.09	0.99	1.0	0.056	55.88	128.80	0.200	3.60	0.96	0.49	0.75	1.24	1.0	0.034	1.18	86.12	0.139	7.79	5.70	2	1.625714	62.785	6.0111	72.922
7.546	0.97	0.08	0.99	1.0	0.055	55.37	126.84	0.195	3.52	0.96	0.49	0.76	1.23	1.0	0.034	1.22	87.14	0.142	7.75	5.63	2	1.612257	61.536	5.8914	71.470
7.710	0.97	0.08	0.99	1.0	0.055	54.69	124.25	0.189	3.41	0.96	0.48	0.76	1.22	1.0	0.035	1.24	86.34	0.140	7.51	5.46	2	1.600873	59.884	5.7333	69.552
7.874	0.96	0.08	0.99	1.0	0.055	54.02	121.65	0.183	3.31	0.96	0.47	0.76	1.21	1.0	0.035	1.26	85.43	0.138	7.26	5.29	2	1.58975	58.228	5.5747	67.628
8.038	0.96	0.08	0.99	1.0	0.055	52.65	116.37	0.172	3.12	0.96	0.46	0.77	1.20	1.0	0.035	1.30	83.14	0.133	6.89	5.01	2	1.58632	54.866	5.2528	63.723
8.202	0.96	0.08	0.99	1.0	0.055	51.79	113.08	0.166	3.01	0.96	0.45	0.77	1.19	1.0	0.036	1.23	75.08	0.119	6.05	4.53	2	1.577541	52.764	5.0516	61.282
8.366	0.96	0.08	0.99	1.0	0.055	52.39	115.38	0.170	3.09	0.96	0.46	0.77	1.19	1.0	0.036	1.22	76.88	0.122	6.08	4.59	2	1.553638	54.233	5.1922	62.988
8.530	0.96	0.08	0.99	1.0	0.055	52.61	116.21	0.172	3.13	0.96	0.46	0.77	1.18	1.0	0.036	1.23	78.46	0.125	6.11	4.62	2	1.534547	54.763	5.243	63.603
8.694	0.96	0.08	0.99	1.0	0.055	53.47	119.53	0.179	3.26	0.96	0.47	0.77	1.18	1.0	0.036	1.23	81.42	0.130	6.25	4.75	2	1.510156	56.876	5.4453	66.057
8.858	0.96	0.08	0.99	1.0	0.055	54.21	122.40	0.185	3.38	0.96	0.48	0.76	1.18	1.0	0.036	1.23	84.20	0.136	6.39	4.89	2	1.488026	58.705	5.6204	68.183
9.022	0.96	0.08	0.99	1.0	0.055	54.60	123.90	0.188	3.45	0.95	0.48	0.76	1.17	1.0	0.036	1.25	86.34	0.140	6.49	4.97	2	1.469827	59.663	5.7121	69.295
9.186	0.96	0.08	0.99	1.0	0.055	53.52	119.74	0.179	3.28	0.95	0.47	0.77	1.17	1.0	0.036	1.31	86.94	0.141	6.44	4.86	2	1.464002	57.01	5.4582	66.214
9.350	0.96	0.08	0.99	1.0	0.054	51.54	112.08	0.164	3.01	0.95	0.45	0.78	1.15	1.0	0.036	1.41	85.30	0.138	6.18	4.59	2	1.46588	52.129	4.9908	60.544
9.514	0.95	0.07	0.99	1.0	0.054	49.72	105.10	0.151	2.78	0.95	0.43	0.79	1.14	1.0	0.037	1.52	84.00	0.135	5.96	4.37	2	1.46671	47.682	4.565	55.379
9.678	0.95	0.07	0.99	1.0	0.054	46.53	92.81	0.131	2.41	0.95	0.39	0.80	1.13	1.0	0.037	1.81	83.75	0.135	5.85	4.13	2	1.4813	39.843	3.8145	46.275
9.842	0.95	0.06	0.99	1.0	0.054	41.45	73.24	0.104	1.91	0.95	0.33	0.80	1.12	1.0	0.037	2.15	68.25	0.110	4.69	3.30	2	1.52243	27.369	2.6203	31.787
10.006	0.95	0.06	0.99	1.0	0.054	39.67	66.40	0.095	1.75	0.95	0.30	0.80	1.12	1.0	0.037	2.45	65.38	0.106	4.46	3.11	2	1.52925	23.011	2.203	26.725
10.170	0.95	0.06	0.99	1.0	0.054	39.94	67.43	0.096	1.78	0.95	0.30	0.80	1.12	1.0	0.038	1.86	51.18	0.092	3.84	2.81	2	1.507886	23.667	2.2659	27.488
10.335	0.95	0.05	0.99	1.0	0.054	37.96	59.79	0.088	1.62	0.95	0.27	0.80	1.11	1.0	0.038	2.60	56.78	0.097	3.96	2.79	2	1.519415	18.799	1.7998	21.834
10.499	0.95	0.05	0.99	1.0	0.054	36.90	55.70	0.083	1.54	0.95	0.25	0.80	1.11	1.0	0.038	2.67	50.18	0.092	3.69	2.62	2	1.506223	16.193	1.5503	18.807
10.663	0.95	0.06	0.99	1.0	0.054	38.94	63.57	0.092	1.70	0.95	0.29	0.80	1.11	1.0	0.038	2.43	59.84	0.100	3.97	2.83	2	1.470756	21.21	2.0306	24.634
10.827	0.95	0.05	0.99	1.0	0.054	37.92	59.63	0.087	1.62	0.95	0.27	0.80	1.10	1.0	0.038	2.67	57.90	0.098	3.84	2.73	2	1.468221	18.696	1.7899	21.714
10.991	0.94	0.06	0.98	1.0	0.054	41.47	73.33	0.104	1.93	0.95	0.33	0.80	1.10	1.0	0.038	1.87	59.57	0.100	3.84	2.89	2	1.410766	27.43	2.6261	31.858
11.155	0.94	0.06	0.99	1.0	0.054	38.87	63.29	0.092	1.70	0.95	0.29	0.80	1.10	1.0	0.038	2.53	61.68	0.102	3.87	2.79	2	1.424057	21.026	2.013	24.420
11.319	0.94	0.05	0.99	1.0	0.054	37.35	57.44	0.085	1.58	0.95	0.26	0.80	1.09	1.0	0.038	2.51	50.41	0.092	3.45	2.52	2	1.423399	17.301	1.6564	20.094
11.483	0.94	0.05	0.99	1.0	0.054	36.08	52.54	0.080	1.49	0.95	0.23	0.80	1.09	1.0	0.038	3.51	57.77	0.098	3.63	2.56	2	1.408057	14.178	1.3574	16.467
11.647	0.94	0.05	0.98	1.0	0.053	38.51	61.93	0.090	1.68	0.95	0.28	0.80	1.09	1.0	0.038	2.87	67.29	0.108	3.96	2.82	2	1.383531	20.162	1.9303	23.417
11.811	0.94	0.05	0.98	1.0	0.053	37.33	57.39	0.085	1.59	0.95	0.26	0.80	1.09	1.0	0.038	2.80	56.18	0.096	3.50	2.54	2	1.383402	17.264	1.6529	20.051
11.975	0.94	0.05	0.98	1.0	0.053	37.36	57.49	0.085	1.60	0.95	0.26	0.80	1.08	1.0	0.039	2.05	41.26	0.084	3.03	2.31	2	1.374638	17.331	1.6593	20.129

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W5-C

Data File: 13-52106_SP2W5-C-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Description
5604.20	Water surface elevation during CPT investigation (ft
5604.20	Water surface elevation at t_0 (ft amsl)
5589.01	Water surface elevation at t_1 (ft amsl)
5584.01	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ear
7.51	Equiv. Number of Uniform Strain Cycles, N
5615.86	Ground Surface Elevation at time of CPT (ft amsl)
5626.28	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
2.42	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1151.89	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5584.01	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5626.03	5625.78	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5624.03	5622.28	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5620.28	5618.28	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	######	5617.07	5615.86	2.42	0.050	101	0.576	0.515	0.00	0.00	0.576	0.515

Column groups: 2013 CPT Data from ConeTec (Depth – fs/qt); CPT Data Interpretations (Material Type – FC); Conditions at t_1 (Total Stress – Saturated); Liquefaction Triggering Analyses: Idriss & Boulanger (2008) [Cyclic Stress Ratio: r_d, C_σ, K_σ, K_a, CSR; Cyclic Resistance Ratio: Δqc_{1n}, qc_{1n-cs}, CRR; FoS], Youd et al. (2001) [Cyclic Stress Ratio: r_d, D_r, f, K_σ, K_a, CSR; Kc, qc_{1n-cs}, CRR; FoS], Avg FoS, Liquefiable?; Idriss & Boulanger (2008) (CN, qc1, qc1, qc1N)

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	r_d	C_σ	K_σ	K_a	CSR M=7.5, s'v=1atm	Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	r_d	D_r	f	K_σ	K_a	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	CN	qc1 TSF	qc1 MPa	qc1N
12.139	5603.72	13.5	0.096	13.4	5.0	2.18	0.71%	Sand-Slime Tailin	0.059	119.0	0.59	0.01	0.58	1	1.36	18.315	254.58	21.32	22	0.75%	2.4	47%	1.17	0.00	1.17	0	0.94	0.05	0.98	1.0	0.053	37.78	59.10	0.087	1.63	0.95	0.27	0.80	1.08	1.0	0.039	2.26	48.23	0.090	3.22	2.42	2	1.364781	18.358	1.7576	21.322
12.303	5603.56	11.6	0.118	11.5	11.0	4.78	1.02%	Sand-Slime Tailin	0.059	119.0	0.60	0.02	0.58	1	1.36	15.638	217.37	18.27	19	1.07%	2.5	47%	1.18	0.00	1.18	0	0.94	0.05	0.98	1.0	0.053	36.71	54.98	0.082	1.55	0.95	0.25	0.80	1.08	1.0	0.039	2.90	53.04	0.094	3.32	2.44	2	1.357485	15.732	1.5061	18.271
12.467	5603.39	11.3	0.166	11.2	12.8	5.56	1.47%	Sand-Slime Tailin	0.059	119.0	0.61	0.03	0.59	1	1.35	15.110	210.03	17.67	18	1.56%	2.6	47%	1.19	0.00	1.19	0	0.93	0.05	0.98	1.0	0.053	36.50	54.18	0.082	1.54	0.95	0.24	0.80	1.08	1.0	0.039	3.47	61.35	0.101	3.57	2.55	2	1.34909	15.218	1.457	17.675
12.631	5603.23	11.0	0.151	10.9	12.5	5.42	1.38%	Sand-Slime Tailin	0.059	119.0	0.62	0.03	0.59	1	1.34	14.588	202.77	17.06	17	1.46%	2.6	47%	1.20	0.00	1.20	0	0.93	0.05	0.98	1.0	0.053	36.29	53.35	0.081	1.52	0.95	0.24	0.80	1.08	1.0	0.039	3.47	59.22	0.099	3.46	2.49	2	1.340812	14.693	1.4067	17.065
12.795	5603.06	18.2	0.083	18.2	2.6	1.13	0.46%	Sand-Slime Tailin	0.059	119.0	0.63	0.04	0.60	1	1.31	23.841	331.39	27.71	29	0.47%	2.2	47%	1.21	0.00	1.21	0	0.93	0.06	0.98	1.0	0.053	40.02	67.74	0.097	1.83	0.95	0.30	0.80	1.08	1.0	0.039	1.65	45.66	0.088	3.05	2.44	2	1.312115	23.862	2.2846	27.715
12.959	5602.90	20.3	0.069	20.3	0.7	0.29	0.34%	Sand-Slime Tailin	0.059	119.0	0.64	0.04	0.60	1	1.30	26.297	365.53	30.55	33	0.35%	2.1	47%	1.22	0.00	1.22	0	0.93	0.06	0.98	1.0	0.053	41.02	71.56	0.102	1.93	0.95	0.32	0.80	1.07	1.0	0.039	1.46	44.47	0.087	2.99	2.46	2	1.297327	26.302	2.5182	30.548
13.123	5602.74	21.3	0.128	21.3	-0.0	-0.01	0.60%	Sand-Slime Tailin	0.059	119.0	0.65	0.05	0.61	1	1.29	27.402	380.89	31.83	34	0.62%	2.2	47%	1.23	0.00	1.23	0	0.93	0.06	0.98	1.0	0.053	41.46	73.29	0.104	1.97	0.95	0.33	0.80	1.07	1.0	0.039	1.63	51.99	0.093	3.18	2.57	2	1.287096	27.402	2.6235	31.826
13.287	5602.57	22.1	0.250	22.1	2.2	0.94	1.13%	Sand-Slime Tailin	0.059	119.0	0.66	0.05	0.61	1	1.28	28.264	392.88	32.85	35	1.16%	2.3	47%	1.24	0.00	1.24	0	0.93	0.06	0.98	1.0	0.052	41.82	74.67	0.106	2.01	0.94	0.33	0.80	1.07	1.0	0.039	1.99	65.50	0.106	3.60	2.80	2	1.277779	28.282	2.7077	32.848
13.451	5602.41	17.9	0.288	17.9	3.9	1.69	1.61%	Sand-Slime Tailin	0.059	119.0	0.67	0.06	0.61	1	1.29	22.955	319.07	26.70	28	1.67%	2.5	47%	1.25	0.00	1.25	0	0.93	0.06	0.98	1.0	0.052	39.66	66.36	0.095	1.81	0.94	0.30	0.80	1.07	1.0	0.039	2.69	71.93	0.115	3.85	2.83	2	1.285254	22.986	2.2007	26.697
13.615	5602.24	16.1	0.193	16.1	8.8	3.83	1.20%	Sand-Slime Tailin	0.059	119.0	0.68	0.06	0.62	1	1.28	20.647	287.00	24.06	25	1.25%	2.5	47%	1.26	0.00	1.26	0	0.93	0.06	0.98	1.0	0.052	38.74	62.80	0.091	1.74	0.94	0.28	0.80	1.07	1.0	0.039	2.56	61.51	0.102	3.39	2.57	2	1.284834	20.718	1.9836	24.063
13.779	5602.08	19.4	0.123	19.3	9.7	4.21	0.63%	Sand-Slime Tailin	0.059	119.0	0.69	0.07	0.62	1	1.27	24.473	340.18	28.51	30	0.66%	2.2	47%	1.27	0.00	1.27	0	0.92	0.06	0.98	1.0	0.052	40.30	68.82	0.098	1.88	0.94	0.31	0.80	1.07	1.0	0.039	1.79	51.10	0.092	3.06	2.47	2	1.266741	24.55	2.3504	28.514
13.943	5601.92	25.1	0.130	25.1	8.8	3.83	0.52%	Sand-Slime Tailin	0.059	119.0	0.70	0.07	0.63	1	1.24	31.169	433.25	36.28	39	0.53%	2.1	47%	1.28	0.00	1.28	0	0.92	0.06	0.98	1.0	0.052	43.03	79.31	0.112	2.15	0.94	0.35	0.80	1.06	1.0	0.039	1.47	53.16	0.094	3.09	2.62	2	1.244282	31.238	2.9907	36.281
14.107	5601.75	25.6	0.219	25.6	8.3	3.58	0.85%	Sand-Slime Tailin	0.059	119.0	0.71	0.08	0.63	1	1.24	31.630	439.66	36.81	39	0.88%	2.2	47%	1.29	0.00	1.29	0	0.92	0.06	0.97	1.0	0.052	43.21	80.02	0.113	2.17	0.94	0.35	0.80	1.06	1.0	0.039	1.68	62.01	0.102	3.34	2.75	2	1.237001	31.694	3.0344	36.811
14.271	5601.59	25.3	0.206	25.3	14.8	6.43	0.81%	Sand-Slime Tailin	0.059	119.0	0.72	0.08	0.64	1	1.23	31.101	432.30	36.25	39	0.84%	2.2	47%	1.30	0.00	1.30	0	0.92	0.06	0.97	1.0	0.052	43.02	79.27	0.112	2.15	0.94	0.35	0.80	1.06	1.0	0.039	1.67	60.69	0.101	3.27	2.71	2	1.231716	31.215	2.9885	36.254
14.436	5601.42	28.0	0.355	27.9	15.7	6.79	1.27%	Sand-Slime Tailin	0.059	119.0	0.73	0.09	0.64	1	1.22	33.991	472.48	39.62	42	1.30%	2.3	47%	1.31	0.00	1.31	0	0.92	0.06	0.97	1.0	0.052	44.20	83.81	0.118	2.28	0.94	0.36	0.80	1.06	1.0	0.039	1.87	74.22	0.118	3.81	3.04	2	1.22008	34.111	3.2658	39.618
14.600	5601.26	21.9	0.337	21.8	19.3	8.38	1.54%	Sand-Slime Tailin	0.059	119.0	0.74	0.09	0.65	1	1.23	26.771	372.11	31.26	33	1.59%	2.4	47%	1.32	0.00	1.32	0	0.92	0.06	0.97	1.0	0.052	41.27	72.53	0.103	1.99	0.94	0.32	0.80	1.06	1.0	0.039	2.38	74.56	0.119	3.80	2.89	2	1.228005	26.919	2.5772	31.265
14.764	5601.10	27.4	0.402	27.2	33.6	14.56	1.47%	Sand-Slime Tailin	0.059	119.0	0.75	0.10	0.65	1	1.21	32.863	456.79	38.46	41	1.51%	2.3	47%	1.32	0.00	1.32	0	0.92	0.06	0.97	1.0	0.052	43.79	82.25	0.116	2.25	0.94	0.36	0.80	1.06	1.0	0.039	2.04	78.35	0.125	3.97	3.11	2	1.20996	33.116	3.1706	38.463
14.928	5600.93	49.6	0.629	49.5	20.9	9.05	1.27%	Sand Tailings	0.062	123.5	0.76	0.10	0.66	1	1.17	57.889	804.66	67.41	74	1.29%	2.1	18%	1.33	0.00	1.33	0	0.92	0.08	0.96	1.0	0.051	39.32	106.73	0.154	3.02	0.94	0.47	0.76	1.07	1.0	0.039	1.42	95.65	0.161	5.10	4.06	2	1.170186	58.042	5.5569	67.412
15.092	5600.77	29.2	0.705	29.1	11.9	5.15	2.41%	Sand-Slime Tailin	0.059	119.0	0.77	0.11	0.66	1	1.19	34.821	484.01	40.55	43	2.48%	2.4	47%	1.34	0.00	1.34	0	0.91	0.07	0.97	1.0	0.051	44.52	85.07	0.120	2.33	0.94	0.37	0.80	1.05	1.0	0.039	2.51	101.61	0.178	5.57	3.95	2	1.194955	34.91	3.3422	40.545
15.256	5600.60	26.1	0.521	26.1	10.3	4.48	1.99%	Sand-Slime Tailin	0.059	119.0	0.78	0.11	0.67	1	1.20	31.170	433.26	36.29	38	2.05%	2.4	47%	1.35	0.00	1.35	0	0.91	0.06	0.97	1.0	0.051	43.03	79.32	0.112	2.18	0.94	0.35	0.80	1.05	1.0	0.039	2.45	88.96	0.145	4.54	3.36	2	1.195155	31.247	2.9916	36.291
15.420	5600.44	21.1	0.398	21.0	25.4	11.00	1.88%	Sand-Slime Tailin	0.059	119.0	0.79	0.12	0.67	1	1.20	25.169	349.85	29.45	30	1.96%	2.5	47%	1.36	0.00	1.36	0	0.91	0.06	0.97	1.0	0.051	40.63	70.08	0.100	1.94	0.94	0.31	0.80	1.05	1.0	0.039	2.75	81.14	0.130	4.02	2.98	2	1.19967	25.359	2.4279	29.453
15.584	5600.28	18.2	0.232	17.9	47.5	20.56	1.28%	Sand-Slime Tailin	0.059	119.0	0.80	0.12	0.68	1	1.20	21.442	298.05	25.32	26	1.34%	2.5	47%	1.37	0.00	1.37	0	0.91	0.06	0.97	1.0	0.051	39.18	64.50	0.093	1.81	0.94	0.29	0.80	1.05	1.0	0.039	2.58	65.28	0.106	3.26	2.54	2	1.200568	21.798	2.0869	25.317
15.748	5600.11	17.7	0.358	17.4	55.7	24.12	2.02%	Sand-Slime Tailin	0.059	119.0	0.81	0.13	0.68	1	1.20	20.745	288.36	24.58	25	2.12%	2.6	47%	1.38	0.00	1.38	0	0.91	0.06	0.97	1.0	0.051	38.92	63.50	0.092	1.79	0.94	0.29	0.80	1.05	1.0	0.039	3.25	79.94	0.128	3.90	2.85	2	1.195675	21.16	2.0259	24.577
15.912	5599.95	15.1	0.207	14.6	74.8	32.40	1.37%	Sand-Slime Tailin	0.059	119.0	0.82	0.13	0.68	1	1.20	17.473	242.88	20.94	21	1.45%	2.6	47%	1.39	0.00	1.39	0	0.91	0.05	0.97	1.0	0.051	37.65	58.59	0.086	1.69	0.94	0.26	0.80	1.05	1.0	0.040	3.07	64.37	0.105	3.18	2.44	2	1.195967	18.031	1.7263	20.942
16.076	5599.78	20.3	0.257	19.8	68.4	29.65	1.27%	Sand-Slime Tailin	0.059	119.0	0.83	0.14	0.69	1	1.18	23.370	324.85	27.73	28	1.32%	2.4	47%	1.40	0.00	1.40	0	0.91	0.06	0.97	1.0	0.051	40.03	67.75	0.097	1.90	0.94	0.30	0.80	1.05	1.0	0.040	2.42	67.01	0.108	3.26	2.58	2	1.178531	23.874	2.2857	27.728
16.240	5599.62	21.4	0.347	21.2	43.6	18.89	1.62%	Sand-Slime Tailin	0.059	119.0	0.84	0.14	0.69	1	1.17	24.772	344.33	29.14	30	1.68%	2.5	47%	1.41	0.00	1.41	0	0.91	0.06	0.97	1.0	0.051	40.52	69.66	0.099	1.95	0.94	0.31	0.80	1.04	1.0	0.040	2.60	75.89	0.121	3.62	2.78	2	1.170704	25.091	2.4022	29.141
16.404	5599.46	16.6	0.322	16.3	49.4	21.39	1.94%	Sand-Slime Tailin	0.059	119.0	0.85	0.15	0.70	1	1.17	19.179	266.59	22.70	23	2.04%	2.6	47%	1.42	0.00	1.42	0	0.90	0.05	0.97	1.0	0.051	38.26	60.96	0.089	1.75	0.94	0.28	0.80	1.04	1.0	0.040	3.39	77.02	0.122	3.65	2.70	2	1.174472	19.541	1.8709	22.696
16.568	5599.29	13.3	0.286	12.8	72.0	31.18	2.16%	Sand-Slime Tailin	0.059	119.0	0.86	0.15	0.70	1	1.17	15.003	208.55	18.04	18	2.31%	2.7	47%	1.43	0.00	1.43	0	0.90	0.05	0.97	1.0	0.051	36.63	54.66	0.082	1.62	0.94	0.25	0.80	1.04	1.0	0.040	4.22	76.04	0.121	3.58	2.60	2	1.171225	15.529	1.4868	18.037
16.732	5599.13	10.2	0.232	9.8	68.1	29.53	2.28%	Slime Tailings	0.057	113.1	0.87	0.16	0.71	1	1.17	11.379	158.16	13.79	13	2.49%	2.9	71%	1.44	0.00	1.44	0	0.90	0.05	0.98	1.0	0.051	34.89	48.68	0.076	1.50	0.94	0.21	0.80	1.04	1.0	0.040	5.25	72.36	0.115	3.40	2.45	2	1.165837	11.874	1.1369	13.792
16.896	5598.96	9.5	0.302	9.0	80.2	34.74	3.18%	Slime Tailings	0.057	113.1	0.88	0.16	0.71	1	1.16	10.433	145.02	12.79	12	3.51%	3.0	71%	1.45	0.00	1.45	0	0.90	0.05	0.98	1.0	0.051	34.54	47.33	0.075	1.48	0.94	0.21	0.80	1.04	1.0	0.040	6.40	81.87	0.131	3.84	2.66	2	1.160506	11.014	1.0545	12.792
17.060	5598.80	16.7	0.143	16.2	83.4	36.16	0.86%	Sand-Slime Tailin	0.059	119.0	0.88	0.17	0.72	1	1.15	18.672	259.55	22.38	22	0.90%	2.4	47%	1.46	0.00	1.46	0	0.90	0.05	0.97	1.0	0.051	38.15	60.54	0.088	1.75	0.94	0.27	0.80	1.04	1.0	0.040	2.43	54.50	0.095	2.77	2.26	2	1.15262	19.273	1.8452	22.384
17.224	5598.64	29.8	0.265	29.6	24.9	10.78	0.89%	Sand-Slime Tailin	0.059	119.0	0.89	0.17	0.72	1	1.13	33.458	465.06	39.06	40	0.92%	2.2	47%	1.47	0.00	1.47	0	0.90	0.06	0.97	1.0	0.050	44.00	83.06	0.117	2.33	0.94	0.36	0.80	1.04	1.0	0.040	1.69	66.07	0.107	3.09	2.71	2	1.1288	33.633	3.22	39.063
17.388	5598.47	19.1	0.394	19.0	18.5	8.03	2.06%	Sand-Slime Tailin	0.059	119.0	0.90	0.18	0.73	1	1.14	21.615	300.45	25.26	25	2.16%	2.6	47%	1.48	0.00	1.48	0	0.90	0.06	0.97	1.0	0.050	39.16	64.42	0.093	1.85	0.94	0.29	0.80	1.03	1.0	0.040	3.26	82.40	0.132	3.80	2.82	2	1.137647	21.747	2.0821	25.258
17.552	5598.31	15.7	0.311	15.6	23.1	10.01	1.98%	Sand-Slime Tailin	0.059	119.0	0.91	0.18	0.73	1	1.14	17.686	245.84	20.73	20	2.10%	2.7	47%	1.49	0.00	1.49	0	0.90	0.05	0.97	1.0	0.050	37.57	58.30	0.086	1.71	0.93	0.26	0.80	1.03	1.0	0.040	3.70	76.68	0.122	3.49	2.60	2	1.137384	17.85	1.709	20.732
17.716	5598.14	13.9	0.260	13.8	26.1	11.33	1.86%	Sand-Slime Tailin	0.059	119.0	0.92	0.19	0.73	1	1.13	15.596	216.78	18.33	18	2.00%	2.7	47%	1.50	0.00	1.50	0	0.89	0.05	0.97	1.0	0.050	36.73	55.06	0.083	1.64	0.93	0.25	0.80	1.03	1.0	0.040	3.94	72.19	0.115	3.27	2.46	2	1.131767	15.78	1.5108	18.328
17.880	5597.98	18.8	0.179	18.5	52.4	22.70	0.95%	Sand-Slime Tailin	0.059	119.0	0.93	0.19	0.74	1	1.12	20.761	288.58	24.54	24	1.00%	2.4	47%	1.51	0.00	1.51	0	0.89	0.06	0.97	1.0	0.050	38.91	63.45	0.092	1.83	0.93	0.29	0.80	1.03	1.0	0.040	2.38	58.47	0.099	2.79	2.31	2	1.122221	21.128	2.0228	24.539
18.044	5597.82	39.1	0.438	39.0	24.3	10.53	1.12%	Sand-Slime Tailin	0.059	119.0	0.94	0.20	0.74	1	1.10	42.754	594.28	49.85	51	1.15%	2.2	47%	1.52	0.00	1.52	0	0.89	0.07	0.96	1.0	0.049	47.78	97.63	0.139	2.80	0.93	0.41	0.80	1.03	1.0	0.040	1.61	80.28	0.128	3.60	3.20	2	1.09766	42.92	4.1092	49.849
18.208	5597.65	18.6	0.428	18.6	11.8	5.10	2.30%	Sand-Slime Tailin	0.059	119.0	0.95	0.20	0.75	1	1.11	20.630	286.76	24.06	24	2.42%	2.6	47%	1.53	0.00	1.53	0	0.89	0.06	0.97	1.0	0.050	38.74	62.79	0.091	1.83	0.93	0.28	0.80	1.03	1.0	0.040	3.58	86.19	0.140	3.90	2.86	2	1.112129	20.712	1.9829	24.055
18.372	5597.49	12.8	0.269	12.7	14.8	6.43	2.10%	Sand-Slime Tailin	0.059	119.0	0.96	0.21	0.75	1	1.11	14.096	195.93	16.49	16	2.27%	2.8	47%	1.54	0.00	1.54	0	0.89	0.05	0.97	1.0	0.050	36.09	52.58	0.080	1.60	0.93	0.23	0.80	1.03	1.0	0.040	4.51	74.42	0.118	3.29	2.45	2	1.109913	14.199	1.3594	16.491
18.537	5597.32	17.7	0.255	17.5	38.1	16.51	1.44%	Sand-Slime Tailin	0.059	119.0	0.97	0.21	0.76	1	1.10	19.280	267.99	22.70	22	1.52%	2.5	47%	1.55	0.00	1.55	0	0.89	0.06	0.97	1.0	0.050	38.26	60.96	0.089	1.79	0.93	0.28	0.80	1.03	1.0	0.040	3.02	68.48	0.110	3.03	2.41	2	1.10298	19.542	1.871	22.697
18.701	5597.16	15.7	0.298	15.5	35.1	15.21	1.90%	Sand-Slime Tailin	0.059	119.0	0.98	0.22	0.76	1	1.10	17.040	236.85	20.07	19	2.02%	2.7	47%	1.56	0.00	1.56	0	0.89	0.05	0.97	1.0	0.050	37.34	57.41	0.085	1.71	0.93	0.26	0.80	1.02	1.0	0.040	3.74	75.13	0.119	3.28	2.50	2	1.099343	17.281	1.6545	20.071
18.865	5597.00	16.1	0.307	15.8	50.1	21.72	1.90%	Sand-Slime Tailin	0.059	119.0	0.99	0.22	0.77	1	1.09	17.309	240.60	20.50	20	2.03%	2.7	47%	1.57	0.00	1.57	0	0.89	0.05	0.97	1.0	0.050	37.49	57.99	0.086	1.73	0.93	0.26	0.80	1.02	1.0	0.040	3.70	75.79	0.120	3.29	2.51	2	1.094143	17.652	1.69	20.501
19.029	5596.83	26.6	0.234	26.5	23.1	10.00	0.88%	Sand-Slime Tailin	0.059	119.0	1.00	0.23	0.77	1	1.08	28.588	397.38	33.38	33	0.91%	2.3	47%	1.58	0.00	1.58	0	0.88	0.06	0.96	1.0	0.049	42.01	75.39	0.106	2.16	0.93	0.33	0.80	1.02	1.0	0.040	1.88	62.88	0.103	2.80	2.48	2	1.080432	28.744	2.7519	33.384
19.193	5596.67	29.7	0.205	29.7	9.5	4.12	0.69%	Sand-Slime Tailin	0.059	119.0	1.01	0.24	0.78	1	1.07	31.852	442.74	37.07	37	0.71%	2.2	47%	1.59	0.00	1.59	0	0.88	0.06	0.96	1.0	0.049	43.30	80.37	0.113	2.31	0.93	0.35	0.80	1.02	1.0	0.040	1.63	60.40	0.100	2.71	2.51	2	1.073899	31.916	3.0556	37.068
19.357	5596.50	31.2	0.166	31.2	6.0	2.60	0.53%	Sand-Slime Tailin	0.059	119.0	1.02	0.24	0.78	1	1.07	33.332	463.32	38.76	39	0.55%	2.1	47%	1.60	0.00	1.60	0	0.88	0.06	0.96	1.0	0.049	43.90	82.66	0.116	2.38	0.93	0.36	0.80	1.02	1.0	0.040	1.48	57.35	0.098	2.62	2.50	2	1.068688	33.372	3.1951	38.760
19.521	5596.34	30.6	0.174	30.6	5.8	2.51	0.57%	Sand-Slime Tailin	0.059	119.0	1.03	0.25	0.79	1	1.06	32.529	452.15	37.83	38	0.59%	2.1	47%	1.61	0.00	1.61	0	0.88	0.06	0.96	1.0	0.049	43.57	81.39	0.115	2.34	0.93	0.36	0.80	1.02	1.0	0.040	1.53	57.77	0.098	2.62	2.48	2	1.064776	32.567	3.118	37.825
19.685	5596.18	30.2	0.251	30.2	5.6	2.43	0.83%	Sand-Slime Tailin	0.059	119.0	1.04	0.25	0.79	1	1.06	32.002	444.83	37.21	37	0.86%	2.2	47%	1.62	0.00	1.62	0	0.88	0.06	0.96	1.0	0.049	43.35	80.56	0.113	2.32	0.93	0.35	0.80	1.02	1.0	0.040	1.73	64.49	0.105	2.79	2.56	2	1.060724	32.039	3.0674	37.212
19.849	5596.01	25.2	0.236	25.2	6.5	2.83	0.93%	Sand-Slime Tailin	0.059	119.0	1.05	0.26	0.80	1	1.06	26.686	370.94	31.04	30	0.98%	2.3	47%	1.63	0.00	1.63	0	0.88	0.06	0.96	1.0	0.049	41.19	72.23	0.102	2.10	0.93	0.32	0.80	1.02	1.0	0.040	2.03	63.17	0.103	2.74	2.42	2	1.058982	26.73	2.5591	31.045
20.013	5595.85	19.0	0.220	19.0	7.3	3.16	1.16%	Sand-Slime Tailin	0.059	119.0	1.06	0.26	0.80	1	1.06	20.060	278.83	23.35	22	1.23%	2.5	47%	1.64	0.00	1.64	0	0.88	0.05	0.96	1.0	0.049	38.49	61.85	0.090	1.84	0.93	0.28	0.80	1.01	1.0	0.040	2.72	63.54	0.104	2.74	2.29	2	1.05802	20.108	1.9252	23.355
20.177	5595.68	29.6	0.210	29.5	8.7	3.79	0.71%	Sand-Slime Tailin	0.059	119.0	1.07	0.27	0.80	1	1.05	30.959	430.33	36.02	35	0.74%	2.2	47%	1.65	0.00	1.65	0	0.87	0.06	0.96	1.0	0.049	42.94	78.96	0.111	2.29	0.93	0.35	0.80	1.01	1.0	0.040	1.68	60.65	0.101	2.64	2.47	2	1.048399	31.016	2.9695	36.024
20.341	5595.52	30.3	0.241	30.2	8.7	3.77	0.80%	Sand-Slime Tailin	0.059	119.0	1.08	0.27	0.81	1	1.04	31.560	438.68	36.72	36	0.83%	2.2	47%	1.66	0.00	1.66	0	0.87	0.06	0.96	1.0	0.048	43.18	79.90	0.112	2.32	0.92	0.35	0.80	1.01	1.0	0.040	1.73	63.52	0.104	2.71	2.52	2	1.043997	31.617	3.027	36.721
20.505	5595.36	30.4	0.302	30.3	9.5	4.11	0.99%	Sand-Slime Tailin	0.059	119.0	1.09	0.28	0.81	1	1.04	31.508	437.97	36.67	36	1.03%	2.3	47%	1.67	0.00	1.67	0	0.87	0.06	0.96	1.0	0.048	43.16	79.83	0.112	2.33	0.92	0.35	0.80	1.01	1.0	0.040	1.88	68.85	0.110	2.87	2.60	2	1.039881	31.57	3.0225	36.667
20.669	5595.19	31.3	0.368	31.3	10.8	4.68	1.17%	Sand-Slime Tailin	0.059	119.0	1.10	0.28	0.82	1	1.04	32.371	449.96	37.68	37	1.22%	2.3	47%	1.68	0.00	1.68	0	0.87	0.06	0.96	1.0	0.048	43.52	81.19	0.114	2.37	0.92	0.35	0.80	1.01	1.0	0.040	1.97	74.32	0.118	3.06	2.72	2	1.035544	32.441	3.1059	37.678
20.833	5595.03	30.5	0.484	30.4	10.9	4.74	1.59%	Sand-Slime Tailin	0.059	119.0	1.11	0.29	0.82	1	1.03	31.396	436.41	36.55	36	1.65%	2.4	47%	1.69	0.00	1.69	0	0.87	0.06	0.96	1.0	0.048	43.12	79.67	0.112	2.33	0.92	0.35	0.80	1.01	1.0	0.040	2.30	83.89	0.135	3.48	2.90	2	1.031761	31.467	3.0126	36.547
20.997	5594.86	26.1	0.582	26.0	10.9	4.74	2.23%	Sand-Slime Tailin	0.059	119.0	1.12	0.29	0.83	1	1.03	26.780	372.24	31.18	30	2.33%	2.5	47%	1.69	0.00	1.69	0	0.87	0.06	0.96	1.0	0.048	41.24	72.42	0.103	2.13	0.92	0.32	0.80	1.01	1.0	0.040	3.01	93.89	0.157	4.03	3.08	2	1.028813	26.85	2.5706	31.185
21.161	5594.70	20.1	0.593	20.1	11.7	5.06	2.95%	Slime Tailings	0.057	113.1	1.13	0.30	0.83	1	1.03	20.583	286.10	23.99	23	3.12%	2.7	71%	1.70	0.00	1.70	0	0.87	0.06	0.96	1.0	0.048	38.44	62.44	0.091	1.88	0.92	0.28	0.80	1.01	1.0	0.040	4.14	99.39	0.171	4.39	3.13	2	1.02656	20.657	1.9777	23.992
21.325	5594.53	18.4	0.531	18.3	20.6	8.93	2.89%	Slime Tailings	0.057	113.1	1.14	0.30	0.84	1	1.02	18.692	259.82	21.86	21	3.08%	2.7	71%	1.71	0.00	1.71	0	0.87	0.05	0.96	1.0	0.048	37.70	59.56	0.087	1.81	0.92	0.27	0.80	1.01	1.0	0.040	4.37	95.63	0.161	4.12	2.96	2	1.023086	18.823	1.8021	21.862
21.489	5594.37	17.0	0.447	16.8	29.0	12.56	2.63%	Slime Tailings	0.057	113.1	1.15	0.31	0.84	1	1.02	17.124	238.03	20.10	19	2.82%	2.8	71%	1.72	0.00	1.72	0	0.86	0.05	0.96	1.0	0.048	37.09	57.19	0.085	1.76	0.91	0.26	0.80	1.00	1.0	0.040	4.44	89.28	0.146	3.72	2.74	2	1.019302	17.309	1.6571	20.103
21.653	5594.21	14.2	0.424	14.0	29.7	12.89	2.99%	Slime Tailings	0.057	113.1	1.16	0.31	0.84	1	1.02	14.215	197.59	16.73	15	3.25%	2.9	71%	1.73	0.00	1.73	0	0.86	0.05	0.96	1.0	0.048	35.91	52.64	0.080	1.66	0.91	0.24	0.80	1.00	1.0	0.040	5.36	89.70	0.147	3.73	2.70	2	1.015373	14.404	1.379	16.729
21.817	5594.04	16.9	0.422	16.5	68.7	29.77	2.50%	Slime Tailings	0.057	113.1	1.17	0.32	0.85	1	1.01	16.669	231.70	19.86	19	2.68%	2.8	71%	1.74	0.00	1.74	0	0.86	0.05	0.96	1.0	0.048	37.01	56.87	0.084	1.76	0.91	0.26	0.80	1.00	1.0	0.040	4.38	86.93	0.141	3.56	2.66	2	1.011479	17.103	1.6374	19.864
21.981	5593.88	21.8	0.335	21.7	23.7	10.26	1.54%	Sand-Slime Tailin	0.059	119.0	1.18	0.32	0.85	1	1.01	21.800	303.01	25.49	24	1.62%	2.5	47%	1.75	0.00	1.75	0	0.86	0.06	0.96	1.0	0.048	39.24	64.73	0.093	1.95	0.91	0.29	0.80	1.00	1.0	0.040	2.93	74.56	0.119	2.98	2.47	2	1.006907	21.948	2.1013	25.492
22.145	5593.71	21.8	0.428	21.7	22.3	9.65	1.96%	Sand-Slime Tailin	0.059	119.0	1.18	0.33	0.86	1	1.00	21.771	302.62	25.45	24	2.07%	2.6	47%	1.76	0.00	1.76	0	0.86	0.06	0.96	1.0	0.048	39.23	64.67	0.093	1.95	0.91	0.29	0.80	1.00	1.0	0.040	3.28	83.48	0.134	3.36	2.66	2	1.002806	21.91	2.0977	25.448
22.309	5593.55	17.7	0.439	17.6	19.7	8.53	2.48%	Sand-Slime Tailin	0.059	119.0	1.19	0.33	0.86	1	1.00	17.547	243.90	20.52	19	2.66%	2.7	47%	1.77	0.00	1.77	0	0.86	0.05	0.96	1.0	0.048	37.50	58.02	0.086	1.80	0.91	0.26	0.80	1.00	1.0	0.040	4.28	87.80	0.143	3.57	2.68	2	0.998694	17.67	1.6917	20.522
22.473	5593.39	16.8	0.471	16.6	34.2	14.81	2.80%	Slime Tailings	0.057	113.1	1.20	0.34	0.87	1	0.99	16.546	229.99	19.46	18	3.01%	2.8	71%	1.78	0.00	1.78	0	0.86	0.05	0.96	1.0	0.048	36.87	56.33	0.084	1.76	0.91	0.25	0.80	1.00	1.0	0.040	4.70	91.53	0.151	3.76	2.76	2	0.994943	16.758	1.6044	19.464
22.638	5593.22	19.3	0.376	19.1	34.2	14.81	1.95%	Sand-Slime Tailin	0.059	119.0	1.21	0.34	0.87	1	0.99	18.876	262.38	22.17	21	2.08%	2.6	47%	1.79	0.00	1.79	0	0.85	0.05	0.96	1.0	0.047	38.08	60.25	0.088	1.86	0.90	0.27	0.80	1.00	1.0	0.040	3.63	80.39	0.128	3.18	2.52	2	0.990892	19.088	1.8275	22.169
22.802	5593.06	15.1	0.327	14.7	65.1	28.22	2.17%	Sand-Slime Tailin	0.059	119.0	1.22	0.35	0.88	1	0.99	14.455	200.93	17.25	16	2.36%	2.8	47%	1.80	0.00	1.80	0	0.85	0.05	0.96	1.0	0.047	36.35	53.61	0.081	1.71	0.90	0.24	0.80	1.00	1.0	0.040	4.57	78.92	0.126	3.10	2.40	2	0.986693	14.856	1.4223	17.255
22.966	5592.89	12.6	0.218	11.9	111.5	48.31	1.73%	Sand-Slime Tailin	0.059	119.0	1.23	0.35	0.88	1	0.98	11.703	162.67	14.39	13	1.92%	2.8	47%	1.81	0.00	1.81	0	0.85	0.05	0.96	1.0	0.047	35.35	49.73	0.077	1.63	0.90	0.22	0.80	1.00	1.0	0.040	4.76	68.44	0.110	2.70	2.16	2	0.982626	12.387	1.1859	14.387
23.130	5592.73	12.0	0.226	11.4	106.7	46.22	1.88%	Sand-Slime Tailin	0.059	119.0	1.24	0.36	0.89	1	0.98	11.107	154.39	13.66	12	2.10%	2.8	47%	1.82	0.00	1.82	0	0.85	0.05	0.96	1.0	0.047	35.09	48.75	0.076	1.61	0.90	0.21	0.80	0.99	1.0	0.040	5.13	70.08	0.112	2.74	2.18	2	0.978597	11.759	1.1258	13.657
23.294	5592.57	14.5	0.334	13.6	154.3	66.85	2.30%	Sand-Slime Tailin	0.059	119.0	1.25	0.36	0.89	1	0.97	13.235	183.97	16.46	15	2.51%	2.8	47%	1.83	0.00	1.83	0	0.85	0.05	0.96	1.0	0.047	36.08	52.54	0.080	1.69	0.90	0.23	0.80	0.99	1.0	0.040	4.87	80.16	0.128	3.12	2.41	2	0.974605	14.174	1.357	16.462
23.458	5592.40	17.3	0.173	16.5	120.2	52.09	1.00%	Sand-Slime Tailin	0.059	119.0	1.26	0.37	0.89	1	0.97	16.025	222.75	19.46	18	1.08%	2.5	47%	1.84	0.00	1.84	0	0.85	0.05	0.96	1.0	0.047	37.13	56.58	0.084	1.79	0.90	0.25	0.80	0.99	1.0	0.040	3.02	58.77	0.099	2.40	2.10	2	0.97065	16.754	1.604	19.459
23.622	5592.24	26.9	0.267	26.6	51.3	22.22	0.99%	Sand-Slime Tailin	0.059	119.0	1.27	0.37	0.90	1	0.97	25.759	358.04	30.28	29	1.04%	2.4	47%	1.85	0.00	1.85	0	0.85	0.06	0.95	1.0	0.047	40.92	71.20	0.101	2.16	0.90	0.32	0.80	0.99	1.0	0.040	2.17	65.84	0.107	2.58	2.37	2	0.969095	26.069	2.4958	30.277
23.786	5592.07	18.3	0.357	17.9	69.4	30.09	1.95%	Sand-Slime Tailin	0.059	119.0	1.28	0.38	0.90	1	0.96	17.187	238.90	20.45	19	2.10%	2.7	47%	1.86	0.00	1.86	0	0.85	0.05	0.96	1.0	0.047	37.47	57.92	0.086	1.83	0.90	0.26	0.80	0.99	1.0	0.040	3.87	79.22	0.126	3.05	2.44	2	0.96285	17.604	1.6854	20.446
23.950	5591.91	13.8	0.283	13.3	90.4	39.18	2.05%	Sand-Slime Tailin	0.059	119.0	1.29	0.38	0.91	1	0.96	12.716	176.76	15.40	14	2.26%	2.8	47%	1.87	0.00	1.87	0	0.84	0.05	0.96	1.0	0.047	35.70	51.10	0.079	1.67	0.89	0.23	0.80	0.99	1.0	0.040	4.89	75.23	0.120	2.88	2.27	2	0.959003	13.258	1.2693	15.398

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W5-C

Data File: 13-52106_SP2W5-C-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5604.20	Water surface elevation during CPT investigation (ft
5604.20	Water surface elevation at t_0 (ft amsl)
5589.01	Water surface elevation at t_1 (ft amsl)
5584.01	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ear
7.51	Equiv. Number of Uniform Strain Cycles, N

5615.86	Ground Surface Elevation at time of CPT (ft amsl)
5626.28	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
2.42	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1151.89	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5584.01	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5626.03	5625.78	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5624.03	5622.28	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5620.28	5618.28	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	######	5617.07	5615.86	2.42	0.050	101	0.576	0.515	0.00	0.00	0.576	0.515

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F, (%)	Type Index, I_c	FC %
24.114	5591.75	10.3	0.189	10.0	60.4	26.18	1.83%	Sand-Slime Tailin	0.059	119.0	1.30	0.39	0.91	1	0.96	9.514	132.24	11.47	10	2.09%	2.9	47%
24.278	5591.58	10.0	0.219	9.3	112.2	48.61	2.19%	Slime Tailings	0.057	113.1	1.31	0.39	0.92	1	0.95	8.871	123.30	11.08	9	2.51%	3.0	71%
24.442	5591.42	14.0	0.326	13.2	122.0	52.86	2.33%	Slime Tailings	0.057	113.1	1.32	0.40	0.92	1	0.95	12.529	174.15	15.39	14	2.58%	2.8	71%
24.606	5591.25	14.1	0.236	13.7	63.7	27.60	1.67%	Sand-Slime Tailin	0.059	119.0	1.33	0.40	0.93	1	0.94	12.962	180.17	15.49	14	1.85%	2.8	47%
24.770	5591.09	23.3	0.448	22.8	72.8	31.55	1.92%	Sand-Slime Tailin	0.059	119.0	1.34	0.41	0.93	1	0.94	21.533	299.31	25.51	24	2.04%	2.6	47%
24.934	5590.93	29.6	0.313	29.2	58.1	25.19	1.06%	Sand-Slime Tailin	0.059	119.0	1.35	0.41	0.94	1	0.94	27.544	382.86	32.39	30	1.11%	2.4	47%
25.098	5590.76	38.5	0.429	38.5	11.6	5.02	1.11%	Sand-Slime Tailin	0.059	119.0	1.36	0.42	0.94	1	0.94	36.269	504.14	42.20	40	1.15%	2.3	47%
25.262	5590.60	30.5	0.493	30.4	9.2	3.99	1.62%	Sand-Slime Tailin	0.059	119.0	1.37	0.42	0.94	1	0.94	28.493	396.05	33.16	31	1.69%	2.5	47%
25.426	5590.43	25.9	0.457	25.8	10.7	4.64	1.77%	Sand-Slime Tailin	0.059	119.0	1.38	0.43	0.95	1	0.93	23.999	333.59	27.95	26	1.87%	2.5	47%
25.590	5590.27	23.2	0.409	23.0	38.5	16.67	1.76%	Sand-Slime Tailin	0.059	119.0	1.39	0.43	0.95	1	0.93	21.279	295.77	24.97	23	1.87%	2.6	47%
25.754	5590.11	23.9	0.457	23.6	50.5	21.90	1.91%	Sand-Slime Tailin	0.059	119.0	1.40	0.44	0.96	1	0.92	21.735	302.12	25.58	23	2.03%	2.6	47%
25.918	5589.94	23.4	0.409	22.9	85.5	37.03	1.75%	Sand-Slime Tailin	0.059	119.0	1.41	0.44	0.96	1	0.92	21.004	291.95	24.96	23	1.86%	2.6	47%
26.082	5589.78	26.8	0.466	26.4	63.1	27.33	1.74%	Sand-Slime Tailin	0.059	119.0	1.42	0.45	0.97	1	0.92	24.200	336.38	28.53	26	1.84%	2.5	47%
26.246	5589.61	24.8	0.467	24.4	58.0	25.13	1.89%	Sand-Slime Tailin	0.059	119.0	1.43	0.46	0.97	1	0.91	22.278	309.67	26.26	24	2.00%	2.6	47%
26.410	5589.45	27.9	0.443	27.7	46.7	20.25	1.59%	Sand-Slime Tailin	0.059	119.0	1.44	0.46	0.98	1	0.91	25.216	350.50	29.60	27	1.67%	2.5	47%
26.574	5589.29	21.4	0.459	21.2	34.8	15.06	2.15%	Sand-Slime Tailin	0.059	119.0	1.45	0.47	0.98	1	0.90	19.114	265.68	22.43	20	2.30%	2.7	47%
26.739	5589.12	22.9	0.449	22.4	91.9	39.81	1.96%	Sand-Slime Tailin	0.059	119.0	1.46	0.47	0.99	1	0.90	20.162	280.25	24.02	22	2.09%	2.6	47%
26.903	5588.96	23.7	0.369	23.3	57.9	25.11	1.56%	Sand-Slime Tailin	0.059	119.0	1.47	0.48	0.99	1	0.90	20.966	291.42	24.73	22	1.66%	2.6	47%
27.067	5588.79	17.9	0.322	17.4	76.8	33.26	1.80%	Sand-Slime Tailin	0.059	119.0	1.48	0.48	1.00	1	0.89	15.524	215.78	18.53	16	1.96%	2.7	47%
27.231	5588.63	17.2	0.221	16.6	101.5	44.00	1.29%	Sand-Slime Tailin	0.059	119.0	1.49	0.49	1.00	1	0.89	14.729	204.74	17.76	16	1.41%	2.7	47%
27.395	5588.47	17.3	0.221	16.7	96.1	41.66	1.28%	Sand-Slime Tailin	0.059	119.0	1.50	0.49	1.00	1	0.89	14.791	205.60	17.80	16	1.40%	2.7	47%
27.559	5588.30	17.1	0.300	16.3	130.8	56.69	1.75%	Sand-Slime Tailin	0.059	119.0	1.51	0.50	1.01	1	0.88	14.394	200.07	17.55	15	1.92%	2.7	47%
27.723	5588.14	24.2	0.427	23.2	165.1	71.55	1.76%	Sand-Slime Tailin	0.059	119.0	1.52	0.50	1.01	1	0.88	20.498	284.93	24.87	22	1.88%	2.6	47%
27.887	5587.97	31.6	0.511	31.4	40.1	17.37	1.62%	Sand-Slime Tailin	0.059	119.0	1.53	0.51	1.02	1	0.89	27.813	386.60	32.56	30	1.70%	2.5	47%
28.051	5587.81	29.9	0.506	29.4	77.3	33.50	1.69%	Sand-Slime Tailin	0.059	119.0	1.53	0.51	1.02	1	0.88	25.927	360.38	30.61	28	1.79%	2.5	47%
28.215	5587.65	34.1	0.485	33.8	56.5	24.47	1.42%	Sand-Slime Tailin	0.059	119.0	1.54	0.52	1.03	1	0.88	29.829	414.63	35.01	32	1.49%	2.4	47%
28.379	5587.48	23.6	0.376	23.3	54.2	23.50	1.59%	Sand-Slime Tailin	0.059	119.0	1.55	0.52	1.03	1	0.87	20.248	281.45	23.86	21	1.71%	2.6	47%
28.543	5587.32	20.0	0.587	19.3	110.3	47.80	2.94%	Slime Tailings	0.057	113.1	1.56	0.53	1.04	1	0.86	16.699	232.11	20.09	18	3.18%	2.8	71%
28.707	5587.15	20.3	0.625	19.3	175.0	75.82	3.07%	Slime Tailings	0.057	113.1	1.57	0.53	1.04	1	0.86	16.595	230.67	20.37	18	3.33%	2.8	71%
28.871	5586.99	70.9	0.744	70.3	91.2	39.52	1.05%	Sand Tailings	0.062	123.5	1.58	0.54	1.05	1	0.90	63.004	875.75	73.77	66	1.07%	2.1	18%
29.035	5586.82	72.6	0.686	72.2	66.2	28.68	0.94%	Sand Tailings	0.062	123.5	1.59	0.54	1.05	1	0.89	64.601	897.96	75.46	68	0.97%	2.0	18%
29.199	5586.66	79.5	1.181	79.4	15.5	6.72	1.49%	Sand Tailings	0.062	123.5	1.60	0.55	1.06	1	0.90	71.104	988.34	82.68	74	1.52%	2.1	18%
29.363	5586.50	113.4	1.549	113.4	8.3	3.58	1.37%	Sand Tailings	0.062	123.5	1.61	0.55	1.06	1	0.91	103.022	1432.01	119.71	105	1.39%	2.0	18%
29.527	5586.33	133.5	2.246	133.4	9.1	3.95	1.68%	Sand Tailings	0.062	123.5	1.62	0.56	1.07	1	0.91	122.058	1696.61	141.82	124	1.70%	2.0	18%
29.691	5586.17	134.1	3.012	134.1	-0.7	-0.28	2.25%	Sand-Slime Tailin	0.059	119.0	1.63	0.56	1.07	1	0.91	122.449	1702.04	142.21	124	2.27%	2.1	47%
29.855	5586.00	114.2	2.896	114.0	26.4	11.45	2.54%	Sand-Slime Tailin	0.059	119.0	1.64	0.57	1.08	1	0.90	102.984	1431.48	119.78	105	2.57%	2.2	47%
30.019	5585.84	179.1	2.896	178.1	160.2	69.40	1.62%	Sand Tailings	0.062	123.5	1.65	0.57	1.08	1	0.93	164.973	2292.29	192.61	164	1.63%	1.9	18%
30.183	5585.68	217.4	2.896	217.3	26.4	11.43	1.33%	Sand Tailings	0.062	123.5	1.66	0.58	1.09	1	0.94	203.425	2827.61	236.45	199	1.34%	1.8	18%

Conditions at t_1 / Liquefaction Triggering Analyses — Idriss & Boulanger (2008)

Depth at time of CPT (ft)	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS
24.114	1.88	0.00	1.88	0	0.84	0.05	0.96	1.0	0.047	34.32	45.79	0.074	1.57
24.278	1.89	0.00	1.89	0	0.84	0.05	0.96	1.0	0.047	33.95	45.02	0.073	1.55
24.442	1.90	0.00	1.90	0	0.84	0.05	0.96	1.0	0.047	35.45	50.84	0.078	1.68
24.606	1.91	0.00	1.91	0	0.84	0.05	0.96	1.0	0.047	35.73	51.22	0.079	1.69
24.770	1.92	0.00	1.92	0	0.84	0.06	0.96	1.0	0.046	39.25	64.75	0.093	2.02
24.934	1.93	0.00	1.93	0	0.84	0.06	0.95	1.0	0.046	41.66	74.05	0.105	2.28
25.098	1.94	0.00	1.94	0	0.83	0.07	0.95	1.0	0.046	45.10	87.31	0.123	2.69
25.262	1.94	0.00	1.94	0	0.83	0.06	0.95	1.0	0.046	41.93	75.08	0.106	2.32
25.426	1.95	0.00	1.95	0	0.83	0.06	0.95	1.0	0.046	40.10	68.05	0.097	2.12
25.590	1.96	0.00	1.96	0	0.83	0.06	0.95	1.0	0.046	39.06	64.03	0.092	2.02
25.754	1.97	0.00	1.97	0	0.83	0.06	0.95	1.0	0.046	39.27	64.86	0.093	2.04
25.918	1.98	0.00	1.98	0	0.83	0.06	0.95	1.0	0.046	39.06	64.02	0.092	2.03
26.082	1.99	0.00	1.99	0	0.83	0.06	0.95	1.0	0.045	40.31	68.83	0.098	2.16
26.246	2.00	0.00	2.00	0	0.82	0.06	0.95	1.0	0.045	39.51	65.77	0.094	2.08
26.410	2.01	0.00	2.01	0	0.82	0.06	0.95	1.0	0.045	40.68	70.28	0.100	2.21
26.574	2.02	0.00	2.02	0	0.82	0.05	0.95	1.0	0.045	38.17	60.59	0.089	1.95
26.739	2.03	0.00	2.03	0	0.82	0.06	0.95	1.0	0.045	38.72	62.74	0.091	2.01
26.903	2.04	0.00	2.04	1	0.82	0.06	0.95	1.0	0.045	38.97	63.70	0.092	2.04
27.067	2.05	0.01	2.05	1	0.82	0.05	0.96	1.0	0.045	36.80	55.33	0.083	1.83
27.231	2.06	0.01	2.05	1	0.82	0.05	0.96	1.0	0.045	36.53	54.29	0.082	1.80
27.395	2.07	0.02	2.05	1	0.82	0.05	0.96	1.0	0.045	36.54	54.34	0.082	1.80
27.559	2.08	0.02	2.06	1	0.81	0.05	0.96	1.0	0.045	36.46	54.01	0.081	1.79
27.723	2.09	0.03	2.06	1	0.81	0.06	0.95	1.0	0.045	39.02	63.89	0.092	2.04
27.887	2.10	0.03	2.07	1	0.81	0.06	0.95	1.0	0.045	41.72	74.28	0.105	2.33
28.051	2.11	0.04	2.07	1	0.81	0.06	0.95	1.0	0.045	41.04	71.64	0.102	2.25
28.215	2.12	0.04	2.08	1	0.81	0.06	0.95	1.0	0.045	42.58	77.59	0.109	2.43
28.379	2.13	0.05	2.08	1	0.81	0.05	0.95	1.0	0.045	38.67	62.53	0.091	2.00
28.543	2.14	0.05	2.09	1	0.81	0.05	0.95	1.0	0.046	37.08	57.17	0.085	1.86
28.707	2.15	0.06	2.09	1	0.80	0.05	0.95	1.0	0.046	37.18	57.55	0.085	1.87
28.871	2.16	0.06	2.10	1	0.80	0.09	0.92	1.0	0.044	40.95	114.71	0.169	3.83
29.035	2.17	0.07	2.10	1	0.80	0.09	0.92	1.0	0.044	41.38	116.84	0.173	3.92
29.199	2.18	0.07	2.11	1	0.80	0.09	0.92	1.0	0.044	43.23	125.91	0.193	4.40
29.363	2.19	0.08	2.11	1	0.80	0.12	0.89	1.0	0.043	52.69	172.40	0.433	10.18
29.527	2.20	0.08	2.12	1	0.80	0.15	0.87	1.0	0.041	58.35	200.17	1.000	24.11
29.691	2.21	0.09	2.12	1	0.80	0.15	0.87	1.0	0.041	80.18	222.39	1.000	24.12
29.855	2.22	0.09	2.13	1	0.79	0.12	0.89	1.0	0.043	72.31	192.09	0.813	19.11
30.019	2.23	0.10	2.13	1	0.79	0.24	0.78	1.0	0.037	71.33	263.94	1.000	26.69
30.183	2.24	0.10	2.14	1	0.79	0.30	0.73	1.0	0.035	82.54	318.98	1.000	28.64

Liquefaction Triggering Analyses — Youd et al. (2001); Idriss & Boulanger (2008)

Depth at time of CPT (ft)	r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	CN	qc1 TSF	qc1 MPa	qc1N
24.114	0.89	0.20	0.80	0.99	1.0	0.040	5.85	67.03	0.108	2.59	2.08	2	0.95519	9.874	0.9453	11.468
24.278	0.89	0.19	0.80	0.99	1.0	0.040	6.45	71.42	0.114	2.72	2.14	2	0.951801	9.5373	0.9131	11.077
24.442	0.89	0.23	0.80	0.99	1.0	0.040	5.19	79.86	0.127	3.03	2.36	2	0.948439	13.251	1.2687	15.390
24.606	0.89	0.23	0.80	0.99	1.0	0.040	4.48	69.42	0.111	2.64	2.16	2	0.944722	13.337	1.2769	15.490
24.770	0.89	0.29	0.80	0.98	1.0	0.040	3.30	84.25	0.136	3.21	2.61	2	0.943183	21.962	2.1026	25.507
24.934	0.89	0.33	0.80	0.98	1.0	0.040	2.15	69.61	0.111	2.62	2.45	2	0.942626	27.886	2.6698	32.388
25.098	0.88	0.38	0.80	0.98	1.0	0.040	1.86	78.30	0.125	2.93	2.81	2	0.943024	36.337	3.4789	42.203
25.262	0.88	0.33	0.80	0.98	1.0	0.040	2.55	84.46	0.136	3.18	2.75	2	0.936336	28.547	2.733	33.155
25.426	0.88	0.31	0.80	0.98	1.0	0.040	2.99	83.54	0.134	3.13	2.63	2	0.930567	24.062	2.3037	27.946
25.590	0.88	0.29	0.80	0.98	1.0	0.040	3.23	80.75	0.129	3.00	2.51	2	0.925559	21.501	2.0585	24.972
25.754	0.88	0.29	0.80	0.98	1.0	0.040	3.31	84.64	0.136	3.16	2.60	2	0.922538	22.026	2.1088	25.582
25.918	0.88	0.29	0.80	0.98	1.0	0.040	3.23	80.65	0.129	2.97	2.50	2	0.918806	21.494	2.0578	24.964
26.082	0.88	0.31	0.80	0.98	1.0	0.040	2.94	83.82	0.135	3.10	2.63	2	0.917709	24.561	2.3515	28.526
26.246	0.88	0.30	0.80	0.98	1.0	0.040	3.24	84.96	0.137	3.14	2.61	2	0.913039	22.609	2.1646	26.259
26.410	0.87	0.31	0.80	0.98	1.0	0.040	2.75	81.34	0.130	2.97	2.59	2	0.911974	25.482	2.4397	29.596
26.574	0.87	0.27	0.80	0.97	1.0	0.040	3.85	86.38	0.140	3.19	2.57	2	0.903719	19.31	1.8487	22.427
26.739	0.87	0.28	0.80	0.97	1.0	0.039	3.52	84.47	0.136	3.09	2.55	2	0.9017	20.679	1.9798	24.018
26.903	0.87	0.29	0.80	0.97	1.0	0.039	3.10	76.78	0.122	2.76	2.40	2	0.899044	21.291	2.0384	24.728
27.067	0.87	0.25	0.80	0.97	1.0	0.040	4.10	75.99	0.121	2.72	2.27	2	0.892685	15.952	1.5272	18.527
27.231	0.87	0.24	0.80	0.97	1.0	0.040	3.67	65.24	0.106	2.37	2.08	2	0.889446	15.293	1.4641	17.762
27.395	0.87	0.24	0.80	0.97	1.0	0.040	3.66	65.18	0.106	2.35	2.08	2	0.886234	15.323	1.467	17.797
27.559	0.86	0.24	0.80	0.97	1.0	0.040	4.23	74.31	0.118	2.61	2.20	2	0.883047	15.115	1.4471	17.555
27.723	0.86	0.29	0.80	0.97	1.0	0.040	3.29	81.72	0.131	2.88	2.46	2	0.883549	21.409	2.0497	24.865
27.887	0.86	0.33	0.80	0.97	1.0	0.040	2.62	85.37	0.138	3.02	2.67	2	0.886883	28.035	2.684	32.561
28.051	0.86	0.32	0.80	0.97	1.0	0.040	2.80	85.63	0.138	3.01	2.63	2	0.882469	26.353	2.523	30.607
28.215	0.86	0.34	0.80	0.97	1.0	0.040	2.36	82.64	0.132	2.87	2.65	2	0.88305	30.141	2.8857	35.007
28.379	0.86	0.28	0.80	0.96	1.0	0.040	3.25	77.44	0.123	2.65	2.33	2	0.870513	20.543	1.9668	23.859
28.543	0.86	0.26	0.80	0.96	1.0	0.040	4.87	97.86	0.167	3.58	2.72	2	0.864778	17.294	1.6558	20.086
28.707	0.86	0.26	0.80	0.96	1.0	0.040	4.93	100.50	0.174	3.72	2.80	2	0.862075	17.537	1.6789	20.368
28.871	0.85	0.50	0.75	0.95	1.0	0.041	1.40	103.45	0.183	3.88	3.85	2	0.896209	63.514	6.0808	73.767
29.035	0.85	0.50	0.75	0.95	1.0	0.041	1.35	101.77	0.178	3.76	3.84	2	0.894632	64.971	6.2203	75.460
29.199	0.85	0.52	0.74	0.95	1.0	0.041	1.51	124.72	0.260	5.46	4.93	2	0.895737	71.19	6.8158	82.683
29.363	0.85	0.63	0.68	0.94	1.0	0.042	1.28	153.66	0.417	8.71	9.44	2	0.908885	103.07	9.8678	119.708
29.527	0.85	0.69	0.66	0.93	1.0	0.042	1.30	184.56	1.000	20.76	22.43	2	0.914773	122.11	11.691	141.824
29.691	0.85	0.69	0.66	0.93	1.0	0.042	1.44	205.32	1.000	20.66	22.39	2	0.91325	122.44	11.723	142.212
29.855	0.85	0.63	0.68	0.93	1.0	0.042	1.62	194.57	1.000	20.55	19.83	2	0.903371	103.13	9.874	119.783
30.019	0.84	0.80	0.60	0.91	1.0	0.043	1.19	229.76	1.000	20.45	23.57	2	0.925852	165.84	15.877	192.611
30.183	0.84	0.89	0.60	0.91	1.0	0.043	1.10	259.26	1.000	20.34	24.49	2	0.936365	203.58	19.491	236.445

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W6-S

Data File: 13-52106_SP2W6-S-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\.\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)
- Max. Horiz. Acceleration, Amax/g: 0.15
- Earthquake Moment Magnitude, M: 5.5
- Magnitude Scaling Factor, MSF: 1.69

Youd, et al (2001)
- Max. Horiz. Acceleration, Amax/g: 0.15
- Earthquake Moment Magnitude, M: 5.5
- Magnitude Scaling Factor, MSF: 2.21

Value	Parameter
5604.40	Water surface elevation during CPT investigation (f
5604.40	Water surface elevation at t_0 (ft amsl)
5588.59	Water surface elevation at t_1 (ft amsl)
5583.59	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ear
7.51	Equiv. Number of Uniform Strain Cycles, N
5615.85	Ground Surface Elevation at time of CPT (ft amsl)
5625.41	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pl
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
1.56	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1065.26	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5583.59	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5625.16	5624.91	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5623.16	5621.41	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5619.41	5617.41	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	######	5616.63	5615.85	1.56	0.050	101	0.533	0.493	0.00	0.00	0.533	0.493

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No
0.164	5615.69	6.5	0.020	6.5	1.2	0.51	0.31%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0
0.328	5615.52	22.2	0.060	22.2	2.8	1.22	0.27%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0
0.492	5615.36	34.7	0.122	34.7	1.7	0.75	0.35%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0
0.656	5615.19	54.7	0.219	54.6	1.9	0.81	0.40%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0
0.820	5615.03	83.1	0.349	83.1	2.0	0.85	0.42%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0
0.984	5614.87	94.0	0.544	94.0	2.0	0.85	0.58%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0
1.148	5614.70	94.8	0.470	94.8	2.0	0.87	0.50%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0
1.312	5614.54	92.2	0.392	92.2	1.8	0.77	0.43%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0
1.476	5614.37	90.8	0.315	90.8	0.7	0.29	0.35%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0
1.640	5614.21	85.8	0.359	85.8	4.3	1.87	0.42%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0
1.804	5614.05	83.8	0.375	83.8	2.0	0.86	0.45%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0
1.968	5613.88	76.6	0.445	76.6	1.8	0.79	0.58%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0
2.133	5613.72	61.3	0.546	61.3	1.1	0.47	0.89%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0
2.297	5613.55	64.2	0.470	64.2	1.8	0.79	0.73%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0
2.461	5613.39	68.7	0.730	68.7	2.8	1.20	1.06%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0
2.625	5613.23	191.6	1.300	191.6	4.3	1.85	0.68%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0
2.789	5613.06	241.3	3.362	241.3	3.2	1.37	1.39%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0
2.953	5612.90	265.3	5.646	265.3	4.3	1.85	2.13%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0
3.117	5612.73	238.5	7.457	238.5	2.5	1.06	3.13%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0
3.281	5612.57	217.3	7.057	217.3	1.3	0.58	3.25%	Sand-Slime Tailing	0.047	93.3	0.16	0.00	0.16	0
3.445	5612.41	217.9	6.621	217.9	0.9	0.38	3.04%	Sand-Slime Tailing	0.047	93.3	0.17	0.00	0.17	0
3.609	5612.24	256.0	7.793	256.0	1.4	0.59	3.04%	Sand-Slime Tailing	0.047	93.3	0.18	0.00	0.18	0
3.773	5612.08	314.1	8.489	314.1	6.9	2.98	2.70%	Sand Tailings	0.051	102.8	0.19	0.00	0.19	0
3.937	5611.91	227.8	8.106	227.7	12.0	5.18	3.56%	Sand-Slime Tailing	0.047	93.3	0.20	0.00	0.20	0
4.101	5611.75	218.4	6.483	218.4	6.5	2.83	2.97%	Sand-Slime Tailing	0.047	93.3	0.20	0.00	0.20	0
4.265	5611.58	214.9	5.761	214.9	3.0	1.32	2.68%	Sand-Slime Tailing	0.047	93.3	0.21	0.00	0.21	0
4.429	5611.42	175.0	4.480	175.0	2.3	0.98	2.56%	Sand-Slime Tailing	0.047	93.3	0.22	0.00	0.22	0
4.593	5611.26	150.8	3.824	150.8	1.6	0.68	2.54%	Sand-Slime Tailing	0.047	93.3	0.23	0.00	0.23	0
4.757	5611.09	121.0	2.453	121.0	1.6	0.71	2.03%	Sand Tailings	0.051	102.8	0.24	0.00	0.24	0
4.921	5610.93	111.4	1.755	111.4	0.9	0.40	1.57%	Sand Tailings	0.051	102.8	0.24	0.00	0.24	0
5.085	5610.76	105.9	2.102	105.9	0.1	0.06	1.99%	Sand Tailings	0.051	102.8	0.25	0.00	0.25	0
5.249	5610.60	102.9	2.378	102.9	-1.0	-0.44	2.31%	Sand-Slime Tailing	0.047	93.3	0.26	0.00	0.26	0
5.413	5610.44	102.4	2.370	102.4	-0.5	-0.23	2.31%	Sand-Slime Tailing	0.047	93.3	0.27	0.00	0.27	0
5.577	5610.27	101.3	2.366	101.3	-0.4	-0.15	2.34%	Sand-Slime Tailing	0.047	93.3	0.27	0.00	0.27	0
5.741	5610.11	96.2	2.597	96.2	-1.0	-0.43	2.70%	Sand-Slime Tailing	0.047	93.3	0.28	0.00	0.28	0
5.905	5609.94	86.9	2.414	86.9	-0.9	-0.40	2.78%	Sand-Slime Tailing	0.047	93.3	0.29	0.00	0.29	0
6.069	5609.78	80.9	2.523	80.9	-1.0	-0.43	3.12%	Sand-Slime Tailing	0.047	93.3	0.30	0.00	0.30	0
6.234	5609.62	79.6	2.316	79.6	-1.1	-0.49	2.91%	Sand-Slime Tailing	0.047	93.3	0.31	0.00	0.31	0
6.398	5609.45	76.6	2.134	76.6	-0.2	-0.10	2.79%	Sand-Slime Tailing	0.047	93.3	0.31	0.00	0.31	0
6.562	5609.29	57.1	1.783	57.1	-0.0	-0.01	3.12%	Sand-Slime Tailing	0.047	93.3	0.32	0.00	0.32	0
6.726	5609.12	51.8	1.588	51.8	-0.1	-0.03	3.07%	Sand-Slime Tailing	0.047	93.3	0.33	0.00	0.33	0
6.890	5608.96	49.7	1.224	49.7	-0.8	-0.33	2.46%	Sand-Slime Tailing	0.047	93.3	0.34	0.00	0.34	0
7.054	5608.80	56.3	1.510	56.4	-0.3	-0.13	2.68%	Sand-Slime Tailing	0.047	93.3	0.34	0.00	0.34	0
7.218	5608.63	68.1	2.477	68.1	7.0	3.01	3.64%	Slime Tailings	0.041	82.7	0.35	0.00	0.35	0
7.382	5608.47	66.2	2.994	66.2	1.5	0.65	4.52%	Slime Tailings	0.041	82.7	0.36	0.00	0.36	0
7.546	5608.30	143.2	1.935	143.2	2.8	1.21	1.35%	Sand Tailings	0.051	102.8	0.37	0.00	0.37	0
7.710	5608.14	161.7	1.640	161.7	-0.1	-0.04	1.01%	Sand Tailings	0.051	102.8	0.37	0.00	0.37	0
7.874	5607.98	86.8	1.774	86.8	4.1	1.79	2.04%	Sand-Slime Tailing	0.047	93.3	0.38	0.00	0.38	0
8.038	5607.81	50.5	1.194	50.5	1.7	0.75	2.36%	Sand-Slime Tailing	0.047	93.3	0.39	0.00	0.39	0
8.202	5607.65	34.7	0.878	34.7	0.9	0.37	2.53%	Sand-Slime Tailing	0.047	93.3	0.40	0.00	0.40	0
8.366	5607.48	25.8	0.664	25.8	0.5	0.20	2.58%	Sand-Slime Tailing	0.047	93.3	0.40	0.00	0.40	0
8.530	5607.32	31.8	0.573	31.8	2.8	1.21	1.80%	Sand-Slime Tailing	0.047	93.3	0.41	0.00	0.41	0
8.694	5607.16	34.8	0.413	34.8	2.3	1.01	1.19%	Sand-Slime Tailing	0.047	93.3	0.42	0.00	0.42	0
8.858	5606.99	33.7	0.343	33.7	0.9	0.37	1.02%	Sand-Slime Tailing	0.047	93.3	0.43	0.00	0.43	0
9.022	5606.83	29.3	0.358	29.3	0.1	0.05	1.22%	Sand-Slime Tailing	0.047	93.3	0.44	0.00	0.44	0
9.186	5606.66	20.9	0.342	20.9	-0.3	-0.13	1.64%	Sand-Slime Tailing	0.047	93.3	0.44	0.00	0.44	0
9.350	5606.50	12.6	0.327	12.6	-0.6	-0.25	2.59%	Slime Tailings	0.041	82.7	0.45	0.00	0.45	0
9.514	5606.34	12.0	0.251	12.0	-0.7	-0.29	2.10%	Slime Tailings	0.041	82.7	0.46	0.00	0.46	0
9.678	5606.17	14.1	0.216	14.1	-0.6	-0.26	1.53%	Sand-Slime Tailing	0.047	93.3	0.46	0.00	0.46	0
9.842	5606.01	23.2	0.158	23.2	-0.3	-0.12	0.68%	Sand-Slime Tailing	0.047	93.3	0.47	0.00	0.47	0
10.006	5605.84	22.6	0.274	22.6	-0.3	-0.12	1.21%	Sand-Slime Tailing	0.047	93.3	0.48	0.00	0.48	0
10.170	5605.68	11.1	0.368	11.1	-0.5	-0.23	3.32%	Slime Tailings	0.041	82.7	0.49	0.00	0.49	0
10.335	5605.52	10.3	0.383	10.3	0.3	0.12	3.73%	Slime Tailings	0.041	82.7	0.49	0.00	0.49	0
10.499	5605.35	8.6	0.299	8.6	1.8	0.79	3.46%	Slime Tailings	0.041	82.7	0.50	0.00	0.50	0
10.663	5605.19	11.2	0.222	11.2	2.1	0.91	1.98%	Slime Tailings	0.041	82.7	0.51	0.00	0.51	0
10.827	5605.02	22.3	0.182	22.3	1.3	0.55	0.82%	Sand-Slime Tailing	0.047	93.3	0.51	0.00	0.51	0
10.991	5604.86	26.2	0.185	26.2	0.6	0.25	0.71%	Sand-Slime Tailing	0.047	93.3	0.52	0.00	0.52	0
11.155	5604.70	24.7	0.273	24.7	0.3	0.14	1.10%	Sand-Slime Tailing	0.047	93.3	0.53	0.00	0.53	0
11.319	5604.53	17.5	0.349	17.5	-0.1	-0.05	1.99%	Sand-Slime Tailing	0.047	93.3	0.54	0.00	0.54	0
11.483	5604.37	12.5	0.390	12.5	-0.2	-0.07	3.12%	Slime Tailings	0.057	113.1	0.55	0.00	0.55	1
11.647	5604.20	12.1	0.339	12.1	2.0	0.88	2.79%	Slime Tailings	0.057	113.1	0.56	0.01	0.55	1
11.811	5604.04	10.7	0.328	10.7	10.4	4.49	3.06%	Slime Tailings	0.057	113.1	0.57	0.01	0.55	1
11.975	5603.88	17.0	0.353	16.9	18.5	8.03	2.08%	Sand-Slime Tailing	0.059	119.0	0.57	0.02	0.56	1

CPT Data Interpretations (cont.), Conditions at t_1, Liquefaction Triggering Analyses – Idriss & Boulanger (2008)

Depth (ft)	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F, (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress t_1 (tsf)	Saturated at t_1 1=Yes 0=No	r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS
0.164	1.70	11.067	153.83	12.87	788	0.31%	0.9	51%	0.54	0.00	0.54	0	1.00	0.05	1.02	1.0	0.059	34.84	47.70	0.075	1.27
0.328	1.70	37.723	524.35	43.85	1343	0.27%	0.7	51%	0.55	0.00	0.55	0	1.00	0.07	1.03	1.0	0.060	45.71	89.56	0.126	2.12
0.492	1.70	58.973	819.72	68.51	1399	0.35%	0.8	51%	0.56	0.00	0.56	0	1.00	0.08	1.04	1.0	0.060	54.36	122.88	0.186	3.10
0.656	1.70	92.888	1291.14	107.91	1653	0.40%	0.9	51%	0.57	0.00	0.57	0	1.00	0.11	1.05	1.0	0.061	68.19	176.10	0.478	7.90
0.820	1.70	141.202	1962.71	164.02	2010	0.42%	0.9	51%	0.57	0.00	0.57	0	1.00	0.18	1.07	1.0	0.062	87.88	251.90	1.000	16.11
0.984	1.70	159.715	2220.04	185.52	1895	0.58%	1.0	51%	0.58	0.00	0.58	0	1.00	0.22	1.09	1.0	0.063	95.43	280.95	1.000	15.90
1.148	1.70	161.126	2239.65	187.16	1638	0.50%	1.0	51%	0.59	0.00	0.59	0	1.00	0.23	1.09	1.0	0.063	96.00	283.16	1.000	15.93
1.312	1.70	156.689	2177.98	182.01	1394	0.43%	0.9	51%	0.60	0.00	0.60	0	1.00	0.22	1.08	1.0	0.062	94.19	276.20	1.000	16.04
1.476	1.70	154.309	2144.90	179.23	1220	0.35%	0.9	51%	0.61	0.00	0.61	0	1.00	0.21	1.07	1.0	0.062	93.22	272.45	1.000	16.12
1.640	1.70	145.843	2027.22	169.44	1038	0.42%	1.0	51%	0.62	0.00	0.62	0	1.00	0.19	1.06	1.0	0.062	89.78	259.22	1.000	16.26
1.804	1.70	142.375	1979.01	165.38	921	0.45%	1.0	51%	0.62	0.00	0.62	0	1.00	0.18	1.06	1.0	0.061	88.36	253.74	1.000	16.33
1.968	1.70	130.135	1808.88	151.17	771	0.58%	1.1	51%	0.63	0.00	0.63	0	1.00	0.16	1.05	1.0	0.061	83.37	234.54	1.000	16.49
2.133	1.70	104.159	1447.81	120.99	570	0.89%	1.4	51%	0.64	0.00	0.64	0	1.00	0.13	1.04	1.0	0.060	72.78	193.77	0.869	14.52
2.297	1.70	109.123	1516.81	126.76	554	0.73%	1.3	51%	0.65	0.00	0.65	0	1.00	0.13	1.04	1.0	0.060	74.81	201.57	1.000	16.72
2.461	1.70	116.807	1623.62	135.70	554	1.06%	1.4	51%	0.66	0.00	0.66	0	1.00	0.14	1.04	1.0	0.060	77.94	213.64	1.000	16.72
2.625	1.64	314.125	4366.34	364.89	1449	0.68%	1.1	51%	0.66	0.00	0.66	0	1.00	0.30	1.08	1.0	0.062	#####	523.26	1.000	16.12
2.789	1.61	389.250	5410.57	452.13	1717	1.39%	1.4	51%	0.67	0.00	0.67	0	0.99	0.30	1.07	1.0	0.062	#####	641.11	1.000	16.19
2.953	1.59	421.663	5861.12	489.79	1783	2.13%	1.6	51%	0.68	0.00	0.68	0	0.99	0.30	1.07	1.0	0.061	#####	691.99	1.000	16.26
3.117	1.57	373.653	5193.78	434.00	1518	3.13%	1.7	51%	0.69	0.00	0.69	0	0.99	0.30	1.07	1.0	0.061	#####	616.63	1.000	16.33
3.281	1.55	336.251	4673.89	390.55	1319	3.25%	1.8	47%	0.70	0.00	0.70	0	0.99	0.30	1.06	1.0	0.061	#####	557.82	1.000	16.40
3.445	1.53	333.101	4630.11	386.89	1264	3.04%	1.7	47%	0.70	0.00	0.70	0	0.99	0.30	1.06	1.0	0.061	#####	552.87	1.000	16.46
3.609	1.51	386.904	5377.97	449.38	1422	3.05%	1.7	47%	0.71	0.00	0.71	0	0.99	0.30	1.06	1.0	0.061	#####	637.29	1.000	16.53
3.773	1.49	469.029	6519.50	544.82	1667	2.70%	1.7	18%	0.72	0.00	0.72	0	0.99	0.30	1.05	1.0	0.060	#####	706.20	1.000	16.60
3.937	1.48	336.474	4676.99	390.92	1161	3.56%	1.8	47%	0.73	0.00	0.73	0	0.99	0.30	1.05	1.0	0.060	#####	558.33	1.000	16.66
4.101	1.46	319.444	4440.28	371.08	1072	2.97%	1.7	47%	0.74	0.00	0.74	0	0.99	0.30	1.05	1.0	0.060	#####	531.53	1.000	16.73
4.265	1.45	311.252	4326.41	361.53	1016	2.68%	1.7	47%	0.74	0.00	0.74	0	0.99	0.30	1.04	1.0	0.060	#####	518.63	1.000	16.79
4.429	1.44	251.142	3490.88	291.71	798	2.56%	1.7	47%	0.75	0.00	0.75	0	0.99	0.30	1.04	1.0	0.059	#####	424.32	1.000	16.86
4.593	1.43	215.630	2997.26	250.46	665	2.54%	1.7	47%	0.76	0.00	0.76	0	0.98	0.30	1.04	1.0	0.059	#####	368.60	1.000	16.93
4.757	1.50	181.995	2529.74	211.39	514	2.03%	1.7	18%	0.77	0.00	0.77	0	0.98	0.30	1.03	1.0	0.059	76.13	287.53	1.000	17.00
4.921	1.52	169.758	2359.64	197.17	457	1.58%	1.6	18%	0.78	0.00	0.78	0	0.98	0.25	1.03	1.0	0.058	72.50	269.67	1.000	17.14
5.085	1.53	161.916	2250.64	188.06	419	1.99%	1.7	18%	0.78	0.00	0.78	0	0.98	0.23	1.02	1.0	0.058	70.17	258.22	1.000	17.25
5.249	1.53	157.250	2185.78	182.63	396	2.32%	1.8	47%	0.79	0.00	0.79	0	0.98	0.22	1.02	1.0	0.058	94.35	276.98	1.000	17.32
5.413	1.52	155.399	2160.05	180.48	382	2.32%	1.8	47%	0.80	0.00	0.80	0	0.98	0.21	1.02	1.0	0.058	93.60	274.08	1.000	17.38
5.577	1.51	152.916	2125.53	177.60	368	2.34%	1.8	47%	0.81	0.00	0.81	0	0.98	0.21	1.01	1.0	0.057	92.59	270.19	1.000	17.44
5.741	1.52	145.768	2026.18	169.29	339	2.71%	1.9	47%	0.82	0.00	0.82	0	0.98	0.19	1.01	1.0	0.057	89.67	258.96	1.000	17.50
5.905	1.54	133.514	1855.84	155.06	298	2.79%	1.9	47%	0.82	0.00	0.82	0	0.98	0.17	1.01	1.0	0.057	84.68	239.74	1.000	17.57
6.069	1.55	125.130	1739.31	145.32	271	3.13%	2.0	47%	0.83	0.00	0.83	0	0.98	0.15	1.01	1.0	0.057	81.27	226.59	1.000	17.62
6.234	1.54	122.573	1703.76	142.35	260	2.92%	2.0	47%	0.84	0.00	0.84	0	0.98	0.15	1.00	1.0	0.057	80.23	222.57	1.000	17.67
6.398	1.54	117.783	1637.19	136.80	244	2.80%	2.0	47%	0.85	0.00	0.85	0	0.97	0.14	1.00	1.0	0.056	78.28	215.07	1.000	17.71
6.562	1.61	91.966	1278.33	106.81	177	3.14%	2.1	47%	0.85	0.00	0.85	0	0.97	0.11	1.00	1.0	0.056	67.76	174.57	0.459	8.14
6.726	1.62	84.096	1168.93	97.67	157	3.09%	2.1	47%	0.86	0.00	0.86	0	0.97	0.10	1.00	1.0	0.056	64.56	162.23	0.341	6.07
6.890	1.62	80.549	1119.63	93.54	147	2.48%	2.1	47%	0.87	0.00	0.87	0	0.97	0.10	1.00	1.0	0.056	63.11	156.65	0.305	5.45
7.054	1.57	88.530	1230.57	102.82	163	2.70%	2.1	47%	0.88	0.00	0.88	0	0.97	0.11	1.00	1.0	0.056	66.36	169.18	0.399	7.14
7.218	1.51	102.716	1427.76	119.37	193	3.66%	2.1	71%	0.88	0.00	0.88	0	0.97	0.12	1.00	1.0	0.056	71.66	191.03	0.781	13.98
7.382	1.51	99.683	1385.59	115.79	184	4.55%	2.2	71%	0.89	0.00	0.89	0	0.97	0.12	1.00	1.0	0.056	70.41	186.20	0.655	11.75
7.546	1.30	186.431	2591.40	216.56	391	1.35%	1.6	18%	0.90	0.00	0.90	0	0.97	0.30	0.99	1.0	0.055	77.45	294.01	1.000	18.12
7.710	1.27	204.599	2843.92	237.63	431	1.02%	1.5	18%	0.91	0.00	0.91	0	0.97	0.30	0.98	1.0	0.055	82.84	320.47	1.000	18.19
7.874	1.40	121.855	1693.79	141.57	226	2.05%	1.9	47%	0.91	0.00	0.91	0	0.96	0.15	0.99	1.0	0.055	79.95	221.52	1.000	18.09
8.038	1.52	76.535	1063.84	88.91	129	2.38%	2.1	47%	0.92	0.00	0.92	0	0.96	0.10	0.99	1.0	0.055	61.48	150.39	0.273	4.93
8.202	1.58	54.878	762.80	63.75	86	2.56%	2.2	47%	0.93	0.00	0.93	0	0.96	0.08	0.99	1.0	0.055	52.66	116.41	0.172	3.11
8.366	1.63	41.903	582.45	48.67	63	2.62%	2.3	47%	0.94	0.00	0.94	0	0.96	0.07	0.99	1.0	0.055	47.37	96.05	0.136	2.46
8.530	1.57	49.800	692.22	57.87	76	1.83%	2.2	47%	0.95	0.00	0.95	0	0.96	0.08	0.99	1.0	0.055	50.60	108.47	0.157	2.85
8.694	1.54	53.460	743.09	62.12	82	1.20%	2.0	47%	0.95	0.00	0.95	0	0.96	0.08	0.99	1.0	0.055	52.09	114.20	0.168	3.05
8.858	1.53	51.481	715.59	59.80	78	1.03%	2.0	47%	0.96	0.00	0.96	0	0.96	0.08	0.99	1.0	0.055	51.27	111.08	0.162	2.95
9.022	1.54	44.964	624.99	52.22	66	1.24%	2.1	47%	0.97	0.00	0.97	0	0.96	0.07	0.99	1.0	0.055	48.62	100.84	0.144	2.62
9.186	1.58	32.960	458.14	38.28	46	1.67%	2.3	47%	0.98	0.00	0.98	0	0.96	0.06	0.99	1.0	0.055	43.73	82.00	0.115	2.10
9.350	1.64	20.679	287.43	24.01	27	2.69%	2.6	71%	0.98	0.00	0.98	0	0.96	0.06	0.99	1.0	0.055	38.45	62.46	0.091	1.65
9.514	1.63	19.500	271.05	22.64	25	2.18%	2.6	71%	0.99	0.00	0.99	0	0.95	0.05	0.99	1.0	0.055	37.97	60.61	0.089	1.62
9.678	1.59	22.445	311.98	26.06	29	1.58%	2.5	47%	1.00	0.00	1.00	0	0.95	0.06	0.99	1.0	0.055	39.44	65.50	0.094	1.72
9.842	1.50	34.822	484.03	40.44	48	0.70%	2.1	47%	1.00	0.00	1.00	0	0.95	0.07	0.99	1.0	0.054	44.48	84.93	0.120	2.19
10.006	1.49	33.696	468.37	39.13	46	1.24%	2.2	47%	1.01	0.00	1.01	0	0.95	0.06	0.99	1.0	0.054	44.03	83.16	0.117	2.15
10.170	1.56	17.349	241.15	20.14	22	3.47%	2.8	71%	1.02	0.00	1.02	0	0.95	0.05	0.99	1.0	0.054	37.10	57.25	0.085	1.56
10.335	1.55	15.894	220.93	18.46	20	3.91%	2.9	71%	1.03	0.00	1.03	0	0.95	0.05	0.99	1.0	0.054	36.52	54.98	0.082	1.52
10.499	1.53	13.186	183.29	15.34	16	3.68%	2.9	71%	1.03	0.00	1.03	0	0.95	0.05	0.99	1.0	0.054	35.43	50.76	0.078	1.44
10.663	1.51	16.923	235.23	19.68	21	2.08%	2.6	71%	1.04	0.00	1.04	0	0.95	0.05	0.99	1.0	0.054	36.94	56.62	0.084	1.55
10.827	1.43	31.828	442.41	36.98	42	0.84%	2.2	47%	1.05	0.00	1.05	0	0.95	0.06	0.99	1.0	0.054	43.27	80.25	0.113	2.09
10.991	1.40	36.562	508.21	42.47	49	0.72%	2.1	47%	1.05	0.00	1.05	0	0.94	0.07	0.99	1.0	0.054	45.20	87.67	0.123	2.29
11.155	1.39	34.382	477.91	39.94	46	1.13%	2.2	47%	1.06	0.00	1.06	0	0.94	0.06	0.99	1.0	0.054	44.31	84.24	0.119	2.20
11.319	1.41	24.763	344.20	28.76	32	2.06%	2.5	47%	1.07	0.00	1.07	0	0.94	0.06	0.99	1.0	0.054	40.39	69.15	0.099	1.83
11.483	1.43	17.845	248.04	20.72	22	3.27%	2.7	71%	1.08	0.00	1.08	0	0.94	0.05	0.99	1.0	0.054	37.30	58.03	0.086	1.59
11.647	1.42	17.214	239.27	20.01	21	2.93%	2.7	71%	1.09	0.00	1.09	0	0.94	0.05	0.99	1.0	0.054	37.06	57.07	0.085	1.58
11.811	1.41	15.051	209.21	17.59	18	3.23%	2.8	71%	1.10	0.00	1.10	0	0.94	0.05	0.99	1.0	0.054	36.21	53.80	0.081	1.52
11.975	1.38	23.239	323.02	27.18	29	2.15%	2.5	47%	1.11	0.00	1.11	0	0.94	0.06	0.99	1.0	0.053	39.83	67.01	0.096	1.80

Liquefaction Triggering Analyses – Youd et al. (2001); Idriss & Boulanger (2008)

Depth (ft)	r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	CN	qc1 TSF	qc1 MPa	qc1N
0.164	0.98	0.21	0.80	2.53	1.0	0.017	1.00	12.87	0.061	3.63	2.45	2	1.7	11.079	1.0607	12.868
0.328	0.98	0.38	0.80	2.20	1.0	0.020	1.00	43.85	0.087	4.59	3.35	2	1.7	37.753	3.6145	43.848
0.492	0.98	0.48	0.76	2.33	1.0	0.018	1.00	68.51	0.110	5.44	4.27	2	1.7	58.991	5.6478	68.515
0.656	0.98	0.60	0.70	2.66	1.0	0.016	1.00	107.91	0.197	119.17	63.53	2	1.7	92.908	8.895	107.907
0.820	0.98	0.74	0.63	3.07	1.0	0.014	1.00	164.02	1.000	484.49	250.30	2	1.7	141.22	13.521	164.022
0.984	0.98	0.79	0.61	3.07	1.0	0.014	1.00	185.52	1.000	403.90	209.90	2	1.7	159.74	15.293	185.524
1.148	0.98	0.79	0.61	2.91	1.0	0.015	1.00	187.16	1.000	346.34	181.13	2	1.7	161.15	15.428	187.163
1.312	0.97	0.78	0.61	2.72	1.0	0.016	1.00	182.01	1.000	303.16	159.60	2	1.7	156.71	15.003	182.007
1.476	0.97	0.77	0.61	2.58	1.0	0.017	1.00	179.23	1.000	269.58	142.85	2	1.7	154.32	14.774	179.229
1.640	0.97	0.75	0.62	2.41	1.0	0.018	1.00	169.44	1.000	242.72	129.49	2	1.7	145.89	13.967	169.441
1.804	0.97	0.74	0.63	2.30	1.0	0.019	1.00	165.38	1.000	220.74	118.54	2	1.7	142.4	13.633	165.384
1.968	0.97	0.71	0.65	2.15	1.0	0.020	1.00	151.17	0.401	81.22	48.86	2	1.7	130.15	12.461	151.167
2.133	0.97	0.64	0.68	1.94	1.0	0.022	1.00	120.99	0.245	45.74	30.13	2	1.7	104.17	9.9733	120.988
2.297	0.97	0.65	0.67	1.92	1.0	0.022	1.00	126.76	0.269	46.79	31.75	2	1.7	109.14	10.449	126.762
2.461	0.97	0.67	0.66	1.92	1.0	0.022	1.00	135.70	0.312	50.65	33.68	2	1.7	116.84	11.186	135.698
2.625	0.97	1.10	0.60	2.12	1.0	0.020	1.00	364.89	1.000	152.06	84.09	2	1.639484	314.17	30.079	364.888
2.789	0.97	1.23	0.60	2.07	1.0	0.021	1.00	452.13	1.000	143.17	79.68	2	1.61347	389.28	37.27	452.127
2.953	0.97	1.28	0.60	2.02	1.0	0.021	1.00	489.79	1.000	135.27	75.77	2	1.589322	421.71	40.374	489.785
3.117	0.97	1.20	0.60	1.98	1.0	0.022	1.06	461.98	1.000	128.20	72.27	2	1.566812	373.68	35.776	434.004
3.281	0.97	1.14	0.60	1.94	1.0	0.022	1.08	423.01	1.000	122.29	69.34	2	1.547263	336.26	32.194	390.550
3.445	0.97	1.14	0.60	1.90	1.0	0.022	1.07	412.59	1.000	116.91	66.68	2	1.52883	333.11	31.892	386.887
3.609	0.97	1.22	0.60	1.87	1.0	0.023	1.06	476.39	1.000	111.98	64.25	2	1.511403	386.92	37.043	449.380
3.773	0.97	1.35	0.60	1.84	1.0	0.023	1.02	554.48	1.000	107.01	61.80	2	1.493247	469.09	44.911	544.823
3.937	0.97	1.14	0.60	1.81	1.0	0.024	1.12	437.65	1.000	102.87	59.77	2	1.477644	336.58	32.225	390.923
4.101	0.97	1.11	0.60	1.78	1.0	0.024	1.07	397.43	1.000	99.05	57.89	2	1.462791	319.5	30.589	371.085
4.265	0.97	1.10	0.60	1.75	1.0	0.024	1.05	378.28	1.000	95.50	56.15	2	1.448628	311.28	29.802	361.533
4.429	0.97	0.99	0.60	1.73	1.0	0.025	1.05	307.64	1.000	92.20	54.53	2	1.435098	251.16	24.046	291.710
4.593	0.97	0.91	0.60	1.71	1.0	0.025	1.07	268.21	1.000	89.12	53.02	2	1.42972	215.64	20.646	250.458
4.757	0.97	0.84	0.60	1.68	1.0	0.025	1.04	220.27	1.000	85.96	51.48	2	1.504592	182.01	17.426	211.395
4.921	0.97	0.81	0.60	1.66	1.0	0.026	1.00	197.17	1.000	83.01	50.08	2	1.523449	169.77	16.253	197.174
5.085	0.97	0.79	0.60	1.63	1.0	0.026	1.06	200.17	1.000	80.26	48.75	2	1.529534	161.92	15.502	188.058
5.249	0.97	0.78	0.61	1.60	1.0	0.027	1.11	203.34	1.000	77.93	47.62	2	1.52774	157.24	15.054	182.626
5.413	0.97	0.78	0.61	1.57	1.0	0.027	1.12	202.03	1.000	75.73	46.55	2	1.517569	155.39	14.877	180.481
5.577	0.96	0.77	0.62	1.55	1.0	0.027	1.13	200.40	1.000	73.65	45.54	2	1.509532	152.91	14.64	177.598
5.741	0.96	0.75	0.62	1.52	1.0	0.028	1.19	201.39	1.000	71.68	44.59	2	1.515261	145.76	13.955	169.290
5.905	0.96	0.72	0.64	1.48	1.0	0.029	1.23	190.57	1.000	69.82	43.69	2	1.53676	133.5	12.782	155.058
6.069	0.96	0.70	0.65	1.45	1.0	0.029	1.31	189.90	1.000	68.05	42.84	2	1.547112	125.12	11.979	145.320
6.234	0.96	0.69	0.66	1.43	1.0	0.030	1.29	182.97	1.000	66.38	42.02	2	1.539087	122.56	11.734	142.348
6.398	0.96	0.68	0.66	1.41	1.0	0.030	1.28	175.75	1.000	64.78	41.25	2	1.538242	117.78	11.276	136.795
6.562	0.96	0.60	0.70	1.34	1.0	0.032	1.47	156.93	0.439	27.80	17.97	2	1.611744	91.966	8.8048	106.813
6.726	0.96	0.57	0.71	1.32	1.0	0.032	1.52	148.18	0.383	23.65	14.86	2	1.624415	84.095	8.0513	97.672
6.890	0.96	0.56	0.72	1.30	1.0	0.033	1.41	131.92	0.294	17.74	11.59	2	1.620049	80.541	7.711	93.544
7.054	0.96	0.59	0.71	1.31	1.0	0.032	1.41	145.18	0.365	21.55	14.34	2	1.571078	88.527	8.4756	102.819
7.218	0.96	0.63	0.68	1.33	1.0	0.032	1.53	182.92	1.000	57.98	35.98	2	1.509204	102.78	9.8403	119.375
7.382	0.96	0.62	0.69	1.31	1.0	0.032	1.75	202.06	1.000	56.91	34.33	2	1.505326	99.697	9.545	115.792
7.546	0.96	0.85	0.60	1.41	1.0	0.030	1.00	216.56	1.000	55.62	36.87	2	1.301895	186.45	17.851	216.555
7.710	0.96	0.89	0.60	1.40	1.0	0.030	1.00	237.63	1.000	54.38	36.29	2	1.265533	204.6	19.588	237.628
7.874	0.96	0.69	0.66	1.32	1.0	0.032	1.18	167.67	1.000	53.32	35.70	2	1.404187	121.89	11.67	141.570
8.038	0.96	0.54	0.73	1.24	1.0	0.034	1.45	128.98	0.280	14.62	9.78	2	1.515245	76.551	7.329	88.910
8.202	0.96	0.46	0.77	1.20	1.0	0.035	1.76	112.27	0.212	10.86	6.98	2	1.581493	54.886	5.2548	63.747
8.366	0.96	0.40	0.80	1.16	1.0	0.036	2.09	101.59	0.178	8.94	5.70	2	1.625416	41.908	4.0123	48.673
8.530	0.96	0.44	0.78	1.18	1.0	0.036	1.60	92.72	0.154	7.62	5.23	2	1.568016	49.827	4.7705	57.872
8.694	0.96	0.46	0.77	1.18	1.0	0.036	1.34	83.09	0.133	6.48	4.76	2	1.535318	53.482	5.1204	62.116
8.858	0.96	0.45	0.78	1.17	1.0	0.036	1.30	77.98	0.124	5.92	4.43	2	1.526724	51.489	4.9296	59.802
9.022	0.96	0.42	0.79	1.15	1.0	0.037	1.47	76.82	0.122	5.73	4.18	2	1.537215	44.965	4.3049	52.224
9.186	0.96	0.36	0.80	1.14	1.0	0.037	1.99	76.07	0.121	5.57	3.84	2	1.577766	32.957	3.1553	38.277
9.350	0.96	0.28	0.80	1.14	1.0	0.037	3.47	83.20	0.134	6.07	3.86	2	1.639861	20.673	1.9792	24.010
9.514	0.96	0.27	0.80	1.14	1.0	0.037	3.27	74.01	0.118	5.27	3.44	2	1.630423	19.493	1.8663	22.640
9.678	0.96	0.29	0.80	1.13	1.0	0.037	2.54	66.27	0.107	4.72	3.22	2	1.588461	22.439	2.1483	26.061
9.842	0.95	0.37	0.80	1.13	1.0	0.037	1.42	57.38	0.098	4.23	3.21	2	1.502248	34.819	3.3336	40.441
10.006	0.95	0.36	0.80	1.12	1.0	0.037	1.75	68.53	0.110	4.69	3.42	2	1.490966	33.693	3.2258	39.133
10.170	0.95	0.26	0.80	1.12	1.0	0.038	4.49	90.38	0.149	6.26	3.91	2	1.562976	17.344	1.6605	20.144
10.335	0.95	0.25	0.80	1.12	1.0	0.038	5.04	92.99	0.155	6.43	3.97	2	1.546147	15.897	1.522	18.464
10.499	0.95	0.23	0.80	1.11	1.0	0.038	5.50	84.30	0.136	5.56	3.50	2	1.529724	13.204	1.2641	15.335
10.663	0.95	0.26	0.80	1.11	1.0	0.038	3.58	70.44	0.113	4.55	3.05	2	1.513694	16.943	1.6221	19.678
10.827	0.95	0.35	0.80	1.11	1.0	0.038	1.59	58.90	0.099	3.95	3.02	2	1.428543	31.839	3.0483	36.979
10.991	0.95	0.38	0.80	1.11	1.0	0.038	1.42	60.27	0.100	3.94	3.12	2	1.397102	36.567	3.5009	42.471
11.155	0.95	0.36	0.80	1.10	1.0	0.038	1.70	67.83	0.109	4.22	3.21	2	1.390862	34.385	3.292	39.936
11.319	0.95	0.31	0.80	1.10	1.0	0.038	2.75	79.07	0.126	4.81	3.32	2	1.413397	24.762	2.3707	28.759
11.483	0.95	0.26	0.80	1.10	1.0	0.038	4.35	90.07	0.148	5.57	3.58	2	1.428725	17.843	1.7083	20.724
11.647	0.95	0.26	0.80	1.09	1.0	0.038	4.22	84.43	0.136	5.08	3.33	2	1.420263	17.231	1.6497	20.013
11.811	0.95	0.24	0.80	1.09	1.0	0.038	4.81	84.62	0.136	5.06	3.29	2	1.411915	15.142	1.4497	17.587
11.975	0.95	0.30	0.80	1.09	1.0	0.038	2.95	80.09	0.128	4.70	3.25	2	1.379148	23.398	2.2401	27.175

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W6-S

Data File: 13-52106_SP2W6-S-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend:
- Tailings Sands
- Tailings Sand-Slimes
- Tailings Slimes
- Interim Cover
- Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5604.40	Water surface elevation during CPT investigation (f
5604.40	Water surface elevation at t_0 (ft amsl)
5588.59	Water surface elevation at t_1 (ft amsl)
5583.59	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ear
7.51	Equiv. Number of Uniform Strain Cycles, N

5615.85	Ground Surface Elevation at time of CPT (ft amsl)
5625.41	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pl
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
1.56	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1065.26	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5583.59	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5625.16	5624.91	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5623.16	5621.41	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5619.41	5617.41	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	######	5616.63	5615.85	1.56	0.050	101	0.533	0.493	0.00	0.00	0.533	0.493

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
12.139	5603.71	12.2	0.338	12.1	8.3	3.58	2.77%	Slime Tailings	0.057	113.1	0.58	0.02	0.56	1	1.39	16.931	235.34	19.75	21	2.91%	2.7	71%	1.12	0.00	1.12	0
12.303	5603.55	8.8	0.266	8.8	6.5	2.80	3.02%	Slime Tailings	0.057	113.1	0.59	0.03	0.57	1	1.39	12.161	169.03	14.19	14	3.24%	2.9	71%	1.13	0.00	1.13	0
12.467	5603.38	5.7	0.163	5.7	9.4	4.08	2.86%	Slime Tailings	0.057	113.1	0.60	0.03	0.57	1	1.38	7.790	108.28	9.14	9	3.19%	3.1	71%	1.14	0.00	1.14	0
12.631	5603.22	6.7	0.119	6.6	17.7	7.65	1.77%	Slime Tailings	0.057	113.1	0.61	0.04	0.58	1	1.37	9.089	126.34	10.73	11	1.94%	2.9	71%	1.14	0.00	1.14	0
12.795	5603.05	9.3	0.181	9.2	25.8	11.18	1.94%	Slime Tailings	0.057	113.1	0.62	0.04	0.58	1	1.36	12.514	173.95	14.79	15	2.08%	2.8	71%	1.15	0.00	1.15	0
12.959	5602.89	8.3	0.182	8.2	18.0	7.82	2.18%	Slime Tailings	0.057	113.1	0.63	0.05	0.58	1	1.36	11.157	155.08	13.13	13	2.36%	2.8	71%	1.16	0.00	1.16	0
13.123	5602.73	6.3	0.181	6.2	22.2	9.60	2.85%	Slime Tailings	0.057	113.1	0.64	0.05	0.59	1	1.35	8.372	116.37	9.94	10	3.17%	3.0	71%	1.17	0.00	1.17	0
13.287	5602.56	5.9	0.160	5.6	56.5	24.47	2.70%	Slime Tailings	0.057	113.1	0.65	0.06	0.59	1	1.34	7.468	103.80	9.22	9	3.03%	3.0	71%	1.18	0.00	1.18	0
13.451	5602.40	5.0	0.142	4.6	62.6	27.11	2.87%	Slime Tailings	0.057	113.1	0.66	0.06	0.60	1	1.33	6.080	84.51	7.67	7	3.31%	3.1	71%	1.19	0.00	1.19	0
13.615	5602.23	4.7	0.156	4.3	65.6	28.41	3.34%	Slime Tailings	0.057	113.1	0.67	0.07	0.60	1	1.33	5.649	78.52	7.19	7	3.90%	3.2	71%	1.20	0.00	1.20	0
13.779	5602.07	5.0	0.155	4.5	70.8	30.68	3.12%	Slime Tailings	0.057	113.1	0.68	0.07	0.60	1	1.32	5.962	82.87	7.60	7	3.62%	3.2	71%	1.21	0.00	1.21	0
13.943	5601.91	5.3	0.171	4.9	65.5	28.40	3.21%	Slime Tailings	0.057	113.1	0.69	0.08	0.61	1	1.31	6.441	89.54	8.10	8	3.69%	3.1	71%	1.22	0.00	1.22	0
14.107	5601.74	5.7	0.161	5.3	66.6	28.87	2.81%	Slime Tailings	0.057	113.1	0.70	0.08	0.61	1	1.30	6.929	96.32	8.68	8	3.20%	3.1	71%	1.23	0.00	1.23	0
14.271	5601.58	6.2	0.224	5.8	64.0	27.75	3.64%	Slime Tailings	0.057	113.1	0.70	0.09	0.62	1	1.30	7.477	103.93	9.29	9	4.11%	3.1	71%	1.24	0.00	1.24	0
14.436	5601.41	6.8	0.221	6.7	27.2	11.78	3.24%	Slime Tailings	0.057	113.1	0.71	0.09	0.62	1	1.29	8.600	119.54	10.24	10	3.61%	3.0	71%	1.25	0.00	1.25	0
14.600	5601.25	12.2	0.194	12.0	33.9	14.70	1.58%	Sand-Slime Tailin	0.059	119.0	0.72	0.10	0.63	1	1.28	15.444	214.67	18.25	18	1.68%	2.6	47%	1.26	0.00	1.26	0
14.764	5601.09	17.1	0.255	17.0	12.7	5.52	1.49%	Sand-Slime Tailin	0.059	119.0	0.73	0.10	0.63	1	1.27	21.529	299.25	25.12	26	1.56%	2.5	47%	1.27	0.00	1.27	0
14.928	5600.92	15.7	0.220	15.7	4.6	1.99	1.40%	Sand-Slime Tailin	0.059	119.0	0.74	0.11	0.63	1	1.26	19.827	275.59	23.07	24	1.47%	2.5	47%	1.28	0.00	1.28	0
15.092	5600.76	10.8	0.225	10.8	8.1	3.49	2.08%	Slime Tailings	0.057	113.1	0.75	0.11	0.64	1	1.26	13.623	189.36	15.90	16	2.23%	2.8	71%	1.29	0.00	1.29	0
15.256	5600.59	23.2	0.308	23.2	2.0	0.87	1.33%	Sand-Slime Tailin	0.059	119.0	0.76	0.12	0.64	1	1.23	28.564	397.04	33.19	35	1.37%	2.4	47%	1.29	0.00	1.29	0
15.420	5600.43	16.2	0.412	16.2	0.7	0.28	2.55%	Slime Tailings	0.057	113.1	0.77	0.12	0.65	1	1.24	20.096	279.34	23.35	24	2.68%	2.7	71%	1.30	0.00	1.30	0
15.584	5600.27	12.6	0.274	12.6	2.6	1.12	2.17%	Slime Tailings	0.057	113.1	0.78	0.13	0.65	1	1.24	15.661	217.69	18.21	18	2.32%	2.7	71%	1.31	0.00	1.31	0
15.748	5600.10	10.3	0.241	10.2	8.8	3.82	2.34%	Slime Tailings	0.057	113.1	0.79	0.13	0.66	1	1.24	12.652	175.86	14.77	14	2.54%	2.8	71%	1.32	0.00	1.32	0
15.912	5599.94	9.3	0.182	8.8	77.2	33.43	1.96%	Slime Tailings	0.057	113.1	0.80	0.14	0.66	1	1.23	10.854	150.88	13.30	13	2.14%	2.8	71%	1.33	0.00	1.33	0
16.076	5599.77	9.1	0.171	8.6	82.6	35.81	1.87%	Slime Tailings	0.057	113.1	0.81	0.14	0.66	1	1.22	10.569	146.90	13.01	13	2.05%	2.8	71%	1.34	0.00	1.34	0
16.240	5599.61	10.3	0.119	9.8	84.2	36.48	1.15%	Sand-Slime Tailin	0.059	119.0	0.82	0.15	0.67	1	1.22	11.912	165.58	14.58	14	1.25%	2.7	47%	1.35	0.00	1.35	0
16.404	5599.45	10.7	0.142	10.3	64.6	28.00	1.33%	Sand-Slime Tailin	0.059	119.0	0.83	0.15	0.67	1	1.21	12.466	173.27	15.05	15	1.44%	2.7	47%	1.36	0.00	1.36	0
16.568	5599.28	9.7	0.148	9.1	90.7	39.29	1.52%	Sand-Slime Tailin	0.059	119.0	0.84	0.16	0.68	1	1.20	11.013	153.08	13.58	13	1.67%	2.8	47%	1.37	0.00	1.37	0
16.732	5599.12	11.2	0.142	10.7	72.9	31.59	1.27%	Sand-Slime Tailin	0.059	119.0	0.85	0.16	0.68	1	1.20	12.872	178.92	15.58	15	1.37%	2.7	47%	1.38	0.00	1.38	0
16.896	5598.95	11.8	0.171	11.3	78.1	33.86	1.45%	Sand-Slime Tailin	0.059	119.0	0.86	0.17	0.69	1	1.19	13.484	187.43	16.34	16	1.56%	2.7	47%	1.39	0.00	1.39	0
17.060	5598.79	12.0	0.161	11.4	83.5	36.17	1.35%	Sand-Slime Tailin	0.059	119.0	0.87	0.18	0.69	1	1.19	13.567	188.59	16.48	16	1.45%	2.7	47%	1.40	0.00	1.40	0
17.224	5598.63	12.8	0.164	12.3	73.7	31.95	1.28%	Sand-Slime Tailin	0.059	119.0	0.88	0.18	0.70	1	1.18	14.547	202.20	17.53	17	1.38%	2.6	47%	1.41	0.00	1.41	0
17.388	5598.46	10.4	0.217	9.9	73.6	31.89	2.09%	Slime Tailings	0.057	113.1	0.89	0.19	0.70	1	1.17	11.637	161.76	14.14	14	2.29%	2.8	71%	1.42	0.00	1.42	0
17.552	5598.30	9.6	0.305	9.0	98.4	42.63	3.19%	Slime Tailings	0.057	113.1	0.90	0.19	0.71	1	1.17	10.462	145.41	12.98	12	3.52%	3.0	71%	1.43	0.00	1.43	0
17.716	5598.13	12.3	0.378	11.6	110.0	47.65	3.07%	Slime Tailings	0.057	113.1	0.90	0.20	0.71	1	1.16	13.532	188.09	16.64	16	3.31%	2.9	71%	1.44	0.00	1.44	0
17.880	5597.97	15.9	0.393	15.5	61.9	26.81	2.47%	Slime Tailings	0.057	113.1	0.91	0.20	0.71	1	1.16	17.966	249.73	21.39	21	2.62%	2.7	71%	1.45	0.00	1.45	0
18.044	5597.81	13.0	0.378	12.5	74.4	32.24	2.91%	Slime Tailings	0.057	113.1	0.92	0.21	0.72	1	1.15	14.435	200.65	17.39	17	3.13%	2.8	71%	1.46	0.00	1.46	0
18.208	5597.64	15.2	0.346	14.8	53.4	23.14	2.28%	Sand-Slime Tailin	0.059	119.0	0.93	0.21	0.72	1	1.15	17.001	236.31	20.19	20	2.43%	2.7	47%	1.47	0.00	1.47	0
18.372	5597.48	20.1	0.278	20.0	22.1	9.56	1.38%	Sand-Slime Tailin	0.059	119.0	0.94	0.22	0.73	1	1.13	22.670	315.11	26.51	26	1.45%	2.5	47%	1.48	0.00	1.48	0
18.537	5597.31	25.1	0.274	25.1	0.0	0.00	1.09%	Sand-Slime Tailin	0.059	119.0	0.95	0.22	0.73	1	1.12	28.232	392.43	32.79	33	1.13%	2.3	47%	1.49	0.00	1.49	0
18.701	5597.15	25.6	0.284	25.6	-1.5	-0.63	1.11%	Sand-Slime Tailin	0.059	119.0	0.96	0.23	0.74	1	1.12	28.599	397.53	33.20	33	1.15%	2.3	47%	1.50	0.00	1.50	0
18.865	5596.99	26.1	0.274	26.0	4.6	1.98	1.05%	Sand-Slime Tailin	0.059	119.0	0.97	0.23	0.74	1	1.11	28.952	402.43	33.66	34	1.09%	2.3	47%	1.50	0.00	1.50	0
19.029	5596.82	26.3	0.324	26.2	6.9	2.99	1.23%	Sand-Slime Tailin	0.059	119.0	0.98	0.24	0.75	1	1.11	29.032	403.54	33.77	34	1.28%	2.4	47%	1.51	0.00	1.51	0
19.193	5596.66	19.7	0.359	19.6	11.6	5.03	1.82%	Sand-Slime Tailin	0.059	119.0	0.99	0.24	0.75	1	1.11	21.744	302.25	25.35	25	1.92%	2.6	47%	1.52	0.00	1.52	0
19.357	5596.49	17.3	0.409	17.2	10.2	4.42	2.36%	Sand-Slime Tailin	0.059	119.0	1.00	0.25	0.75	1	1.11	19.087	265.31	22.25	22	2.51%	2.7	47%	1.53	0.00	1.53	0
19.521	5596.33	21.7	0.317	21.6	11.8	5.13	1.46%	Sand-Slime Tailin	0.059	119.0	1.01	0.25	0.76	1	1.10	23.745	330.06	27.67	27	1.53%	2.5	47%	1.54	0.00	1.54	0
19.685	5596.17	22.7	0.488	22.7	9.2	3.99	2.15%	Sand-Slime Tailin	0.059	119.0	1.02	0.26	0.76	1	1.09	24.734	343.80	28.80	28	2.25%	2.6	47%	1.55	0.00	1.55	0
19.849	5596.00	19.2	0.558	19.2	4.8	2.06	2.91%	Slime Tailings	0.057	113.1	1.03	0.26	0.77	1	1.09	20.883	290.27	24.29	24	3.07%	2.7	71%	1.56	0.00	1.56	0
20.013	5595.84	17.8	0.580	17.8	9.9	4.27	3.26%	Slime Tailings	0.057	113.1	1.04	0.27	0.77	1	1.09	19.301	268.29	22.49	22	3.46%	2.8	71%	1.57	0.00	1.57	0
20.177	5595.67	16.5	0.428	16.5	3.3	1.42	2.59%	Slime Tailings	0.057	113.1	1.05	0.27	0.78	1	1.08	17.865	248.32	20.77	20	2.77%	2.7	71%	1.58	0.00	1.58	0
20.341	5595.51	16.1	0.364	15.8	46.6	20.19	2.26%	Sand-Slime Tailin	0.059	119.0	1.06	0.28	0.78	1	1.08	17.027	236.67	20.14	19	2.42%	2.7	47%	1.59	0.00	1.59	0
20.505	5595.35	17.0	0.387	16.6	69.6	30.17	2.27%	Sand-Slime Tailin	0.059	119.0	1.07	0.28	0.79	1	1.07	17.836	247.93	21.26	20	2.42%	2.7	47%	1.60	0.00	1.60	0
20.669	5595.18	17.8	0.559	17.1	110.3	47.80	3.15%	Slime Tailings	0.057	113.1	1.08	0.29	0.79	1	1.07	18.247	253.63	22.05	21	3.35%	2.8	71%	1.61	0.00	1.61	0
20.833	5595.02	20.8	0.452	20.2	105.5	45.73	2.17%	Sand-Slime Tailin	0.059	119.0	1.09	0.29	0.79	1	1.06	21.444	298.07	25.72	25	2.29%	2.6	47%	1.62	0.00	1.62	0
20.997	5594.85	32.5	0.419	32.2	39.9	17.27	1.29%	Sand-Slime Tailin	0.059	119.0	1.10	0.30	0.80	1	1.05	33.912	471.38	39.69	39	1.33%	2.3	47%	1.63	0.00	1.63	0
21.161	5594.69	30.5	0.438	30.5	-5.4	-2.35	1.44%	Sand-Slime Tailin	0.059	119.0	1.11	0.30	0.80	1	1.05	32.002	444.83	37.13	37	1.49%	2.4	47%	1.64	0.00	1.64	0
21.325	5594.52	26.6	0.429	26.6	10.9	4.71	1.61%	Sand-Slime Tailin	0.059	119.0	1.12	0.31	0.81	1	1.05	27.780	386.14	32.35	32	1.68%	2.4	47%	1.65	0.00	1.65	0
21.489	5594.36	31.3	0.445	31.2	10.5	4.56	1.42%	Sand-Slime Tailin	0.059	119.0	1.13	0.31	0.81	1	1.04	32.472	451.36	37.79	37	1.48%	2.4	47%	1.66	0.00	1.66	0
21.653	5594.20	33.9	0.558	33.9	8.4	3.65	1.64%	Sand-Slime Tailin	0.059	119.0	1.14	0.32	0.82	1	1.04	35.087	487.71	40.81	40	1.70%	2.4	47%	1.67	0.00	1.67	0
21.817	5594.03	28.7	0.579	28.7	11.6	5.03	2.01%	Sand-Slime Tailin	0.059	119.0	1.15	0.32	0.82	1	1.03	29.609	411.56	34.48	34	2.10%	2.5	47%	1.68	0.00	1.68	0
21.981	5593.87	32.2	0.577	32.1	12.6	5.46	1.79%	Sand-Slime Tailin	0.059	119.0	1.16	0.33	0.83	1	1.03	33.006	458.78	38.43	38	1.86%	2.4	47%	1.69	0.00	1.69	0
22.145	5593.70	31.5	0.519	31.4	11.5	4.97	1.65%	Sand-Slime Tailin	0.059	119.0	1.17	0.33	0.83	1	1.02	32.168	447.13	37.45	36	1.71%	2.4	47%	1.70	0.00	1.70	0
22.309	5593.54	38.3	0.405	38.2	9.8	4.23	1.06%	Sand-Slime Tailin	0.059	119.0	1.18	0.34	0.84	1	1.02	38.964	541.60	45.33	44	1.09%	2.2	47%	1.71	0.00	1.71	0
22.473	5593.38	36.9	0.465	36.9	8.3	3.58	1.26%	Sand-Slime Tailin	0.059	119.0	1.18	0.34	0.84	1	1.02	37.469	520.81	43.58	43	1.30%	2.3	47%	1.72	0.00	1.72	0
22.638	5593.21	38.4	0.519	38.4	9.0	3.91	1.35%	Sand-Slime Tailin	0.059	119.0	1.19	0.35	0.85	1	1.01	38.805	539.39	45.14	44	1.39%	2.3	47%	1.73	0.00	1.73	0
22.802	5593.05	41.4	0.519	41.3	10.3	4.46	1.25%	Sand-Slime Tailin	0.059	119.0	1.20	0.35	0.85	1	1.01	41.633	578.70	48.43	47	1.29%	2.2	47%	1.74	0.00	1.74	0
22.966	5592.88	42.6	0.493	42.5	9.8	4.23	1.16%	Sand-Slime Tailin	0.059	119.0	1.21	0.36	0.85	1	1.00	42.702	593.55	49.67	48	1.19%	2.2	47%	1.75	0.00	1.75	0
23.130	5592.72	41.6	0.532	41.6	11.5	4.97	1.28%	Sand-Slime Tailin	0.059	119.0	1.22	0.36	0.86	1	1.00	41.593	578.15	48.39	47	1.32%	2.2	47%	1.76	0.00	1.76	0
23.294	5592.56	42.3	0.534	42.2	13.1	5.66	1.26%	Sand-Slime Tailin	0.059	119.0	1.23	0.37	0.86	1	1.00	42.088	585.03	48.98	47	1.30%	2.2	47%	1.77	0.00	1.77	0
23.458	5592.39	47.2	0.593	47.2	13.5	5.86	1.26%	Sand-Slime Tailin	0.059	119.0	1.24	0.37	0.87	1	0.99	46.893	651.82	54.56	53	1.29%	2.2	47%	1.78	0.00	1.78	0
23.622	5592.23	49.1	0.674	49.0	13.7	5.94	1.37%	Sand-Slime Tailin	0.059	119.0	1.25	0.38	0.87	1	0.99	48.576	675.21	56.52	55	1.41%	2.2	47%	1.79	0.00	1.79	0
23.786	5592.06	47.0	0.774	46.9	14.2	6.14	1.65%	Sand-Slime Tailin	0.059	119.0	1.26	0.38	0.88	1	0.99	46.335	644.06	53.92	52	1.69%	2.3	47%	1.80	0.00	1.80	0
23.950	5591.90	41.4	0.772	41.4	13.6	5.88	1.86%	Sand-Slime Tailin	0.059	119.0	1.27	0.39	0.88	1	0.98	40.695	565.65	47.36	46	1.92%	2.4	47%	1.81	0.00	1.81	0

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	I&B (2008) CSR r_d	I&B C_σ	I&B K_σ	I&B K_α	I&B CSR M=7.5, s'v=1atm	I&B CRR Δqc_{1n}	I&B CRR qc_{1n-cs}	I&B (CRR) M=7.5, s'v=1atm	I&B FoS	Youd (2001) CSR r_d	Youd D_r	Youd f	Youd K_σ	Youd K_α	Youd CSR M=7.5, s'v=1atm	Youd Kc	Youd qc_{1n-cs}	Youd (CRR) M=7.5, s'v=1atm	Youd FoS	Avg FoS	Liquefiable? 1=Yes 2=No	I&B (2008) CN	qc1 TSF	qc1 MPa	qc1N
12.139	0.94	0.05	0.99	1.0	0.053	36.96	56.71	0.084	1.58	0.95	0.26	0.80	1.09	1.0	0.038	4.26	84.15	0.135	4.95	3.26	2	1.39462	17.003	1.6278	19.748
12.303	0.94	0.05	0.99	1.0	0.053	35.03	49.22	0.077	1.44	0.95	0.22	0.80	1.09	1.0	0.038	5.55	78.80	0.126	4.56	3.00	2	1.38661	12.217	1.1696	14.189
12.467	0.93	0.04	0.99	1.0	0.053	33.27	42.41	0.071	1.32	0.95	0.17	0.80	1.09	1.0	0.039	7.34	67.12	0.108	3.90	2.61	2	1.378705	7.8707	0.7535	9.141
12.631	0.93	0.05	0.99	1.0	0.053	33.82	44.56	0.072	1.36	0.95	0.19	0.80	1.08	1.0	0.039	5.42	58.12	0.098	3.52	2.44	2	1.370901	9.2401	0.8846	10.732
12.795	0.93	0.05	0.99	1.0	0.053	35.24	50.03	0.078	1.46	0.95	0.22	0.80	1.08	1.0	0.039	4.45	65.88	0.107	3.79	2.63	2	1.363197	12.734	1.2191	14.789
12.959	0.93	0.05	0.99	1.0	0.053	34.66	47.80	0.075	1.42	0.95	0.21	0.80	1.08	1.0	0.039	5.12	67.20	0.108	3.82	2.62	2	1.355592	11.309	1.0827	13.135
13.123	0.93	0.05	0.99	1.0	0.053	33.55	43.49	0.072	1.35	0.95	0.18	0.80	1.08	1.0	0.039	6.98	69.37	0.111	3.90	2.62	2	1.348082	8.558	0.8193	9.940
13.287	0.93	0.04	0.99	1.0	0.053	33.30	42.52	0.071	1.34	0.95	0.18	0.80	1.08	1.0	0.039	7.21	66.51	0.107	3.74	2.54	2	1.340666	7.9402	0.7602	9.222
13.451	0.93	0.04	0.99	1.0	0.053	32.76	40.42	0.069	1.31	0.95	0.16	0.80	1.08	1.0	0.039	8.42	64.56	0.105	3.64	2.47	2	1.333343	6.6009	0.632	7.666
13.615	0.93	0.04	0.99	1.0	0.053	32.59	39.78	0.068	1.30	0.95	0.15	0.80	1.07	1.0	0.039	9.34	67.15	0.108	3.72	2.51	2	1.32611	6.192	0.5928	7.192
13.779	0.92	0.04	0.99	1.0	0.053	32.73	40.34	0.069	1.31	0.95	0.16	0.80	1.07	1.0	0.039	8.78	66.76	0.108	3.68	2.49	2	1.318966	6.5446	0.6266	7.601
13.943	0.92	0.04	0.98	1.0	0.053	32.91	41.01	0.069	1.32	0.95	0.16	0.80	1.07	1.0	0.039	8.51	68.96	0.111	3.75	2.54	2	1.31191	6.9782	0.6681	8.105
14.107	0.92	0.04	0.98	1.0	0.052	33.11	41.79	0.070	1.34	0.94	0.17	0.80	1.07	1.0	0.039	7.72	67.00	0.108	3.64	2.49	2	1.304938	7.472	0.7154	8.678
14.271	0.92	0.04	0.98	1.0	0.052	33.32	42.61	0.071	1.35	0.94	0.18	0.80	1.07	1.0	0.039	8.17	75.85	0.121	4.04	2.70	2	1.298051	7.9957	0.7655	9.287
14.436	0.92	0.05	0.98	1.0	0.052	33.65	43.90	0.072	1.38	0.94	0.18	0.80	1.07	1.0	0.039	7.30	74.79	0.119	3.96	2.67	2	1.291246	8.8188	0.8443	10.242
14.600	0.92	0.05	0.98	1.0	0.052	36.70	54.96	0.082	1.58	0.94	0.25	0.80	1.07	1.0	0.039	3.56	64.99	0.106	3.49	2.54	2	1.283752	15.715	1.5046	18.252
14.764	0.92	0.06	0.98	1.0	0.052	39.11	64.23	0.093	1.79	0.94	0.29	0.80	1.06	1.0	0.039	2.74	68.85	0.110	3.63	2.71	2	1.265666	21.63	2.0708	25.121
14.928	0.92	0.05	0.98	1.0	0.052	38.39	61.46	0.089	1.73	0.94	0.28	0.80	1.06	1.0	0.039	2.84	65.58	0.106	3.47	2.60	2	1.263662	19.863	1.9017	23.070
15.092	0.91	0.05	0.98	1.0	0.052	35.62	51.52	0.079	1.52	0.94	0.23	0.80	1.06	1.0	0.039	4.46	70.87	0.113	3.67	2.60	2	1.262592	13.687	1.3104	15.896
15.256	0.91	0.06	0.98	1.0	0.051	41.94	75.14	0.106	2.06	0.94	0.33	0.80	1.06	1.0	0.039	2.14	71.16	0.114	3.66	2.86	2	1.229629	28.58	2.7362	33.194
15.420	0.91	0.05	0.98	1.0	0.052	38.22	61.56	0.090	1.74	0.94	0.28	0.80	1.06	1.0	0.039	3.75	87.44	0.142	4.55	3.15	2	1.243568	20.101	1.9245	23.346
15.584	0.91	0.05	0.98	1.0	0.052	36.43	54.64	0.082	1.59	0.94	0.25	0.80	1.06	1.0	0.039	4.15	75.50	0.120	3.82	2.71	2	1.242925	15.681	1.5013	18.212
15.748	0.91	0.05	0.98	1.0	0.051	35.23	50.01	0.077	1.51	0.94	0.22	0.80	1.06	1.0	0.039	4.99	73.70	0.117	3.71	2.61	2	1.236759	12.72	1.2178	14.774
15.912	0.91	0.05	0.98	1.0	0.051	34.72	48.01	0.076	1.47	0.94	0.21	0.80	1.05	1.0	0.039	4.99	66.36	0.107	3.37	2.42	2	1.230662	11.447	1.096	13.295
16.076	0.91	0.05	0.98	1.0	0.051	34.62	47.63	0.075	1.47	0.94	0.21	0.80	1.05	1.0	0.039	4.99	64.85	0.105	3.29	2.38	2	1.224633	11.2	1.0723	13.009
16.240	0.91	0.05	0.98	1.0	0.051	35.41	49.99	0.077	1.51	0.94	0.22	0.80	1.05	1.0	0.039	3.76	54.85	0.095	2.96	2.24	2	1.217988	12.552	1.2017	14.578
16.404	0.90	0.05	0.98	1.0	0.051	35.58	50.62	0.078	1.53	0.94	0.22	0.80	1.05	1.0	0.039	3.89	58.50	0.099	3.04	2.29	2	1.211425	12.954	1.2402	15.046
16.568	0.90	0.05	0.98	1.0	0.051	35.07	48.65	0.076	1.49	0.94	0.21	0.80	1.05	1.0	0.039	4.46	60.55	0.101	3.09	2.29	2	1.204942	11.695	1.1197	13.583
16.732	0.90	0.05	0.98	1.0	0.051	35.77	51.35	0.079	1.55	0.94	0.23	0.80	1.05	1.0	0.040	3.73	58.07	0.098	2.99	2.27	2	1.198538	13.418	1.2846	15.584
16.896	0.90	0.05	0.98	1.0	0.051	36.03	52.37	0.080	1.57	0.94	0.23	0.80	1.05	1.0	0.040	3.80	62.13	0.102	3.10	2.33	2	1.19221	14.065	1.3466	16.336
17.060	0.90	0.05	0.98	1.0	0.051	36.08	52.56	0.080	1.58	0.94	0.23	0.80	1.04	1.0	0.040	3.67	60.46	0.101	3.02	2.30	2	1.185959	14.185	1.3581	16.476
17.224	0.90	0.05	0.97	1.0	0.051	36.45	53.97	0.081	1.61	0.94	0.24	0.80	1.04	1.0	0.040	3.44	60.21	0.100	3.00	2.30	2	1.179781	15.09	1.4447	17.526
17.388	0.90	0.05	0.98	1.0	0.051	35.01	49.16	0.077	1.52	0.94	0.22	0.80	1.04	1.0	0.040	4.98	70.37	0.112	3.34	2.43	2	1.174304	12.177	1.1658	14.143
17.552	0.90	0.05	0.98	1.0	0.051	34.61	47.59	0.075	1.49	0.94	0.21	0.80	1.04	1.0	0.040	6.35	82.50	0.132	3.91	2.70	2	1.168884	11.179	1.0703	12.984
17.716	0.89	0.05	0.97	1.0	0.050	35.88	52.53	0.080	1.59	0.94	0.24	0.80	1.04	1.0	0.040	5.27	87.75	0.143	4.20	2.89	2	1.163521	14.33	1.372	16.644
17.880	0.89	0.05	0.97	1.0	0.050	37.54	58.92	0.087	1.73	0.94	0.27	0.80	1.04	1.0	0.040	4.01	85.65	0.138	4.05	2.89	2	1.15763	18.413	1.7629	21.386
18.044	0.89	0.05	0.97	1.0	0.050	36.14	53.53	0.081	1.61	0.94	0.24	0.80	1.04	1.0	0.040	5.00	87.01	0.141	4.11	2.86	2	1.152961	14.971	1.4333	17.387
18.208	0.89	0.05	0.97	1.0	0.050	37.38	57.57	0.085	1.70	0.94	0.26	0.80	1.04	1.0	0.040	4.03	81.33	0.130	3.76	2.73	2	1.147167	17.384	1.6643	20.190
18.372	0.89	0.06	0.97	1.0	0.050	39.60	66.11	0.095	1.90	0.93	0.30	0.80	1.03	1.0	0.040	2.63	69.61	0.111	3.20	2.55	2	1.134641	22.826	2.1854	26.511
18.537	0.89	0.06	0.97	1.0	0.050	41.80	74.59	0.105	2.12	0.93	0.33	0.80	1.03	1.0	0.040	2.05	67.17	0.108	3.09	2.61	2	1.123003	28.232	2.703	32.790
18.701	0.89	0.06	0.97	1.0	0.050	41.95	75.15	0.106	2.14	0.93	0.33	0.80	1.03	1.0	0.040	2.05	68.05	0.109	3.10	2.62	2	1.117594	28.589	2.7371	33.205
18.865	0.89	0.06	0.97	1.0	0.049	42.11	75.77	0.107	2.16	0.93	0.33	0.80	1.03	1.0	0.040	1.99	66.98	0.108	3.05	2.61	2	1.112238	28.983	2.7749	33.662
19.029	0.88	0.06	0.97	1.0	0.049	42.15	75.92	0.107	2.17	0.93	0.34	0.80	1.03	1.0	0.040	2.12	71.66	0.114	3.21	2.69	2	1.107245	29.08	2.7841	33.774
19.193	0.88	0.06	0.97	1.0	0.049	39.19	64.54	0.093	1.88	0.93	0.29	0.80	1.03	1.0	0.040	3.10	78.57	0.125	3.49	2.69	2	1.109408	21.825	2.0895	25.348
19.357	0.88	0.05	0.97	1.0	0.049	38.11	60.36	0.088	1.79	0.93	0.27	0.80	1.03	1.0	0.040	3.85	85.76	0.139	3.85	2.82	2	1.107144	19.158	1.8341	22.250
19.521	0.88	0.06	0.97	1.0	0.049	40.01	67.68	0.097	1.97	0.93	0.30	0.80	1.03	1.0	0.040	2.63	72.87	0.116	3.20	2.58	2	1.09729	23.826	2.2811	27.673
19.685	0.88	0.06	0.97	1.0	0.049	40.40	69.20	0.099	2.01	0.93	0.31	0.80	1.02	1.0	0.040	3.07	88.53	0.145	3.96	2.99	2	1.091531	24.797	2.374	28.800
19.849	0.88	0.06	0.97	1.0	0.049	38.55	62.84	0.091	1.86	0.93	0.28	0.80	1.02	1.0	0.040	4.03	97.81	0.167	4.56	3.21	2	1.09049	20.915	2.0024	24.292
20.013	0.88	0.05	0.97	1.0	0.049	37.92	60.42	0.088	1.80	0.93	0.27	0.80	1.02	1.0	0.040	4.49	101.07	0.176	4.78	3.29	2	1.087393	19.368	1.8543	22.495
20.177	0.87	0.05	0.97	1.0	0.049	37.32	58.10	0.086	1.75	0.93	0.26	0.80	1.02	1.0	0.040	4.25	88.39	0.144	3.90	2.82	2	1.084035	17.887	1.7125	20.775
20.341	0.87	0.05	0.97	1.0	0.049	37.36	57.50	0.085	1.74	0.93	0.26	0.80	1.02	1.0	0.040	4.08	82.25	0.132	3.54	2.64	2	1.078998	17.34	1.6602	20.140
20.505	0.87	0.05	0.97	1.0	0.049	37.76	59.02	0.087	1.78	0.93	0.27	0.80	1.02	1.0	0.040	3.94	83.73	0.135	3.60	2.69	2	1.073838	18.303	1.7524	21.258
20.669	0.87	0.05	0.97	1.0	0.049	37.77	59.81	0.088	1.80	0.93	0.27	0.80	1.02	1.0	0.040	4.50	99.19	0.171	4.55	3.18	2	1.068928	18.983	1.8174	22.047
20.833	0.87	0.06	0.96	1.0	0.048	39.32	65.04	0.094	1.93	0.93	0.29	0.80	1.02	1.0	0.040	3.37	86.69	0.141	3.73	2.83	2	1.062097	22.143	2.12	25.718
20.997	0.87	0.06	0.96	1.0	0.048	44.22	83.91	0.118	2.45	0.93	0.36	0.80	1.01	1.0	0.040	1.98	78.44	0.125	3.30	2.88	2	1.051875	34.174	3.2718	39.691
21.161	0.87	0.06	0.96	1.0	0.048	43.32	80.45	0.113	2.36	0.92	0.35	0.80	1.01	1.0	0.040	2.16	80.34	0.128	3.37	2.86	2	1.048569	31.967	3.0605	37.128
21.325	0.87	0.06	0.96	1.0	0.048	41.65	73.99	0.105	2.18	0.92	0.33	0.80	1.01	1.0	0.040	2.50	80.95	0.129	3.39	2.78	2	1.045923	27.851	2.6664	32.347
21.489	0.86	0.06	0.96	1.0	0.048	43.56	81.35	0.114	2.39	0.92	0.35	0.80	1.01	1.0	0.040	2.13	80.68	0.129	3.36	2.87	2	1.0401	32.54	3.1154	37.794
21.653	0.86	0.07	0.96	1.0	0.048	44.62	85.43	0.120	2.52	0.92	0.37	0.80	1.01	1.0	0.040	2.17	88.64	0.145	3.76	3.14	2	1.035325	35.142	3.3645	40.815
21.817	0.86	0.06	0.96	1.0	0.048	42.39	76.87	0.108	2.27	0.92	0.34	0.80	1.01	1.0	0.040	2.68	92.26	0.153	3.96	3.11	2	1.032743	29.684	2.8419	34.476
21.981	0.86	0.06	0.96	1.0	0.048	43.78	82.21	0.116	2.43	0.92	0.36	0.80	1.01	1.0	0.040	2.36	90.58	0.149	3.84	3.13	2	1.0279	33.087	3.1677	38.428
22.145	0.86	0.06	0.96	1.0	0.048	43.43	80.88	0.114	2.40	0.92	0.35	0.80	1.01	1.0	0.040	2.31	86.41	0.140	3.59	2.99	2	1.024123	32.241	3.0868	37.446
22.309	0.86	0.07	0.95	1.0	0.047	46.20	91.53	0.129	2.73	0.91	0.39	0.80	1.01	1.0	0.040	1.70	77.22	0.123	3.14	2.93	2	1.019209	39.027	3.7364	45.327
22.473	0.86	0.07	0.95	1.0	0.047	45.59	89.16	0.126	2.66	0.91	0.38	0.80	1.00	1.0	0.040	1.87	81.40	0.130	3.31	2.99	2	1.015682	37.521	3.5923	43.578
22.638	0.85	0.07	0.95	1.0	0.047	46.13	91.27	0.129	2.74	0.91	0.39	0.80	1.00	1.0	0.040	1.89	85.12	0.137	3.48	3.11	2	1.011867	38.862	3.7207	45.136
22.802	0.85	0.07	0.95	1.0	0.047	47.29	95.72	0.136	2.89	0.91	0.40	0.80	1.00	1.0	0.040	1.76	85.15	0.137	3.47	3.18	2	1.008074	41.698	3.9922	48.430
22.966	0.85	0.07	0.95	1.0	0.047	47.72	97.39	0.138	2.96	0.91	0.41	0.80	1.00	1.0	0.040	1.68	83.56	0.134	3.37	3.16	2	1.004512	42.763	4.0941	49.667
23.130	0.85	0.07	0.95	1.0	0.047	47.27	95.66	0.136	2.90	0.91	0.40	0.80	1.00	1.0	0.040	1.78	85.96	0.139	3.48	3.19	2	1.001047	41.665	3.989	48.392
23.294	0.85	0.07	0.95	1.0	0.047	47.48	96.46	0.137	2.93	0.91	0.40	0.80	1.00	1.0	0.040	1.76	86.10	0.139	3.47	3.20	2	0.997587	42.169	4.0373	48.977
23.458	0.85	0.07	0.95	1.0	0.046	49.44	104.00	0.149	3.22	0.91	0.43	0.79	1.00	1.0	0.040	1.66	90.30	0.148	3.69	3.45	2	0.994344	46.977	4.4976	54.561
23.622	0.85	0.08	0.95	1.0	0.046	50.12	106.64	0.154	3.32	0.90	0.43	0.78	1.00	1.0	0.040	1.68	95.21	0.160	3.96	3.64	2	0.99115	48.661	4.6588	56.517
23.786	0.85	0.07	0.95	1.0	0.046	49.21	103.13	0.148	3.20	0.90	0.42	0.79	1.00	1.0	0.040	1.87	100.76	0.175	4.31	3.76	2	0.987748	46.423	4.4445	53.917
23.950	0.84	0.07	0.95	1.0	0.046	46.91	94.27	0.133	2.88	0.90	0.40	0.80	1.00	1.0	0.040	2.14	101.19	0.176	4.33	3.61	2	0.983912	40.778	3.9041	47.361

Energy Fuels Resources (USA) Inc.
White Mesa Mill
Liquefaction Analyses

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W6-S

Data File: 13-52106_SP2W6-S-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Description
5604.40	Water surface elevation during CPT investigation (f
5604.40	Water surface elevation at t_0 (ft amsl)
5588.59	Water surface elevation at t_1 (ft amsl)
5583.59	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ear
7.51	Equiv. Number of Uniform Strain Cycles, N

Value	Description
5615.85	Ground Surface Elevation at time of CPT (ft amsl)
5625.41	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pl
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
1.56	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1065.26	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5583.59	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5625.16	5624.91	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
Water Storage/Rooting Zone Layer	######	5623.16	5621.41	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5619.41	5617.41	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	######	5616.63	5615.85	1.56	0.050	101	0.533	0.493	0.00	0.00	0.533	0.493

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No
24.114	5591.74	41.1	0.727	41.0	13.4	5.82	1.77%	Sand-Slime Tailing	0.059	119.0	1.28	0.40	0.89	1
24.278	5591.57	37.0	0.661	36.9	13.4	5.82	1.79%	Sand-Slime Tailing	0.059	119.0	1.29	0.40	0.89	1
24.442	5591.41	32.5	0.603	32.4	13.5	5.86	1.85%	Sand-Slime Tailing	0.059	119.0	1.30	0.41	0.90	1
24.606	5591.24	31.6	0.528	31.5	13.5	5.86	1.67%	Sand-Slime Tailing	0.059	119.0	1.31	0.41	0.90	1
24.770	5591.08	31.6	0.507	31.5	15.0	6.51	1.60%	Sand-Slime Tailing	0.059	119.0	1.32	0.42	0.91	1
24.934	5590.92	32.8	0.414	32.7	16.5	7.16	1.26%	Sand-Slime Tailing	0.059	119.0	1.33	0.42	0.91	1
25.098	5590.75	34.3	0.437	34.2	17.3	7.49	1.27%	Sand-Slime Tailing	0.059	119.0	1.34	0.43	0.92	1
25.262	5590.59	36.0	0.512	35.9	14.2	6.17	1.42%	Sand-Slime Tailing	0.059	119.0	1.35	0.43	0.92	1
25.426	5590.42	41.3	0.688	41.2	15.1	6.55	1.67%	Sand-Slime Tailing	0.059	119.0	1.36	0.44	0.92	1
25.590	5590.26	34.2	0.767	34.1	15.3	6.63	2.24%	Sand-Slime Tailing	0.059	119.0	1.37	0.44	0.93	1
25.754	5590.10	26.7	0.796	26.6	16.0	6.92	2.98%	Slime Tailings	0.057	113.1	1.38	0.45	0.93	1
25.918	5589.93	29.3	0.592	29.2	15.0	6.51	2.02%	Sand-Slime Tailing	0.059	119.0	1.39	0.45	0.94	1
26.082	5589.77	35.4	0.454	35.3	14.3	6.19	1.28%	Sand-Slime Tailing	0.059	119.0	1.40	0.46	0.94	1
26.246	5589.60	36.2	0.371	36.2	3.2	1.39	1.02%	Sand-Slime Tailing	0.059	119.0	1.41	0.46	0.95	1
26.410	5589.44	36.1	0.419	36.1	4.6	1.98	1.16%	Sand-Slime Tailing	0.059	119.0	1.42	0.47	0.95	1
26.574	5589.28	33.9	0.531	33.8	12.8	5.56	1.57%	Sand-Slime Tailing	0.059	119.0	1.43	0.47	0.96	1
26.739	5589.11	36.3	0.568	36.2	16.5	7.16	1.57%	Sand-Slime Tailing	0.059	119.0	1.44	0.48	0.96	1
26.903	5588.95	38.8	0.595	38.7	16.5	7.16	1.53%	Sand-Slime Tailing	0.059	119.0	1.45	0.48	0.97	1
27.067	5588.78	39.4	0.647	39.3	18.0	7.81	1.64%	Sand-Slime Tailing	0.059	119.0	1.46	0.49	0.97	1
27.231	5588.62	40.3	0.712	40.2	20.4	8.83	1.77%	Sand-Slime Tailing	0.059	119.0	1.47	0.49	0.98	1
27.395	5588.46	41.4	0.723	41.3	21.0	9.12	1.75%	Sand-Slime Tailing	0.059	119.0	1.48	0.50	0.98	1
27.559	5588.29	42.9	0.670	42.8	19.2	8.30	1.56%	Sand-Slime Tailing	0.059	119.0	1.49	0.50	0.98	1
27.723	5588.13	42.3	0.619	42.2	18.1	7.86	1.46%	Sand-Slime Tailing	0.059	119.0	1.50	0.51	0.99	1
27.887	5587.96	42.4	0.626	42.2	20.2	8.77	1.48%	Sand-Slime Tailing	0.059	119.0	1.51	0.51	0.99	1
28.051	5587.80	39.8	0.634	39.7	20.9	9.07	1.59%	Sand-Slime Tailing	0.059	119.0	1.52	0.52	1.00	1
28.215	5587.64	43.4	0.590	43.3	19.6	8.48	1.36%	Sand-Slime Tailing	0.059	119.0	1.53	0.52	1.00	1
28.379	5587.47	44.3	0.552	44.2	15.3	6.61	1.25%	Sand-Slime Tailing	0.059	119.0	1.54	0.53	1.01	1
28.543	5587.31	44.6	0.539	44.5	16.5	7.16	1.21%	Sand-Slime Tailing	0.059	119.0	1.55	0.53	1.01	1
28.707	5587.14	45.4	0.570	45.2	18.3	7.93	1.26%	Sand-Slime Tailing	0.059	119.0	1.56	0.54	1.02	1
28.871	5586.98	47.7	0.530	47.6	19.4	8.39	1.11%	Sand Tailings	0.062	123.5	1.57	0.54	1.02	1
29.035	5586.81	50.3	0.530	50.2	19.4	8.42	1.05%	Sand Tailings	0.062	123.5	1.58	0.55	1.03	1
29.199	5586.65	52.6	0.530	52.4	18.7	8.10	1.01%	Sand Tailings	0.062	123.5	1.59	0.55	1.03	1

CPT Data Interpretations (continued) / Conditions at t_1

Depth at time of CPT (ft)	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
24.114	0.98	40.240	559.34	46.83	45	1.82%	2.3	47%	1.82	0.00	1.82	0
24.278	0.98	36.033	500.86	41.95	40	1.85%	2.4	47%	1.82	0.00	1.82	0
24.442	0.97	31.538	438.38	36.73	35	1.93%	2.4	47%	1.83	0.00	1.83	0
24.606	0.97	30.546	424.59	35.57	34	1.74%	2.4	47%	1.84	0.00	1.84	0
24.770	0.97	30.436	423.06	35.45	33	1.67%	2.4	47%	1.85	0.00	1.85	0
24.934	0.96	31.433	436.92	36.62	35	1.32%	2.4	47%	1.86	0.00	1.86	0
25.098	0.96	32.804	455.97	38.22	36	1.33%	2.3	47%	1.87	0.00	1.87	0
25.262	0.96	34.352	477.49	40.00	38	1.48%	2.3	47%	1.88	0.00	1.88	0
25.426	0.95	39.342	546.86	45.80	43	1.72%	2.3	47%	1.89	0.00	1.89	0
25.590	0.95	32.336	449.47	37.66	35	2.34%	2.5	47%	1.90	0.00	1.90	0
25.754	0.94	25.105	348.96	29.27	27	3.14%	2.7	71%	1.91	0.00	1.91	0
25.918	0.94	27.443	381.46	31.98	30	2.12%	2.5	47%	1.92	0.00	1.92	0
26.082	0.94	33.177	461.16	38.63	36	1.34%	2.3	47%	1.93	0.00	1.93	0
26.246	0.94	33.911	471.36	39.41	37	1.07%	2.3	47%	1.94	0.00	1.94	0
26.410	0.93	33.729	468.84	39.21	36	1.21%	2.3	47%	1.95	0.00	1.95	0
26.574	0.93	31.447	437.12	36.61	34	1.63%	2.4	47%	1.96	0.00	1.96	0
26.739	0.93	33.570	466.63	39.10	36	1.63%	2.4	47%	1.97	0.00	1.97	0
26.903	0.93	35.865	498.52	41.77	39	1.59%	2.4	47%	1.98	0.00	1.98	0
27.067	0.92	36.285	504.36	42.26	39	1.70%	2.4	47%	1.99	0.00	1.99	0
27.231	0.92	37.005	514.36	43.11	40	1.83%	2.4	47%	2.00	0.00	2.00	0
27.395	0.92	37.919	527.07	44.18	41	1.81%	2.4	47%	2.01	0.00	2.01	1
27.559	0.92	39.157	544.29	45.61	42	1.62%	2.3	47%	2.02	0.01	2.01	1
27.723	0.91	38.500	535.15	44.84	41	1.52%	2.3	47%	2.03	0.01	2.01	1
27.887	0.91	38.435	534.24	44.77	41	1.53%	2.3	47%	2.04	0.02	2.02	1
28.051	0.91	35.941	499.57	41.88	38	1.66%	2.4	47%	2.05	0.02	2.02	1
28.215	0.90	39.142	544.07	45.59	42	1.41%	2.3	47%	2.06	0.03	2.03	1
28.379	0.90	39.911	554.76	46.45	42	1.29%	2.3	47%	2.07	0.03	2.03	1
28.543	0.90	40.085	557.18	46.66	43	1.25%	2.3	47%	2.08	0.04	2.04	1
28.707	0.90	40.610	564.48	47.29	43	1.30%	2.3	47%	2.09	0.05	2.04	1
28.871	0.90	42.658	592.95	49.67	45	1.15%	2.2	18%	2.10	0.05	2.05	1
29.035	0.89	44.933	624.57	52.31	47	1.09%	2.2	18%	2.11	0.06	2.05	1
29.199	0.89	46.851	651.23	54.54	49	1.04%	2.2	18%	2.12	0.06	2.06	1

Liquefaction Triggering Analyses — Idriss & Boulanger (2008)

Depth at time of CPT (ft)	r_d	C_σ	K_σ	K_a	CSR (M=7.5, s'v=1atm)	Δqc_{1n}	qc_{1n-cs}	(CRR) (M=7.5, s'v=1atm)	FoS
24.114	0.84	0.07	0.95	1.0	0.046	46.73	93.56	0.132	2.86
24.278	0.84	0.07	0.95	1.0	0.046	45.01	86.96	0.122	2.65
24.442	0.84	0.06	0.95	1.0	0.046	43.18	79.91	0.113	2.43
24.606	0.84	0.06	0.95	1.0	0.046	42.78	78.35	0.110	2.39
24.770	0.84	0.06	0.95	1.0	0.046	42.74	78.19	0.110	2.39
24.934	0.84	0.06	0.95	1.0	0.046	43.15	79.77	0.112	2.44
25.098	0.83	0.06	0.95	1.0	0.046	43.71	81.93	0.115	2.51
25.262	0.83	0.06	0.95	1.0	0.046	44.33	84.32	0.119	2.60
25.426	0.83	0.07	0.95	1.0	0.045	46.36	92.16	0.130	2.86
25.590	0.83	0.06	0.95	1.0	0.046	43.51	81.17	0.114	2.51
25.754	0.83	0.06	0.95	1.0	0.046	40.28	69.55	0.099	2.17
25.918	0.83	0.06	0.95	1.0	0.046	41.52	73.49	0.104	2.28
26.082	0.83	0.06	0.95	1.0	0.045	43.85	82.48	0.116	2.56
26.246	0.82	0.06	0.95	1.0	0.045	44.12	83.53	0.118	2.60
26.410	0.82	0.06	0.95	1.0	0.045	44.05	83.26	0.117	2.60
26.574	0.82	0.06	0.95	1.0	0.045	43.14	79.75	0.112	2.49
26.739	0.82	0.06	0.95	1.0	0.045	44.01	83.12	0.117	2.60
26.903	0.82	0.07	0.95	1.0	0.045	44.95	86.72	0.122	2.73
27.067	0.82	0.07	0.94	1.0	0.045	45.12	87.39	0.123	2.76
27.231	0.82	0.07	0.94	1.0	0.045	45.42	88.54	0.125	2.80
27.395	0.82	0.07	0.94	1.0	0.045	45.80	89.98	0.127	2.85
27.559	0.81	0.07	0.94	1.0	0.045	46.30	91.90	0.130	2.91
27.723	0.81	0.07	0.94	1.0	0.045	46.03	90.86	0.128	2.88
27.887	0.81	0.07	0.94	1.0	0.045	46.00	90.78	0.128	2.87
28.051	0.81	0.07	0.94	1.0	0.045	44.99	86.87	0.122	2.74
28.215	0.81	0.07	0.94	1.0	0.045	46.29	91.88	0.130	2.91
28.379	0.81	0.07	0.94	1.0	0.045	46.59	93.05	0.132	2.95
28.543	0.81	0.07	0.94	1.0	0.045	46.67	93.33	0.132	2.95
28.707	0.80	0.07	0.94	1.0	0.045	46.89	94.17	0.133	2.98
28.871	0.80	0.07	0.94	1.0	0.045	34.79	84.46	0.119	2.66
29.035	0.80	0.07	0.94	1.0	0.045	35.46	87.78	0.124	2.77
29.199	0.80	0.07	0.94	1.0	0.045	36.03	90.57	0.128	2.87

Liquefaction Triggering Analyses — Youd et al. (2001); Idriss & Boulanger (2008)

Depth at time of CPT (ft)	r_d	D_r	f	K_σ	K_a	CSR (M=7.5, s'v=1atm)	Kc	qc_{1n-cs}	(CRR) (M=7.5, s'v=1atm)	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	CN	qc1 TSF	qc1 MPa	qc1N
24.114	0.90	0.40	0.80	0.99	1.0	0.040	2.10	98.40	0.169	4.12	3.49	2	0.980512	40.322	3.8605	46.832
24.278	0.90	0.37	0.80	0.99	1.0	0.040	2.26	94.94	0.160	3.89	3.27	2	0.976508	36.115	3.4576	41.945
24.442	0.90	0.35	0.80	0.99	1.0	0.040	2.51	92.27	0.153	3.71	3.07	2	0.972208	31.62	3.0273	36.725
24.606	0.90	0.34	0.80	0.99	1.0	0.040	2.44	86.95	0.141	3.41	2.90	2	0.968496	30.628	2.9323	35.573
24.770	0.89	0.34	0.80	0.99	1.0	0.040	2.41	85.32	0.138	3.32	2.85	2	0.965	30.527	2.9226	35.455
24.934	0.89	0.35	0.80	0.99	1.0	0.040	2.12	77.71	0.124	2.97	2.71	2	0.961855	31.533	3.0189	36.623
25.098	0.89	0.36	0.80	0.99	1.0	0.040	2.07	79.27	0.126	3.02	2.77	2	0.958897	32.907	3.1505	38.220
25.262	0.89	0.37	0.80	0.99	1.0	0.040	2.12	84.60	0.136	3.25	2.92	2	0.956072	34.437	3.297	39.996
25.426	0.89	0.39	0.80	0.99	1.0	0.040	2.09	95.76	0.162	3.84	3.35	2	0.954444	39.432	3.7752	45.798
25.590	0.89	0.35	0.80	0.98	1.0	0.040	2.74	103.10	0.182	4.31	3.41	2	0.94883	32.427	3.1045	37.662
25.754	0.89	0.31	0.80	0.98	1.0	0.040	3.74	109.38	0.202	4.76	3.46	2	0.942728	25.199	2.4125	29.267
25.918	0.89	0.33	0.80	0.98	1.0	0.040	2.90	92.83	0.154	3.63	2.96	2	0.940474	27.531	2.6358	31.976
26.082	0.88	0.36	0.80	0.98	1.0	0.040	2.08	80.35	0.128	3.01	2.78	2	0.939859	33.261	3.1844	38.630
26.246	0.88	0.36	0.80	0.98	1.0	0.040	1.88	73.99	0.118	2.75	2.67	2	0.937013	33.929	3.2484	39.407
26.410	0.88	0.36	0.80	0.98	1.0	0.040	1.98	77.62	0.123	2.87	2.74	2	0.933816	33.756	3.2318	39.206
26.574	0.88	0.35	0.80	0.98	1.0	0.040	2.36	86.38	0.140	3.25	2.87	2	0.929574	31.522	3.0179	36.611
26.739	0.88	0.36	0.80	0.98	1.0	0.040	2.26	88.48	0.144	3.34	2.97	2	0.92761	33.666	3.2232	39.101
26.903	0.88	0.37	0.80	0.98	1.0	0.040	2.15	89.86	0.147	3.40	3.06	2	0.92579	35.961	3.4429	41.766
27.067	0.88	0.38	0.80	0.98	1.0	0.040	2.21	93.25	0.155	3.57	3.16	2	0.923048	36.389	3.4839	42.264
27.231	0.87	0.38	0.80	0.98	1.0	0.040	2.26	97.33	0.166	3.80	3.30	2	0.920512	37.122	3.554	43.115
27.395	0.87	0.38	0.80	0.97	1.0	0.040	2.21	97.80	0.167	3.80	3.33	2	0.918124	38.039	3.6419	44.180
27.559	0.87	0.39	0.80	0.97	1.0	0.040	2.07	94.21	0.158	3.57	3.24	2	0.91596	39.267	3.7594	45.606
27.723	0.87	0.39	0.80	0.97	1.0	0.040	2.03	90.98	0.150	3.38	3.13	2	0.912754	38.603	3.6959	44.835
27.887	0.87	0.39	0.80	0.97	1.0	0.040	2.04	91.41	0.151	3.38	3.13	2	0.909913	38.55	3.6907	44.773
28.051	0.87	0.37	0.80	0.97	1.0	0.040	2.20	92.24	0.153	3.41	3.07	2	0.905532	36.059	3.4523	41.880
28.215	0.87	0.39	0.80	0.97	1.0	0.040	1.95	89.01	0.146	3.22	3.07	2	0.904807	39.253	3.758	45.589
28.379	0.87	0.39	0.80	0.97	1.0	0.040	1.86	86.56	0.140	3.09	3.02	2	0.902555	39.997	3.8293	46.454
28.543	0.86	0.39	0.80	0.97	1.0	0.040	1.84	85.72	0.139	3.04	3.00	2	0.899974	40.178	3.8466	46.664
28.707	0.86	0.40	0.80	0.97	1.0	0.040	1.85	87.70	0.143	3.11	3.05	2	0.897657	40.713	3.8978	47.285
28.871	0.86	0.41	0.80	0.97	1.0	0.040	1.72	85.44	0.138	2.99	2.83	2	0.896182	42.767	4.0945	49.671
29.035	0.86	0.42	0.79	0.96	1.0	0.040	1.64	85.89	0.139	2.99	2.88	2	0.894898	45.041	4.3123	52.313
29.199	0.86	0.43	0.79	0.96	1.0	0.041	1.58	86.40	0.140	3.00	2.93	2	0.893422	46.955	4.4955	54.536

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W7-C

Data File: 13-52106_SP2W7-C-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5613.10	Water surface elevation during CPT investigation (ft
5611.32	Water surface elevation at t_0 (ft amsl)
5595.40	Water surface elevation at t_1 (ft amsl)
5590.40	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ea
7.51	Equiv. Number of Uniform Strain Cycles, N

Value	Parameter
5619.60	Ground Surface Elevation at time of CPT (ft amsl)
5626.65	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pl
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
-0.95	Thickness of Random/Platform Fill on top of existing interim cover (ft)
812.44	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5590.40	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5626.4	5626.15	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5624.4	5622.65	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5620.65	5618.65	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	######	5619.13	5619.60	-0.95	0.050	101	0.406	0.430	0.00	0.00	0.406	0.430

Column groups: 2013 CPT Data from ConeTec | CPT Data Interpretations | Conditions at t_1 | Liquefaction Triggering Analyses: Idriss & Boulanger (2008), Youd et al. (2001) | Idriss & Boulanger (2008)

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil. Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Qt	Normalized Friction Ratio, Fr (%)	Type Index, Ic	FC %	Total Stress at t1 (tsf)	Equil. Pore Pressure at t1 (tsf)	Effective Stress at t1 (tsf)	Saturated at t1 1=Yes 0=No	I&B rd	I&B Cσ	I&B Kσ	I&B Kα	I&B CSR M=7.5, s'v=1atm	Δqc1n	qc1n-cs	(CRR) M=7.5, s'v=1atm	I&B FoS	Youd rd	Youd Dr	Youd f	Youd Kσ	Youd Kα	Youd CSR M=7.5, s'v=1atm	Kc	qc1n-cs	(CRR) M=7.5, s'v=1atm	Youd FoS	Avg FoS	Liquefiable? 1=Yes 2=No	CN	qc1 TSF	qc1 MPa	qc1N
0.164	5619.44	37.3	0.106	37.3	3.0	1.31	0.28%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	63.359	880.69	73.63	4513	0.28%	0.7	51%	0.41	0.00	0.41	0	1.00	0.09	1.06	1.0	0.061	56.16	129.78	0.202	3.29	0.98	0.50	0.75	3.16	1.0	0.014	1.00	73.63	0.117	281.58	142.44	2	1.7	63.391	6.0691	73.625
0.328	5619.27	49.3	0.150	49.3	3.1	1.34	0.30%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	83.827	######	97.40	2985	0.30%	0.7	51%	0.42	0.00	0.42	0	1.00	0.10	1.07	1.0	0.062	64.50	161.90	0.339	5.46	0.98	0.57	0.72	3.08	1.0	0.014	1.00	97.40	0.166	199.54	102.50	2	1.7	83.86	8.0287	97.398
0.492	5619.11	59.2	0.224	59.1	4.5	1.95	0.38%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	100.521	######	116.80	2386	0.38%	0.8	51%	0.43	0.00	0.43	0	1.00	0.12	1.08	1.0	0.063	71.31	188.12	0.701	11.18	0.98	0.62	0.69	3.02	1.0	0.014	1.00	116.80	0.228	183.03	97.10	2	1.7	100.57	9.6285	116.805
0.656	5618.94	63.9	0.317	63.8	2.3	0.98	0.50%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	108.528	######	126.08	1931	0.50%	0.9	51%	0.44	0.00	0.44	0	1.00	0.13	1.09	1.0	0.063	74.56	200.64	1.000	15.90	0.98	0.65	0.68	2.88	1.0	0.015	1.00	126.08	0.266	160.29	88.10	2	1.7	108.55	10.393	126.076
0.820	5618.78	65.3	0.442	65.3	2.3	1.01	0.68%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	110.925	######	128.86	1579	0.68%	1.1	51%	0.45	0.00	0.45	0	1.00	0.13	1.09	1.0	0.063	75.54	204.40	1.000	15.91	0.98	0.66	0.67	2.71	1.0	0.016	1.00	128.86	0.279	134.37	75.14	2	1.7	110.95	10.622	128.862
0.984	5618.62	74.0	0.500	74.0	6.1	2.66	0.68%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	125.766	######	146.15	1492	0.68%	1.1	51%	0.46	0.00	0.46	0	1.00	0.15	1.10	1.0	0.063	81.61	227.75	1.000	15.75	0.98	0.70	0.65	2.71	1.0	0.016	1.00	146.15	0.370	148.67	82.21	2	1.7	125.83	12.047	146.145
1.148	5618.45	70.5	0.458	70.5	1.5	0.67	0.65%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	119.799	######	139.16	1218	0.65%	1.1	51%	0.46	0.00	0.46	0	1.00	0.15	1.09	1.0	0.063	79.16	218.31	1.000	15.87	0.98	0.68	0.66	2.51	1.0	0.017	1.00	139.16	0.331	113.82	64.85	2	1.7	119.82	11.471	139.158
1.312	5618.29	76.0	0.403	76.0	0.8	0.34	0.53%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	129.234	######	150.11	1149	0.53%	1.0	51%	0.47	0.00	0.47	0	1.00	0.16	1.10	1.0	0.063	83.00	233.11	1.000	15.78	0.98	0.71	0.65	2.48	1.0	0.017	1.00	150.11	0.395	118.90	67.34	2	1.7	129.24	12.374	150.107
1.476	5618.12	71.1	0.468	71.1	3.0	1.32	0.66%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	120.887	######	140.44	956	0.66%	1.1	51%	0.48	0.00	0.48	0	1.00	0.15	1.09	1.0	0.063	79.61	220.05	1.000	15.93	0.98	0.68	0.66	2.31	1.0	0.019	1.00	140.44	0.338	90.47	53.20	2	1.7	120.92	11.577	140.440
1.640	5617.96	69.3	0.535	69.3	1.0	0.42	0.77%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	117.742	######	136.76	837	0.77%	1.2	51%	0.49	0.00	0.49	0	1.00	0.14	1.08	1.0	0.062	78.31	215.08	1.000	16.00	0.98	0.68	0.66	2.21	1.0	0.020	1.00	136.76	0.318	76.70	46.35	2	1.7	117.75	11.274	136.762
1.804	5617.80	67.9	0.630	67.9	1.5	0.63	0.93%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	115.362	######	134.00	746	0.93%	1.3	51%	0.50	0.00	0.50	0	1.00	0.14	1.08	1.0	0.062	77.35	211.35	1.000	16.07	0.98	0.67	0.67	2.12	1.0	0.020	1.00	134.00	0.304	66.66	41.36	2	1.7	115.38	11.046	134.004
1.968	5617.63	62.3	0.676	62.3	2.1	0.91	1.08%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	105.927	######	123.05	628	1.09%	1.4	51%	0.51	0.00	0.51	0	1.00	0.13	1.07	1.0	0.062	73.50	196.56	0.977	15.83	0.98	0.64	0.68	2.00	1.0	0.022	1.00	123.05	0.253	50.97	33.40	2	1.7	105.95	10.144	123.054
2.133	5617.47	58.0	0.590	58.0	0.7	0.30	1.02%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	98.566	######	114.49	539	1.02%	1.4	51%	0.51	0.00	0.51	0	1.00	0.12	1.06	1.0	0.061	70.50	184.98	0.628	10.25	0.98	0.62	0.69	1.90	1.0	0.023	1.00	114.49	0.220	40.80	25.53	2	1.7	98.573	9.4374	114.487
2.297	5617.30	56.9	0.428	56.9	1.5	0.65	0.75%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	96.730	######	112.36	491	0.75%	1.3	51%	0.52	0.00	0.52	0	1.00	0.12	1.06	1.0	0.061	69.75	182.12	0.572	9.37	0.98	0.61	0.69	1.85	1.0	0.023	1.00	112.36	0.212	36.58	22.98	2	1.7	96.746	9.2624	112.364
2.461	5617.14	58.9	0.597	58.9	2.3	0.99	1.01%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	100.062	######	116.24	474	1.02%	1.5	51%	0.53	0.00	0.53	0	1.00	0.12	1.06	1.0	0.061	71.11	187.36	0.682	11.18	0.98	0.62	0.69	1.83	1.0	0.024	1.00	116.24	0.226	36.44	23.81	2	1.7	100.09	9.5823	116.244
2.625	5616.98	67.5	0.562	67.5	1.5	0.63	0.83%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.70	114.801	######	133.35	510	0.83%	1.4	51%	0.54	0.00	0.54	0	1.00	0.14	1.07	1.0	0.061	77.12	210.47	1.000	16.31	0.98	0.67	0.67	1.87	1.0	0.023	1.00	133.35	0.301	45.43	30.87	2	1.7	114.82	10.993	133.352
2.789	5616.81	68.3	0.681	68.3	1.1	0.49	1.00%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0	1.70	116.076	######	134.83	485	1.00%	1.4	51%	0.55	0.00	0.55	0	0.99	0.14	1.06	1.0	0.061	77.64	212.47	1.000	16.34	0.98	0.67	0.66	1.84	1.0	0.023	1.00	134.83	0.308	43.82	30.08	2	1.7	116.09	11.114	134.829
2.953	5616.65	72.4	0.913	72.4	0.1	0.04	1.26%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0	1.70	123.114	######	142.99	486	1.26%	1.5	51%	0.55	0.00	0.55	0	0.99	0.15	1.07	1.0	0.061	80.50	223.49	1.000	16.32	0.98	0.69	0.65	1.83	1.0	0.023	1.00	142.99	0.352	47.32	31.82	2	1.7	123.11	11.787	142.991
3.117	5616.48	67.6	0.613	67.6	0.1	0.04	0.91%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0	1.70	114.869	######	133.41	429	0.91%	1.4	51%	0.56	0.00	0.56	0	0.99	0.14	1.06	1.0	0.061	77.14	210.55	1.000	16.45	0.98	0.67	0.67	1.76	1.0	0.024	1.00	133.41	0.301	38.34	27.39	2	1.7	114.87	10.998	133.415
3.281	5616.32	81.3	2.130	81.3	-0.3	-0.12	2.62%	Sand-Slime Tailing	0.047	93.3	0.16	0.00	0.16	0	1.70	138.261	######	160.58	493	2.62%	1.8	47%	0.57	0.00	0.57	0	0.99	0.18	1.07	1.0	0.062	86.62	247.20	1.000	16.26	0.98	0.73	0.63	1.83	1.0	0.023	1.12	179.35	1.000	121.56	68.91	2	1.7	138.26	13.237	160.578
3.445	5616.16	80.0	1.732	79.9	8.4	3.65	2.17%	Sand-Slime Tailing	0.047	93.3	0.17	0.00	0.17	0	1.70	135.864	######	157.90	463	2.17%	1.8	47%	0.58	0.00	0.58	0	0.99	0.17	1.07	1.0	0.061	85.68	243.58	1.000	16.34	0.98	0.73	0.64	1.79	1.0	0.024	1.07	168.91	1.000	116.20	66.27	2	1.7	135.95	13.016	157.902
3.609	5615.99	65.9	1.776	65.8	3.9	1.68	2.70%	Sand-Slime Tailing	0.047	93.3	0.18	0.00	0.18	0	1.70	111.911	######	130.03	365	2.70%	1.9	47%	0.59	0.00	0.59	0	0.99	0.14	1.05	1.0	0.060	75.90	205.93	1.000	16.60	0.98	0.66	0.67	1.67	1.0	0.026	1.18	152.78	0.412	45.82	31.21	2	1.7	111.95	10.718	130.026
3.773	5615.83	50.8	1.506	50.8	2.8	1.21	2.96%	Sand-Slime Tailing	0.047	93.3	0.19	0.00	0.19	0	1.70	86.343	######	100.32	270	2.98%	2.0	47%	0.59	0.00	0.59	0	0.99	0.11	1.04	1.0	0.059	65.48	165.80	0.369	6.21	0.97	0.58	0.71	1.55	1.0	0.028	1.28	128.71	0.278	29.73	17.97	2	1.7	86.373	8.2693	100.317
3.937	5615.66	56.3	1.282	56.3	3.5	1.52	2.28%	Sand-Slime Tailing	0.047	93.3	0.20	0.00	0.20	0	1.70	95.642	######	111.13	287	2.29%	1.9	47%	0.60	0.00	0.60	0	0.99	0.12	1.04	1.0	0.060	69.27	180.40	0.542	9.11	0.97	0.61	0.70	1.57	1.0	0.027	1.17	129.62	0.283	29.01	19.06	2	1.7	95.679	9.1603	111.126
4.101	5615.50	62.9	1.087	62.9	1.5	0.65	1.73%	Sand-Slime Tailing	0.047	93.3	0.20	0.00	0.20	0	1.70	106.913	######	124.19	309	1.73%	1.8	47%	0.61	0.00	0.61	0	0.99	0.13	1.04	1.0	0.060	73.86	198.05	1.000	16.77	0.97	0.64	0.68	1.59	1.0	0.027	1.08	133.72	0.302	29.89	23.33	2	1.7	106.93	10.237	124.191
4.265	5615.33	59.1	1.275	59.1	0.2	0.10	2.16%	Sand-Slime Tailing	0.047	93.3	0.21	0.00	0.21	0	1.70	100.422	######	116.61	280	2.17%	1.9	47%	0.62	0.00	0.62	0	0.99	0.12	1.04	1.0	0.059	71.20	187.81	0.693	11.68	0.97	0.62	0.69	1.55	1.0	0.028	1.16	134.72	0.307	29.29	20.48	2	1.7	100.4	9.6127	116.614
4.429	5615.17	53.9	1.413	53.9	6.9	3.00	2.62%	Sand-Slime Tailing	0.047	93.3	0.22	0.00	0.22	0	1.70	91.630	######	106.51	246	2.63%	2.0	47%	0.62	0.00	0.62	0	0.99	0.11	1.04	1.0	0.059	67.66	174.16	0.453	7.68	0.97	0.60	0.70	1.51	1.0	0.029	1.25	133.61	0.302	27.76	17.72	2	1.7	91.703	8.7797	106.508
4.593	5615.01	52.0	1.603	52.0	1.0	0.44	3.08%	Sand-Slime Tailing	0.047	93.3	0.23	0.00	0.23	0	1.70	88.468	######	102.76	229	3.09%	2.0	47%	0.63	0.00	0.63	0	0.98	0.11	1.03	1.0	0.059	66.34	169.10	0.399	6.77	0.97	0.59	0.71	1.48	1.0	0.029	1.35	139.13	0.330	29.37	18.07	2	1.7	88.479	8.471	102.763
4.757	5614.84	50.3	1.706	50.2	1.6	0.71	3.40%	Sand-Slime Tailing	0.047	93.3	0.23	0.00	0.23	0	1.70	85.408	######	99.22	214	3.41%	2.1	47%	0.64	0.00	0.64	0	0.98	0.11	1.03	1.0	0.059	65.10	164.31	0.357	6.09	0.97	0.58	0.71	1.46	1.0	0.029	1.44	142.65	0.350	30.10	18.09	2	1.7	85.425	8.1786	99.216
4.921	5614.68	56.7	1.658	56.7	1.0	0.41	2.93%	Sand-Slime Tailing	0.047	93.3	0.24	0.00	0.24	0	1.70	96.339	######	111.90	234	2.94%	2.0	47%	0.65	0.00	0.65	0	0.98	0.12	1.03	1.0	0.059	69.55	181.45	0.560	9.54	0.97	0.61	0.69	1.48	1.0	0.029	1.32	147.75	0.380	31.66	20.60	2	1.7	96.349	9.2245	111.904
5.085	5614.51	41.7	0.963	41.7	2.7	1.19	2.31%	Sand-Slime Tailing	0.047	93.3	0.25	0.00	0.25	0	1.70	70.856	984.90	82.33	167	2.32%	2.0	47%	0.65	0.00	0.65	0	0.98	0.09	1.03	1.0	0.058	59.18	141.50	0.238	4.08	0.97	0.52	0.74	1.38	1.0	0.031	1.32	109.07	0.201	16.21	10.15	2	1.7	70.885	6.7865	82.329
5.249	5614.35	52.5	1.083	52.5	3.5	1.53	2.06%	Sand-Slime Tailing	0.047	93.3	0.26	0.00	0.26	0	1.70	89.199	######	103.64	204	2.07%	1.9	47%	0.66	0.00	0.66	0	0.98	0.11	1.03	1.0	0.058	66.65	170.29	0.410	7.03	0.97	0.59	0.71	1.43	1.0	0.030	1.21	125.85	0.265	20.81	13.92	2	1.7	89.237	8.5435	103.643
5.413	5614.19	21.3	0.563	21.3	1.4	0.60	2.64%	Sand-Slime Tailing	0.047	93.3	0.26	0.00	0.26	0	1.70	36.210	503.32	42.07	80	2.68%	2.3	47%	0.67	0.00	0.67	0	0.98	0.07	1.02	1.0	0.058	45.06	87.13	0.123	2.13	0.97	0.37	0.80	1.27	1.0	0.034	1.87	78.68	0.125	9.54	5.84	2	1.7	36.225	3.4681	42.073
5.577	5614.02	22.2	0.545	22.2	0.6	0.28	2.46%	Sand-Slime Tailing	0.047	93.3	0.27	0.00	0.27	0	1.70	37.706	524.11	43.80	81	2.49%	2.2	47%	0.68	0.00	0.68	0	0.98	0.07	1.02	1.0	0.058	45.66	89.46	0.126	2.19	0.97	0.38	0.80	1.26	1.0	0.034	1.79	78.56	0.125	9.26	5.73	2	1.7	37.713	3.6106	43.801
5.741	5613.86	18.0	0.373	18.0	0.3	0.13	2.07%	Sand-Slime Tailing	0.047	93.3	0.28	0.00	0.28	0	1.70	30.668	426.29	35.62	64	2.10%	2.3	47%	0.69	0.00	0.69	0	0.98	0.06	1.01	1.0	0.057	42.80	78.42	0.110	1.93	0.97	0.34	0.80	1.25	1.0	0.034	1.86	66.20	0.107	7.71	4.82	2	1.7	30.671	2.9365	35.623
5.905	5613.69	7.7	0.333	7.7	3.8	1.64	4.34%	Slime Tailings	0.041	82.7	0.29	0.00	0.29	0	1.70	13.005	180.77	15.15	26	4.51%	2.8	71%	0.69	0.00	0.69	0	0.98	0.05	1.01	1.0	0.057	35.36	50.52	0.078	1.37	0.97	0.22	0.80	1.25	1.0	0.034	4.65	70.38	0.112	7.91	4.64	2	1.7	13.045	1.2489	15.151
6.069	5613.53	10.4	0.134	10.3	9.4	4.09	1.29%	Sand-Slime Tailing	0.047	93.3	0.29	0.00	0.29	0	1.70	17.544	243.86	20.49	34	1.33%	2.4	47%	0.70	0.00	0.70	0	0.98	0.05	1.01	1.0	0.057	37.49	57.98	0.086	1.50	0.97	0.26	0.80	1.24	1.0	0.034	2.14	43.82	0.087	5.93	3.72	2	1.7	17.644	1.6893	20.493
6.234	5613.37	11.4	0.206	11.4	8.9	3.87	1.80%	Sand-Slime Tailing	0.047	93.3	0.30	0.00	0.30	0	1.70	19.363	269.15	22.60	37	1.85%	2.4	47%	0.71	0.00	0.71	0	0.98	0.05	1.01	1.0	0.057	38.23	60.83	0.089	1.56	0.97	0.27	0.80	1.23	1.0	0.035	2.37	53.60	0.094	6.31	3.93	2	1.7	19.458	1.8629	22.599
6.398	5613.20	13.7	0.185	13.7	7.0	3.03	1.35%	Sand-Slime Tailing	0.047	93.3	0.31	0.00	0.31	0	1.70	23.239	323.02	27.08	43	1.38%	2.3	47%	0.72	0.00	0.72	0	0.97	0.06	1.01	1.0	0.057	39.80	66.87	0.096	1.68	0.97	0.30	0.80	1.23	1.0	0.035	1.89	51.26	0.093	6.03	3.86	2	1.7	23.313	2.232	27.077
6.562	5613.04	12.1	0.174	12.0	6.7	2.91	1.44%	Sand-Slime Tailing	0.059	119.0	0.32	0.00	0.32	1	1.70	20.417	283.80	23.80	37	1.48%	2.4	47%	0.73	0.00	0.73	0	0.97	0.05	1.01	1.0	0.057	38.65	62.44	0.091	1.60	0.97	0.28	0.80	1.22	1.0	0.035	2.14	50.97	0.092	5.87	3.73	2	1.7	20.488	1.9616	23.796
6.726	5612.87	13.0	0.171	13.0	6.5	2.83	1.32%	Sand-Slime Tailing	0.059	119.0	0.33	0.01	0.32	1	1.70	22.032	306.24	25.67	39	1.35%	2.3	47%	0.73	0.00	0.73	0	0.97	0.06	1.01	1.0	0.057	39.30	64.97	0.094	1.65	0.97	0.29	0.80	1.22	1.0	0.035	1.98	50.86	0.092	5.79	3.72	2	1.7	22.101	2.116	25.669
6.890	5612.71	12.7	0.139	12.6	5.2	2.27	1.10%	Sand-Slime Tailing	0.059	119.0	0.34	0.01	0.33	1	1.70	21.488	298.68	25.02	38	1.13%	2.3	47%	0.74	0.00	0.74	0	0.97	0.06	1.01	1.0	0.057	39.08	64.10	0.093	1.63	0.97	0.29	0.80	1.21	1.0	0.035	1.89	47.20	0.089	5.53	3.58	2	1.7	21.544	2.0626	25.021
7.054	5612.55	17.0	0.146	16.9	6.6	2.86	0.86%	Sand-Slime Tailing	0.059	119.0	0.35	0.02	0.33	1	1.70	28.747	399.58	33.47	50	0.88%	2.1	47%	0.75	0.00	0.75	0	0.97	0.06	1.01	1.0	0.057	42.04	75.51	0.107	1.89	0.97	0.33	0.80	1.21	1.0	0.035	1.49	49.82	0.091	5.58	3.74	2	1.7	28.817	2.7589	33.469
7.218	5612.38	20.2	0.150	20.2	3.0	1.29	0.74%	Sand-Slime Tailing	0.059	119.0	0.36	0.02	0.34	1	1.70	34.272	476.38	39.84	59	0.76%	2.0	47%	0.76	0.00	0.76	0	0.97	0.06	1.01	1.0	0.056	44.27	84.12	0.118	2.10	0.97	0.36	0.80	1.21	1.0	0.035	1.33	53.04	0.094	5.65	3.87	2	1.7	34.304	3.2842	39.842
7.382	5612.22	19.8	0.235	19.8	2.2	0.97	1.18%	Sand-Slime Tailing	0.059	119.0	0.37	0.03	0.34	1	1.70	33.711	468.58	39.18	57	1.21%	2.2	47%	0.77	0.00	0.77	0	0.97	0.06	1.01	1.0	0.056	44.04	83.22	0.117	2.08	0.97	0.36	0.80	1.20	1.0	0.035	1.55	60.90	0.101	6.00	4.04	2	1.7	33.735	3.2298	39.181
7.546	5612.05	17.7	0.285	17.7	2.4	1.03	1.61%	Sand-Slime Tailing	0.059	119.0	0.38	0.03	0.34	1	1.70	30.022	417.31	34.90	50	1.65%	2.3	47%	0.78	0.00	0.78	0	0.97	0.06	1.01	1.0	0.056	42.54	77.44	0.109	1.94	0.97	0.34	0.80	1.20	1.0	0.035	1.88	65.77	0.106	6.24	4.09	2	1.7	30.047	2.8767	34.898
7.710	5611.89	13.4	0.165	13.3	4.3	1.85	1.24%	Sand-Slime Tailing	0.059	119.0	0.39	0.04	0.35	1	1.70	22.661	314.99	26.37	37	1.27%	2.3	47%	0.79	0.00	0.79	0	0.97	0.06	1.00	1.0	0.056	39.55	65.92	0.095	1.69	0.97	0.30	0.80	1.20	1.0	0.036	2.00	52.82	0.094	5.42	3.56	2	1.7	22.706	2.1739	26.372
7.874	5611.73	9.6	0.188	9.6	6.8	2.93	1.96%	Slime Tailings	0.057	113.1	0.40	0.04	0.35	1	1.70	16.269	226.14	18.98	26	2.04%	2.6	71%	0.80	0.00	0.80	0	0.96	0.05	1.00	1.0	0.056	36.70	55.68	0.083	1.49	0.97	0.25	0.80	1.19	1.0	0.036	3.10	58.76	0.099	5.66	3.57	2	1.7	16.341	1.5645	18.979
8.038	5611.56	13.1	0.151	13.1	10.1	4.39	1.15%	Sand-Slime Tailing	0.059	119.0	0.41	0.05	0.36	1	1.70	22.219	308.84	25.93	36	1.19%	2.3	47%	0.81	0.00	0.81	0	0.96	0.06	1.00	1.0	0.056	39.40	65.33	0.094	1.68	0.96	0.29	0.80	1.19	1.0	0.036	2.00	51.81	0.093	5.25	3.47	2	1.7	22.327	2.1375	25.931
8.202	5611.40	15.0	0.146	15.0	9.8	4.25	0.97%	Sand-Slime Tailing	0.059	119.0	0.42	0.05	0.36	1	1.70	25.449	353.74	29.68	40	1.00%	2.2	47%	0.82	0.00	0.82	0	0.96	0.06	1.00	1.0	0.056	40.71	70.39	0.100	1.79	0.96	0.31	0.80	1.19	1.0	0.036	1.74	51.61	0.093	5.18	3.49	2	1.7	25.553	2.4465	29.678
8.366	5611.23	23.6	0.220	23.6	9.0	3.91	0.93%	Sand-Slime Tailing	0.059	119.0	0.43	0.06	0.37	1	1.70	40.086	557.20	46.67	63	0.95%	2.1	47%	0.83	0.00	0.83	0	0.96	0.07	1.00	1.0	0.056	46.67	93.34	0.132	2.37	0.96	0.39	0.80	1.19	1.0	0.036	1.38	64.29	0.105	5.77	4.07	2	1.7	40.182	3.847	46.669
8.530	5611.07	19.7	0.264	19.7	4.3	1.88	1.34%	Sand-Slime Tailing	0.059	119.0	0.44	0.06	0.37	1	1.70	33.473	465.27	38.93	52	1.37%	2.2	47%	0.84	0.00	0.84	0	0.96	0.06	1.00	1.0	0.056	43.95	82.89	0.117	2.10	0.96	0.36	0.80	1.18	1.0	0.036	1.71	66.71	0.108	5.86	3.98	2	1.7	33.519	3.2091	38.930
8.694	5610.91	18.6	0.186	18.5	5.3	2.28	1.00%	Sand-Slime Tailing	0.059	119.0	0.45	0.07	0.38	1	1.70	31.518	438.10	36.67	48	1.03%	2.2	47%	0.85	0.00	0.85	0	0.96	0.06	1.00	1.0	0.056	43.16	79.83	0.112	2.02	0.96	0.35	0.80	1.18	1.0	0.036	1.60	58.60	0.099	5.31	3.67	2	1.7	31.574	3.0229	36.671
8.858	5610.74	20.2	0.179	20.2	4.2	1.83	0.88%	Sand-Slime Tailing	0.059	119.0	0.46	0.07	0.38	1	1.70	34.340	477.33	39.94	52	0.91%	2.1	47%	0.86	0.00	0.86	0	0.96	0.06	1.00	1.0	0.055	44.31	84.24	0.119	2.14	0.96	0.36	0.80	1.18	1.0	0.036	1.48	59.08	0.099	5.27	3.71	2	1.7	34.385	3.292	39.936
9.022	5610.58	17.5	0.248	17.5	1.3	0.56	1.42%	Sand-Slime Tailing	0.059	119.0	0.46	0.08	0.39	1	1.70	29.750	413.53	34.57	44	1.46%	2.3	47%	0.87	0.00	0.87	0	0.96	0.06	1.00	1.0	0.055	42.43	76.99	0.109	1.96	0.96	0.34	0.80	1.17	1.0	0.036	1.92	66.25	0.107	5.63	3.79	2	1.7	29.764	2.8496	34.569
9.186	5610.41	11.5	0.137	11.5	1.4	0.62	1.19%	Sand-Slime Tailing	0.059	119.0	0.47	0.08	0.39	1	1.70	19.584	272.22	22.76	28	1.24%	2.4	47%	0.88	0.00	0.88	0	0.96	0.05	1.00	1.0	0.055	38.29	61.05	0.089	1.61	0.96	0.28	0.80	1.17	1.0	0.036	2.34	53.38	0.094	4.89	3.25	2	1.7	19.599	1.8764	22.763
9.350	5610.25	8.4	0.124	8.3	6.1	2.63	1.48%	Sand-Slime Tailing	0.059	119.0	0.48	0.09	0.40	1	1.70	14.178	197.07	16.54	20	1.57%	2.6	47%	0.89	0.00	0.89	0	0.96	0.05	1.00	1.0	0.055	36.10	52.64	0.080	1.45	0.96	0.23	0.80	1.17	1.0	0.036	3.27	54.12	0.095	4.87	3.16	2	1.7	14.243	1.3636	16.542
9.514	5610.09	6.6	0.048	6.4	25.6	11.08	0.73%	Slime Tailings	0.057	113.1	0.49	0.09	0.40	1	1.70	10.897	151.47	12.97	15	0.79%	2.5	71%	0.90	0.00	0.90	0	0.95	0.05	1.00	1.0	0.055	34.60	47.58	0.075	1.37	0.96	0.21	0.80	1.17	1.0	0.036	3.01	39.09	0.083	4.20	2.78	2	1.7	11.168	1.0693	12.971
9.678	5609.92	7.3	0.052	7.1	34.6	14.98	0.72%	Sand-Slime Tailing	0.059	119.0	0.50	0.10	0.40	1	1.70	11.985	166.59	14.35	17	0.77%	2.5	47%	0.91	0.00	0.91	0	0.95	0.05	1.00	1.0	0.055	35.33	49.68	0.077	1.40	0.96	0.22	0.80	1.16	1.0	0.036	2.79	40.00	0.083	4.19	2.80	2	1.7	12.352	1.1826	14.346
9.842	5609.76	7.7	0.118	7.4	48.9	21.19	1.54%	Slime Tailings	0.057	113.1	0.51	0.10	0.41	1	1.70	12.529	174.15	15.15	18	1.65%	2.6	71%	0.92	0.00	0.92	0	0.95	0.05	1.00	1.0	0.055	35.36	50.52	0.078	1.42	0.96	0.22	0.80	1.16	1.0	0.036	3.64	55.20	0.096	4.76	3.09	2	1.7	13.048	1.2492	15.154
10.006	5609.59	9.2	0.064	8.8	56.4	24.42	0.70%	Sand-Slime Tailing	0.059	119.0	0.52	0.11	0.41	1	1.70	15.028	208.89	18.15	21	0.74%	2.4	47%	0.93	0.00	0.93	0	0.95	0.05	1.00	1.0	0.055	36.67	54.82	0.082	1.50	0.96	0.25	0.80	1.16	1.0	0.037	2.34	42.55	0.085	4.21	2.86	2	1.7	15.626	1.496	18.149
10.170	5609.43	12.6	0.064	12.5	12.0	5.22	0.51%	Sand-Slime Tailing	0.059	119.0	0.53	0.11	0.42	1	1.70	21.318	296.32	24.91	29	0.53%	2.2	47%	0.94	0.00	0.94	0	0.95	0.06	1.00	1.0	0.055	39.04	63.95	0.092	1.69	0.96	0.29	0.80	1.16	1.0	0.037	1.72	42.73	0.086	4.17	2.93	2	1.7	21.446	2.0532	24.908
10.335	5609.27	10.7	0.069	10.6	15.8	6.85	0.65%	Sand-Slime Tailing	0.059	119.0	0.54	0.12	0.42	1	1.70	17.969	249.77	21.06	24	0.68%	2.3	47%	0.95	0.00	0.95	0	0.95	0.05	0.99	1.0	0.055	37.69	58.75	0.086	1.59	0.96	0.26	0.80	1.15	1.0	0.037	2.09	43.93	0.087	4.17	2.88	2	1.7	18.137	1.7364	21.065
10.499	5609.10	9.8	0.093	9.6	39.8	17.26	0.95%	Sand-Slime Tailing	0.059	119.0	0.55	0.12	0.43	1	1.70	16.235	225.67	19.35	22	1.01%	2.5	47%	0.96	0.00	0.96	0	0.95	0.05	0.99	1.0	0.054	37.09	56.43	0.084	1.54	0.96	0.25	0.80	1.15	1.0	0.037	2.57	49.77	0.091	4.36	2.95	2	1.7	16.658	1.5948	19.347
10.663	5608.94	10.0	0.042	9.7	47.3	20.49	0.42%	Sand-Slime Tailing	0.059	119.0	0.56	0.13	0.43	1	1.70	16.558	230.16	19.81	22	0.44%	2.3	47%	0.97	0.00	0.97	0	0.95	0.05	0.99	1.0	0.054	37.25	57.06	0.085	1.56	0.96	0.26	0.80	1.15	1.0	0.037	1.94	38.50	0.082	3.87	2.72	2	1.7	17.06	1.6333	19.814
10.827	5608.77	11.7	0.072	11.4	46.6	20.18	0.62%	Sand-Slime Tailing	0.059	119.0	0.57	0.13	0.44	1	1.69	19.231	267.31	22.91	25	0.65%	2.3	47%	0.98	0.00	0.98	0	0.95	0.05	0.99	1.0	0.054	38.33	61.24	0.089	1.64	0.96	0.28	0.80	1.15	1.0	0.037	1.97	45.15	0.088	4.09	2.87	2	1.686916	19.721	1.8881	22.905
10.991	5608.61	10.9	0.095	10.4	75.1	32.54	0.87%	Sand-Slime Tailing	0.059	119.0	0.58	0.14	0.44	1	1.69	17.592	244.52	21.35	23	0.92%	2.4	47%	0.99	0.00	0.99	0	0.94	0.05	0.99	1.0	0.054	37.79	59.14	0.087	1.60	0.96	0.27	0.80	1.14	1.0	0.037	2.36	50.32	0.092	4.25	2.93	2	1.68502	18.382	1.7599	21.349
11.155	5608.45	12.8	0.156	12.4	77.1	33.42	1.22%	Sand-Slime Tailing	0.059	119.0	0.59	0.15	0.45	1	1.65	20.356	282.95	24.56	27	1.27%	2.4	47%	1.00	0.00	1.00	0	0.94	0.06	0.99	1.0	0.054	38.92	63.48	0.092	1.70	0.96	0.29	0.80	1.14	1.0	0.037	2.42	59.39	0.099	4.55	3.13	2	1.64827	21.15	2.0249	24.564
11.319	5608.28	18.2	0.117	17.6	85.5	37.06	0.64%	Sand-Slime Tailing	0.059	119.0	0.60	0.15	0.45	1	1.58	27.942	388.40	33.44	39	0.67%	2.1	47%	1.01	0.00	1.01	0	0.94	0.06	0.99	1.0	0.054	42.03	75.46	0.107	1.98	0.96	0.33	0.80	1.14	1.0	0.037	1.55	51.83	0.093	4.21	3.09	2	1.584035	28.788	2.7562	33.436
11.483	5608.12	21.9	0.123	21.8	24.8	10.73	0.56%	Sand-Slime Tailing	0.059	119.0	0.61	0.16	0.45	1	1.55	33.650	467.74	39.36	47	0.58%	2.0	47%	1.02	0.00	1.02	0	0.94	0.06	0.99	1.0	0.054	44.11	83.47	0.117	2.18	0.96	0.36	0.80	1.14	1.0	0.037	1.37	53.90	0.095	4.24	3.21	2	1.545013	33.889	3.2445	39.360
11.647	5607.95	18.8	0.102	18.7	18.8	8.14	0.54%	Sand-Slime Tailing	0.059	119.0	0.62	0.16	0.46	1	1.56	29.097	404.45	34.01	40	0.56%	2.1	47%	1.03	0.00	1.03	0	0.94	0.06	0.99	1.0	0.054	42.23	76.24	0.108	2.00	0.96	0.34	0.80	1.13	1.0	0.037	1.47	50.02	0.092	4.07	3.04	2	1.558511	29.28	2.8033	34.007
11.811	5607.79	17.1	0.083	17.0	30.1	13.06	0.48%	Sand-Slime Tailing	0.059	119.0	0.63	0.17	0.46	1	1.56	26.471	367.95	31.09	36	0.50%	2.1	47%	1.04	0.00	1.04	0	0.94	0.06	0.99	1.0	0.054	41.20	72.29	0.102	1.91	0.96	0.32	0.80	1.13	1.0	0.037	1.51	46.90	0.089	3.92	2.92	2	1.561715	26.765	2.5625	31.086
11.975	5607.63	15.6	0.099	15.4	45.3	19.65	0.63%	Sand-Slime Tailing	0.059	119.0	0.64	0.17	0.47	1	1.56	24.026	333.97	28.42	32	0.66%	2.2	47%	1.05	0.00	1.05	0	0.94	0.06	0.99	1.0	0.054	40.27	68.69	0.098	1.83	0.96	0.31	0.80	1.13	1.0	0.037	1.72	49.00	0.091	3.96	2.89	2	1.564224	24.469	2.3427	28.420

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W7-C

Data File: 13-52106_SP2W7-C-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\.\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend:
- Tailings Sands
- Tailings Sand-Slimes
- Tailings Slimes
- Interim Cover
- Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69

Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5613.10	Water surface elevation during CPT investigation (ft
5611.32	Water surface elevation at t_0 (ft amsl)
5595.40	Water surface elevation at t_1 (ft amsl)
5590.40	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ea
7.51	Equiv. Number of Uniform Strain Cycles, N

5619.60	Ground Surface Elevation at time of CPT (ft amsl)
5626.65	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pl
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
-0.95	Thickness of Random/Platform Fill on top of existing interim cover (ft)
812.44	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5590.40	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5626.4	5626.15	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5624.4	5622.65	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5620.65	5618.65	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	######	5619.13	5619.60	-0.95	0.050	101	0.406	0.430	0.00	0.00	0.406	0.430

2013 CPT Data from ConeTec | CPT Data Interpretations | Conditions at t_1 | Liquefaction Triggering Analyses: Idriss & Boulanger (2008) (Cyclic Stress Ratio, Cyclic Resistance Ratio); Youd et al. (2001) (Cyclic Stress Ratio) | Idriss & Boulanger (2008)

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil. Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil. Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	I&B r_d	I&B C_σ	I&B K_σ	I&B K_α	I&B CSR M=7.5, σ'v=1atm	I&B Δq_{c1n}	I&B q_{c1n-cs}	I&B (CRR) M=7.5, σ'v=1atm	I&B FoS	Youd r_d	Youd D_r	Youd f	Youd K_σ	Youd K_α	Youd CSR M=7.5, σ'v=1atm	Youd Kc	Youd q_{c1n-cs}	Youd (CRR) M=7.5, σ'v=1atm	Youd FoS	Avg FoS	Liquefiable? 1=Yes 2=No	CN	qc1 TSF	qc1 MPa	qc1N
12.139	5607.46	12.7	0.171	12.4	58.5	25.36	1.34%	Sand-Slime Tailing	0.059	119.0	0.65	0.18	0.47	1	1.58	19.546	271.68	23.37	26	1.42%	2.5	47%	1.06	0.00	1.06	0	0.94	0.05	0.99	1.0	0.054	38.50	61.87	0.090	1.68	0.96	0.28	0.80	1.13	1.0	0.037	2.66	62.07	0.102	4.42	3.05	2	1.581356	20.123	1.9266	23.372
12.303	5607.30	13.0	0.141	12.6	69.8	30.26	1.09%	Sand-Slime Tailing	0.059	119.0	0.66	0.18	0.48	1	1.57	19.678	273.52	23.65	26	1.14%	2.4	47%	1.07	0.00	1.07	0	0.94	0.05	0.99	1.0	0.053	38.60	62.24	0.090	1.69	0.95	0.28	0.80	1.12	1.0	0.037	2.41	56.98	0.097	4.16	2.93	2	1.567943	20.361	1.9494	23.648
12.467	5607.13	17.3	0.074	17.2	11.4	4.93	0.43%	Sand-Slime Tailing	0.059	119.0	0.67	0.19	0.48	1	1.52	26.200	364.19	30.56	34	0.44%	2.1	47%	1.07	0.00	1.07	0	0.93	0.06	0.99	1.0	0.053	41.02	71.57	0.102	1.91	0.95	0.32	0.80	1.12	1.0	0.037	1.49	45.52	0.088	3.73	2.82	2	1.520626	26.308	2.5188	30.556
12.631	5606.97	14.6	0.118	14.6	12.4	5.38	0.81%	Sand-Slime Tailing	0.059	119.0	0.68	0.19	0.49	1	1.53	22.293	309.87	26.03	29	0.85%	2.3	47%	1.08	0.00	1.08	0	0.93	0.06	0.99	1.0	0.053	39.43	65.46	0.094	1.77	0.95	0.29	0.80	1.12	1.0	0.038	2.00	52.19	0.093	3.92	2.84	2	1.532171	22.412	2.1457	26.030
12.795	5606.80	14.9	0.109	14.7	29.3	12.70	0.73%	Sand-Slime Tailing	0.059	119.0	0.69	0.20	0.49	1	1.52	22.317	310.21	26.24	29	0.77%	2.3	47%	1.09	0.00	1.09	0	0.93	0.06	0.99	1.0	0.053	39.51	65.75	0.094	1.78	0.95	0.30	0.80	1.12	1.0	0.038	1.93	50.67	0.092	3.83	2.81	2	1.520247	22.595	2.1633	26.243
12.959	5606.64	17.4	0.213	17.4	6.0	2.59	1.23%	Sand-Slime Tailing	0.059	119.0	0.70	0.20	0.50	1	1.49	25.878	359.71	30.12	34	1.28%	2.4	47%	1.10	0.00	1.10	0	0.93	0.06	0.99	1.0	0.053	40.87	70.99	0.101	1.90	0.95	0.32	0.80	1.12	1.0	0.038	2.13	64.14	0.105	4.31	3.11	2	1.491547	25.934	2.4829	30.121
13.123	5606.48	11.4	0.174	11.3	13.4	5.82	1.53%	Sand-Slime Tailing	0.059	119.0	0.71	0.21	0.50	1	1.53	17.252	239.81	20.19	21	1.63%	2.6	47%	1.11	0.00	1.11	0	0.93	0.05	0.99	1.0	0.053	37.38	57.57	0.085	1.61	0.95	0.26	0.80	1.11	1.0	0.038	3.18	64.28	0.105	4.28	2.94	2	1.526744	17.38	1.664	20.186
13.287	5606.32	10.3	0.144	10.2	24.4	10.58	1.40%	Sand-Slime Tailing	0.059	119.0	0.72	0.21	0.51	1	1.52	15.385	213.85	18.14	19	1.50%	2.6	47%	1.12	0.00	1.12	0	0.93	0.05	0.99	1.0	0.053	36.66	54.80	0.082	1.56	0.95	0.25	0.80	1.11	1.0	0.038	3.32	60.28	0.100	4.07	2.81	2	1.515783	15.616	1.4951	18.137
13.451	5606.15	8.1	0.085	7.9	29.0	12.57	1.05%	Sand-Slime Tailing	0.059	119.0	0.73	0.22	0.51	1	1.50	11.935	165.89	14.18	14	1.15%	2.6	47%	1.13	0.00	1.13	0	0.93	0.05	0.99	1.0	0.053	35.27	49.45	0.077	1.46	0.95	0.22	0.80	1.11	1.0	0.038	3.59	50.87	0.092	3.71	2.58	2	1.504999	12.207	1.1687	14.178
13.615	5605.98	8.1	0.071	7.9	37.9	16.43	0.88%	Sand-Slime Tailing	0.059	119.0	0.74	0.22	0.52	1	1.49	11.761	163.48	14.07	14	0.96%	2.6	47%	1.14	0.00	1.14	0	0.93	0.05	0.99	1.0	0.053	35.24	49.31	0.077	1.46	0.95	0.22	0.80	1.11	1.0	0.038	3.38	47.57	0.090	3.57	2.51	2	1.494389	12.115	1.1599	14.070
13.779	5605.82	8.4	0.071	8.2	32.9	14.24	0.85%	Sand-Slime Tailing	0.059	119.0	0.75	0.23	0.52	1	1.48	12.139	168.73	14.45	15	0.93%	2.6	47%	1.15	0.00	1.15	0	0.92	0.05	0.99	1.0	0.053	35.37	49.82	0.077	1.47	0.95	0.22	0.80	1.11	1.0	0.038	3.27	47.31	0.089	3.53	2.50	2	1.483948	12.443	1.1913	14.452
13.943	5605.66	8.9	0.054	8.7	37.7	16.35	0.61%	Sand-Slime Tailing	0.059	119.0	0.76	0.23	0.53	1	1.47	12.806	178.01	15.28	16	0.66%	2.5	47%	1.16	0.00	1.16	0	0.92	0.05	0.99	1.0	0.053	35.66	50.94	0.078	1.49	0.95	0.23	0.80	1.10	1.0	0.038	2.79	42.58	0.085	3.35	2.42	2	1.473672	13.153	1.2593	15.277
14.107	5605.49	11.6	0.101	11.4	38.4	16.62	0.87%	Sand-Slime Tailing	0.059	119.0	0.77	0.24	0.53	1	1.46	16.641	231.30	19.73	20	0.93%	2.5	47%	1.17	0.00	1.17	0	0.92	0.05	0.98	1.0	0.052	37.22	56.96	0.085	1.61	0.95	0.26	0.80	1.10	1.0	0.038	2.59	51.19	0.092	3.59	2.60	2	1.463556	16.991	1.6267	19.734
14.271	5605.33	9.4	0.125	9.3	28.4	12.32	1.32%	Sand-Slime Tailing	0.059	119.0	0.78	0.24	0.53	1	1.45	13.475	187.30	15.95	16	1.44%	2.6	47%	1.18	0.00	1.18	0	0.92	0.05	0.98	1.0	0.052	35.90	51.85	0.079	1.51	0.95	0.23	0.80	1.10	1.0	0.038	3.62	57.81	0.098	3.77	2.64	2	1.453597	13.733	1.3148	15.950
14.436	5605.16	8.8	0.126	8.5	40.5	17.53	1.44%	Sand-Slime Tailing	0.059	119.0	0.79	0.25	0.54	1	1.44	12.287	170.78	14.69	15	1.58%	2.7	47%	1.19	0.00	1.19	0	0.92	0.05	0.98	1.0	0.052	35.45	50.15	0.078	1.48	0.95	0.22	0.80	1.10	1.0	0.038	4.01	58.88	0.099	3.78	2.63	2	1.443792	12.651	1.2112	14.694
14.600	5605.00	11.2	0.094	11.1	28.5	12.36	0.84%	Sand-Slime Tailing	0.059	119.0	0.80	0.25	0.54	1	1.43	15.862	220.48	18.72	19	0.90%	2.5	47%	1.20	0.00	1.20	0	0.92	0.05	0.98	1.0	0.052	36.87	55.59	0.083	1.59	0.95	0.25	0.80	1.10	1.0	0.038	2.68	50.09	0.092	3.47	2.53	2	1.434136	16.117	1.543	18.719
14.764	5604.84	15.3	0.076	15.3	10.5	4.53	0.50%	Sand-Slime Tailing	0.059	119.0	0.81	0.26	0.55	1	1.41	21.493	298.76	25.07	27	0.52%	2.3	47%	1.21	0.00	1.21	0	0.92	0.06	0.98	1.0	0.052	39.09	64.16	0.093	1.78	0.95	0.29	0.80	1.09	1.0	0.038	1.80	45.16	0.088	3.29	2.54	2	1.407553	21.585	2.0666	25.070
14.928	5604.67	15.6	0.127	15.5	13.6	5.87	0.81%	Sand-Slime Tailing	0.059	119.0	0.82	0.26	0.55	1	1.40	21.691	301.51	25.33	27	0.86%	2.3	47%	1.22	0.00	1.22	0	0.92	0.06	0.98	1.0	0.052	39.19	64.52	0.093	1.79	0.95	0.29	0.80	1.09	1.0	0.038	2.10	53.28	0.094	3.51	2.65	2	1.397623	21.809	2.088	25.330
15.092	5604.51	13.7	0.155	13.6	16.5	7.13	1.13%	Sand-Slime Tailing	0.059	119.0	0.82	0.27	0.56	1	1.40	19.062	264.96	22.31	23	1.20%	2.5	47%	1.23	0.00	1.23	0	0.91	0.05	0.98	1.0	0.052	38.12	60.43	0.088	1.70	0.95	0.27	0.80	1.09	1.0	0.038	2.64	58.96	0.099	3.66	2.68	2	1.400566	19.206	1.8387	22.306
15.256	5604.34	17.0	0.133	17.0	4.9	2.14	0.78%	Sand-Slime Tailing	0.059	119.0	0.83	0.27	0.56	1	1.37	23.328	324.26	27.14	29	0.82%	2.3	47%	1.24	0.00	1.24	0	0.91	0.06	0.98	1.0	0.052	39.82	66.96	0.096	1.85	0.95	0.30	0.80	1.09	1.0	0.038	1.98	53.66	0.094	3.46	2.66	2	1.373842	23.37	2.2375	27.143
15.420	5604.18	13.1	0.107	13.1	3.5	1.53	0.82%	Sand-Slime Tailing	0.059	119.0	0.84	0.28	0.57	1	1.39	18.162	252.45	21.13	22	0.87%	2.4	47%	1.25	0.00	1.25	0	0.91	0.05	0.98	1.0	0.052	37.71	58.84	0.087	1.68	0.95	0.27	0.80	1.09	1.0	0.038	2.44	51.47	0.093	3.37	2.52	2	1.387453	18.192	1.7417	21.129
15.584	5604.02	9.6	0.107	9.5	9.3	4.03	1.12%	Sand-Slime Tailing	0.059	119.0	0.85	0.28	0.57	1	1.38	13.129	182.50	15.34	15	1.23%	2.6	47%	1.26	0.00	1.26	0	0.91	0.05	0.98	1.0	0.052	35.68	51.02	0.078	1.52	0.95	0.23	0.80	1.09	1.0	0.038	3.54	54.32	0.095	3.43	2.47	2	1.379148	13.209	1.2647	15.342
15.748	5603.85	9.8	0.122	9.7	17.6	7.63	1.24%	Sand-Slime Tailing	0.059	119.0	0.86	0.29	0.58	1	1.37	13.307	184.97	15.63	16	1.36%	2.6	47%	1.27	0.00	1.27	0	0.91	0.05	0.98	1.0	0.052	35.78	51.41	0.079	1.53	0.95	0.23	0.80	1.08	1.0	0.039	3.65	57.00	0.097	3.49	2.51	2	1.370446	13.458	1.2884	15.630
15.912	5603.69	7.9	0.102	7.7	32.5	14.09	1.29%	Sand-Slime Tailing	0.059	119.0	0.87	0.29	0.58	1	1.36	10.527	146.33	12.55	12	1.44%	2.8	47%	1.28	0.00	1.28	0	0.91	0.05	0.98	1.0	0.052	34.70	47.25	0.075	1.45	0.95	0.20	0.80	1.08	1.0	0.039	4.42	55.40	0.096	3.41	2.43	2	1.361867	10.804	1.0343	12.548
16.076	5603.52	8.2	0.088	7.9	46.7	20.23	1.07%	Sand-Slime Tailing	0.059	119.0	0.88	0.30	0.58	1	1.35	10.719	148.99	12.91	13	1.20%	2.7	47%	1.29	0.00	1.29	0	0.91	0.05	0.98	1.0	0.051	34.83	47.74	0.075	1.46	0.95	0.21	0.80	1.08	1.0	0.039	4.03	52.01	0.093	3.29	2.38	2	1.35341	11.113	1.064	12.908
16.240	5603.36	8.7	0.081	8.3	59.6	25.83	0.93%	Sand-Slime Tailing	0.059	119.0	0.89	0.30	0.59	1	1.35	11.178	155.37	13.56	13	1.04%	2.7	47%	1.30	0.00	1.30	0	0.91	0.05	0.98	1.0	0.051	35.06	48.62	0.076	1.48	0.95	0.21	0.80	1.08	1.0	0.039	3.68	49.89	0.092	3.21	2.35	2	1.345072	11.678	1.1181	13.563
16.404	5603.20	8.6	0.104	8.2	71.5	31.00	1.21%	Sand-Slime Tailing	0.059	119.0	0.90	0.31	0.59	1	1.34	10.935	152.00	13.39	13	1.35%	2.7	47%	1.31	0.00	1.31	0	0.90	0.05	0.98	1.0	0.051	35.00	48.39	0.076	1.48	0.95	0.21	0.80	1.08	1.0	0.039	4.11	54.99	0.095	3.32	2.40	2	1.33685	11.532	1.1041	13.394
16.568	5603.03	9.3	0.138	8.8	83.6	36.24	1.48%	Sand-Slime Tailing	0.059	119.0	0.91	0.31	0.60	1	1.33	11.719	162.90	14.42	14	1.64%	2.7	47%	1.32	0.00	1.32	0	0.90	0.05	0.98	1.0	0.051	35.36	49.78	0.077	1.51	0.94	0.22	0.80	1.08	1.0	0.039	4.21	60.68	0.101	3.48	2.50	2	1.328741	12.413	1.1884	14.417
16.732	5602.87	9.9	0.155	9.3	84.3	36.52	1.57%	Sand-Slime Tailing	0.059	119.0	0.92	0.32	0.60	1	1.32	12.323	171.28	15.12	15	1.74%	2.7	47%	1.33	0.00	1.33	0	0.90	0.05	0.98	1.0	0.051	35.60	50.72	0.078	1.53	0.94	0.22	0.80	1.07	1.0	0.039	4.17	63.04	0.103	3.54	2.54	2	1.320744	13.017	1.2463	15.119
16.896	5602.70	26.6	0.355	26.0	83.4	36.16	1.34%	Sand-Slime Tailing	0.059	119.0	0.93	0.32	0.61	1	1.27	33.013	458.88	39.11	42	1.39%	2.3	47%	1.34	0.00	1.34	0	0.90	0.06	0.97	1.0	0.051	44.02	83.13	0.117	2.31	0.94	0.36	0.80	1.07	1.0	0.039	1.93	75.38	0.120	4.08	3.19	2	1.268264	33.674	3.2239	39.110
17.060	5602.54	17.7	0.388	17.6	16.1	6.97	2.20%	Sand-Slime Tailing	0.059	119.0	0.94	0.33	0.61	1	1.29	22.634	314.61	26.44	27	2.32%	2.6	47%	1.35	0.00	1.35	0	0.90	0.06	0.97	1.0	0.051	39.57	66.01	0.095	1.87	0.94	0.30	0.80	1.07	1.0	0.039	3.20	84.66	0.136	4.61	3.24	2	1.289668	22.763	2.1793	26.438
17.224	5602.38	12.0	0.476	11.8	26.8	11.63	3.97%	Slime Tailings	0.057	113.1	0.95	0.33	0.62	1	1.30	15.332	213.11	18.06	18	4.32%	2.9	71%	1.36	0.00	1.36	0	0.90	0.05	0.98	1.0	0.051	36.38	54.44	0.082	1.62	0.94	0.25	0.80	1.07	1.0	0.039	5.61	101.37	0.177	5.94	3.78	2	1.298185	15.549	1.4887	18.059
17.388	5602.21	14.6	0.394	14.5	24.8	10.76	2.69%	Slime Tailings	0.057	113.1	0.96	0.34	0.62	1	1.29	18.673	259.56	21.92	22	2.88%	2.7	71%	1.37	0.00	1.37	0	0.90	0.05	0.98	1.0	0.051	37.72	59.64	0.087	1.73	0.94	0.27	0.80	1.07	1.0	0.039	4.07	89.16	0.146	4.87	3.30	2	1.288706	18.873	1.8069	21.920
17.552	5602.05	10.6	0.341	10.5	16.3	7.05	3.20%	Slime Tailings	0.057	113.1	0.97	0.34	0.62	1	1.28	13.540	188.21	15.88	15	3.53%	2.9	71%	1.38	0.00	1.38	0	0.90	0.05	0.98	1.0	0.051	35.62	51.49	0.079	1.56	0.94	0.23	0.80	1.07	1.0	0.039	5.55	88.16	0.144	4.76	3.16	2	1.284652	13.671	1.3088	15.878
17.716	5601.88	11.2	0.288	10.8	64.1	27.78	2.57%	Slime Tailings	0.057	113.1	0.98	0.35	0.63	1	1.28	13.790	191.68	16.61	16	2.82%	2.8	71%	1.39	0.00	1.39	0	0.89	0.05	0.98	1.0	0.050	35.87	52.48	0.080	1.58	0.94	0.24	0.80	1.06	1.0	0.039	4.87	80.89	0.129	4.26	2.92	2	1.278005	14.301	1.3692	16.610
17.880	5601.72	12.9	0.210	12.7	33.7	14.62	1.63%	Sand-Slime Tailing	0.059	119.0	0.99	0.36	0.63	1	1.27	16.138	224.31	19.05	19	1.76%	2.6	47%	1.40	0.00	1.40	0	0.89	0.05	0.97	1.0	0.050	36.98	56.04	0.084	1.66	0.94	0.25	0.80	1.06	1.0	0.039	3.58	68.22	0.110	3.58	2.62	2	1.270685	16.405	1.5706	19.054
18.044	5601.56	10.5	0.231	10.2	41.6	18.04	2.20%	Slime Tailings	0.057	113.1	1.00	0.36	0.64	1	1.26	12.920	179.59	15.39	15	2.44%	2.8	71%	1.40	0.00	1.40	0	0.89	0.05	0.98	1.0	0.050	35.45	50.83	0.078	1.56	0.94	0.23	0.80	1.06	1.0	0.039	4.82	74.13	0.118	3.83	2.69	2	1.264201	13.249	1.2684	15.387
18.208	5601.39	9.1	0.184	8.6	70.9	30.71	2.03%	Slime Tailings	0.057	113.1	1.01	0.37	0.64	1	1.26	10.855	150.88	13.25	13	2.28%	2.8	71%	1.41	0.00	1.41	0	0.89	0.05	0.98	1.0	0.050	34.70	47.96	0.076	1.50	0.94	0.21	0.80	1.06	1.0	0.039	5.21	69.03	0.111	3.57	2.54	2	1.257793	11.411	1.0925	13.253
18.372	5601.23	10.2	0.118	9.8	69.3	30.03	1.16%	Sand-Slime Tailing	0.059	119.0	1.02	0.37	0.65	1	1.25	12.220	169.85	14.82	14	1.28%	2.7	47%	1.42	0.00	1.42	0	0.89	0.05	0.98	1.0	0.050	35.50	50.32	0.078	1.55	0.94	0.22	0.80	1.06	1.0	0.039	3.79	56.22	0.097	3.10	2.32	2	1.250732	12.761	1.2217	14.821
18.537	5601.06	10.3	0.159	9.8	81.3	35.24	1.55%	Sand-Slime Tailing	0.059	119.0	1.03	0.38	0.65	1	1.24	12.152	168.91	14.85	14	1.72%	2.7	47%	1.43	0.00	1.43	0	0.89	0.05	0.98	1.0	0.050	35.51	50.36	0.078	1.55	0.94	0.22	0.80	1.06	1.0	0.039	4.27	63.40	0.104	3.31	2.43	2	1.243762	12.783	1.2238	14.847
18.701	5600.90	12.1	0.167	11.4	113.1	49.03	1.38%	Sand-Slime Tailing	0.059	119.0	1.04	0.38	0.66	1	1.24	14.138	196.51	17.43	17	1.50%	2.6	47%	1.44	0.00	1.44	0	0.89	0.05	0.97	1.0	0.050	36.42	53.85	0.081	1.63	0.94	0.24	0.80	1.06	1.0	0.039	3.59	62.60	0.103	3.26	2.44	2	1.236879	15.011	1.4372	17.435
18.865	5600.74	14.0	0.166	13.5	77.6	33.64	1.19%	Sand-Slime Tailing	0.059	119.0	1.05	0.39	0.66	1	1.23	16.569	230.31	19.94	20	1.29%	2.6	47%	1.45	0.00	1.45	0	0.89	0.05	0.97	1.0	0.050	37.29	57.23	0.085	1.70	0.94	0.26	0.80	1.05	1.0	0.039	3.05	60.77	0.101	3.17	2.44	2	1.230082	17.165	1.6434	19.936
19.029	5600.57	13.9	0.222	13.5	75.7	32.80	1.59%	Sand-Slime Tailing	0.059	119.0	1.06	0.39	0.67	1	1.22	16.479	229.06	19.81	19	1.72%	2.6	47%	1.46	0.00	1.46	0	0.88	0.05	0.97	1.0	0.050	37.25	57.06	0.085	1.70	0.94	0.26	0.80	1.05	1.0	0.039	3.48	68.88	0.110	3.45	2.58	2	1.22337	17.057	1.633	19.811
19.193	5600.41	14.2	0.182	13.9	41.6	18.02	1.28%	Sand-Slime Tailing	0.059	119.0	1.07	0.40	0.67	1	1.22	16.937	235.42	20.04	20	1.39%	2.6	47%	1.47	0.00	1.47	0	0.88	0.05	0.97	1.0	0.050	37.33	57.37	0.085	1.71	0.94	0.26	0.80	1.05	1.0	0.039	3.14	62.99	0.103	3.21	2.46	2	1.216741	17.253	1.6518	20.038
19.357	5600.24	12.2	0.148	11.8	73.0	31.64	1.21%	Sand-Slime Tailing	0.059	119.0	1.08	0.40	0.67	1	1.21	14.220	197.65	17.16	16	1.33%	2.6	47%	1.48	0.00	1.48	0	0.88	0.05	0.97	1.0	0.050	36.32	53.47	0.081	1.63	0.94	0.24	0.80	1.05	1.0	0.039	3.47	59.53	0.100	3.07	2.35	2	1.210193	14.771	1.4142	17.156
19.521	5600.08	10.5	0.113	9.8	106.9	46.30	1.08%	Sand-Slime Tailing	0.059	119.0	1.09	0.41	0.68	1	1.20	11.845	164.64	14.69	14	1.20%	2.7	47%	1.49	0.00	1.49	0	0.88	0.05	0.97	1.0	0.050	35.45	50.14	0.078	1.57	0.94	0.22	0.80	1.05	1.0	0.039	3.75	55.14	0.096	2.93	2.25	2	1.203725	12.648	1.2109	14.689
19.685	5599.92	10.6	0.200	9.8	131.7	57.08	1.89%	Slime Tailings	0.057	113.1	1.09	0.41	0.68	1	1.20	11.716	162.86	14.75	14	2.10%	2.8	71%	1.50	0.00	1.50	0	0.88	0.05	0.97	1.0	0.049	35.22	49.98	0.077	1.57	0.94	0.22	0.80	1.05	1.0	0.039	4.71	69.55	0.111	3.39	2.48	2	1.197992	12.702	1.216	14.752
19.849	5599.75	36.3	0.300	35.3	156.8	67.96	0.83%	Sand Tailings	0.062	123.5	1.10	0.42	0.69	1	1.15	40.813	567.29	48.71	51	0.85%	2.1	18%	1.51	0.00	1.51	0	0.88	0.07	0.96	1.0	0.049	34.54	83.26	0.117	2.40	0.94	0.40	0.80	1.05	1.0	0.040	1.46	71.18	0.114	3.44	2.92	2	1.154854	41.943	4.0156	48.715
20.013	5599.59	33.0	0.456	32.9	14.8	6.43	1.38%	Sand-Slime Tailing	0.059	119.0	1.11	0.42	0.69	1	1.15	37.997	528.16	44.26	46	1.43%	2.3	47%	1.52	0.00	1.52	0	0.88	0.07	0.96	1.0	0.049	45.82	90.08	0.127	2.61	0.94	0.38	0.80	1.04	1.0	0.040	1.86	82.24	0.132	3.96	3.29	2	1.154221	38.104	3.6481	44.255
20.177	5599.42	18.7	0.520	18.6	13.8	5.96	2.78%	Slime Tailings	0.057	113.1	1.12	0.43	0.70	1	1.17	21.803	303.07	25.44	25	2.96%	2.7	71%	1.53	0.00	1.53	0	0.87	0.06	0.97	1.0	0.049	38.95	64.39	0.093	1.90	0.94	0.29	0.80	1.04	1.0	0.040	3.80	96.63	0.164	4.90	3.40	2	1.17223	21.904	2.0971	25.440
20.341	5599.26	13.7	0.464	13.5	40.0	17.35	3.39%	Slime Tailings	0.057	113.1	1.13	0.43	0.70	1	1.17	15.789	219.47	18.68	18	3.69%	2.8	71%	1.54	0.00	1.54	0	0.87	0.05	0.97	1.0	0.049	36.59	55.27	0.083	1.69	0.94	0.25	0.80	1.04	1.0	0.040	5.20	97.17	0.165	4.92	3.30	2	1.173927	16.083	1.5398	18.679
20.505	5599.10	11.5	0.373	11.1	62.3	27.01	3.25%	Slime Tailings	0.057	113.1	1.14	0.44	0.71	1	1.17	12.959	180.13	15.58	15	3.61%	2.9	71%	1.55	0.00	1.55	0	0.87	0.05	0.97	1.0	0.049	35.51	51.09	0.079	1.60	0.94	0.23	0.80	1.04	1.0	0.040	5.80	90.30	0.148	4.39	3.00	2	1.168511	13.413	1.2842	15.579
20.669	5598.93	12.4	0.338	11.7	107.6	46.62	2.73%	Slime Tailings	0.057	113.1	1.15	0.44	0.71	1	1.16	13.644	189.65	16.75	16	3.00%	2.8	71%	1.56	0.00	1.56	0	0.87	0.05	0.97	1.0	0.049	35.92	52.68	0.080	1.64	0.94	0.24	0.80	1.04	1.0	0.040	5.09	85.21	0.138	4.05	2.84	2	1.163152	14.425	1.3811	16.754
20.833	5598.77	13.3	0.244	12.9	67.9	29.44	1.84%	Sand-Slime Tailing	0.059	119.0	1.16	0.45	0.71	1	1.16	14.894	207.02	17.87	17	2.01%	2.7	47%	1.57	0.00	1.57	0	0.87	0.05	0.97	1.0	0.049	36.57	54.44	0.082	1.68	0.93	0.24	0.80	1.04	1.0	0.040	4.06	72.57	0.116	3.38	2.53	2	1.157241	15.385	1.4729	17.868
20.997	5598.60	15.3	0.235	15.0	45.2	19.60	1.54%	Sand-Slime Tailing	0.059	119.0	1.17	0.45	0.72	1	1.15	17.248	239.75	20.41	20	1.67%	2.6	47%	1.58	0.00	1.58	0	0.87	0.05	0.97	1.0	0.049	37.46	57.87	0.086	1.76	0.93	0.26	0.80	1.04	1.0	0.040	3.40	69.41	0.111	3.23	2.49	2	1.151398	17.573	1.6824	20.410
21.161	5598.44	18.4	0.276	18.0	52.8	22.87	1.50%	Sand-Slime Tailing	0.059	119.0	1.18	0.46	0.72	1	1.14	20.588	286.17	24.35	24	1.61%	2.5	47%	1.59	0.00	1.59	0	0.87	0.06	0.97	1.0	0.048	38.84	63.19	0.091	1.89	0.93	0.28	0.80	1.04	1.0	0.040	2.94	71.66	0.114	3.30	2.59	2	1.141217	20.964	2.0071	24.348
21.325	5598.27	17.9	0.231	17.7	21.2	9.20	1.29%	Sand-Slime Tailing	0.059	119.0	1.19	0.46	0.73	1	1.14	20.141	279.96	23.57	23	1.39%	2.5	47%	1.60	0.00	1.60	0	0.87	0.05	0.97	1.0	0.048	38.57	62.13	0.090	1.87	0.93	0.28	0.80	1.03	1.0	0.040	2.83	66.67	0.108	3.09	2.48	2	1.136632	20.292	1.9427	23.568
21.489	5598.11	12.3	0.171	12.1	31.8	13.76	1.39%	Sand-Slime Tailing	0.059	119.0	1.20	0.47	0.73	1	1.13	13.736	190.93	16.21	15	1.54%	2.7	47%	1.61	0.00	1.61	0	0.86	0.05	0.97	1.0	0.048	35.99	52.20	0.080	1.65	0.93	0.23	0.80	1.03	1.0	0.040	3.91	63.32	0.104	2.96	2.30	2	1.134265	13.961	1.3366	16.215
21.653	5597.95	9.4	0.173	9.0	70.1	30.36	1.84%	Slime Tailings	0.057	113.1	1.21	0.47	0.74	1	1.13	10.141	140.96	12.35	11	2.11%	2.9	71%	1.62	0.00	1.62	0	0.86	0.05	0.97	1.0	0.048	34.39	46.74	0.074	1.54	0.93	0.20	0.80	1.03	1.0	0.040	5.44	67.21	0.108	3.07	2.31	2	1.129256	10.635	1.0182	12.351
21.817	5597.78	10.2	0.308	9.6	109.8	47.60	3.01%	Slime Tailings	0.057	113.1	1.22	0.48	0.74	1	1.12	10.748	149.40	13.38	12	3.41%	3.0	71%	1.63	0.00	1.63	0	0.86	0.05	0.97	1.0	0.048	34.75	48.13	0.076	1.57	0.93	0.21	0.80	1.03	1.0	0.040	6.30	84.34	0.136	3.84	2.70	2	1.124297	11.519	1.1028	13.379
21.981	5597.62	16.3	0.494	15.9	55.4	24.01	3.04%	Slime Tailings	0.057	113.1	1.23	0.48	0.75	1	1.12	17.829	247.82	21.16	20	3.28%	2.8	71%	1.63	0.00	1.63	0	0.86	0.05	0.97	1.0	0.048	37.46	58.61	0.086	1.80	0.93	0.27	0.80	1.03	1.0	0.040	4.58	96.83	0.164	4.62	3.21	2	1.119211	18.216	1.744	21.157
22.145	5597.45	14.7	0.580	14.5	37.9	16.40	3.94%	Slime Tailings	0.057	113.1	1.24	0.49	0.75	1	1.11	16.127	224.17	19.04	18	4.31%	2.9	71%	1.64	0.00	1.64	0	0.86	0.05	0.97	1.0	0.048	36.72	55.75	0.083	1.74	0.93	0.25	0.80	1.03	1.0	0.040	5.59	106.43	0.192	5.37	3.55	2	1.114527	16.391	1.5692	19.037
22.309	5597.29	15.8	0.533	15.5	43.5	18.86	3.38%	Slime Tailings	0.057	113.1	1.25	0.49	0.75	1	1.11	17.189	238.93	20.31	19	3.67%	2.8	71%	1.65	0.00	1.65	0	0.86	0.05	0.97	1.0	0.048	37.16	57.48	0.085	1.78	0.93	0.26	0.80	1.03	1.0	0.040	4.97	100.99	0.176	4.89	3.33	2	1.109714	17.491	1.6746	20.315
22.473	5597.13	14.0	0.457	13.9	15.6	6.74	3.26%	Slime Tailings	0.057	113.1	1.26	0.50	0.76	1	1.10	15.381	213.79	17.99	17	3.58%	2.9	71%	1.66	0.00	1.66	0	0.86	0.05	0.97	1.0	0.048	36.35	54.34	0.082	1.71	0.93	0.24	0.80	1.03	1.0	0.040	5.32	95.70	0.162	4.47	3.09	2	1.104948	15.488	1.4828	17.989
22.638	5596.96	22.3	0.455	22.1	22.5	9.75	2.04%	Sand-Slime Tailing	0.059	119.0	1.27	0.50	0.76	1	1.09	24.213	336.55	28.30	28	2.17%	2.6	47%	1.67	0.00	1.67	0	0.85	0.06	0.96	1.0	0.048	40.23	68.53	0.098	2.06	0.93	0.31	0.80	1.02	1.0	0.040	3.07	87.01	0.141	3.89	2.97	2	1.093612	24.366	2.3328	28.300
22.802	5596.80	17.6	0.383	17.4	21.7	9.38	2.18%	Sand-Slime Tailing	0.059	119.0	1.28	0.51	0.77	1	1.09	19.057	264.90	22.31	21	2.35%	2.7	47%	1.68	0.00	1.68	0	0.85	0.05	0.96	1.0	0.048	38.12	60.43	0.088	1.86	0.93	0.27	0.80	1.02	1.0	0.040	3.78	84.25	0.136	3.71	2.78	2	1.093357	19.205	1.8387	22.305
22.966	5596.63	11.2	0.327	10.7	70.0	30.33	2.93%	Slime Tailings	0.057	113.1	1.28	0.51	0.77	1	1.09	11.705	162.70	14.15	13	3.31%	2.9	71%	1.69	0.00	1.69	0	0.85	0.05	0.97	1.0	0.048	35.01	49.16	0.077	1.61	0.93	0.22	0.80	1.02	1.0	0.040	6.03	85.32	0.138	3.75	2.68	2	1.089866	12.181	1.1662	14.148
23.130	5596.47	11.9	0.236	11.3	90.3	39.11	1.99%	Sand-Slime Tailing	0.059	119.0	1.29	0.52	0.78	1	1.08	12.269	170.54	14.96	14	2.23%	2.8	47%	1.70	0.00	1.70	0	0.85	0.05	0.97	1.0	0.048	35.55	50.51	0.078	1.64	0.93	0.22	0.80	1.02	1.0	0.040	4.90	73.26	0.117	3.16	2.40	2	1.084767	12.88	1.2331	14.959
23.294	5596.31	13.5	0.214	12.9	103.9	45.01	1.59%	Sand-Slime Tailing	0.059	119.0	1.30	0.52	0.78	1	1.08	13.874	192.85	16.93	16	1.75%	2.7	47%	1.71	0.00	1.71	0	0.85	0.05	0.97	1.0	0.047	36.24	53.17	0.081	1.70	0.93	0.24	0.80	1.02	1.0	0.040	4.04	68.45	0.110	2.96	2.33	2	1.079723	14.575	1.3954	16.927
23.458	5596.14	12.3	0.222	11.8	82.8	35.86	1.80%	Sand-Slime Tailing	0.059	119.0	1.31	0.53	0.79	1	1.07	12.714	176.73	15.41	14	2.01%	2.8	47%	1.72	0.00	1.72	0	0.85	0.05	0.97	1.0	0.047	35.71	51.12	0.079	1.66	0.93	0.23	0.80	1.02	1.0	0.040	4.60	70.84	0.113	3.04	2.35	2	1.074732	13.269	1.2704	15.411
23.622	5595.98	10.7	0.234	10.1	92.5	40.09	2.19%	Slime Tailings	0.057	113.1	1.32	0.53	0.79	1	1.07	10.821	150.41	13.29	12	2.50%	2.9	71%	1.73	0.00	1.73	0	0.85	0.05	0.97	1.0	0.047	34.71	48.00	0.076	1.60	0.92	0.21	0.80	1.02	1.0	0.040	5.61	74.52	0.118	3.17	2.38	2	1.0703	11.439	1.0952	13.286
23.786	5595.81	17.2	0.313	16.6	101.1	43.81	1.82%	Sand-Slime Tailing	0.059	119.0	1.33	0.54	0.79	1	1.07	17.630	245.06	21.26	20	1.98%	2.6	47%	1.74	0.00	1.74	0	0.85	0.05	0.96	1.0	0.047	37.76	59.01	0.087	1.84	0.92	0.27	0.80	1.02	1.0	0.040	3.63	77.06	0.123	3.27	2.56	2	1.065253	18.302	1.7523	21.257
23.950	5595.65	18.0	0.305	17.9	11.3	4.88	1.70%	Sand-Slime Tailing	0.059	119.0	1.34	0.54	0.80	1	1.06	18.952	263.44	22.10	21	1.84%	2.6	47%	1.75	0.00	1.75	0	0.84	0.05	0.96	1.0	0.047	38.05	60.15	0.088	1.88	0.92	0.27	0.80	1.02	1.0	0.040	3.41	75.45	0.120	3.18	2.53	2	1.059964	19.027	1.8216	22.098

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2W7-C

Data File: 13-52106_SP2W7-C-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3 Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5613.10	Water surface elevation during CPT investigation (f
5611.32	Water surface elevation at t_0 (ft amsl)
5595.40	Water surface elevation at t_1 (ft amsl)
5590.40	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ea
7.51	Equiv. Number of Uniform Strain Cycles, N

5619.60	Ground Surface Elevation at time of CPT (ft amsl)
5626.65	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pl
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
-0.95	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
812.44	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5590.40	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5626.4	5626.15	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5624.4	5622.65	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5620.65	5618.65	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	######	5619.13	5619.60	-0.95	0.050	101	0.406	0.430	0.00	0.00	0.406	0.430

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %
24.114	5595.49	13.6	0.288	13.4	40.7	17.64	2.12%	Sand-Slime Tailing	0.059	119.0	1.35	0.55	0.80	1	1.06	14.105	196.06	16.69	15	2.35%	2.8	47%
24.278	5595.32	19.1	0.356	18.5	95.5	41.38	1.87%	Sand-Slime Tailing	0.059	119.0	1.36	0.55	0.81	1	1.05	19.383	269.43	23.24	22	2.01%	2.6	47%
24.442	5595.16	19.8	0.406	19.6	24.9	10.80	2.05%	Sand-Slime Tailing	0.059	119.0	1.37	0.56	0.81	1	1.05	20.495	284.88	23.99	23	2.21%	2.6	47%
24.606	5594.99	17.4	0.456	17.3	12.2	5.27	2.62%	Slime Tailings	0.057	113.1	1.38	0.56	0.82	1	1.04	18.050	250.89	21.06	20	2.85%	2.7	71%
24.770	5594.83	12.0	0.315	11.9	21.2	9.17	2.62%	Slime Tailings	0.057	113.1	1.39	0.57	0.82	1	1.04	12.353	171.70	14.51	13	2.96%	2.9	71%
24.934	5594.67	10.2	0.249	9.9	49.0	21.21	2.45%	Slime Tailings	0.057	113.1	1.40	0.58	0.83	1	1.03	10.195	141.71	12.21	11	2.84%	3.0	71%
25.098	5594.50	10.1	0.244	9.6	79.6	34.51	2.41%	Slime Tailings	0.057	113.1	1.41	0.58	0.83	1	1.03	9.897	137.57	12.09	10	2.81%	3.0	71%
25.262	5594.34	14.2	0.261	14.1	10.4	4.50	1.84%	Sand-Slime Tailing	0.059	119.0	1.42	0.59	0.83	1	1.03	14.489	201.40	16.91	15	2.04%	2.7	47%
25.426	5594.17	14.1	0.415	13.8	52.2	22.60	2.93%	Slime Tailings	0.057	113.1	1.43	0.59	0.84	1	1.02	14.116	196.21	16.78	15	3.26%	2.9	71%
25.590	5594.01	15.1	0.371	15.0	20.2	8.75	2.46%	Slime Tailings	0.057	113.1	1.44	0.60	0.84	1	1.02	15.231	211.72	17.84	16	2.72%	2.8	71%
25.754	5593.85	12.5	0.387	12.0	70.3	30.45	3.10%	Slime Tailings	0.057	113.1	1.45	0.60	0.85	1	1.01	12.203	169.62	14.69	13	3.51%	2.9	71%
25.918	5593.68	15.4	0.224	15.0	51.8	22.46	1.46%	Sand-Slime Tailing	0.059	119.0	1.46	0.61	0.85	1	1.01	15.169	210.85	18.00	16	1.61%	2.7	47%
26.082	5593.52	20.6	0.226	20.5	15.0	6.51	1.10%	Sand-Slime Tailing	0.059	119.0	1.47	0.61	0.86	1	1.00	20.609	286.46	24.05	22	1.18%	2.5	47%
26.246	5593.35	17.9	0.228	17.7	30.6	13.24	1.27%	Sand-Slime Tailing	0.059	119.0	1.48	0.62	0.86	1	1.00	17.733	246.48	20.82	19	1.39%	2.6	47%
26.410	5593.19	13.3	0.303	13.1	41.9	18.16	2.27%	Slime Tailings	0.057	113.1	1.49	0.62	0.86	1	1.00	13.030	181.12	15.44	14	2.56%	2.8	71%
26.574	5593.03	12.3	0.204	11.9	75.2	32.58	1.65%	Sand-Slime Tailing	0.059	119.0	1.50	0.63	0.87	1	0.99	11.774	163.66	14.22	12	1.88%	2.8	47%
26.739	5592.86	21.0	0.154	20.8	25.1	10.86	0.73%	Sand-Slime Tailing	0.059	119.0	1.51	0.63	0.87	1	0.99	20.610	286.48	24.12	22	0.79%	2.4	47%
26.903	5592.70	21.7	0.157	21.6	16.6	7.20	0.72%	Sand-Slime Tailing	0.059	119.0	1.51	0.64	0.88	1	0.99	21.287	295.89	24.84	23	0.78%	2.4	47%
27.067	5592.53	21.5	0.222	21.4	21.0	9.11	1.03%	Sand-Slime Tailing	0.059	119.0	1.52	0.64	0.88	1	0.98	20.946	291.15	24.48	23	1.11%	2.5	47%
27.231	5592.37	20.3	0.256	20.2	23.1	10.02	1.26%	Sand-Slime Tailing	0.059	119.0	1.53	0.65	0.89	1	0.98	19.734	274.30	23.08	21	1.36%	2.5	47%
27.395	5592.21	26.5	0.406	26.3	23.6	10.23	1.53%	Sand-Slime Tailing	0.059	119.0	1.54	0.65	0.89	1	0.97	25.657	356.63	29.97	28	1.63%	2.5	47%
27.559	5592.04	19.7	0.516	19.6	24.8	10.73	2.61%	Sand-Slime Tailing	0.059	119.0	1.55	0.66	0.90	1	0.97	18.972	263.71	22.21	20	2.84%	2.7	47%
27.723	5591.88	15.4	0.486	15.2	25.6	11.08	3.16%	Slime Tailings	0.057	113.1	1.56	0.66	0.90	1	0.97	14.708	204.44	17.26	15	3.51%	2.9	71%
27.887	5591.71	13.0	0.486	12.8	45.1	19.56	3.73%	Slime Tailings	0.057	113.1	1.57	0.67	0.91	1	0.96	12.270	170.56	14.57	13	4.24%	3.0	71%
28.051	5591.55	11.8	0.486	11.3	75.6	32.75	4.13%	Slime Tailings	0.057	113.1	1.58	0.67	0.91	1	0.96	10.818	150.37	13.09	11	4.77%	3.1	71%

Conditions at t_1 / Liquefaction Triggering Analyses – Idriss & Boulanger (2008)

Depth at time of CPT (ft)	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	Cyclic Stress Ratio r_d	C_σ	K_σ	K_a	CSR M=7.5, s'v=1atm	Cyclic Resistance Ratio Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS
24.114	1.76	0.00	1.76	0	0.84	0.05	0.96	1.0	0.047	36.16	52.85	0.080	1.71
24.278	1.77	0.00	1.77	1	0.84	0.05	0.96	1.0	0.047	38.45	61.69	0.090	1.92
24.442	1.78	0.01	1.77	1	0.84	0.06	0.96	1.0	0.047	38.72	62.71	0.091	1.94
24.606	1.79	0.01	1.78	1	0.84	0.05	0.96	1.0	0.047	37.42	58.48	0.086	1.84
24.770	1.80	0.02	1.78	1	0.84	0.05	0.96	1.0	0.047	35.14	49.65	0.077	1.64
24.934	1.81	0.02	1.78	1	0.84	0.05	0.97	1.0	0.047	34.34	46.55	0.074	1.57
25.098	1.82	0.03	1.79	1	0.83	0.05	0.97	1.0	0.047	34.30	46.39	0.074	1.57
25.262	1.83	0.03	1.79	1	0.83	0.05	0.96	1.0	0.047	36.23	53.14	0.081	1.71
25.426	1.83	0.04	1.80	1	0.83	0.05	0.96	1.0	0.047	35.93	52.71	0.080	1.70
25.590	1.84	0.04	1.80	1	0.83	0.05	0.96	1.0	0.047	36.30	54.14	0.082	1.73
25.754	1.85	0.05	1.80	1	0.83	0.05	0.96	1.0	0.047	35.20	49.89	0.077	1.63
25.918	1.86	0.05	1.81	1	0.83	0.05	0.96	1.0	0.047	36.61	54.61	0.082	1.73
26.082	1.87	0.06	1.81	1	0.83	0.06	0.96	1.0	0.047	38.73	62.78	0.091	1.92
26.246	1.88	0.06	1.82	1	0.82	0.05	0.96	1.0	0.047	37.60	58.42	0.086	1.82
26.410	1.89	0.07	1.82	1	0.82	0.05	0.96	1.0	0.048	35.46	50.90	0.078	1.65
26.574	1.90	0.07	1.83	1	0.82	0.05	0.96	1.0	0.048	35.29	49.50	0.077	1.62
26.739	1.91	0.08	1.83	1	0.82	0.06	0.96	1.0	0.047	38.76	62.88	0.091	1.92
26.903	1.92	0.08	1.84	1	0.82	0.06	0.96	1.0	0.047	39.01	63.86	0.092	1.94
27.067	1.93	0.09	1.84	1	0.82	0.06	0.96	1.0	0.047	38.89	63.36	0.092	1.93
27.231	1.94	0.09	1.85	1	0.82	0.05	0.96	1.0	0.048	38.40	61.48	0.090	1.88
27.395	1.95	0.10	1.85	1	0.82	0.06	0.96	1.0	0.047	40.81	70.78	0.101	2.12
27.559	1.96	0.10	1.86	1	0.81	0.05	0.96	1.0	0.048	38.09	60.30	0.088	1.85
27.723	1.97	0.11	1.86	1	0.81	0.05	0.96	1.0	0.048	36.10	53.36	0.081	1.69
27.887	1.98	0.12	1.86	1	0.81	0.05	0.96	1.0	0.048	35.16	49.73	0.077	1.61
28.051	1.99	0.12	1.87	1	0.81	0.05	0.96	1.0	0.048	34.65	47.74	0.075	1.57

Liquefaction Triggering Analyses – Youd et al. (2001) / Idriss & Boulanger (2008)

Depth at time of CPT (ft)	Cyclic Stress Ratio r_d	D_r	f	K_σ	K_a	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	Idriss & Boulanger (2008) CN	qc1 TSF	qc1 MPa	qc1N
24.114	0.92	0.24	0.80	1.01	1.0	0.040	4.66	77.81	0.124	3.27	2.49	2	1.055773	14.373	1.3761	16.694
24.278	0.92	0.28	0.80	1.01	1.0	0.040	3.44	79.99	0.128	3.35	2.63	2	1.050021	20.009	1.9157	23.240
24.442	0.92	0.28	0.80	1.01	1.0	0.040	3.52	84.43	0.136	3.55	2.74	2	1.045128	20.658	1.9778	23.993
24.606	0.92	0.26	0.80	1.01	1.0	0.040	4.35	91.61	0.151	3.92	2.88	2	1.042144	18.129	1.7357	21.056
24.770	0.92	0.22	0.80	1.01	1.0	0.040	5.71	82.84	0.133	3.42	2.53	2	1.038033	12.49	1.1958	14.506
24.934	0.91	0.20	0.80	1.01	1.0	0.040	6.33	77.25	0.123	3.14	2.36	2	1.033939	10.511	1.0063	12.207
25.098	0.91	0.20	0.80	1.01	1.0	0.041	6.34	76.70	0.122	3.10	2.33	2	1.029881	10.409	0.9966	12.090
25.262	0.91	0.24	0.80	1.01	1.0	0.041	4.37	73.93	0.118	2.97	2.34	2	1.025398	14.555	1.3935	16.905
25.426	0.91	0.24	0.80	1.01	1.0	0.041	5.42	91.00	0.150	3.76	2.73	2	1.021415	14.449	1.3833	16.781
25.590	0.91	0.24	0.80	1.00	1.0	0.041	4.79	85.43	0.138	3.44	2.58	2	1.017468	15.36	1.4705	17.839
25.754	0.91	0.22	0.80	1.00	1.0	0.041	6.13	90.06	0.148	3.67	2.65	2	1.013556	12.648	1.2109	14.690
25.918	0.91	0.24	0.80	1.00	1.0	0.041	3.79	68.14	0.109	2.69	2.21	2	1.009233	15.495	1.4835	17.997
26.082	0.90	0.28	0.80	1.00	1.0	0.041	2.68	64.55	0.105	2.57	2.25	2	1.004823	20.703	1.9821	24.046
26.246	0.90	0.26	0.80	1.00	1.0	0.041	3.20	66.52	0.107	2.61	2.21	2	1.000711	17.924	1.716	20.817
26.410	0.90	0.23	0.80	1.00	1.0	0.041	5.18	79.94	0.128	3.08	2.36	2	0.996943	13.291	1.2725	15.437
26.574	0.90	0.22	0.80	1.00	1.0	0.041	4.83	68.70	0.110	2.64	2.13	2	0.99278	12.24	1.1719	14.216
26.739	0.90	0.28	0.80	1.00	1.0	0.041	2.30	55.56	0.096	2.29	2.10	2	0.988954	20.765	1.988	24.117
26.903	0.90	0.29	0.80	1.00	1.0	0.042	2.24	55.75	0.096	2.28	2.11	2	0.985064	21.389	2.0478	24.842
27.067	0.90	0.29	0.80	0.99	1.0	0.042	2.60	63.68	0.104	2.45	2.19	2	0.981089	21.075	2.0177	24.477
27.231	0.90	0.28	0.80	0.99	1.0	0.042	2.95	68.20	0.110	2.56	2.22	2	0.976931	19.875	1.9028	23.084
27.395	0.89	0.32	0.80	0.99	1.0	0.042	2.66	79.84	0.127	2.96	2.54	2	0.974439	25.801	2.4701	29.966
27.559	0.89	0.27	0.80	0.99	1.0	0.042	4.26	94.50	0.158	3.66	2.76	2	0.968933	19.122	1.8307	22.208
27.723	0.89	0.24	0.80	0.99	1.0	0.042	5.57	96.13	0.163	3.73	2.71	2	0.965107	14.862	1.4229	17.262
27.887	0.89	0.22	0.80	0.99	1.0	0.042	6.77	98.65	0.169	3.87	2.74	2	0.961637	12.541	1.2007	14.566
28.051	0.89	0.21	0.80	0.99	1.0	0.042	7.64	100.00	0.173	3.93	2.75	2	0.958196	11.27	1.079	13.090

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2E1

Data File: 13-52106_SP2E1-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)

Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69

Youd, et al (2001)

Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5613.10	Water surface elevation during CPT investigation (ft amsl)
5611.67	Water surface elevation at t_0 (ft amsl)
5595.46	Water surface elevation at t_1 (ft amsl)
5590.46	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earth
7.51	Equiv. Number of Uniform Strain Cycles, N

5619.95	Ground Surface Elevation at time of CPT (ft amsl)
5630.46	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after plac
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
2.51	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1160.95	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5590.46	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5630.21	5629.96	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5628.21	5626.46	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5624.46	5622.46	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	######	5621.21	5619.95	2.51	0.050	101	0.580	0.517	0.00	0.00	0.580	0.517

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil. Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %
0.164	5619.79	13.5	0.057	13.5	-0.0	-0.01	0.42%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	22.933	318.77	26.63	1632	0.42%	0.9	51%
0.328	5619.62	36.9	0.160	36.9	0.1	0.05	0.43%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	62.713	871.71	72.84	2232	0.43%	0.9	51%
0.492	5619.46	45.5	0.725	45.5	0.2	0.09	1.59%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	77.333	1074.93	89.82	1834	1.59%	1.4	51%
0.656	5619.29	78.6	0.721	78.6	0.4	0.19	0.92%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	133.671	1858.03	155.26	2379	0.92%	1.2	51%
0.820	5619.13	133.5	1.017	133.5	1.1	0.48	0.76%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	226.865	3153.42	263.50	3230	0.76%	1.1	51%
0.984	5618.97	159.6	1.857	159.6	1.1	0.48	1.16%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	271.388	3772.29	315.21	3220	1.16%	1.3	51%
1.148	5618.80	202.0	1.570	202.0	1.5	0.66	0.78%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	343.332	4772.31	398.78	3491	0.78%	1.1	51%
1.312	5618.64	282.1	2.962	282.1	2.0	0.85	1.05%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	479.536	6665.55	556.98	4267	1.05%	1.3	51%
1.476	5618.47	258.6	3.915	258.6	2.8	1.19	1.51%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	439.552	6109.77	510.55	3477	1.51%	1.4	51%
1.640	5618.31	203.5	4.263	203.5	3.0	1.31	2.09%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	345.933	4808.47	401.82	2462	2.10%	1.5	51%
1.804	5618.15	196.8	3.157	196.7	3.4	1.46	1.60%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	334.441	4648.73	388.47	2164	1.61%	1.4	51%
1.968	5617.98	198.9	2.435	198.9	3.1	1.34	1.22%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	338.113	4699.77	392.74	2005	1.22%	1.3	51%
2.133	5617.82	169.5	1.671	169.5	3.4	1.46	0.99%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	288.167	4005.52	334.73	1578	0.99%	1.2	51%
2.297	5617.65	152.5	1.369	152.5	3.4	1.45	0.90%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	258.952	3599.44	300.80	1318	0.90%	1.2	51%
2.461	5617.49	96.6	1.501	96.6	1.4	0.60	1.55%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	164.203	2282.42	190.73	779	1.56%	1.5	51%
2.625	5617.33	111.8	1.580	111.8	1.3	0.55	1.41%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.70	190.060	2641.83	220.76	845	1.41%	1.5	51%
2.789	5617.16	136.8	1.973	136.8	1.2	0.50	1.44%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0	1.61	220.642	3066.92	256.28	973	1.44%	1.5	51%
2.953	5617.00	124.7	1.720	124.7	1.6	0.69	1.38%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0	1.64	204.705	2845.41	237.77	837	1.38%	1.5	51%
3.117	5616.83	124.7	1.712	124.7	1.4	0.61	1.37%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0	1.63	202.585	2815.93	235.31	793	1.37%	1.5	51%
3.281	5616.67	121.9	1.635	121.9	1.2	0.52	1.34%	Sand Tailings	0.051	102.8	0.17	0.00	0.17	0	1.62	197.463	2744.73	229.35	736	1.34%	1.5	18%
3.445	5616.51	125.5	1.702	125.5	0.9	0.41	1.36%	Sand Tailings	0.051	102.8	0.17	0.00	0.17	0	1.59	199.479	2772.75	231.69	721	1.36%	1.5	18%
3.609	5616.34	150.5	1.842	150.5	1.6	0.68	1.22%	Sand Tailings	0.051	102.8	0.18	0.00	0.18	0	1.51	226.750	3151.82	263.37	825	1.22%	1.4	18%
3.773	5616.18	107.6	1.906	107.6	1.3	0.56	1.77%	Sand Tailings	0.051	102.8	0.19	0.00	0.19	0	1.63	175.430	2438.48	203.77	563	1.78%	1.6	18%
3.937	5616.01	87.2	1.794	87.2	1.1	0.46	2.06%	Sand-Slime Tailings	0.047	93.3	0.20	0.00	0.20	0	1.70	148.257	2060.77	172.20	439	2.06%	1.7	47%
4.101	5615.85	65.2	1.491	65.2	1.0	0.41	2.29%	Sand-Slime Tailings	0.047	93.3	0.21	0.00	0.21	0	1.70	110.823	1540.44	128.73	315	2.29%	1.9	47%
4.265	5615.68	46.2	1.366	46.2	0.5	0.23	2.96%	Sand-Slime Tailings	0.047	93.3	0.21	0.00	0.21	0	1.70	78.506	1091.23	91.19	215	2.97%	2.0	47%
4.429	5615.52	32.1	1.104	32.1	0.4	0.18	3.44%	Slime Tailings	0.041	82.7	0.22	0.00	0.22	0	1.70	54.519	757.81	63.33	144	3.47%	2.2	71%
4.593	5615.36	21.5	0.652	21.5	-0.3	-0.13	3.03%	Slime Tailings	0.041	82.7	0.23	0.00	0.23	0	1.70	36.601	508.75	42.51	94	3.06%	2.3	71%
4.757	5615.19	14.9	0.336	15.0	-0.3	-0.11	2.25%	Sand-Slime Tailings	0.047	93.3	0.23	0.00	0.23	0	1.70	25.415	353.27	29.51	63	2.28%	2.3	47%
4.921	5615.03	12.8	0.162	12.8	2.1	0.92	1.27%	Sand-Slime Tailings	0.047	93.3	0.24	0.00	0.24	0	1.70	21.675	301.28	25.20	52	1.29%	2.2	47%
5.085	5614.86	42.1	0.172	42.1	8.1	3.53	0.41%	Sand Tailings	0.051	102.8	0.25	0.00	0.25	0	1.70	71.536	994.35	83.19	167	0.41%	1.5	18%
5.249	5614.70	49.6	0.237	49.6	-0.1	-0.03	0.48%	Sand Tailings	0.051	102.8	0.26	0.00	0.26	0	1.70	84.371	1172.76	97.99	190	0.48%	1.5	18%
5.413	5614.54	53.8	0.297	53.8	0.1	0.06	0.55%	Sand Tailings	0.051	102.8	0.27	0.00	0.27	0	1.70	91.511	1272.00	106.29	200	0.55%	1.5	18%
5.577	5614.37	52.6	0.352	52.6	-0.1	-0.03	0.67%	Sand Tailings	0.051	102.8	0.28	0.00	0.28	0	1.70	89.454	1243.41	103.89	189	0.67%	1.6	18%
5.741	5614.21	48.6	0.424	48.6	-0.1	-0.03	0.87%	Sand Tailings	0.051	102.8	0.28	0.00	0.28	0	1.70	82.637	1148.65	95.98	170	0.88%	1.7	18%
5.905	5614.04	40.4	0.469	40.4	-0.1	-0.02	1.16%	Sand-Slime Tailings	0.047	93.3	0.29	0.00	0.29	0	1.70	68.646	954.18	79.73	137	1.17%	1.9	47%
6.069	5613.88	31.5	0.463	31.5	-0.1	-0.02	1.47%	Sand-Slime Tailings	0.047	93.3	0.30	0.00	0.30	0	1.70	53.584	744.82	62.23	104	1.48%	2.0	47%
6.234	5613.72	26.6	0.418	26.6	-0.2	-0.07	1.57%	Sand-Slime Tailings	0.047	93.3	0.31	0.00	0.31	0	1.70	45.254	629.03	52.56	86	1.59%	2.1	47%
6.398	5613.55	29.2	0.352	29.2	-0.1	-0.04	1.20%	Sand-Slime Tailings	0.047	93.3	0.32	0.00	0.32	0	1.70	49.674	690.47	57.69	92	1.22%	2.0	47%
6.562	5613.39	31.3	0.327	31.3	-0.1	-0.04	1.04%	Sand-Slime Tailings	0.047	93.3	0.32	0.00	0.32	0	1.70	53.244	740.09	61.84	96	1.05%	1.9	47%
6.726	5613.22	39.3	0.336	39.4	-0.1	-0.06	0.85%	Sand Tailings	0.051	102.8	0.33	0.00	0.33	0	1.70	66.713	927.31	77.48	118	0.86%	1.8	18%
6.890	5613.06	39.3	0.331	39.4	-0.2	-0.10	0.84%	Sand Tailings	0.062	123.5	0.34	0.00	0.34	1	1.67	65.899	915.99	76.53	115	0.85%	1.8	18%
7.054	5612.90	38.3	0.410	38.3	-0.2	-0.07	1.07%	Sand-Slime Tailings	0.059	119.0	0.35	0.01	0.34	1	1.67	63.953	888.95	74.28	110	1.08%	1.9	47%
7.218	5612.73	36.3	0.454	36.4	-0.2	-0.09	1.25%	Sand-Slime Tailings	0.059	119.0	0.36	0.01	0.35	1	1.67	60.858	845.93	70.68	103	1.26%	2.0	47%
7.382	5612.57	32.3	0.463	32.3	-0.5	-0.21	1.43%	Sand-Slime Tailings	0.059	119.0	0.37	0.02	0.35	1	1.69	54.740	760.88	63.57	90	1.45%	2.0	47%
7.546	5612.40	29.1	0.420	29.1	-0.5	-0.23	1.44%	Sand-Slime Tailings	0.059	119.0	0.38	0.02	0.36	1	1.70	49.419	686.92	57.39	80	1.46%	2.1	47%
7.710	5612.24	35.5	0.360	35.5	-0.4	-0.19	1.01%	Sand-Slime Tailings	0.059	119.0	0.39	0.03	0.36	1	1.65	58.534	813.62	67.98	97	1.03%	1.9	47%
7.874	5612.08	29.1	0.340	29.1	-0.8	-0.33	1.17%	Sand-Slime Tailings	0.059	119.0	0.40	0.03	0.37	1	1.69	48.995	681.04	56.90	78	1.19%	2.0	47%
8.038	5611.91	19.8	0.302	19.8	-0.8	-0.33	1.53%	Sand-Slime Tailings	0.059	119.0	0.41	0.04	0.37	1	1.70	33.592	466.93	39.01	52	1.56%	2.3	47%
8.202	5611.75	15.7	0.241	15.7	-0.7	-0.32	1.53%	Sand-Slime Tailings	0.059	119.0	0.42	0.04	0.38	1	1.70	26.758	371.94	31.07	41	1.57%	2.3	47%
8.366	5611.58	12.1	0.199	12.1	0.0	0.00	1.64%	Sand-Slime Tailings	0.059	119.0	0.43	0.05	0.38	1	1.70	20.587	286.16	23.91	31	1.70%	2.5	47%
8.530	5611.42	12.2	0.172	12.2	1.6	0.68	1.41%	Sand-Slime Tailings	0.059	119.0	0.44	0.05	0.39	1	1.70	20.672	287.34	24.03	30	1.47%	2.4	47%
8.694	5611.26	15.4	0.055	15.4	3.8	1.64	0.36%	Sand-Slime Tailings	0.059	119.0	0.45	0.06	0.39	1	1.70	26.197	364.14	30.47	38	0.37%	2.0	47%
8.858	5611.09	18.3	0.062	18.3	2.3	0.99	0.34%	Sand-Slime Tailings	0.059	119.0	0.46	0.06	0.40	1	1.70	31.076	431.96	36.12	45	0.35%	2.0	47%
9.022	5610.93	16.7	0.107	16.7	1.6	0.68	0.64%	Sand-Slime Tailings	0.059	119.0	0.47	0.07	0.40	1	1.70	28.441	395.33	33.05	41	0.66%	2.1	47%
9.186	5610.76	20.6	0.079	20.6	2.3	1.01	0.38%	Sand-Slime Tailings	0.059	119.0	0.48	0.07	0.41	1	1.67	34.288	476.60	39.85	50	0.39%	2.0	47%
9.350	5610.60	19.5	0.075	19.5	1.6	0.68	0.38%	Sand-Slime Tailings	0.059	119.0	0.49	0.08	0.41	1	1.67	32.552	452.47	37.83	46	0.39%	2.0	47%
9.514	5610.44	17.8	0.086	17.8	1.5	0.66	0.48%	Sand-Slime Tailings	0.059	119.0	0.50	0.08	0.41	1	1.67	29.767	413.77	34.59	42	0.50%	2.1	47%
9.678	5610.27	15.7	0.078	15.6	1.8	0.77	0.50%	Sand-Slime Tailings	0.059	119.0	0.51	0.09	0.42	1	1.68	26.331	366.00	30.60	36	0.52%	2.1	47%
9.842	5610.11	16.0	0.072	16.0	2.3	1.01	0.45%	Sand-Slime Tailings	0.059	119.0	0.52	0.09	0.42	1	1.67	26.712	371.30	31.05	37	0.46%	2.1	47%
10.006	5609.94	15.8	0.137	15.8	2.7	1.18	0.87%	Sand-Slime Tailings	0.059	119.0	0.53	0.10	0.43	1	1.66	26.226	364.54	30.49	36	0.89%	2.2	47%
10.170	5609.78	17.6	0.093	17.6	0.8	0.35	0.53%	Sand-Slime Tailings	0.059	119.0	0.54	0.10	0.43	1	1.63	28.606	397.62	33.23	39	0.55%	2.1	47%
10.335	5609.62	16.3	0.209	16.3	0.9	0.39	1.28%	Sand-Slime Tailings	0.059	119.0	0.55	0.11	0.44	1	1.63	26.555	369.12	30.85	36	1.33%	2.3	47%
10.499	5609.45	17.8	0.152	17.8	2.3	1.00	0.85%	Sand-Slime Tailings	0.059	119.0	0.56	0.11	0.44	1	1.60	28.581	397.27	33.22	39	0.88%	2.2	47%
10.663	5609.29	19.9	0.083	19.9	0.8	0.33	0.42%	Sand-Slime Tailings	0.059	119.0	0.57	0.12	0.45	1	1.58	31.420	436.73	36.50	43	0.43%	2.0	47%
10.827	5609.12	16.0	0.095	16.0	-0.5	-0.20	0.59%	Sand-Slime Tailings	0.059	119.0	0.58	0.12	0.45	1	1.60	25.570	355.42	29.69	34	0.62%	2.2	47%
10.991	5608.96	13.0	0.120	13.0	0.1	0.02	0.92%	Sand-Slime Tailings	0.059	119.0	0.59	0.13	0.46	1	1.62	21.109	293.42	24.52	27	0.96%	2.4	47%
11.155	5608.80	10.5	0.104	10.5	0.8	0.35	0.99%	Sand-Slime Tailings	0.059	119.0	0.60	0.13	0.46	1	1.63	17.098	237.66	19.87	21	1.05%	2.5	47%
11.319	5608.63	9.8	0.058	9.8	2.8	1.20	0.59%	Sand-Slime Tailings	0.059	119.0	0.60	0.14	0.47	1	1.62	15.832	220.07	18.42	20	0.63%	2.4	47%
11.483	5608.47	10.7	0.143	10.7	4.7	2.02	1.33%	Sand-Slime Tailings	0.059	119.0	0.61	0.14	0.47	1	1.60	17.154	238.45	19.98	21	1.42%	2.5	47%
11.647	5608.30	9.4	0.085	9.4	6.2	2.70	0.91%	Sand-Slime Tailings	0.059	119.0	0.62	0.15	0.47	1	1.59	14.889	206.96	17.37	18	0.97%	2.5	47%
11.811	5608.14	9.7	0.067	9.6	8.3	3.60	0.69%	Sand-Slime Tailings	0.059	119.0	0.63	0.15	0.48	1	1.58	15.172	210.89	17.72	19	0.74%	2.5	47%
11.975	5607.98	9.5	0.042	9.4	9.2	3.97	0.44%	Sand-Slime Tailings	0.059	119.0	0.64	0.16	0.48	1	1.57	14.744	204.94	17.23	18	0.48%	2.4	47%

Conditions at t_1 / Liquefaction Triggering Analyses – Idriss & Boulanger (2008)

Depth (ft)	Total Stress at t_1 (tsf)	Equil. Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	r_d	C_σ	K_σ	K_α	CSR M=7.5, σ'v=1atm	Δq_{c1n}	q_{c1n-cs}	(CRR) M=7.5, σ'v=1atm	FoS
0.164	0.59	0.00	0.59	0	1.00	0.06	1.02	1.0	0.059	39.67	66.30	0.095	1.61
0.328	0.60	0.00	0.60	0	1.00	0.09	1.03	1.0	0.060	55.88	128.72	0.200	3.35
0.492	0.61	0.00	0.61	0	1.00	0.10	1.03	1.0	0.060	61.84	151.66	0.279	4.67
0.656	0.61	0.00	0.61	0	1.00	0.17	1.06	1.0	0.061	84.80	240.06	1.000	16.37
0.820	0.62	0.00	0.62	0	1.00	0.30	1.10	1.0	0.063	122.79	386.30	1.000	15.76
0.984	0.63	0.00	0.63	0	1.00	0.30	1.09	1.0	0.063	140.94	456.15	1.000	15.82
1.148	0.64	0.00	0.64	0	1.00	0.30	1.09	1.0	0.063	170.26	569.04	1.000	15.87
1.312	0.65	0.00	0.65	0	1.00	0.30	1.09	1.0	0.063	225.78	782.76	1.000	15.93
1.476	0.65	0.00	0.65	0	1.00	0.30	1.08	1.0	0.063	209.49	720.03	1.000	15.99
1.640	0.66	0.00	0.66	0	1.00	0.30	1.08	1.0	0.063	171.33	573.15	1.000	16.04
1.804	0.67	0.00	0.67	0	1.00	0.30	1.07	1.0	0.062	166.65	555.12	1.000	16.10
1.968	0.68	0.00	0.68	0	1.00	0.30	1.07	1.0	0.062	168.14	560.88	1.000	16.17
2.133	0.69	0.00	0.69	0	1.00	0.30	1.07	1.0	0.062	147.79	482.52	1.000	16.23
2.297	0.70	0.00	0.70	0	1.00	0.30	1.06	1.0	0.061	135.88	436.68	1.000	16.30
2.461	0.70	0.00	0.70	0	1.00	0.24	1.05	1.0	0.060	97.25	287.98	1.000	16.57
2.625	0.71	0.00	0.71	0	1.00	0.30	1.06	1.0	0.061	107.79	328.55	1.000	16.44
2.789	0.72	0.00	0.72	0	0.99	0.30	1.05	1.0	0.061	120.26	376.53	1.000	16.51
2.953	0.73	0.00	0.73	0	0.99	0.30	1.05	1.0	0.060	113.76	351.53	1.000	16.58
3.117	0.74	0.00	0.74	0	0.99	0.30	1.05	1.0	0.060	112.90	348.20	1.000	16.64
3.281	0.75	0.00	0.75	0	0.99	0.30	1.04	1.0	0.060	80.72	310.08	1.000	16.71
3.445	0.75	0.00	0.75	0	0.99	0.30	1.04	1.0	0.060	81.32	313.02	1.000	16.78
3.609	0.76	0.00	0.76	0	0.99	0.30	1.04	1.0	0.059	89.42	352.79	1.000	16.85
3.773	0.77	0.00	0.77	0	0.99	0.27	1.03	1.0	0.059	74.18	277.95	1.000	16.97
3.937	0.78	0.00	0.78	0	0.99	0.20	1.02	1.0	0.058	90.70	262.90	1.000	17.16
4.101	0.79	0.00	0.79	0	0.99	0.13	1.01	1.0	0.058	75.45	204.17	1.000	17.30
4.265	0.79	0.00	0.79	0	0.99	0.10	1.01	1.0	0.058	62.28	153.47	0.288	5.01
4.429	0.80	0.00	0.80	0	0.99	0.08	1.01	1.0	0.057	52.14	115.47	0.170	2.97
4.593	0.81	0.00	0.81	0	0.98	0.07	1.00	1.0	0.057	44.89	87.40	0.123	2.15
4.757	0.82	0.00	0.82	0	0.98	0.06	1.00	1.0	0.057	40.65	70.17	0.100	1.75
4.921	0.82	0.00	0.82	0	0.98	0.06	1.00	1.0	0.057	39.14	64.34	0.093	1.63
5.085	0.83	0.00	0.83	0	0.98	0.09	1.00	1.0	0.057	43.36	126.54	0.194	3.41
5.249	0.84	0.00	0.84	0	0.98	0.10	1.00	1.0	0.057	47.14	145.13	0.251	4.41
5.413	0.85	0.00	0.85	0	0.98	0.11	1.00	1.0	0.057	49.26	155.55	0.299	5.27
5.577	0.86	0.00	0.86	0	0.98	0.11	1.00	1.0	0.057	48.65	152.54	0.283	5.00
5.741	0.87	0.00	0.87	0	0.98	0.10	1.00	1.0	0.057	46.63	142.60	0.241	4.27
5.905	0.87	0.00	0.87	0	0.98	0.09	1.00	1.0	0.056	58.26	137.99	0.226	4.00
6.069	0.88	0.00	0.88	0	0.98	0.08	1.00	1.0	0.056	52.13	114.36	0.168	2.98
6.234	0.89	0.00	0.89	0	0.98	0.07	1.00	1.0	0.056	48.73	101.29	0.145	2.57
6.398	0.90	0.00	0.90	0	0.97	0.08	1.00	1.0	0.056	50.54	108.23	0.157	2.79
6.562	0.90	0.00	0.90	0	0.97	0.08	1.00	1.0	0.056	51.99	113.83	0.167	2.98
6.726	0.91	0.00	0.91	0	0.97	0.09	0.99	1.0	0.056	41.90	119.38	0.178	3.19
6.890	0.92	0.00	0.92	0	0.97	0.09	0.99	1.0	0.056	41.66	118.19	0.176	3.15
7.054	0.93	0.00	0.93	0	0.97	0.09	0.99	1.0	0.056	56.35	130.63	0.205	3.67
7.218	0.94	0.00	0.94	0	0.97	0.08	0.99	1.0	0.056	55.09	125.77	0.193	3.46
7.382	0.95	0.00	0.95	0	0.97	0.08	0.99	1.0	0.056	52.60	116.17	0.172	3.09
7.546	0.96	0.00	0.96	0	0.97	0.08	0.99	1.0	0.055	50.43	107.82	0.156	2.81
7.710	0.97	0.00	0.97	0	0.97	0.08	0.99	1.0	0.055	54.14	122.12	0.184	3.33
7.874	0.98	0.00	0.98	0	0.96	0.08	0.99	1.0	0.055	50.26	107.15	0.155	2.80
8.038	0.99	0.00	0.99	0	0.96	0.06	0.99	1.0	0.055	43.98	82.99	0.117	2.11
8.202	1.00	0.00	1.00	0	0.96	0.06	0.99	1.0	0.055	41.20	72.27	0.102	1.86
8.366	1.01	0.00	1.01	0	0.96	0.06	0.99	1.0	0.055	38.69	62.60	0.091	1.65
8.530	1.02	0.00	1.02	0	0.96	0.06	0.99	1.0	0.055	38.73	62.76	0.091	1.65
8.694	1.03	0.00	1.03	0	0.96	0.06	0.99	1.0	0.055	40.99	71.46	0.101	1.85
8.858	1.04	0.00	1.04	0	0.96	0.06	0.99	1.0	0.055	42.97	79.09	0.111	2.03
9.022	1.05	0.00	1.05	0	0.96	0.06	0.99	1.0	0.055	41.89	74.95	0.106	1.94
9.186	1.06	0.00	1.06	0	0.96	0.06	0.99	1.0	0.055	44.28	84.13	0.118	2.17
9.350	1.07	0.00	1.07	0	0.96	0.06	0.99	1.0	0.054	43.57	81.39	0.115	2.10
9.514	1.08	0.00	1.08	0	0.95	0.06	0.99	1.0	0.054	42.43	77.02	0.109	2.00
9.678	1.09	0.00	1.09	0	0.95	0.06	0.99	1.0	0.054	41.03	71.64	0.102	1.87
9.842	1.10	0.00	1.10	0	0.95	0.06	0.99	1.0	0.054	41.19	72.24	0.102	1.89
10.006	1.11	0.00	1.11	0	0.95	0.06	0.99	1.0	0.054	41.00	71.49	0.101	1.87
10.170	1.12	0.00	1.12	0	0.95	0.06	0.98	1.0	0.054	41.96	75.19	0.106	1.97
10.335	1.13	0.00	1.13	0	0.95	0.06	0.98	1.0	0.054	41.12	71.97	0.102	1.89
10.499	1.14	0.00	1.14	0	0.95	0.06	0.98	1.0	0.054	41.95	75.17	0.106	1.97
10.663	1.15	0.00	1.15	0	0.95	0.06	0.98	1.0	0.054	43.10	79.60	0.112	2.09
10.827	1.16	0.00	1.16	0	0.95	0.06	0.98	1.0	0.054	40.72	70.41	0.100	1.86
10.991	1.17	0.00	1.17	0	0.94	0.06	0.98	1.0	0.054	38.90	63.42	0.092	1.71
11.155	1.18	0.00	1.18	0	0.94	0.05	0.98	1.0	0.054	37.27	57.14	0.085	1.58
11.319	1.19	0.00	1.19	0	0.94	0.05	0.98	1.0	0.054	36.76	55.18	0.083	1.54
11.483	1.20	0.00	1.20	0	0.94	0.05	0.98	1.0	0.053	37.31	57.29	0.085	1.59
11.647	1.20	0.00	1.20	0	0.94	0.05	0.98	1.0	0.053	36.39	53.76	0.081	1.52
11.811	1.21	0.00	1.21	0	0.94	0.05	0.98	1.0	0.053	36.51	54.23	0.082	1.53
11.975	1.22	0.00	1.22	0	0.94	0.05	0.98	1.0	0.053	36.34	53.57	0.081	1.52

Liquefaction Triggering Analyses – Youd et al. (2001); Idriss & Boulanger (2008)

Depth (ft)	r_d	D_r	f	K_σ	K_α	CSR M=7.5, σ'v=1atm	Kc	q_{c1n-cs}	(CRR) M=7.5, σ'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	CN (I&B 2008)	qc1 TSF	qc1 MPa	qc1N
0.164	0.98	0.30	0.80	2.53	1.0	0.017	1.00	26.63	0.072	174.99	88.30	2	1.7	22.933	2.1956	26.635
0.328	0.97	0.49	0.75	2.65	1.0	0.016	1.00	72.84	0.116	140.58	71.97	2	1.7	62.714	6.0043	72.839
0.492	0.97	0.55	0.73	2.64	1.0	0.016	1.00	89.82	0.147	119.19	61.93	2	1.7	77.335	7.4041	89.820
0.656	0.97	0.72	0.64	3.23	1.0	0.013	1.00	155.26	0.428	259.71	138.04	2	1.7	133.68	12.798	155.256
0.820	0.97	0.94	0.60	3.37	1.0	0.013	1.00	263.50	1.000	485.59	250.68	2	1.7	226.88	21.721	263.504
0.984	0.97	1.03	0.60	3.13	1.0	0.014	1.00	315.21	1.000	404.82	210.32	2	1.7	271.4	25.984	315.214
1.148	0.97	1.15	0.60	2.95	1.0	0.015	1.00	398.78	1.000	347.12	181.50	2	1.7	343.35	32.872	398.778
1.312	0.97	1.36	0.60	2.79	1.0	0.015	1.00	556.98	1.000	303.85	159.89	2	1.7	479.56	45.913	556.976
1.476	0.97	1.30	0.60	2.66	1.0	0.016	1.00	510.55	1.000	270.20	143.09	2	1.7	439.58	42.086	510.547
1.640	0.97	1.16	0.60	2.55	1.0	0.017	1.00	401.82	1.000	243.27	129.66	2	1.7	345.97	33.123	401.818
1.804	0.97	1.14	0.60	2.46	1.0	0.017	1.00	388.47	1.000	221.25	118.67	2	1.7	334.48	32.023	388.475
1.968	0.97	1.14	0.60	2.37	1.0	0.018	1.00	392.74	1.000	202.89	109.53	2	1.7	338.15	32.374	392.736
2.133	0.97	1.06	0.60	2.30	1.0	0.019	1.00	334.73	1.000	187.35	101.79	2	1.7	288.2	27.593	334.730
2.297	0.97	1.00	0.60	2.23	1.0	0.019	1.00	300.80	1.000	174.04	95.17	2	1.69827	258.99	24.795	300.799
2.461	0.97	0.80	0.60	2.17	1.0	0.020	1.00	190.73	1.000	162.50	89.54	2	1.7	164.22	15.722	190.729
2.625	0.97	0.86	0.60	2.12	1.0	0.020	1.00	220.76	1.000	152.41	84.42	2	1.7	190.07	18.198	220.759
2.789	0.97	0.92	0.60	2.07	1.0	0.021	1.00	256.28	1.000	143.50	80.00	2	1.61347	220.65	21.125	256.276
2.953	0.97	0.89	0.60	2.02	1.0	0.021	1.00	237.77	1.000	135.58	76.08	2	1.641978	204.72	19.6	237.772
3.117	0.97	0.89	0.60	1.98	1.0	0.022	1.00	235.31	1.000	128.49	72.57	2	1.625102	202.6	19.397	235.307
3.281	0.97	0.87	0.60	1.93	1.0	0.022	1.00	229.35	1.000	121.99	69.35	2	1.619873	197.47	18.906	229.355
3.445	0.97	0.88	0.60	1.90	1.0	0.022	1.00	231.69	1.000	116.12	66.45	2	1.589344	199.49	19.099	231.693
3.609	0.97	0.94	0.60	1.86	1.0	0.023	1.00	263.37	1.000	110.79	63.82	2	1.506243	226.76	21.71	263.373
3.773	0.97	0.82	0.60	1.83	1.0	0.023	1.00	203.77	1.000	105.93	61.45	2	1.631001	175.44	16.797	203.767
3.937	0.97	0.76	0.62	1.74	1.0	0.024	1.07	183.75	1.000	101.89	59.52	2	1.7	148.27	14.195	172.204
4.101	0.97	0.66	0.67	1.60	1.0	0.027	1.15	147.94	0.381	37.40	27.35	2	1.7	110.83	10.611	128.726
4.265	0.97	0.55	0.72	1.47	1.0	0.029	1.36	123.57	0.255	24.18	14.60	2	1.7	78.512	7.5167	91.186
4.429	0.97	0.46	0.77	1.37	1.0	0.031	1.65	104.62	0.186	17.12	10.04	2	1.7	54.523	5.2201	63.326
4.593	0.96	0.38	0.80	1.31	1.0	0.033	1.86	78.93	0.126	11.20	6.68	2	1.7	36.598	3.5039	42.506
4.757	0.96	0.31	0.80	1.30	1.0	0.033	1.95	57.54	0.098	8.43	5.09	2	1.7	25.412	2.433	29.515
4.921	0.96	0.29	0.80	1.29	1.0	0.033	1.68	42.30	0.085	7.12	4.37	2	1.7	21.697	2.0773	25.200
5.085	0.96	0.53	0.74	1.38	1.0	0.031	1.00	83.19	0.134	10.78	7.10	2	1.7	71.622	6.8571	83.185
5.249	0.96	0.57	0.71	1.41	1.0	0.030	1.00	97.99	0.168	13.09	8.75	2	1.7	84.37	8.0776	97.991
5.413	0.96	0.60	0.70	1.42	1.0	0.030	1.00	106.29	0.192	14.51	9.89	2	1.7	91.512	8.7614	106.286
5.577	0.96	0.59	0.71	1.40	1.0	0.030	1.00	103.89	0.184	13.54	9.27	2	1.7	89.453	8.5643	103.895
5.741	0.96	0.57	0.72	1.37	1.0	0.031	1.04	99.63	0.172	12.26	8.27	2	1.7	82.636	7.9116	95.977
5.905	0.96	0.52	0.74	1.32	1.0	0.032	1.15	91.53	0.151	10.51	7.26	2	1.7	68.645	6.5721	79.728
6.069	0.96	0.46	0.77	1.27	1.0	0.033	1.32	81.85	0.131	8.87	5.93	2	1.7	53.583	5.1301	62.234
6.234	0.96	0.42	0.79	1.24	1.0	0.034	1.44	75.88	0.121	7.97	5.27	2	1.7	45.252	4.3325	52.558
6.398	0.96	0.44	0.78	1.25	1.0	0.034	1.29	74.59	0.119	7.65	5.22	2	1.7	49.673	4.7557	57.692
6.562	0.96	0.45	0.77	1.25	1.0	0.034	1.23	75.92	0.121	7.60	5.29	2	1.7	53.243	5.0975	61.839
6.726	0.96	0.51	0.75	1.27	1.0	0.033	1.12	86.56	0.140	8.62	5.90	2	1.69537	66.711	6.3869	77.481
6.890	0.96	0.51	0.75	1.26	1.0	0.033	1.12	85.79	0.139	8.30	5.72	2	1.674687	65.897	6.3089	76.535
7.054	0.96	0.50	0.75	1.26	1.0	0.034	1.19	88.39	0.144	8.51	6.09	2	1.671539	63.951	6.1227	74.276
7.218	0.96	0.49	0.76	1.24	1.0	0.034	1.26	88.99	0.146	8.48	5.97	2	1.674222	60.856	5.8263	70.680
7.382	0.96	0.46	0.77	1.23	1.0	0.034	1.37	87.13	0.142	8.14	5.62	2	1.69316	54.735	5.2403	63.571
7.546	0.96	0.44	0.78	1.21	1.0	0.035	1.44	82.66	0.133	7.53	5.17	2	1.7	49.413	4.7308	57.391
7.710	0.96	0.48	0.76	1.23	1.0	0.034	1.22	82.74	0.133	7.44	5.39	2	1.648375	58.529	5.6036	67.978
7.874	0.96	0.44	0.78	1.20	1.0	0.035	1.36	77.25	0.123	6.81	4.81	2	1.685427	48.987	4.6901	56.896
8.038	0.96	0.36	0.80	1.18	1.0	0.036	1.81	70.50	0.113	6.17	4.14	2	1.7	33.584	3.2153	39.006
8.202	0.96	0.32	0.80	1.18	1.0	0.036	2.08	64.68	0.105	5.69	3.77	2	1.7	26.75	2.5611	31.069
8.366	0.96	0.28	0.80	1.18	1.0	0.036	2.57	61.41	0.102	5.43	3.54	2	1.7	20.587	1.971	23.911
8.530	0.96	0.28	0.80	1.17	1.0	0.036	2.41	57.94	0.098	5.18	3.42	2	1.7	20.689	1.9807	24.029
8.694	0.96	0.32	0.80	1.17	1.0	0.036	1.36	41.48	0.085	4.42	3.13	2	1.7	26.237	2.5119	30.473
8.858	0.95	0.35	0.80	1.17	1.0	0.036	1.26	45.58	0.088	4.54	3.29	2	1.7	31.1	2.9775	36.121
9.022	0.95	0.33	0.80	1.17	1.0	0.036	1.51	50.04	0.092	4.68	3.31	2	1.7	28.458	2.7245	33.052
9.186	0.95	0.36	0.80	1.16	1.0	0.036	1.24	49.54	0.091	4.61	3.39	2	1.668509	34.312	3.285	39.851
9.350	0.95	0.36	0.80	1.16	1.0	0.036	1.27	48.15	0.090	4.50	3.30	2	1.666763	32.568	3.1181	37.826
9.514	0.95	0.34	0.80	1.16	1.0	0.036	1.39	48.17	0.090	4.45	3.23	2	1.672322	29.783	2.8515	34.592
9.678	0.95	0.32	0.80	1.15	1.0	0.036	1.51	46.09	0.088	4.32	3.10	2	1.683575	26.35	2.5227	30.604
9.842	0.95	0.32	0.80	1.15	1.0	0.036	1.46	45.31	0.088	4.24	3.07	2	1.667416	26.736	2.5597	31.053
10.006	0.95	0.32	0.80	1.15	1.0	0.037	1.79	54.55	0.095	4.55	3.21	2	1.657787	26.254	2.5136	30.493
10.170	0.95	0.33	0.80	1.15	1.0	0.037	1.46	48.69	0.091	4.29	3.13	2	1.629036	28.614	2.7395	33.233
10.335	0.95	0.32	0.80	1.14	1.0	0.037	2.08	64.08	0.104	4.90	3.40	2	1.630155	26.564	2.5433	30.853
10.499	0.95	0.33	0.80	1.14	1.0	0.037	1.69	56.22	0.097	4.48	3.23	2	1.604757	28.604	2.7385	33.222
10.663	0.95	0.35	0.80	1.14	1.0	0.037	1.33	48.51	0.090	4.16	3.12	2	1.576497	31.427	3.0088	36.501
10.827	0.95	0.31	0.80	1.14	1.0	0.037	1.63	48.41	0.090	4.11	2.99	2	1.600097	25.565	2.4476	29.692
10.991	0.95	0.29	0.80	1.14	1.0	0.037	2.17	53.19	0.094	4.24	2.97	2	1.618819	21.11	2.0211	24.518
11.155	0.95	0.26	0.80	1.13	1.0	0.037	2.63	52.29	0.093	4.16	2.87	2	1.629917	17.106	1.6377	19.868
11.319	0.95	0.25	0.80	1.13	1.0	0.037	2.32	42.69	0.086	3.78	2.66	2	1.617204	15.86	1.5185	18.421
11.483	0.95	0.26	0.80	1.13	1.0	0.037	2.98	59.46	0.100	4.36	2.97	2	1.604714	17.201	1.6468	19.978
11.647	0.95	0.24	0.80	1.13	1.0	0.037	2.83	49.19	0.091	3.95	2.73	2	1.592442	14.951	1.4314	17.365
11.811	0.95	0.24	0.80	1.12	1.0	0.037	2.54	44.93	0.087	3.76	2.64	2	1.580381	15.254	1.4604	17.716
11.975	0.95	0.24	0.80	1.12	1.0	0.037	2.25	38.83	0.082	3.51	2.51	2	1.568527	14.834	1.4202	17.229

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2E1

Data File: 13-52106_SP2E1-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5613.10	Water surface elevation during CPT investigation (ft a
5611.67	Water surface elevation at t_0 (ft amsl)
5595.46	Water surface elevation at t_1 (ft amsl)
5590.46	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earth
7.51	Equiv. Number of Uniform Strain Cycles, N

5619.95	Ground Surface Elevation at time of CPT (ft amsl)
5630.46	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after plac
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
2.51	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1160.95	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5590.46	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5630.21	5629.96	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5628.21	5626.46	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5624.46	5622.46	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	######	5621.21	5619.95	2.51	0.050	101	0.580	0.517	0.00	0.00	0.580	0.517

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil. Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil. Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
12.139	5607.81	8.5	0.033	8.5	11.3	4.90	0.39%	Sand-Slime Tailing	0.059	119.0	0.65	0.17	0.49	1	1.56	13.171	183.08	15.43	16	0.42%	2.4	47%	1.23	0.00	1.23	0
12.303	5607.65	7.5	0.137	7.4	15.9	6.87	1.83%	Slime Tailings	0.057	113.1	0.66	0.17	0.49	1	1.55	11.398	158.44	13.42	14	2.01%	2.8	71%	1.24	0.00	1.24	0
12.467	5607.48	9.8	0.166	9.7	9.9	4.27	1.70%	Sand-Slime Tailing	0.059	119.0	0.67	0.18	0.50	1	1.54	14.939	207.65	17.46	18	1.82%	2.7	47%	1.25	0.00	1.25	0
12.631	5607.32	8.6	0.151	8.5	17.3	7.50	1.76%	Slime Tailings	0.057	113.1	0.68	0.18	0.50	1	1.53	12.904	179.37	15.18	16	1.91%	2.7	71%	1.26	0.00	1.26	0
12.795	5607.15	13.0	0.092	12.9	18.8	8.15	0.71%	Sand-Slime Tailing	0.059	119.0	0.69	0.19	0.51	1	1.51	19.343	268.87	22.67	24	0.75%	2.4	47%	1.27	0.00	1.27	0
12.959	5606.99	16.0	0.166	15.9	19.0	8.23	1.04%	Sand-Slime Tailing	0.059	119.0	0.70	0.19	0.51	1	1.47	23.423	325.57	27.41	30	1.08%	2.4	47%	1.28	0.00	1.28	0
13.123	5606.83	14.4	0.162	14.3	15.8	6.85	1.13%	Sand-Slime Tailing	0.059	119.0	0.71	0.20	0.52	1	1.48	21.034	292.37	24.60	26	1.19%	2.4	47%	1.29	0.00	1.29	0
13.287	5606.66	17.3	0.194	17.2	19.5	8.43	1.12%	Sand-Slime Tailing	0.059	119.0	0.72	0.20	0.52	1	1.45	24.868	345.66	29.09	32	1.17%	2.4	47%	1.30	0.00	1.30	0
13.451	5606.50	19.4	0.173	19.3	8.1	3.49	0.89%	Sand-Slime Tailing	0.059	119.0	0.73	0.21	0.52	1	1.43	27.509	382.38	32.03	35	0.93%	2.3	47%	1.31	0.00	1.31	0
13.615	5606.33	16.0	0.144	15.9	7.5	3.27	0.90%	Sand-Slime Tailing	0.059	119.0	0.74	0.21	0.53	1	1.44	22.875	317.96	26.65	29	0.95%	2.3	47%	1.32	0.00	1.32	0
13.779	5606.17	12.6	0.124	12.5	6.8	2.94	0.99%	Sand-Slime Tailing	0.059	119.0	0.75	0.22	0.53	1	1.45	18.200	252.98	21.21	22	1.05%	2.5	47%	1.33	0.00	1.33	0
13.943	5606.01	11.2	0.094	11.1	15.0	6.52	0.84%	Sand-Slime Tailing	0.059	119.0	0.76	0.22	0.54	1	1.44	16.070	223.37	18.82	19	0.90%	2.5	47%	1.34	0.00	1.34	0
14.107	5605.84	10.0	0.113	9.9	19.5	8.43	1.13%	Sand-Slime Tailing	0.059	119.0	0.77	0.23	0.54	1	1.43	14.143	196.59	16.63	17	1.23%	2.6	47%	1.35	0.00	1.35	0
14.271	5605.68	9.1	0.159	8.8	48.1	20.86	1.75%	Slime Tailings	0.057	113.1	0.78	0.23	0.55	1	1.42	12.506	173.84	15.02	15	1.92%	2.7	71%	1.36	0.00	1.36	0
14.436	5605.51	14.3	0.207	13.9	61.3	26.57	1.45%	Sand-Slime Tailing	0.059	119.0	0.79	0.24	0.55	1	1.41	19.507	271.15	23.28	24	1.54%	2.5	47%	1.37	0.00	1.37	0
14.600	5605.35	20.5	0.331	20.4	11.3	4.89	1.62%	Sand-Slime Tailing	0.059	119.0	0.80	0.24	0.56	1	1.37	27.819	386.69	32.42	35	1.68%	2.4	47%	1.38	0.00	1.38	0
14.764	5605.19	14.9	0.361	14.8	6.9	3.00	2.43%	Slime Tailings	0.057	113.1	0.81	0.25	0.56	1	1.39	20.567	285.88	23.96	25	2.56%	2.6	71%	1.39	0.00	1.39	0
14.928	5605.02	12.9	0.158	12.8	9.8	4.24	1.23%	Sand-Slime Tailing	0.059	119.0	0.82	0.25	0.57	1	1.39	17.775	247.07	20.74	21	1.31%	2.5	47%	1.40	0.00	1.40	0
15.092	5604.86	13.3	0.157	13.3	13.5	5.85	1.18%	Sand-Slime Tailing	0.059	119.0	0.83	0.26	0.57	1	1.38	18.278	254.06	21.36	22	1.25%	2.5	47%	1.41	0.00	1.41	0
15.256	5604.69	16.0	0.117	16.0	9.0	3.88	0.73%	Sand-Slime Tailing	0.059	119.0	0.84	0.26	0.57	1	1.36	21.654	300.99	25.24	26	0.77%	2.3	47%	1.42	0.00	1.42	0
15.420	5604.53	20.1	0.148	20.0	8.1	3.53	0.74%	Sand-Slime Tailing	0.059	119.0	0.85	0.27	0.58	1	1.33	26.610	369.88	30.98	33	0.77%	2.2	47%	1.43	0.00	1.43	0
15.584	5604.37	17.1	0.147	17.1	5.0	2.18	0.86%	Sand-Slime Tailing	0.059	119.0	0.86	0.27	0.58	1	1.34	22.799	316.91	26.53	28	0.90%	2.3	47%	1.44	0.00	1.44	0
15.748	5604.20	24.6	0.148	24.6	5.9	2.55	0.60%	Sand-Slime Tailing	0.059	119.0	0.87	0.28	0.59	1	1.30	31.972	444.41	37.19	40	0.62%	2.1	47%	1.45	0.00	1.45	0
15.912	5604.04	28.1	0.259	28.1	1.3	0.58	0.92%	Sand-Slime Tailing	0.059	119.0	0.88	0.28	0.59	1	1.28	36.048	501.07	41.88	46	0.95%	2.2	47%	1.46	0.00	1.46	0
16.076	5603.87	18.4	0.329	18.4	2.2	0.96	1.79%	Sand-Slime Tailing	0.059	119.0	0.89	0.29	0.60	1	1.31	24.074	334.62	27.98	29	1.88%	2.5	47%	1.47	0.00	1.47	0
16.240	5603.71	15.8	0.279	15.8	3.6	1.57	1.76%	Sand-Slime Tailing	0.059	119.0	0.90	0.29	0.60	1	1.31	20.712	287.90	24.09	25	1.87%	2.6	47%	1.48	0.00	1.48	0
16.404	5603.55	16.9	0.229	16.8	5.1	2.20	1.36%	Sand-Slime Tailing	0.059	119.0	0.91	0.30	0.61	1	1.30	21.871	304.00	25.45	26	1.44%	2.5	47%	1.49	0.00	1.49	0
16.568	5603.38	15.2	0.239	15.2	7.9	3.42	1.57%	Sand-Slime Tailing	0.059	119.0	0.92	0.30	0.61	1	1.30	19.693	273.73	22.95	23	1.67%	2.5	47%	1.50	0.00	1.50	0
16.732	5603.22	13.1	0.158	13.0	11.1	4.82	1.21%	Sand-Slime Tailing	0.059	119.0	0.93	0.31	0.62	1	1.30	16.874	234.55	19.70	20	1.30%	2.6	47%	1.51	0.00	1.51	0
16.896	5603.05	15.1	0.126	15.0	13.3	5.78	0.84%	Sand-Slime Tailing	0.059	119.0	0.93	0.31	0.62	1	1.29	19.254	267.63	22.49	23	0.89%	2.4	47%	1.52	0.00	1.52	0
17.060	5602.89	12.8	0.181	12.7	13.0	5.63	1.41%	Sand-Slime Tailing	0.059	119.0	0.94	0.32	0.63	1	1.28	16.345	227.19	19.10	19	1.52%	2.6	47%	1.53	0.00	1.53	0
17.224	5602.73	12.9	0.200	12.8	18.8	8.16	1.55%	Sand-Slime Tailing	0.059	119.0	0.95	0.32	0.63	1	1.28	16.340	227.12	19.15	19	1.67%	2.6	47%	1.53	0.00	1.53	0
17.388	5602.56	12.5	0.226	12.4	18.9	8.17	1.81%	Sand-Slime Tailing	0.059	119.0	0.96	0.33	0.64	1	1.27	15.676	217.89	18.38	18	1.96%	2.7	47%	1.54	0.00	1.54	0
17.552	5602.40	10.1	0.119	9.9	19.4	8.42	1.18%	Sand-Slime Tailing	0.059	119.0	0.97	0.33	0.64	1	1.26	12.534	174.24	14.74	14	1.31%	2.7	47%	1.55	0.00	1.55	0
17.716	5602.23	11.0	0.133	10.8	23.1	10.02	1.21%	Sand-Slime Tailing	0.059	119.0	0.98	0.34	0.64	1	1.25	13.593	188.94	16.00	16	1.33%	2.6	47%	1.56	0.00	1.56	0
17.880	5602.07	10.6	0.104	10.5	25.6	11.08	0.98%	Sand-Slime Tailing	0.059	119.0	0.99	0.34	0.65	1	1.25	13.043	181.30	15.38	15	1.08%	2.6	47%	1.57	0.00	1.57	0
18.044	5601.91	15.6	0.215	15.4	27.3	11.85	1.38%	Sand-Slime Tailing	0.059	119.0	1.00	0.35	0.65	1	1.24	19.083	265.26	22.41	22	1.47%	2.5	47%	1.58	0.00	1.58	0
18.208	5601.74	11.4	0.182	11.3	22.1	9.59	1.59%	Sand-Slime Tailing	0.059	119.0	1.01	0.35	0.66	1	1.23	13.923	193.53	16.37	16	1.75%	2.7	47%	1.59	0.00	1.59	0
18.372	5601.58	9.5	0.143	9.3	33.5	14.51	1.50%	Sand-Slime Tailing	0.059	119.0	1.02	0.36	0.66	1	1.23	11.418	158.71	13.56	13	1.68%	2.8	47%	1.60	0.00	1.60	0
18.537	5601.41	16.2	0.140	15.9	56.4	24.43	0.86%	Sand-Slime Tailing	0.059	119.0	1.03	0.36	0.67	1	1.22	19.318	268.52	22.93	23	0.92%	2.4	47%	1.61	0.00	1.61	0
18.701	5601.25	17.9	0.177	17.7	23.0	9.97	0.99%	Sand-Slime Tailing	0.059	119.0	1.04	0.37	0.67	1	1.21	21.370	297.05	25.02	25	1.05%	2.4	47%	1.62	0.00	1.62	0
18.865	5601.09	14.9	0.143	14.7	24.5	10.62	0.96%	Sand-Slime Tailing	0.059	119.0	1.05	0.37	0.68	1	1.21	17.787	247.23	20.87	20	1.03%	2.5	47%	1.63	0.00	1.63	0
19.029	5600.92	18.2	0.189	18.2	13.4	5.82	1.04%	Sand-Slime Tailing	0.059	119.0	1.06	0.38	0.68	1	1.19	21.656	301.01	25.27	25	1.10%	2.4	47%	1.64	0.00	1.64	0
19.193	5600.76	15.7	0.226	15.6	17.1	7.41	1.44%	Sand-Slime Tailing	0.059	119.0	1.07	0.39	0.69	1	1.19	18.615	258.74	21.77	21	1.54%	2.6	47%	1.65	0.00	1.65	0
19.357	5600.59	12.4	0.221	12.1	42.6	18.48	1.79%	Sand-Slime Tailing	0.059	119.0	1.08	0.39	0.69	1	1.19	14.370	199.75	17.06	16	1.96%	2.7	47%	1.66	0.00	1.66	0
19.521	5600.43	15.2	0.223	14.8	64.4	27.89	1.47%	Sand-Slime Tailing	0.059	119.0	1.09	0.40	0.70	1	1.18	17.474	242.88	20.85	20	1.58%	2.6	47%	1.67	0.00	1.67	0
19.685	5600.27	12.3	0.248	12.1	35.7	15.47	2.01%	Sand-Slime Tailing	0.059	119.0	1.10	0.40	0.70	1	1.18	14.233	197.84	16.84	16	2.21%	2.8	47%	1.68	0.00	1.68	0
19.849	5600.10	12.3	0.010	12.0	55.6	24.11	0.08%	Sand-Slime Tailing	0.059	119.0	1.11	0.41	0.70	1	1.17	14.008	194.71	16.74	16	0.09%	2.3	47%	1.69	0.00	1.69	0
20.013	5599.94	16.7	0.105	16.5	32.1	13.89	0.63%	Sand-Slime Tailing	0.059	119.0	1.12	0.41	0.71	1	1.16	19.178	266.58	22.54	22	0.67%	2.4	47%	1.70	0.00	1.70	0
20.177	5599.77	11.0	0.151	11.0	8.6	3.72	1.37%	Sand-Slime Tailing	0.059	119.0	1.13	0.42	0.71	1	1.16	12.696	176.48	14.82	14	1.53%	2.7	47%	1.71	0.00	1.71	0
20.341	5599.61	16.5	0.104	16.4	12.3	5.34	0.63%	Sand-Slime Tailing	0.059	119.0	1.14	0.42	0.72	1	1.15	18.850	262.02	22.00	21	0.68%	2.4	47%	1.72	0.00	1.72	0
20.505	5599.45	26.3	0.244	26.2	16.8	7.29	0.93%	Sand-Slime Tailing	0.059	119.0	1.15	0.43	0.72	1	1.13	29.559	410.87	34.47	35	0.97%	2.3	47%	1.73	0.00	1.73	0
20.669	5599.28	18.0	0.319	18.0	11.3	4.89	1.77%	Sand-Slime Tailing	0.059	119.0	1.16	0.43	0.73	1	1.14	20.422	283.87	23.81	23	1.89%	2.6	47%	1.74	0.00	1.74	0
20.833	5599.12	15.8	0.362	15.7	15.0	6.52	2.29%	Sand-Slime Tailing	0.059	119.0	1.17	0.44	0.73	1	1.13	17.855	248.19	20.86	20	2.47%	2.7	47%	1.75	0.00	1.75	0
20.997	5598.95	13.5	0.268	13.3	25.6	11.09	1.99%	Sand-Slime Tailing	0.059	119.0	1.18	0.44	0.74	1	1.13	15.024	208.84	17.66	17	2.18%	2.7	47%	1.76	0.00	1.76	0
21.161	5598.79	13.5	0.247	13.3	33.1	14.34	1.83%	Sand-Slime Tailing	0.059	119.0	1.19	0.45	0.74	1	1.12	14.951	207.82	17.63	17	2.00%	2.7	47%	1.77	0.00	1.77	0
21.325	5598.62	14.2	0.171	14.0	32.9	14.27	1.20%	Sand-Slime Tailing	0.059	119.0	1.20	0.45	0.75	1	1.12	15.661	217.68	18.46	17	1.31%	2.6	47%	1.78	0.00	1.78	0
21.489	5598.46	21.5	0.169	21.3	27.8	12.05	0.79%	Sand-Slime Tailing	0.059	119.0	1.21	0.46	0.75	1	1.11	23.539	327.20	27.56	27	0.83%	2.3	47%	1.79	0.00	1.79	0
21.653	5598.30	19.5	0.201	19.4	19.6	8.49	1.03%	Sand-Slime Tailing	0.059	119.0	1.22	0.46	0.76	1	1.10	21.372	297.07	24.98	24	1.10%	2.4	47%	1.80	0.00	1.80	0
21.817	5598.13	15.2	0.196	15.1	19.5	8.45	1.29%	Sand-Slime Tailing	0.059	119.0	1.23	0.47	0.76	1	1.10	16.637	231.26	19.48	18	1.40%	2.6	47%	1.81	0.00	1.81	0
21.981	5597.97	13.5	0.188	13.3	22.6	9.79	1.40%	Sand-Slime Tailing	0.059	119.0	1.24	0.47	0.77	1	1.10	14.595	202.88	17.13	16	1.54%	2.7	47%	1.82	0.00	1.82	0
22.145	5597.80	12.1	0.166	12.0	27.8	12.05	1.37%	Sand-Slime Tailing	0.059	119.0	1.25	0.48	0.77	1	1.09	13.053	181.44	15.38	14	1.52%	2.7	47%	1.83	0.00	1.83	0
22.309	5597.64	9.5	0.208	9.3	33.0	14.31	2.19%	Slime Tailings	0.057	113.1	1.26	0.48	0.77	1	1.09	10.097	140.34	11.99	11	2.52%	2.9	71%	1.84	0.00	1.84	0
22.473	5597.48	10.2	0.214	9.9	57.5	24.93	2.09%	Slime Tailings	0.057	113.1	1.27	0.49	0.78	1	1.08	10.671	148.33	12.85	12	2.39%	2.9	71%	1.85	0.00	1.85	0
22.638	5597.31	12.2	0.168	12.0	43.6	18.90	1.37%	Sand-Slime Tailing	0.059	119.0	1.28	0.49	0.78	1	1.08	12.884	179.09	15.30	14	1.53%	2.7	47%	1.86	0.00	1.86	0
22.802	5597.15	15.7	0.124	15.5	28.3	12.28	0.79%	Sand-Slime Tailing	0.059	119.0	1.29	0.50	0.79	1	1.07	16.653	231.47	19.56	18	0.86%	2.5	47%	1.87	0.00	1.87	0
22.966	5596.98	18.3	0.115	18.2	21.4	9.29	0.63%	Sand-Slime Tailing	0.059	119.0	1.29	0.50	0.79	1	1.07	19.355	269.03	22.65	21	0.68%	2.4	47%	1.88	0.00	1.88	0
23.130	5596.82	17.6	0.122	17.5	22.6	9.77	0.69%	Sand-Slime Tailing	0.059	119.0	1.30	0.51	0.80	1	1.06	18.534	257.62	21.70	20	0.75%	2.4	47%	1.89	0.00	1.89	0
23.294	5596.66	16.7	0.117	16.6	23.3	10.10	0.70%	Sand-Slime Tailing	0.059	119.0	1.31	0.51	0.80	1	1.06	17.505	243.32	20.51	19	0.76%	2.4	47%	1.89	0.00	1.89	0
23.458	5596.49	18.6	0.112	18.5	23.3	10.10	0.60%	Sand-Slime Tailing	0.059	119.0	1.32	0.52	0.81	1	1.05	19.432	270.11	22.75	21	0.65%	2.4	47%	1.90	0.00	1.90	0
23.622	5596.33	24.6	0.061	24.5	18.8	8.15	0.25%	Sand-Slime Tailing	0.059	119.0	1.33	0.52	0.81	1	1.04	25.556	355.23	29.82	29	0.26%	2.1	47%	1.91	0.00	1.91	0
23.786	5596.16	27.8	0.103	27.7	11.3	4.89	0.37%	Sand-Slime Tailing	0.059	119.0	1.34	0.53	0.82	1	1.04	28.802	400.34	33.54	32	0.39%	2.1	47%	1.92	0.00	1.92	0
23.950	5596.00	23.4	0.209	23.4	12.0	5.22	0.89%	Sand-Slime Tailing	0.059	119.0	1.35	0.53	0.82	1	1.04	24.226	336.75	28.23	27	0.95%	2.4	47%	1.93	0.00	1.93	0

Liquefaction Triggering Analyses (Idriss & Boulanger (2008); Youd et al. (2001)); Idriss & Boulanger (2008)

Depth at time of CPT (ft)	I&B Cyclic Stress Ratio r_d	C_σ	K_σ	K_a	CSR M=7.5, s'v=1atm	I&B Cyclic Resistance Ratio Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd Cyclic Stress Ratio r_d	D_r	f	K_σ	K_a	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	CN	qc1 TSF	qc1 MPa	qc1N
12.139	0.94	0.05	0.98	1.0	0.053	35.71	51.14	0.079	1.48	0.95	0.23	0.80	1.12	1.0	0.037	2.37	36.59	0.080	3.39	2.44	2	1.556874	13.281	1.2715	15.425
12.303	0.94	0.05	0.98	1.0	0.053	34.76	48.18	0.076	1.43	0.95	0.21	0.80	1.12	1.0	0.037	4.65	62.38	0.103	4.29	2.86	2	1.546591	11.551	1.1059	13.416
12.467	0.93	0.05	0.98	1.0	0.053	36.43	53.88	0.081	1.54	0.95	0.24	0.80	1.12	1.0	0.037	3.70	64.54	0.105	4.35	2.95	2	1.535304	15.033	1.4393	17.460
12.631	0.93	0.05	0.98	1.0	0.053	35.37	50.55	0.078	1.47	0.95	0.22	0.80	1.11	1.0	0.037	4.18	63.47	0.104	4.27	2.87	2	1.525341	13.069	1.2512	15.179
12.795	0.93	0.05	0.98	1.0	0.053	38.25	60.92	0.089	1.69	0.95	0.27	0.80	1.11	1.0	0.037	2.14	48.49	0.090	3.69	2.69	2	1.505298	19.52	1.8688	22.671
12.959	0.93	0.06	0.98	1.0	0.053	39.91	67.32	0.096	1.83	0.95	0.30	0.80	1.11	1.0	0.038	2.14	58.59	0.099	3.99	2.91	2	1.472195	23.597	2.2592	27.407
13.123	0.93	0.06	0.98	1.0	0.053	38.93	63.53	0.092	1.75	0.94	0.29	0.80	1.11	1.0	0.038	2.41	59.16	0.099	3.98	2.86	2	1.475007	21.179	2.0277	24.598
13.287	0.93	0.06	0.98	1.0	0.052	40.50	69.59	0.099	1.89	0.94	0.31	0.80	1.11	1.0	0.038	2.12	61.68	0.102	4.05	2.97	2	1.44579	25.043	2.3976	29.086
13.451	0.93	0.06	0.97	1.0	0.052	41.54	73.57	0.104	1.99	0.94	0.33	0.80	1.10	1.0	0.038	1.82	58.33	0.098	3.88	2.94	2	1.425348	27.581	2.6406	32.033
13.615	0.93	0.06	0.98	1.0	0.052	39.65	66.29	0.095	1.82	0.94	0.30	0.80	1.10	1.0	0.038	2.08	55.52	0.096	3.75	2.78	2	1.436853	22.942	2.1965	26.646
13.779	0.92	0.05	0.98	1.0	0.052	37.74	58.95	0.087	1.66	0.94	0.27	0.80	1.10	1.0	0.038	2.58	54.62	0.095	3.69	2.67	2	1.451332	18.261	1.7483	21.209
13.943	0.92	0.05	0.98	1.0	0.052	36.90	55.72	0.083	1.60	0.94	0.25	0.80	1.10	1.0	0.038	2.65	49.94	0.092	3.52	2.56	2	1.442557	16.206	1.5515	18.822
14.107	0.92	0.05	0.98	1.0	0.052	36.13	52.76	0.080	1.54	0.94	0.24	0.80	1.10	1.0	0.038	3.29	54.75	0.095	3.63	2.59	2	1.432919	14.317	1.3707	16.628
14.271	0.92	0.05	0.98	1.0	0.052	35.32	50.34	0.078	1.50	0.94	0.22	0.80	1.09	1.0	0.038	4.28	64.34	0.105	3.97	2.73	2	1.424401	12.934	1.2383	15.022
14.436	0.92	0.05	0.97	1.0	0.052	38.47	61.75	0.090	1.73	0.94	0.28	0.80	1.09	1.0	0.038	2.84	66.01	0.107	4.01	2.87	2	1.405423	20.045	1.9191	23.281
14.600	0.92	0.06	0.97	1.0	0.052	41.67	74.09	0.105	2.03	0.94	0.33	0.80	1.09	1.0	0.038	2.34	75.74	0.120	4.48	3.26	2	1.365022	27.915	2.6726	32.422
14.764	0.92	0.06	0.97	1.0	0.052	38.43	62.39	0.091	1.75	0.94	0.28	0.80	1.09	1.0	0.038	3.55	84.93	0.137	5.07	3.41	2	1.385922	20.627	1.9748	23.957
14.928	0.92	0.05	0.97	1.0	0.052	37.58	58.32	0.086	1.67	0.94	0.26	0.80	1.09	1.0	0.038	2.90	60.16	0.100	3.68	2.67	2	1.388686	17.86	1.7099	20.743
15.092	0.91	0.05	0.97	1.0	0.051	37.79	59.16	0.087	1.69	0.94	0.27	0.80	1.09	1.0	0.038	2.79	59.56	0.100	3.63	2.66	2	1.378412	18.394	1.761	21.363
15.256	0.91	0.06	0.97	1.0	0.051	39.15	64.39	0.093	1.81	0.94	0.29	0.80	1.08	1.0	0.038	2.04	51.53	0.093	3.35	2.58	2	1.355907	21.73	2.0804	25.238
15.420	0.91	0.06	0.97	1.0	0.051	41.17	72.15	0.102	2.00	0.94	0.32	0.80	1.08	1.0	0.038	1.78	55.03	0.095	3.42	2.71	2	1.330494	26.677	2.5541	30.984
15.584	0.91	0.06	0.97	1.0	0.051	39.61	66.13	0.095	1.86	0.94	0.30	0.80	1.08	1.0	0.038	2.09	55.54	0.096	3.41	2.64	2	1.33562	22.841	2.1868	26.529
15.748	0.91	0.06	0.97	1.0	0.051	43.34	80.53	0.113	2.23	0.94	0.35	0.80	1.08	1.0	0.038	1.50	55.66	0.096	3.39	2.81	2	1.300215	32.02	3.0656	37.189
15.912	0.91	0.07	0.97	1.0	0.051	44.99	86.87	0.122	2.41	0.94	0.37	0.80	1.08	1.0	0.038	1.60	66.81	0.108	3.78	3.10	2	1.283307	36.059	3.4523	41.880
16.076	0.91	0.06	0.97	1.0	0.051	40.11	68.10	0.097	1.91	0.94	0.31	0.80	1.08	1.0	0.038	2.76	77.26	0.123	4.28	3.10	2	1.308352	24.092	2.3065	27.981
16.240	0.91	0.06	0.97	1.0	0.051	38.75	62.84	0.091	1.79	0.94	0.28	0.80	1.07	1.0	0.038	3.07	74.03	0.118	4.07	2.93	2	1.31174	20.742	1.9858	24.091
16.404	0.90	0.06	0.97	1.0	0.051	39.23	64.68	0.093	1.84	0.94	0.29	0.80	1.07	1.0	0.039	2.62	66.75	0.108	3.69	2.77	2	1.300283	21.912	2.0979	25.449
16.568	0.90	0.05	0.97	1.0	0.051	38.35	61.30	0.089	1.76	0.94	0.28	0.80	1.07	1.0	0.039	3.03	69.61	0.111	3.79	2.78	2	1.299836	19.757	1.8915	22.946
16.732	0.90	0.05	0.97	1.0	0.051	37.21	56.91	0.085	1.67	0.94	0.26	0.80	1.07	1.0	0.039	3.05	60.03	0.100	3.39	2.53	2	1.298003	16.964	1.6241	19.703
16.896	0.90	0.05	0.97	1.0	0.050	38.19	60.67	0.089	1.76	0.94	0.27	0.80	1.07	1.0	0.039	2.38	53.50	0.094	3.16	2.46	2	1.286162	19.361	1.8536	22.486
17.060	0.90	0.05	0.97	1.0	0.050	37.00	56.11	0.084	1.66	0.94	0.25	0.80	1.07	1.0	0.039	3.34	63.84	0.104	3.47	2.57	2	1.282937	16.449	1.5748	19.104
17.224	0.90	0.05	0.97	1.0	0.050	37.02	56.17	0.084	1.66	0.94	0.25	0.80	1.06	1.0	0.039	3.48	66.58	0.107	3.56	2.61	2	1.275552	16.49	1.5787	19.152
17.388	0.90	0.05	0.97	1.0	0.050	36.75	55.13	0.083	1.64	0.93	0.25	0.80	1.06	1.0	0.039	3.85	70.78	0.113	3.71	2.68	2	1.268263	15.825	1.5151	18.380
17.552	0.90	0.05	0.97	1.0	0.050	35.47	50.21	0.078	1.54	0.93	0.22	0.80	1.06	1.0	0.039	3.82	56.34	0.097	3.16	2.35	2	1.261069	12.688	1.2147	14.736
17.716	0.89	0.05	0.97	1.0	0.050	35.91	51.91	0.079	1.58	0.93	0.23	0.80	1.06	1.0	0.039	3.62	57.91	0.098	3.18	2.38	2	1.253967	13.774	1.3187	15.998
17.880	0.89	0.05	0.97	1.0	0.050	35.70	51.08	0.079	1.57	0.93	0.23	0.80	1.06	1.0	0.039	3.44	52.94	0.094	3.02	2.29	2	1.246955	13.242	1.2678	15.380
18.044	0.89	0.05	0.97	1.0	0.050	38.16	60.57	0.088	1.77	0.93	0.27	0.80	1.06	1.0	0.039	2.95	66.15	0.107	3.42	2.60	2	1.236754	19.294	1.8472	22.409
18.208	0.89	0.05	0.97	1.0	0.050	36.04	52.41	0.080	1.60	0.93	0.23	0.80	1.06	1.0	0.039	4.00	65.53	0.106	3.37	2.49	2	1.233196	14.093	1.3493	16.368
18.372	0.89	0.05	0.97	1.0	0.050	35.06	48.62	0.076	1.53	0.93	0.21	0.80	1.05	1.0	0.039	4.53	61.47	0.102	3.21	2.37	2	1.226446	11.675	1.1177	13.559
18.537	0.89	0.05	0.97	1.0	0.050	38.34	61.28	0.089	1.80	0.93	0.28	0.80	1.05	1.0	0.039	2.40	55.11	0.096	3.00	2.40	2	1.215729	19.746	1.8905	22.934
18.701	0.89	0.06	0.96	1.0	0.049	39.08	64.10	0.093	1.87	0.93	0.29	0.80	1.05	1.0	0.039	2.38	59.44	0.100	3.10	2.49	2	1.205321	21.543	2.0626	25.021
18.865	0.89	0.05	0.97	1.0	0.049	37.62	58.49	0.086	1.74	0.93	0.26	0.80	1.05	1.0	0.039	2.70	56.46	0.097	3.00	2.37	2	1.206689	17.971	1.7206	20.872
19.029	0.88	0.06	0.96	1.0	0.049	39.16	64.43	0.093	1.89	0.93	0.29	0.80	1.05	1.0	0.039	2.41	60.84	0.101	3.11	2.50	2	1.192486	21.755	2.0829	25.268
19.193	0.88	0.05	0.97	1.0	0.049	37.94	59.70	0.088	1.78	0.93	0.27	0.80	1.05	1.0	0.039	3.11	67.59	0.109	3.32	2.55	2	1.192482	18.742	1.7944	21.768
19.357	0.88	0.05	0.97	1.0	0.049	36.28	53.34	0.081	1.64	0.93	0.24	0.80	1.04	1.0	0.039	4.12	70.25	0.112	3.41	2.52	2	1.187643	14.687	1.4061	17.058
19.521	0.88	0.05	0.96	1.0	0.049	37.61	58.46	0.086	1.76	0.93	0.26	0.80	1.04	1.0	0.039	3.25	67.72	0.109	3.29	2.52	2	1.181446	17.948	1.7184	20.846
19.685	0.88	0.05	0.97	1.0	0.049	36.21	53.04	0.080	1.64	0.93	0.24	0.80	1.04	1.0	0.039	4.39	73.96	0.118	3.53	2.59	2	1.175321	14.495	1.3878	16.835
19.849	0.88	0.05	0.97	1.0	0.049	36.17	52.91	0.080	1.64	0.93	0.24	0.80	1.04	1.0	0.039	1.87	31.30	0.076	2.27	1.96	2	1.169269	14.414	1.38	16.741
20.013	0.88	0.05	0.96	1.0	0.049	38.21	60.75	0.089	1.82	0.93	0.27	0.80	1.04	1.0	0.039	2.20	49.63	0.091	2.72	2.27	2	1.160922	19.411	1.8584	22.544
20.177	0.87	0.05	0.97	1.0	0.049	35.50	50.32	0.078	1.59	0.92	0.22	0.80	1.04	1.0	0.039	4.13	61.27	0.101	3.00	2.30	2	1.157375	12.758	1.2215	14.818
20.341	0.87	0.05	0.96	1.0	0.049	38.02	60.01	0.088	1.81	0.92	0.27	0.80	1.04	1.0	0.039	2.25	49.58	0.091	2.69	2.25	2	1.150108	18.939	1.8132	21.996
20.505	0.87	0.06	0.96	1.0	0.048	42.39	76.86	0.108	2.25	0.92	0.34	0.80	1.04	1.0	0.039	1.88	64.63	0.105	3.08	2.66	2	1.130354	29.678	2.8413	34.469
20.669	0.87	0.05	0.96	1.0	0.048	38.65	62.46	0.091	1.87	0.92	0.28	0.80	1.03	1.0	0.039	3.22	76.70	0.122	3.55	2.71	2	1.13646	20.502	1.9629	23.812
20.833	0.87	0.05	0.96	1.0	0.048	37.62	58.48	0.086	1.78	0.92	0.26	0.80	1.03	1.0	0.039	4.01	83.73	0.135	3.90	2.84	2	1.134393	17.962	1.7197	20.862
20.997	0.87	0.05	0.96	1.0	0.048	36.50	54.15	0.082	1.69	0.92	0.24	0.80	1.03	1.0	0.039	4.26	75.26	0.120	3.45	2.57	2	1.128809	15.205	1.4557	17.659
21.161	0.87	0.05	0.96	1.0	0.048	36.49	54.12	0.082	1.69	0.92	0.24	0.80	1.03	1.0	0.039	4.11	72.54	0.115	3.32	2.50	2	1.123287	15.183	1.4536	17.634
21.325	0.87	0.05	0.96	1.0	0.048	36.77	55.23	0.083	1.72	0.91	0.25	0.80	1.03	1.0	0.039	3.32	61.36	0.101	2.90	2.31	2	1.117826	15.89	1.5214	18.456
21.489	0.86	0.06	0.96	1.0	0.048	39.97	67.53	0.097	2.02	0.91	0.30	0.80	1.03	1.0	0.039	2.07	57.16	0.097	2.77	2.39	2	1.106167	23.731	2.272	27.562
21.653	0.86	0.06	0.96	1.0	0.048	39.06	64.04	0.092	1.93	0.91	0.29	0.80	1.03	1.0	0.039	2.48	61.83	0.102	2.89	2.41	2	1.103335	21.507	2.059	24.979
21.817	0.86	0.05	0.96	1.0	0.048	37.13	56.61	0.084	1.76	0.91	0.25	0.80	1.03	1.0	0.039	3.29	64.11	0.105	2.95	2.35	2	1.101801	16.771	1.6057	19.479
21.981	0.86	0.05	0.96	1.0	0.048	36.31	53.44	0.081	1.69	0.91	0.24	0.80	1.02	1.0	0.039	3.77	64.60	0.105	2.95	2.32	2	1.096574	14.75	1.4122	17.131
22.145	0.86	0.05	0.96	1.0	0.048	35.70	51.08	0.079	1.64	0.91	0.23	0.80	1.02	1.0	0.039	4.08	62.70	0.103	2.87	2.26	2	1.091404	13.243	1.2679	15.381
22.309	0.86	0.05	0.96	1.0	0.048	34.26	46.25	0.074	1.55	0.91	0.20	0.80	1.02	1.0	0.039	6.02	72.19	0.115	3.20	2.37	2	1.086815	10.321	0.9881	11.987
22.473	0.86	0.05	0.96	1.0	0.048	34.56	47.41	0.075	1.57	0.91	0.21	0.80	1.02	1.0	0.039	5.61	72.09	0.115	3.18	2.38	2	1.08227	11.06	1.0589	12.845
22.638	0.85	0.05	0.96	1.0	0.048	35.67	50.97	0.078	1.65	0.90	0.23	0.80	1.02	1.0	0.039	4.11	62.96	0.103	2.85	2.25	2	1.077252	13.177	1.2616	15.305
22.802	0.85	0.05	0.96	1.0	0.047	37.16	56.72	0.084	1.78	0.90	0.26	0.80	1.02	1.0	0.039	2.72	53.26	0.094	2.58	2.18	2	1.072287	16.842	1.6125	19.561
22.966	0.85	0.05	0.96	1.0	0.047	38.24	60.89	0.089	1.88	0.90	0.27	0.80	1.02	1.0	0.039	2.24	50.80	0.092	2.52	2.20	2	1.066378	19.497	1.8667	22.645
23.130	0.85	0.05	0.96	1.0	0.047	37.91	59.61	0.087	1.86	0.90	0.27	0.80	1.02	1.0	0.039	2.40	52.09	0.093	2.54	2.20	2	1.062112	18.683	1.7887	21.700
23.294	0.85	0.05	0.96	1.0	0.047	37.49	58.00	0.086	1.82	0.90	0.26	0.80	1.01	1.0	0.039	2.52	51.71	0.093	2.52	2.17	2	1.057698	17.659	1.6906	20.510
23.458	0.85	0.05	0.96	1.0	0.047	38.28	61.03	0.089	1.90	0.90	0.28	0.80	1.01	1.0	0.039	2.21	50.28	0.092	2.48	2.19	2	1.052111	19.586	1.8751	22.747
23.622	0.85	0.06	0.95	1.0	0.047	40.76	70.59	0.100	2.15	0.90	0.32	0.80	1.01	1.0	0.039	1.48	44.02	0.087	2.33	2.24	2	1.044818	25.679	2.4585	29.824
23.786	0.85	0.06	0.95	1.0	0.046	42.06	75.60	0.107	2.30	0.89	0.33	0.80	1.01	1.0	0.039	1.49	50.05	0.092	2.45	2.38	2	1.039399	28.875	2.7645	33.537
23.950	0.84	0.06	0.95	1.0	0.047	40.20	68.43	0.098	2.10	0.89	0.31	0.80	1.01	1.0	0.039	2.17	61.33	0.101	2.70	2.40	2	1.036644	24.304	2.3269	28.228

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 2E1

Data File: 13-52106_SP2E1-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend
Tailings Sands
Tailings Sand-Slimes
Tailings Slimes
Interim Cover
Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69

Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5613.10	Water surface elevation during CPT investigation (ft a
5611.67	Water surface elevation at t_0 (ft amsl)
5595.46	Water surface elevation at t_1 (ft amsl)
5590.46	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earth
7.51	Equiv. Number of Uniform Strain Cycles, N

Value	Parameter
5619.95	Ground Surface Elevation at time of CPT (ft amsl)
5630.46	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after plac
3.50	Thickness of Water Storage/Rooting Zone (ft)
4.00	Thickness of High Compaction Layer (ft)
2.51	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1160.95	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5590.46	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5630.21	5629.96	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5628.21	5626.46	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5624.46	5622.46	4.00	0.060	120	0.454	0.334	0.00	0.00	0.454	0.334
Platform/Random Fill Layer	######	5621.21	5619.95	2.51	0.050	101	0.580	0.517	0.00	0.00	0.580	0.517

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %
24.114	5595.84	18.1	0.289	18.0	13.9	6.03	1.60%	Sand-Slime Tailing	0.059	119.0	1.36	0.54	0.82	1	1.03	18.635	259.03	21.75	20	1.73%	2.6	47%
24.278	5595.67	18.2	0.238	18.1	15.7	6.80	1.31%	Sand-Slime Tailing	0.059	119.0	1.37	0.54	0.83	1	1.03	18.616	258.76	21.74	20	1.42%	2.6	47%
24.442	5595.51	24.4	0.195	24.3	16.8	7.27	0.80%	Sand-Slime Tailing	0.059	119.0	1.38	0.55	0.83	1	1.02	24.907	346.21	29.05	28	0.85%	2.3	47%
24.606	5595.34	34.4	0.343	34.3	15.2	6.60	1.00%	Sand-Slime Tailing	0.059	119.0	1.39	0.55	0.84	1	1.02	34.889	484.95	40.63	39	1.04%	2.2	47%
24.770	5595.18	20.5	0.393	20.4	14.3	6.19	1.91%	Sand-Slime Tailing	0.059	119.0	1.40	0.56	0.84	1	1.02	20.768	288.68	24.23	23	2.05%	2.6	47%
24.934	5595.02	16.7	0.314	16.6	16.6	7.19	1.89%	Sand-Slime Tailing	0.059	119.0	1.41	0.56	0.85	1	1.01	16.751	232.84	19.58	18	2.06%	2.7	47%
25.098	5594.85	14.6	0.266	14.4	26.3	11.40	1.83%	Sand-Slime Tailing	0.059	119.0	1.42	0.57	0.85	1	1.01	14.503	201.59	17.04	15	2.03%	2.7	47%
25.262	5594.69	24.0	0.214	23.8	30.2	13.07	0.89%	Sand-Slime Tailing	0.059	119.0	1.43	0.57	0.86	1	1.00	23.851	331.52	27.92	26	0.95%	2.4	47%
25.426	5594.52	24.6	0.322	24.5	24.1	10.42	1.31%	Sand-Slime Tailing	0.059	119.0	1.44	0.58	0.86	1	1.00	24.455	339.93	28.58	27	1.39%	2.5	47%
25.590	5594.36	18.9	0.380	18.7	25.6	11.07	2.01%	Sand-Slime Tailing	0.059	119.0	1.45	0.58	0.87	1	1.00	18.640	259.10	21.83	20	2.18%	2.7	47%
25.754	5594.20	17.6	0.410	17.4	32.3	14.00	2.33%	Sand-Slime Tailing	0.059	119.0	1.46	0.59	0.87	1	0.99	17.234	239.55	20.25	19	2.54%	2.7	47%
25.918	5594.03	15.1	0.388	14.8	47.4	20.55	2.56%	Slime Tailings	0.057	113.1	1.47	0.59	0.88	1	0.99	14.652	203.67	17.36	16	2.84%	2.8	71%
26.082	5593.87	12.7	0.338	12.4	51.7	22.40	2.65%	Slime Tailings	0.057	113.1	1.48	0.60	0.88	1	0.98	12.217	169.82	14.56	13	3.00%	2.9	71%
26.246	5593.70	17.4	0.296	17.0	74.4	32.24	1.70%	Sand-Slime Tailing	0.059	119.0	1.49	0.61	0.88	1	0.98	16.605	230.81	19.81	18	1.86%	2.7	47%
26.410	5593.54	15.8	0.331	15.5	39.8	17.23	2.10%	Sand-Slime Tailing	0.059	119.0	1.50	0.61	0.89	1	0.98	15.162	210.75	17.89	16	2.32%	2.8	47%
26.574	5593.38	15.8	0.404	15.3	86.3	37.40	2.55%	Slime Tailings	0.057	113.1	1.51	0.62	0.89	1	0.97	14.863	206.60	17.87	16	2.82%	2.8	71%
26.739	5593.21	16.2	0.416	16.0	39.0	16.89	2.56%	Slime Tailings	0.057	113.1	1.52	0.62	0.90	1	0.97	15.487	215.27	18.26	16	2.83%	2.8	71%
26.903	5593.05	19.8	0.353	19.4	59.3	25.69	1.78%	Sand-Slime Tailing	0.059	119.0	1.53	0.63	0.90	1	0.97	18.751	260.63	22.19	20	1.93%	2.6	47%
27.067	5592.88	25.7	0.481	25.6	31.0	13.43	1.87%	Sand-Slime Tailing	0.059	119.0	1.54	0.63	0.91	1	0.96	24.609	342.07	28.80	27	1.99%	2.5	47%
27.231	5592.72	23.6	0.456	23.3	42.6	18.45	1.93%	Sand-Slime Tailing	0.059	119.0	1.55	0.64	0.91	1	0.96	22.359	310.79	26.26	24	2.07%	2.6	47%
27.395	5592.56	22.8	0.504	22.4	57.1	24.73	2.21%	Sand-Slime Tailing	0.059	119.0	1.56	0.64	0.92	1	0.95	21.416	297.69	25.27	23	2.37%	2.6	47%
27.559	5592.39	17.8	0.379	17.4	71.1	30.80	2.13%	Sand-Slime Tailing	0.059	119.0	1.57	0.65	0.92	1	0.95	16.510	229.49	19.67	18	2.33%	2.7	47%
27.723	5592.23	23.3	0.387	22.9	65.4	28.36	1.66%	Sand-Slime Tailing	0.059	119.0	1.58	0.65	0.92	1	0.95	21.674	301.27	25.62	23	1.78%	2.6	47%
27.887	5592.06	19.0	0.387	18.8	36.8	15.95	2.03%	Sand-Slime Tailing	0.059	119.0	1.59	0.66	0.93	1	0.94	17.700	246.03	20.81	19	2.22%	2.7	47%
28.051	5591.90	23.9	0.387	23.5	75.0	32.50	1.62%	Sand-Slime Tailing	0.059	119.0	1.60	0.66	0.93	1	0.94	22.063	306.68	26.14	24	1.73%	2.6	47%

Conditions at t_1 / Liquefaction Triggering Analyses

Depth at time of CPT (ft)	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	I&B (2008) CSR: r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	I&B (2008) CRR: Δqc_{1n}	$qc_{1n\text{-}cs}$	(CRR) M=7.5, s'v=1atm	FoS	Youd et al. (2001) CSR: r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	$qc_{1n\text{-}cs}$	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	I&B (2008): CN	qc1 TSF	qc1 MPa	qc1N
24.114	1.94	0.00	1.94	0	0.84	0.05	0.96	1.0	0.047	37.93	59.68	0.087	1.88	0.89	0.27	0.80	1.01	1.0	0.039	3.37	73.35	0.117	3.10	2.49	2	1.034131	18.725	1.7927	21.748
24.278	1.95	0.00	1.95	0	0.84	0.05	0.96	1.0	0.046	37.93	59.66	0.087	1.88	0.89	0.27	0.80	1.01	1.0	0.039	3.10	67.33	0.108	2.87	2.37	2	1.029637	18.717	1.7919	21.738
24.442	1.96	0.00	1.96	0	0.84	0.06	0.95	1.0	0.046	40.49	69.54	0.099	2.14	0.89	0.31	0.80	1.01	1.0	0.039	2.05	59.56	0.100	2.62	2.38	2	1.023719	25.014	2.3949	29.053
24.606	1.97	0.00	1.97	1	0.84	0.07	0.95	1.0	0.046	44.55	85.19	0.120	2.61	0.89	0.37	0.80	1.01	1.0	0.039	1.79	72.69	0.116	3.03	2.82	2	1.018055	34.986	3.3495	40.634
24.770	1.98	0.01	1.97	1	0.84	0.06	0.95	1.0	0.046	38.80	63.02	0.091	1.97	0.89	0.28	0.80	1.00	1.0	0.039	3.40	82.30	0.132	3.43	2.70	2	1.016063	20.859	1.997	24.226
24.934	1.99	0.01	1.98	1	0.84	0.05	0.96	1.0	0.047	37.17	56.75	0.084	1.81	0.89	0.26	0.80	1.00	1.0	0.039	3.96	77.45	0.123	3.18	2.50	2	1.012167	16.856	1.6138	19.577
25.098	2.00	0.02	1.98	1	0.83	0.05	0.96	1.0	0.047	36.28	53.31	0.081	1.73	0.88	0.24	0.80	1.00	1.0	0.039	4.34	73.97	0.118	3.02	2.38	2	1.007857	14.669	1.4044	17.037
25.262	2.01	0.02	1.99	1	0.83	0.06	0.95	1.0	0.046	40.09	68.01	0.097	2.09	0.88	0.31	0.80	1.00	1.0	0.039	2.21	61.74	0.102	2.60	2.35	2	1.003389	24.039	2.3015	27.920
25.426	2.02	0.03	1.99	1	0.83	0.06	0.95	1.0	0.046	40.32	68.90	0.098	2.12	0.88	0.31	0.80	1.00	1.0	0.039	2.54	72.71	0.116	2.93	2.52	2	0.9994	24.605	2.3557	28.578
25.590	2.03	0.03	2.00	1	0.83	0.05	0.95	1.0	0.047	37.96	59.79	0.088	1.88	0.88	0.27	0.80	1.00	1.0	0.040	3.77	82.36	0.132	3.32	2.60	2	0.995211	18.799	1.7998	21.834
25.754	2.04	0.04	2.00	1	0.83	0.05	0.96	1.0	0.047	37.40	57.65	0.085	1.83	0.88	0.26	0.80	1.00	1.0	0.040	4.27	86.54	0.140	3.51	2.67	2	0.991028	17.434	1.6691	20.248
25.918	2.05	0.04	2.01	1	0.83	0.05	0.96	1.0	0.047	36.13	53.49	0.081	1.73	0.88	0.24	0.80	1.00	1.0	0.040	5.00	86.83	0.141	3.50	2.62	2	0.987343	14.944	1.4308	17.357
26.082	2.06	0.05	2.01	1	0.83	0.05	0.96	1.0	0.047	35.16	49.72	0.077	1.65	0.88	0.22	0.80	1.00	1.0	0.040	5.79	84.24	0.136	3.35	2.50	2	0.983689	12.535	1.2001	14.558
26.246	2.07	0.05	2.01	1	0.82	0.05	0.96	1.0	0.047	37.25	57.06	0.085	1.81	0.87	0.26	0.80	0.99	1.0	0.040	3.77	74.76	0.119	2.92	2.37	2	0.97965	17.06	1.6333	19.814
26.410	2.08	0.06	2.02	1	0.82	0.05	0.96	1.0	0.047	36.58	54.47	0.082	1.75	0.87	0.24	0.80	0.99	1.0	0.040	4.48	80.16	0.128	3.13	2.44	2	0.975649	15.404	1.4748	17.891
26.574	2.09	0.07	2.02	1	0.82	0.05	0.96	1.0	0.047	36.31	54.18	0.082	1.74	0.87	0.24	0.80	0.99	1.0	0.040	4.91	87.67	0.143	3.47	2.60	2	0.972092	15.387	1.4732	17.871
26.739	2.10	0.07	2.03	1	0.82	0.05	0.96	1.0	0.047	36.45	54.71	0.082	1.75	0.87	0.25	0.80	0.99	1.0	0.040	4.84	88.43	0.144	3.49	2.62	2	0.968565	15.723	1.5053	18.261
26.903	2.11	0.08	2.03	1	0.82	0.05	0.95	1.0	0.047	38.08	60.28	0.088	1.88	0.87	0.27	0.80	0.99	1.0	0.040	3.55	78.85	0.126	3.02	2.45	2	0.965029	19.108	1.8294	22.192
27.067	2.12	0.08	2.04	1	0.82	0.06	0.95	1.0	0.047	40.40	69.20	0.099	2.11	0.87	0.31	0.80	0.99	1.0	0.040	3.01	86.67	0.141	3.36	2.73	2	0.963182	24.796	2.3739	28.799
27.231	2.13	0.09	2.04	1	0.82	0.06	0.95	1.0	0.047	39.51	65.78	0.094	2.02	0.87	0.30	0.80	0.99	1.0	0.040	3.27	85.87	0.139	3.30	2.66	2	0.958797	22.614	2.1651	26.265
27.395	2.14	0.09	2.05	1	0.82	0.06	0.95	1.0	0.047	39.16	64.43	0.093	1.98	0.87	0.29	0.80	0.99	1.0	0.040	3.59	90.66	0.149	3.52	2.75	2	0.95481	21.757	2.083	25.269
27.559	2.15	0.10	2.05	1	0.81	0.05	0.95	1.0	0.047	37.20	56.86	0.084	1.80	0.86	0.26	0.80	0.99	1.0	0.040	4.23	83.15	0.133	3.13	2.46	2	0.94942	16.932	1.621	19.665
27.723	2.16	0.10	2.06	1	0.81	0.06	0.95	1.0	0.047	39.29	64.91	0.093	1.99	0.86	0.29	0.80	0.99	1.0	0.040	3.11	79.73	0.127	2.97	2.48	2	0.947722	22.062	2.1122	25.623
27.887	2.17	0.11	2.06	1	0.81	0.05	0.95	1.0	0.047	37.60	58.41	0.086	1.83	0.86	0.26	0.80	0.98	1.0	0.041	3.98	82.85	0.133	3.08	2.46	2	0.942001	17.917	1.7153	20.809
28.051	2.18	0.11	2.06	1	0.81	0.06	0.95	1.0	0.047	39.47	65.61	0.094	2.01	0.86	0.30	0.80	0.98	1.0	0.041	3.04	79.33	0.126	2.92	2.46	2	0.940871	22.504	2.1545	26.137

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-1S

Data File: 13-52106_SP3-1S-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)
Max. Horiz. Acceleration, Amax/g: 0.15
Earthquake Moment Magnitude, M: 5.5
Magnitude Scaling Factor, MSF: 1.69

Youd, et al (2001)
Max. Horiz. Acceleration, Amax/g: 0.15
Earthquake Moment Magnitude, M: 5.5
Magnitude Scaling Factor, MSF: 2.21

5608.00 Water surface elevation during CPT investigation (ft
5604.28 Water surface elevation at t_0 (ft amsl)
5595.59 Water surface elevation at t_1 (ft amsl)
5590.59 Water surface elevation at t_2 (ft amsl)

1.44 Scaling Factor for stress ration, r_m
0.47 Volumetric Strain Ratio for Site-Specific Design Ear
7.51 Equiv. Number of Uniform Strain Cycles, N

5612.56 Ground Surface Elevation at time of CPT (ft amsl)
5620.47 Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50 Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pl
3.50 Thickness of Water Storage/Rooting Zone (ft)
3.50 Thickness of High Compaction Layer (ft)
0.41 Thickness of Random/Platform Fill on on top of existing interim cover (ft)
887.10 Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5590.59 Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5620.22	5619.97	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5618.22	5616.47	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5614.72	5612.97	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320
Platform/Random Fill Layer	######	5612.77	5612.56	0.41	0.050	101	0.445	0.434	0.00	0.00	0.445	0.434

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
0.164	5612.40	1.0	0.010	1.0	-0.2	-0.10	1.00%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	1.700	23.63	1.97	120	1.01%	1.9	51%	0.45	0.00	0.45	0
0.328	5612.23	1.0	0.010	1.0	0.4	0.19	1.00%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	1.700	23.63	1.98	60	1.01%	2.1	51%	0.46	0.00	0.46	0
0.492	5612.07	1.0	0.010	1.0	-0.1	-0.04	1.00%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	1.700	23.63	1.97	39	1.03%	2.2	51%	0.47	0.00	0.47	0
0.656	5611.90	1.0	0.010	1.0	-0.2	-0.08	1.00%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	1.700	23.63	1.97	29	1.04%	2.4	51%	0.48	0.00	0.48	0
0.820	5611.74	5.6	0.026	5.6	14.4	6.23	0.46%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	9.435	131.15	11.14	136	0.46%	1.6	51%	0.48	0.00	0.48	0
0.984	5611.58	9.5	0.093	9.4	16.6	7.20	0.98%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	15.929	221.41	18.71	190	0.99%	1.7	51%	0.49	0.00	0.49	0
1.148	5611.41	19.7	0.245	19.6	13.4	5.80	1.24%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	33.371	463.86	38.92	340	1.25%	1.6	51%	0.50	0.00	0.50	0
1.312	5611.25	35.4	0.510	35.4	11.0	4.76	1.44%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	60.146	836.03	69.99	535	1.44%	1.6	51%	0.51	0.00	0.51	0
1.476	5611.08	80.0	0.912	79.9	17.9	7.76	1.14%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	135.830	1888.04	157.98	1075	1.14%	1.4	51%	0.52	0.00	0.52	0
1.640	5610.92	89.0	1.063	88.9	17.5	7.59	1.19%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	151.130	2100.71	175.74	1076	1.20%	1.4	51%	0.53	0.00	0.53	0
1.804	5610.76	96.1	1.232	96.1	7.4	3.19	1.28%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	163.370	2270.84	189.84	1057	1.28%	1.4	51%	0.53	0.00	0.53	0
1.968	5610.59	77.7	1.349	77.7	5.5	2.40	1.74%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	132.073	1835.81	153.46	783	1.74%	1.6	51%	0.54	0.00	0.54	0
2.133	5610.43	53.3	1.640	53.3	9.6	4.14	3.07%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	90.576	1259.01	105.32	496	3.08%	1.9	51%	0.55	0.00	0.55	0
2.297	5610.26	46.3	1.974	46.2	9.6	4.14	4.27%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	78.557	1091.94	91.36	399	4.28%	2.0	51%	0.56	0.00	0.56	0
2.461	5610.10	39.8	1.642	39.7	8.0	3.48	4.13%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	67.507	938.35	78.50	320	4.14%	2.1	51%	0.57	0.00	0.57	0
2.625	5609.94	45.3	1.613	45.3	4.3	1.87	3.56%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.70	76.959	1069.73	89.44	342	3.57%	2.0	51%	0.58	0.00	0.58	0
2.789	5609.77	38.8	1.441	38.8	0.7	0.30	3.72%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0	1.70	65.892	915.90	76.54	275	3.73%	2.1	51%	0.58	0.00	0.58	0
2.953	5609.61	36.0	1.125	36.0	0.5	0.22	3.13%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0	1.70	61.149	849.97	71.03	241	3.14%	2.0	51%	0.59	0.00	0.59	0
3.117	5609.44	31.9	1.113	31.9	-1.8	-0.76	3.49%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0	1.70	54.213	753.56	62.94	202	3.51%	2.1	51%	0.60	0.00	0.60	0
3.281	5609.28	30.2	1.010	30.2	-1.8	-0.77	3.35%	Slime Tailings	0.041	82.7	0.16	0.00	0.16	0	1.70	51.306	713.15	59.57	183	3.37%	2.1	71%	0.61	0.00	0.61	0
3.445	5609.12	27.8	0.976	27.8	-1.7	-0.73	3.52%	Slime Tailings	0.041	82.7	0.17	0.00	0.17	0	1.70	47.209	656.21	54.81	162	3.54%	2.2	71%	0.61	0.00	0.61	0
3.609	5608.95	23.2	0.881	23.2	-1.0	-0.45	3.80%	Slime Tailings	0.041	82.7	0.18	0.00	0.18	0	1.70	39.406	547.74	45.75	130	3.83%	2.3	71%	0.62	0.00	0.62	0
3.773	5608.79	18.8	1.037	18.8	-0.3	-0.12	5.50%	Slime Tailings	0.041	82.7	0.18	0.00	0.18	0	1.70	32.028	445.19	37.20	101	5.56%	2.5	71%	0.63	0.00	0.63	0
3.937	5608.62	11.7	1.018	11.7	-0.3	-0.13	8.69%	Slime Tailings	0.041	82.7	0.19	0.00	0.19	0	1.70	19.907	276.71	23.12	60	8.84%	2.7	71%	0.63	0.00	0.63	0
4.101	5608.46	25.7	1.084	25.7	0.5	0.20	4.22%	Slime Tailings	0.041	82.7	0.20	0.00	0.20	0	1.70	43.622	606.35	50.67	129	4.26%	2.3	71%	0.64	0.00	0.64	0
4.265	5608.29	24.3	1.143	24.3	0.5	0.20	4.70%	Slime Tailings	0.041	82.7	0.20	0.00	0.20	0	1.70	41.361	574.92	48.04	118	4.74%	2.4	71%	0.65	0.00	0.65	0
4.429	5608.13	21.7	1.211	21.7	-1.0	-0.45	5.58%	Slime Tailings	0.041	82.7	0.21	0.00	0.21	0	1.70	36.907	513.01	42.85	102	5.63%	2.5	71%	0.65	0.00	0.65	0
4.593	5607.97	36.9	1.373	36.9	-0.2	-0.10	3.72%	Slime Tailings	0.057	113.1	0.22	0.00	0.22	1	1.70	62.696	871.47	72.81	167	3.75%	2.2	71%	0.66	0.00	0.66	0
4.757	5607.80	75.7	1.484	75.7	0.5	0.20	1.96%	Sand-Slime Tailing	0.059	119.0	0.23	0.01	0.22	1	1.70	128.690	1788.79	149.47	337	1.97%	1.8	47%	0.67	0.00	0.67	0
4.921	5607.64	90.7	1.093	90.7	1.8	0.79	1.21%	Sand Tailings	0.062	123.5	0.24	0.01	0.23	1	1.63	147.850	2055.11	171.74	395	1.21%	1.6	18%	0.68	0.00	0.68	0
5.085	5607.47	113.7	1.047	113.6	8.3	3.60	0.92%	Sand Tailings	0.062	123.5	0.25	0.02	0.23	1	1.53	173.889	2417.06	202.05	484	0.92%	1.4	18%	0.69	0.00	0.69	0
5.249	5607.31	123.4	0.699	123.3	4.9	2.11	0.57%	Sand Tailings	0.062	123.5	0.26	0.02	0.24	1	1.49	183.875	2555.86	213.61	515	0.57%	1.2	18%	0.70	0.00	0.70	0
5.413	5607.15	101.2	0.707	101.2	3.6	1.54	0.70%	Sand Tailings	0.062	123.5	0.27	0.03	0.24	1	1.56	157.808	2193.53	183.32	414	0.70%	1.4	18%	0.71	0.00	0.71	0
5.577	5606.98	80.8	0.675	80.8	2.2	0.94	0.84%	Sand Tailings	0.062	123.5	0.28	0.03	0.25	1	1.64	132.252	1838.30	153.63	323	0.84%	1.5	18%	0.72	0.00	0.72	0
5.741	5606.82	76.8	0.595	76.8	2.1	0.89	0.77%	Sand Tailings	0.062	123.5	0.29	0.04	0.25	1	1.65	126.407	1757.06	146.84	301	0.78%	1.5	18%	0.73	0.00	0.73	0
5.905	5606.65	74.6	0.547	74.6	2.0	0.86	0.73%	Sand Tailings	0.062	123.5	0.30	0.04	0.26	1	1.65	122.801	1706.93	142.65	287	0.74%	1.5	18%	0.74	0.00	0.74	0
6.069	5606.49	70.2	0.520	70.2	1.3	0.57	0.74%	Sand Tailings	0.062	123.5	0.31	0.05	0.26	1	1.66	116.482	1619.10	135.30	265	0.74%	1.5	18%	0.75	0.00	0.75	0
6.234	5606.33	60.0	0.488	60.0	1.2	0.52	0.81%	Sand Tailings	0.062	123.5	0.32	0.05	0.27	1	1.70	101.915	1416.62	118.38	222	0.82%	1.6	18%	0.76	0.00	0.76	0
6.398	5606.16	59.3	0.442	59.3	0.8	0.36	0.75%	Sand Tailings	0.062	123.5	0.33	0.06	0.27	1	1.70	100.623	1398.66	116.88	215	0.75%	1.6	18%	0.78	0.00	0.78	0
6.562	5606.00	58.2	0.392	58.2	1.2	0.52	0.67%	Sand Tailings	0.062	123.5	0.34	0.06	0.28	1	1.69	98.587	1370.35	114.52	207	0.68%	1.6	18%	0.79	0.00	0.79	0
6.726	5605.83	53.1	0.371	53.1	1.1	0.46	0.70%	Sand Tailings	0.062	123.5	0.35	0.07	0.28	1	1.70	90.304	1255.23	104.90	186	0.70%	1.6	18%	0.80	0.00	0.80	0
6.890	5605.67	49.1	0.311	49.1	0.6	0.26	0.63%	Sand Tailings	0.062	123.5	0.36	0.07	0.29	1	1.70	83.470	1160.23	96.95	169	0.64%	1.6	18%	0.81	0.00	0.81	0
7.054	5605.51	56.4	0.288	56.4	1.2	0.51	0.51%	Sand Tailings	0.062	123.5	0.37	0.08	0.29	1	1.67	94.245	1310.00	109.47	191	0.51%	1.5	18%	0.82	0.00	0.82	0
7.218	5605.34	56.4	0.275	56.4	1.4	0.59	0.49%	Sand Tailings	0.062	123.5	0.38	0.08	0.30	1	1.66	93.553	1300.38	108.67	187	0.49%	1.5	18%	0.83	0.00	0.83	0
7.382	5605.18	44.0	0.351	44.0	0.2	0.09	0.80%	Sand Tailings	0.062	123.5	0.39	0.09	0.30	1	1.70	74.766	1039.25	86.84	143	0.81%	1.7	18%	0.84	0.00	0.84	0
7.546	5605.01	36.9	0.372	36.9	-0.1	-0.05	1.01%	Sand-Slime Tailing	0.059	119.0	0.40	0.09	0.31	1	1.70	62.747	872.18	72.88	118	1.02%	1.9	47%	0.85	0.00	0.85	0
7.710	5604.85	30.0	0.299	30.0	0.2	0.08	1.00%	Sand-Slime Tailing	0.059	119.0	0.41	0.10	0.31	1	1.70	51.034	709.37	59.28	94	1.01%	1.9	47%	0.86	0.00	0.86	0
7.874	5604.69	32.9	0.212	32.9	1.1	0.46	0.64%	Sand-Slime Tailing	0.059	119.0	0.42	0.10	0.32	1	1.70	55.896	776.95	64.93	102	0.65%	1.8	47%	0.87	0.00	0.87	0
8.038	5604.52	38.9	0.166	38.9	2.2	0.94	0.43%	Sand Tailings	0.062	123.5	0.43	0.11	0.32	1	1.70	66.079	918.50	76.77	119	0.43%	1.6	18%	0.88	0.00	0.88	0
8.202	5604.36	38.5	0.158	38.5	1.2	0.52	0.41%	Sand Tailings	0.062	123.5	0.44	0.11	0.33	1	1.70	65.399	909.05	75.97	116	0.42%	1.6	18%	0.89	0.00	0.89	0
8.366	5604.19	36.9	0.159	36.9	0.5	0.22	0.43%	Sand Tailings	0.062	123.5	0.45	0.12	0.33	1	1.70	62.798	872.89	72.94	110	0.44%	1.7	18%	0.90	0.00	0.90	0
8.530	5604.03	31.2	0.156	31.2	-0.5	-0.20	0.50%	Sand-Slime Tailing	0.059	119.0	0.46	0.12	0.34	1	1.70	53.040	737.26	61.60	91	0.51%	1.8	47%	0.91	0.00	0.91	0
8.694	5603.87	24.0	0.142	24.0	-0.0	-0.02	0.59%	Sand-Slime Tailing	0.059	119.0	0.47	0.13	0.34	1	1.70	40.800	567.12	47.39	69	0.60%	1.9	47%	0.92	0.00	0.92	0
8.858	5603.70	20.0	0.119	20.0	3.7	1.59	0.60%	Sand-Slime Tailing	0.059	119.0	0.48	0.13	0.35	1	1.70	33.949	471.89	39.48	56	0.61%	2.0	47%	0.92	0.00	0.92	0
9.022	5603.54	23.7	0.086	23.7	6.8	2.94	0.36%	Sand-Slime Tailing	0.059	119.0	0.49	0.14	0.35	1	1.70	40.273	559.79	46.86	66	0.37%	1.8	47%	0.93	0.00	0.93	0
9.186	5603.37	27.5	0.145	27.5	5.4	2.34	0.53%	Sand-Slime Tailing	0.059	119.0	0.50	0.14	0.36	1	1.70	46.665	648.64	54.27	76	0.54%	1.9	47%	0.94	0.00	0.94	0
9.350	5603.21	37.0	0.177	37.0	6.8	2.95	0.48%	Sand Tailings	0.062	123.5	0.51	0.15	0.36	1	1.64	60.777	844.79	70.67	101	0.48%	1.7	18%	0.95	0.00	0.95	0
9.514	5603.05	43.3	0.205	43.3	8.3	3.61	0.47%	Sand Tailings	0.062	123.5	0.52	0.15	0.37	1	1.59	68.941	958.28	80.17	117	0.48%	1.7	18%	0.96	0.00	0.96	0
9.678	5602.88	41.4	0.300	41.3	6.0	2.61	0.73%	Sand Tailings	0.062	123.5	0.53	0.16	0.37	1	1.59	65.913	916.19	76.62	110	0.73%	1.8	18%	0.97	0.00	0.97	0
9.842	5602.72	27.8	0.053	27.7	6.0	2.62	0.19%	Sand-Slime Tailing	0.059	119.0	0.54	0.16	0.38	1	1.68	46.511	646.50	54.09	72	0.19%	1.7	47%	0.98	0.00	0.98	0
10.006	5602.55	18.0	0.353	17.9	7.9	3.43	1.96%	Sand-Slime Tailing	0.059	119.0	0.55	0.17	0.38	1	1.70	30.464	423.45	35.48	46	2.03%	2.4	47%	0.99	0.00	0.99	0
10.170	5602.39	8.2	0.125	8.2	7.0	3.02	1.52%	Slime Tailings	0.057	113.1	0.56	0.18	0.38	1	1.70	13.889	193.06	16.22	20	1.63%	2.6	71%	1.00	0.00	1.00	0
10.335	5602.23	13.5	0.090	13.4	11.9	5.17	0.67%	Sand-Slime Tailing	0.059	119.0	0.57	0.18	0.39	1	1.70	22.763	316.41	26.58	33	0.70%	2.2	47%	1.01	0.00	1.01	0
10.499	5602.06	10.5	0.118	10.3	21.6	9.36	1.13%	Sand-Slime Tailing	0.059	119.0	0.58	0.19	0.39	1	1.70	17.561	244.10	20.66	25	1.19%	2.4	47%	1.02	0.00	1.02	0
10.663	5601.90	9.7	0.087	9.5	38.5	16.68	0.89%	Sand-Slime Tailing	0.059	119.0	0.59	0.19	0.40	1	1.70	16.150	224.49	19.23	23	0.95%	2.4	47%	1.03	0.00	1.03	0
10.827	5601.73	10.0	0.117	9.7	46.7	20.25	1.17%	Sand-Slime Tailing	0.059	119.0	0.60	0.20	0.40	1	1.70	16.490	229.21	19.73	23	1.25%	2.5	47%	1.04	0.00	1.04	0
10.991	5601.57	10.2	0.059	9.9	46.8	20.28	0.58%	Sand-Slime Tailing	0.059	119.0	0.61	0.20	0.41	1	1.70	16.898	234.88	20.20	24	0.61%	2.3	47%	1.05	0.00	1.05	0
11.155	5601.41	16.6	0.090	16.3	43.7	18.93	0.54%	Sand-Slime Tailing	0.059	119.0	0.62	0.21	0.41	1	1.69	27.563	383.13	32.55	39	0.56%	2.1	47%	1.06	0.00	1.06	0
11.319	5601.24	15.8	0.118	15.7	25.2	10.92	0.75%	Sand-Slime Tailing	0.059	119.0	0.63	0.21	0.42	1	1.69	26.439	367.50	31.02	36	0.78%	2.2	47%	1.07	0.00	1.07	0
11.483	5601.08	12.9	0.083	12.7	24.3	10.51	0.64%	Sand-Slime Tailing	0.059	119.0	0.64	0.22	0.42	1	1.70	21.658	301.05	25.45	29	0.68%	2.3	47%	1.08	0.00	1.08	0
11.647	5600.91	11.0	0.114	10.8	43.0	18.65	1.03%	Sand-Slime Tailing	0.059	119.0	0.65	0.22	0.43	1	1.70	18.309	254.50	21.80	24	1.10%	2.4	47%	1.09	0.00	1.09	0
11.811	5600.75	9.6	0.088	9.2	64.1	27.78	0.91%	Sand-Slime Tailing	0.059	119.0	0.66	0.23	0.43	1	1.70	15.691	218.10	19.01	21	0.98%	2.5	47%	1.10	0.00	1.10	0
11.975	5600.59	9.8	0.035	9.4	61.1	26.46	0.36%	Sand-Slime Tailing	0.059	119.0	0.67	0.23	0.44	1	1.70	16.014	222.59	19.35	21	0.38%	2.3	47%	1.11	0.00	1.11	0

Liquefaction Triggering Analyses (Idriss & Boulanger (2008); Youd et al. (2001)) / Idriss & Boulanger (2008)

Depth (ft)	I&B r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	CN	qc1 TSF	qc1 MPa	qc1N
0.164	1.00	0.04	1.02	1.0	0.059	31.01	32.98	0.063	1.07	0.98	0.08	0.80	2.53	1.0	0.017	1.15	2.26	0.052	125.00	63.03	2	1.7	1.6975	0.1625	1.971
0.328	1.00	0.04	1.02	1.0	0.059	31.02	32.99	0.063	1.07	0.98	0.08	0.80	2.20	1.0	0.020	1.44	2.85	0.052	63.11	32.09	2	1.7	1.7046	0.1632	1.980
0.492	1.00	0.04	1.02	1.0	0.059	31.01	32.98	0.063	1.07	0.98	0.08	0.80	2.03	1.0	0.021	1.78	3.51	0.053	42.54	21.80	2	1.7	1.6989	0.1627	1.973
0.656	1.00	0.04	1.02	1.0	0.059	31.01	32.98	0.063	1.07	0.98	0.08	0.80	1.92	1.0	0.023	2.14	4.21	0.054	32.26	16.67	2	1.7	1.6981	0.1626	1.972
0.820	1.00	0.05	1.03	1.0	0.059	34.23	45.36	0.073	1.23	0.98	0.19	0.80	1.84	1.0	0.024	1.00	11.14	0.059	28.61	14.92	2	1.7	9.5875	0.9179	11.135
0.984	1.00	0.05	1.03	1.0	0.059	36.88	55.59	0.083	1.40	0.98	0.25	0.80	1.77	1.0	0.024	1.04	19.42	0.066	26.63	14.01	2	1.7	16.105	1.5419	18.705
1.148	1.00	0.06	1.03	1.0	0.060	43.98	82.90	0.117	1.95	0.98	0.36	0.80	1.72	1.0	0.025	1.00	38.92	0.082	28.43	15.19	2	1.7	33.513	3.2085	38.923
1.312	1.00	0.08	1.04	1.0	0.060	54.88	124.87	0.190	3.16	0.98	0.48	0.76	1.86	1.0	0.023	1.00	69.99	0.112	33.79	18.47	2	1.7	60.263	5.7695	69.991
1.476	1.00	0.17	1.09	1.0	0.063	85.76	243.74	1.000	15.91	0.98	0.73	0.64	2.43	1.0	0.018	1.00	157.98	0.447	119.94	67.93	2	1.7	136.02	13.023	157.979
1.640	1.00	0.20	1.10	1.0	0.064	91.99	267.74	1.000	15.73	0.98	0.77	0.62	2.45	1.0	0.018	1.00	175.74	1.000	241.77	128.75	2	1.7	151.32	14.487	175.744
1.804	1.00	0.23	1.10	1.0	0.064	96.94	286.77	1.000	15.73	0.98	0.80	0.60	2.45	1.0	0.018	1.00	189.84	1.000	219.87	117.80	2	1.7	163.45	15.649	189.835
1.968	1.00	0.16	1.08	1.0	0.062	84.18	237.64	1.000	16.09	0.98	0.72	0.64	2.17	1.0	0.020	1.00	153.46	0.416	83.90	50.00	2	1.7	132.13	12.65	153.463
2.133	1.00	0.11	1.05	1.0	0.061	67.28	172.60	0.435	7.18	0.98	0.59	0.70	1.85	1.0	0.023	1.17	122.92	0.253	47.06	27.12	2	1.7	90.677	8.6815	105.316
2.297	1.00	0.10	1.04	1.0	0.060	62.38	153.74	0.290	4.81	0.98	0.55	0.72	1.74	1.0	0.025	1.36	124.55	0.260	44.92	24.86	2	1.7	78.658	7.5308	91.357
2.461	1.00	0.09	1.04	1.0	0.060	57.87	136.37	0.221	3.70	0.98	0.51	0.74	1.64	1.0	0.026	1.41	110.83	0.207	33.36	18.53	2	1.7	67.592	6.4713	78.504
2.625	1.00	0.10	1.04	1.0	0.060	61.71	151.14	0.277	4.62	0.98	0.55	0.73	1.67	1.0	0.026	1.31	116.85	0.228	34.59	19.61	2	1.7	77.005	7.3724	89.436
2.789	0.99	0.09	1.03	1.0	0.059	57.18	133.72	0.213	3.58	0.98	0.51	0.75	1.58	1.0	0.027	1.40	107.01	0.194	27.66	15.62	2	1.7	65.899	6.3092	76.538
2.953	0.99	0.08	1.03	1.0	0.059	55.25	126.27	0.194	3.27	0.97	0.49	0.76	1.53	1.0	0.028	1.35	95.55	0.161	21.71	12.49	2	1.7	61.154	5.8549	71.027
3.117	0.99	0.08	1.03	1.0	0.059	52.41	115.35	0.170	2.88	0.97	0.46	0.77	1.48	1.0	0.029	1.48	93.27	0.155	19.85	11.37	2	1.7	54.194	5.1886	62.944
3.281	0.99	0.08	1.03	1.0	0.059	50.83	110.40	0.161	2.73	0.97	0.45	0.78	1.45	1.0	0.030	1.50	89.29	0.146	17.90	10.31	2	1.7	51.287	4.9102	59.567
3.445	0.99	0.07	1.03	1.0	0.059	49.17	103.98	0.149	2.54	0.97	0.43	0.79	1.41	1.0	0.030	1.60	87.77	0.143	16.81	9.67	2	1.7	47.191	4.5181	54.810
3.609	0.99	0.07	1.02	1.0	0.059	46.02	91.78	0.130	2.21	0.97	0.39	0.80	1.37	1.0	0.031	1.82	83.18	0.134	15.11	8.66	2	1.7	39.395	3.7717	45.755
3.773	0.99	0.06	1.02	1.0	0.058	43.04	80.24	0.113	1.94	0.97	0.35	0.80	1.36	1.0	0.032	2.53	94.13	0.158	17.18	9.56	2	1.7	32.025	3.0661	37.195
3.937	0.99	0.05	1.02	1.0	0.058	38.14	61.26	0.089	1.54	0.97	0.28	0.80	1.35	1.0	0.032	4.35	100.63	0.175	18.39	9.96	2	1.7	19.904	1.9056	23.117
4.101	0.99	0.07	1.02	1.0	0.058	47.73	98.40	0.140	2.40	0.97	0.41	0.79	1.35	1.0	0.032	1.93	97.99	0.168	17.03	9.71	2	1.7	43.627	4.1768	50.670
4.265	0.99	0.07	1.02	1.0	0.058	46.82	94.86	0.134	2.31	0.97	0.40	0.80	1.33	1.0	0.032	2.14	102.77	0.181	17.79	10.05	2	1.7	41.366	3.9604	48.044
4.429	0.99	0.07	1.02	1.0	0.058	45.01	87.86	0.124	2.13	0.97	0.38	0.80	1.32	1.0	0.032	2.55	109.16	0.201	19.13	10.63	2	1.7	36.896	3.5324	42.852
4.593	0.98	0.09	1.02	1.0	0.058	55.44	128.26	0.199	3.41	0.97	0.49	0.75	1.40	1.0	0.031	1.63	118.67	0.235	21.58	12.49	2	1.7	62.693	6.0023	72.815
4.757	0.98	0.16	1.04	1.0	0.059	82.72	232.19	1.000	16.92	0.97	0.71	0.65	1.61	1.0	0.027	1.09	163.61	1.000	89.79	53.36	2	1.7	128.69	12.321	149.471
4.921	0.98	0.20	1.04	1.0	0.059	65.99	237.73	1.000	16.84	0.97	0.76	0.62	1.65	1.0	0.026	1.00	171.74	1.000	87.86	52.35	2	1.630457	147.87	14.157	171.740
5.085	0.98	0.27	1.06	1.0	0.060	73.74	275.80	1.000	16.65	0.97	0.82	0.60	1.68	1.0	0.025	1.00	202.05	1.000	86.02	51.33	2	1.530444	173.97	16.656	202.054
5.249	0.98	0.30	1.06	1.0	0.060	76.70	290.31	1.000	16.63	0.97	0.84	0.60	1.67	1.0	0.026	1.00	213.61	1.000	84.25	50.44	2	1.491041	183.92	17.609	213.613
5.413	0.98	0.22	1.04	1.0	0.059	68.96	252.28	1.000	16.96	0.97	0.78	0.61	1.64	1.0	0.026	1.00	183.32	1.000	82.55	49.75	2	1.55921	157.84	15.112	183.324
5.577	0.98	0.17	1.03	1.0	0.058	61.36	214.99	1.000	17.18	0.97	0.72	0.64	1.56	1.0	0.027	1.00	153.63	0.417	33.76	25.47	2	1.636779	132.27	12.664	153.628
5.741	0.98	0.16	1.02	1.0	0.058	59.63	206.47	1.000	17.26	0.97	0.70	0.65	1.53	1.0	0.028	1.00	146.84	0.374	29.72	23.49	2	1.646141	126.43	12.104	146.839
5.905	0.98	0.15	1.02	1.0	0.058	58.56	201.21	1.000	17.32	0.97	0.69	0.66	1.51	1.0	0.028	1.00	142.65	0.350	27.25	22.29	2	1.647003	122.82	11.759	142.649
6.069	0.98	0.14	1.02	1.0	0.057	56.68	191.98	0.810	14.09	0.97	0.67	0.66	1.49	1.0	0.029	1.00	135.30	0.310	23.72	18.90	2	1.65882	116.5	11.153	135.303
6.234	0.98	0.12	1.01	1.0	0.057	52.35	170.74	0.415	7.26	0.97	0.63	0.69	1.44	1.0	0.030	1.00	118.38	0.234	17.58	12.42	2	1.7	101.93	9.7586	118.383
6.398	0.97	0.12	1.01	1.0	0.057	51.97	168.85	0.396	6.95	0.97	0.62	0.69	1.43	1.0	0.030	1.00	116.88	0.228	16.83	11.89	2	1.698285	100.63	9.6345	116.878
6.562	0.97	0.12	1.01	1.0	0.057	51.37	165.88	0.370	6.50	0.97	0.62	0.69	1.42	1.0	0.030	1.00	114.52	0.220	15.90	11.20	2	1.693055	98.599	9.4399	114.517
6.726	0.97	0.11	1.01	1.0	0.057	48.91	153.80	0.290	5.11	0.97	0.59	0.70	1.39	1.0	0.031	1.00	104.90	0.187	13.33	9.22	2	1.7	90.315	8.6468	104.896
6.890	0.97	0.10	1.01	1.0	0.057	46.88	143.83	0.246	4.35	0.97	0.57	0.72	1.36	1.0	0.031	1.00	96.95	0.165	11.52	7.94	2	1.7	83.476	7.992	96.953
7.054	0.97	0.11	1.01	1.0	0.056	50.08	159.55	0.323	5.73	0.97	0.60	0.70	1.38	1.0	0.031	1.00	109.47	0.202	13.89	9.81	2	1.670412	94.257	9.0242	109.474
7.218	0.97	0.11	1.00	1.0	0.056	49.87	158.54	0.317	5.63	0.96	0.60	0.70	1.37	1.0	0.031	1.00	108.67	0.199	13.49	9.56	2	1.659913	93.567	8.9581	108.672
7.382	0.97	0.10	1.00	1.0	0.056	44.29	131.13	0.206	3.67	0.96	0.54	0.73	1.32	1.0	0.032	1.06	91.90	0.152	10.13	6.90	2	1.7	74.768	7.1583	86.839
7.546	0.97	0.09	1.00	1.0	0.056	55.86	128.74	0.200	3.57	0.96	0.49	0.75	1.29	1.0	0.033	1.15	84.08	0.135	8.87	6.22	2	1.7	62.746	6.0073	72.875
7.710	0.97	0.08	1.00	1.0	0.056	51.09	110.37	0.161	2.87	0.96	0.44	0.78	1.25	1.0	0.034	1.22	72.36	0.115	7.45	5.16	2	1.7	51.036	4.8862	59.275
7.874	0.96	0.08	1.00	1.0	0.056	53.07	118.01	0.175	3.15	0.96	0.47	0.77	1.26	1.0	0.034	1.10	71.42	0.114	7.26	5.20	2	1.7	55.907	5.3526	64.933
8.038	0.96	0.09	1.00	1.0	0.056	41.72	118.49	0.176	3.17	0.96	0.51	0.75	1.28	1.0	0.033	1.00	76.77	0.122	7.66	5.42	2	1.7	66.102	6.3286	76.773
8.202	0.96	0.09	1.00	1.0	0.056	41.51	117.48	0.174	3.14	0.96	0.50	0.75	1.27	1.0	0.033	1.00	75.97	0.121	7.47	5.30	2	1.7	65.412	6.2625	75.972
8.366	0.96	0.09	1.00	1.0	0.055	40.74	113.68	0.167	3.01	0.96	0.49	0.75	1.26	1.0	0.034	1.02	74.14	0.118	7.18	5.10	2	1.7	62.803	6.0128	72.942
8.530	0.96	0.08	1.00	1.0	0.055	51.90	113.50	0.166	3.01	0.96	0.45	0.77	1.24	1.0	0.034	1.09	66.94	0.108	6.49	4.75	2	1.7	53.035	5.0776	61.597
8.694	0.96	0.07	1.00	1.0	0.055	46.92	94.31	0.133	2.42	0.96	0.40	0.80	1.20	1.0	0.035	1.20	57.03	0.097	5.77	4.09	2	1.7	40.8	3.9062	47.386
8.858	0.96	0.06	1.00	1.0	0.055	44.15	83.62	0.118	2.13	0.96	0.36	0.80	1.20	1.0	0.035	1.29	50.93	0.092	5.40	3.77	2	1.7	33.988	3.254	39.475
9.022	0.96	0.07	0.99	1.0	0.055	46.74	93.59	0.132	2.40	0.96	0.40	0.80	1.20	1.0	0.035	1.13	52.86	0.094	5.42	3.91	2	1.7	40.345	3.8626	46.858
9.186	0.96	0.07	0.99	1.0	0.055	49.33	103.60	0.149	2.70	0.96	0.43	0.79	1.21	1.0	0.035	1.15	62.27	0.102	5.85	4.28	2	1.7	46.722	4.4732	54.265
9.350	0.96	0.08	0.99	1.0	0.055	40.16	110.82	0.161	2.95	0.96	0.49	0.76	1.23	1.0	0.034	1.05	74.41	0.118	6.66	4.80	2	1.642609	60.846	5.8254	70.669
9.514	0.95	0.09	0.99	1.0	0.055	42.58	122.75	0.186	3.40	0.96	0.52	0.74	1.25	1.0	0.034	1.02	81.39	0.130	7.23	5.31	2	1.594014	69.024	6.6083	80.167
9.678	0.95	0.09	0.99	1.0	0.054	41.68	118.30	0.176	3.23	0.96	0.51	0.75	1.24	1.0	0.034	1.10	84.50	0.136	7.46	5.35	2	1.594798	65.973	6.3163	76.624
9.842	0.95	0.07	0.99	1.0	0.054	49.27	103.37	0.148	2.72	0.96	0.42	0.79	1.19	1.0	0.035	1.03	55.73	0.096	5.21	3.96	2	1.676664	46.574	4.459	54.093
10.006	0.95	0.06	0.99	1.0	0.054	42.74	78.22	0.110	2.02	0.96	0.34	0.80	1.18	1.0	0.036	2.18	77.52	0.123	6.60	4.31	2	1.7	30.548	2.9247	35.480
10.170	0.95	0.05	0.99	1.0	0.054	35.74	51.95	0.079	1.46	0.96	0.23	0.80	1.17	1.0	0.036	3.34	54.12	0.095	5.02	3.24	2	1.7	13.963	1.3368	16.217
10.335	0.95	0.06	0.99	1.0	0.054	39.63	66.21	0.095	1.75	0.96	0.30	0.80	1.17	1.0	0.036	1.72	45.75	0.088	4.61	3.18	2	1.7	22.89	2.1915	26.585
10.499	0.95	0.05	0.99	1.0	0.054	37.55	58.21	0.086	1.58	0.96	0.26	0.80	1.17	1.0	0.036	2.50	51.61	0.093	4.80	3.19	2	1.7	17.79	1.7032	20.662
10.663	0.95	0.05	0.99	1.0	0.054	37.05	56.28	0.084	1.55	0.96	0.25	0.80	1.17	1.0	0.036	2.42	46.55	0.089	4.54	3.05	2	1.7	16.559	1.5853	19.232
10.827	0.95	0.05	0.99	1.0	0.054	37.22	56.95	0.085	1.56	0.96	0.26	0.80	1.16	1.0	0.036	2.67	52.71	0.094	4.74	3.15	2	1.7	16.986	1.6262	19.728
10.991	0.94	0.05	0.99	1.0	0.054	37.39	57.59	0.085	1.58	0.96	0.26	0.80	1.16	1.0	0.036	2.04	41.17	0.084	4.22	2.90	2	1.7	17.395	1.6654	20.203
11.155	0.94	0.06	0.99	1.0	0.054	41.72	74.26	0.105	1.95	0.96	0.33	0.80	1.16	1.0	0.036	1.49	48.45	0.090	4.47	3.21	2	1.689954	28.024	2.683	32.548
11.319	0.94	0.06	0.99	1.0	0.054	41.18	72.19	0.102	1.90	0.96	0.32	0.80	1.16	1.0	0.036	1.69	52.28	0.093	4.57	3.24	2	1.686149	26.704	2.5566	31.015
11.483	0.94	0.06	0.99	1.0	0.054	39.23	64.68	0.093	1.74	0.95	0.29	0.80	1.15	1.0	0.037	1.84	46.90	0.089	4.32	3.03	2	1.7	21.915	2.0982	25.453
11.647	0.94	0.05	0.99	1.0	0.054	37.95	59.74	0.088	1.63	0.95	0.27	0.80	1.15	1.0	0.037	2.46	53.63	0.094	4.52	3.08	2	1.7	18.766	1.7966	21.795
11.811	0.94	0.05	0.99	1.0	0.054	36.97	55.98	0.084	1.56	0.95	0.25	0.80	1.15	1.0	0.037	2.62	49.79	0.091	4.34	2.95	2	1.7	16.371	1.5674	19.014
11.975	0.94	0.05	0.99	1.0	0.053	37.09	56.44	0.084	1.57	0.95	0.25	0.80	1.15	1.0	0.037	1.93	37.34	0.081	3.81	2.69	2	1.7	16.662	1.5952	19.352

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-1S

Data File:	13-52106_SP3-1S-BSC-CPT
Location:	White Mesa 2013 CPT Investigation
..\..\..\6.2.3 Field Data\2013 Field Investigation\Conetec Da	

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5608.00	Water surface elevation during CPT investigation (ft
5604.28	Water surface elevation at t_0 (ft amsl)
5595.59	Water surface elevation at t_1 (ft amsl)
5590.59	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Eart
7.51	Equiv. Number of Uniform Strain Cycles, N

5612.56	Ground Surface Elevation at time of CPT (ft amsl)
5620.47	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pl
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
0.41	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
887.10	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5590.59	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5620.22	5619.97	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
Water Storage/Rooting Zone Layer	######	5618.22	5616.47	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5614.72	5612.97	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320
Platform/Random Fill Layer	######	5612.77	5612.56	0.41	0.050	101	0.445	0.434	0.00	0.00	0.445	0.434

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %
12.139	5600.42	9.7	0.064	9.4	51.9	22.49	0.66%	Sand-Slime Tailing	0.059	119.0	0.68	0.24	0.44	1	1.69	15.804	219.68	18.99	20	0.71%	2.4	47%
12.303	5600.26	11.1	0.121	10.7	65.5	28.37	1.09%	Sand-Slime Tailing	0.059	119.0	0.69	0.24	0.45	1	1.67	17.874	248.45	21.55	23	1.16%	2.5	47%
12.467	5600.09	16.8	0.110	16.4	67.8	29.38	0.66%	Sand-Slime Tailing	0.059	119.0	0.70	0.25	0.45	1	1.60	26.138	363.32	31.14	36	0.68%	2.2	47%
12.631	5599.93	30.9	0.086	30.8	23.6	10.23	0.28%	Sand Tailings	0.062	123.5	0.71	0.25	0.45	1	1.49	45.876	637.67	53.54	66	0.28%	1.8	18%
12.795	5599.76	30.6	0.167	30.5	23.2	10.07	0.55%	Sand-Slime Tailing	0.059	119.0	0.72	0.26	0.46	1	1.48	45.191	628.16	52.74	65	0.56%	1.9	47%
12.959	5599.60	24.9	0.293	24.8	9.7	4.19	1.18%	Sand-Slime Tailing	0.059	119.0	0.73	0.26	0.46	1	1.51	37.430	520.28	43.58	52	1.21%	2.2	47%
13.123	5599.44	22.1	0.250	22.0	13.6	5.90	1.13%	Sand-Slime Tailing	0.059	119.0	0.74	0.27	0.47	1	1.52	33.392	464.15	38.93	46	1.17%	2.2	47%
13.287	5599.27	17.9	0.174	17.8	18.4	7.98	0.97%	Sand-Slime Tailing	0.059	119.0	0.75	0.27	0.47	1	1.54	27.284	379.25	31.89	36	1.02%	2.3	47%
13.451	5599.11	18.6	0.120	18.3	33.7	14.61	0.65%	Sand-Slime Tailing	0.059	119.0	0.76	0.28	0.48	1	1.52	27.891	387.68	32.76	37	0.67%	2.2	47%
13.615	5598.94	19.0	0.093	18.8	27.6	11.94	0.49%	Sand-Slime Tailing	0.059	119.0	0.77	0.28	0.48	1	1.51	28.342	393.95	33.22	38	0.51%	2.1	47%
13.779	5598.78	18.8	0.035	18.6	24.7	10.70	0.19%	Sand-Slime Tailing	0.059	119.0	0.77	0.29	0.49	1	1.50	27.908	387.92	32.68	37	0.19%	2.0	47%
13.943	5598.62	17.5	0.045	17.4	14.9	6.47	0.26%	Sand-Slime Tailing	0.059	119.0	0.78	0.29	0.49	1	1.50	26.084	362.57	30.46	34	0.27%	2.0	47%
14.107	5598.45	15.4	0.100	15.2	27.0	11.68	0.65%	Sand-Slime Tailing	0.059	119.0	0.79	0.30	0.50	1	1.51	22.922	318.61	26.92	29	0.69%	2.3	47%
14.271	5598.29	16.8	0.261	16.6	35.9	15.54	1.55%	Sand-Slime Tailing	0.059	119.0	0.80	0.30	0.50	1	1.49	24.694	343.25	29.07	32	1.63%	2.4	47%
14.436	5598.12	15.9	0.208	15.7	41.2	17.86	1.31%	Sand-Slime Tailing	0.059	119.0	0.81	0.31	0.51	1	1.48	23.240	323.03	27.43	30	1.38%	2.4	47%
14.600	5597.96	17.8	0.165	17.6	26.3	11.41	0.93%	Sand-Slime Tailing	0.059	119.0	0.82	0.31	0.51	1	1.46	25.776	358.29	30.22	33	0.97%	2.3	47%
14.764	5597.80	15.1	0.105	15.0	29.7	12.88	0.69%	Sand-Slime Tailing	0.059	119.0	0.83	0.32	0.52	1	1.47	21.980	305.52	25.85	28	0.73%	2.3	47%
14.928	5597.63	16.4	0.396	16.2	36.8	15.96	2.41%	Sand-Slime Tailing	0.059	119.0	0.84	0.32	0.52	1	1.45	23.488	326.48	27.67	30	2.55%	2.6	47%
15.092	5597.47	15.6	0.201	15.3	59.5	25.80	1.29%	Sand-Slime Tailing	0.059	119.0	0.85	0.33	0.52	1	1.45	22.121	307.48	26.32	28	1.36%	2.4	47%
15.256	5597.30	25.6	0.270	25.4	23.7	10.26	1.06%	Sand-Slime Tailing	0.059	119.0	0.86	0.33	0.53	1	1.39	35.271	490.27	41.20	47	1.09%	2.2	47%
15.420	5597.14	21.4	0.308	21.3	15.0	6.48	1.44%	Sand-Slime Tailing	0.059	119.0	0.87	0.34	0.53	1	1.40	29.754	413.58	34.71	38	1.50%	2.3	47%
15.584	5596.98	18.8	0.188	18.7	18.8	8.16	1.00%	Sand-Slime Tailing	0.059	119.0	0.88	0.34	0.54	1	1.40	26.274	365.21	30.71	33	1.05%	2.3	47%
15.748	5596.81	20.6	0.295	20.4	18.0	7.78	1.44%	Sand-Slime Tailing	0.059	119.0	0.89	0.35	0.54	1	1.39	28.363	394.25	33.12	36	1.50%	2.4	47%
15.912	5596.65	16.7	0.170	16.4	37.1	16.09	1.02%	Sand-Slime Tailing	0.059	119.0	0.90	0.35	0.55	1	1.40	22.984	319.47	27.07	29	1.08%	2.4	47%
16.076	5596.48	19.8	0.165	19.5	48.9	21.20	0.83%	Sand-Slime Tailing	0.059	119.0	0.91	0.36	0.55	1	1.38	26.799	372.50	31.61	34	0.87%	2.3	47%
16.240	5596.32	21.9	0.284	21.7	42.0	18.19	1.30%	Sand-Slime Tailing	0.059	119.0	0.92	0.36	0.56	1	1.36	29.415	408.87	34.58	38	1.35%	2.3	47%
16.404	5596.16	21.9	0.319	21.5	65.3	28.28	1.46%	Sand-Slime Tailing	0.059	119.0	0.93	0.37	0.56	1	1.35	29.002	403.13	34.32	37	1.52%	2.4	47%
16.568	5595.99	28.0	0.500	27.9	24.0	10.38	1.78%	Sand-Slime Tailing	0.059	119.0	0.94	0.37	0.57	1	1.32	36.866	512.44	43.05	48	1.85%	2.3	47%
16.732	5595.83	19.0	0.522	18.7	40.7	17.62	2.75%	Slime Tailings	0.057	113.1	0.95	0.38	0.57	1	1.35	25.254	351.03	29.73	32	2.90%	2.6	71%
16.896	5595.66	22.1	0.393	21.4	112.6	48.78	1.78%	Sand-Slime Tailing	0.059	119.0	0.96	0.38	0.57	1	1.33	28.441	395.33	34.12	37	1.86%	2.4	47%
17.060	5595.50	22.9	0.460	22.6	47.8	20.69	2.01%	Sand-Slime Tailing	0.059	119.0	0.97	0.39	0.58	1	1.32	29.824	414.56	35.10	38	2.10%	2.4	47%
17.224	5595.34	19.0	0.308	18.5	76.9	33.34	1.62%	Sand-Slime Tailing	0.059	119.0	0.98	0.40	0.58	1	1.33	24.585	341.73	29.29	31	1.71%	2.5	47%
17.388	5595.17	26.8	0.182	26.7	20.4	8.84	0.68%	Sand-Slime Tailing	0.059	119.0	0.99	0.40	0.59	1	1.29	34.509	479.67	40.27	44	0.70%	2.1	47%
17.552	5595.01	24.3	0.073	24.2	8.2	3.55	0.30%	Sand-Slime Tailing	0.059	119.0	1.00	0.41	0.59	1	1.29	31.333	435.53	36.47	39	0.31%	2.0	47%
17.716	5594.84	21.7	0.073	21.6	11.9	5.16	0.34%	Sand-Slime Tailing	0.059	119.0	1.01	0.41	0.60	1	1.30	27.980	388.93	32.61	35	0.35%	2.1	47%
17.880	5594.68	17.6	0.073	17.5	13.5	5.83	0.42%	Sand-Slime Tailing	0.059	119.0	1.02	0.42	0.60	1	1.30	22.828	317.31	26.64	27	0.44%	2.2	47%

Conditions at t_1 / Liquefaction Triggering Analyses

Depth at time of CPT (ft)	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	Idriss & Boulanger (2008) Cyclic Stress Ratio r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Cyclic Resistance Ratio Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd et al. (2001) Cyclic Stress Ratio r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
12.139	1.12	0.00	1.12	0	0.94	0.05	0.99	1.0	0.053	36.96	55.95	0.083	1.56	0.95	0.25	0.80	1.14	1.0	0.037	2.36	44.75	0.087	4.06	2.81	2
12.303	1.13	0.00	1.13	0	0.94	0.05	0.99	1.0	0.053	37.86	59.41	0.087	1.64	0.95	0.27	0.80	1.14	1.0	0.037	2.59	55.72	0.096	4.42	3.03	2
12.467	1.14	0.00	1.14	0	0.93	0.06	0.98	1.0	0.053	41.22	72.37	0.103	1.93	0.95	0.32	0.80	1.14	1.0	0.037	1.64	50.96	0.092	4.21	3.07	2
12.631	1.15	0.00	1.15	0	0.93	0.07	0.98	1.0	0.053	35.78	89.31	0.126	2.39	0.95	0.42	0.79	1.14	1.0	0.037	1.09	58.49	0.099	4.45	3.42	2
12.795	1.16	0.00	1.16	0	0.93	0.07	0.98	1.0	0.053	48.80	101.53	0.145	2.75	0.95	0.42	0.79	1.14	1.0	0.037	1.21	63.65	0.104	4.64	3.70	2
12.959	1.17	0.00	1.17	0	0.93	0.07	0.98	1.0	0.053	45.59	89.16	0.126	2.39	0.95	0.38	0.80	1.13	1.0	0.037	1.63	71.04	0.113	5.01	3.70	2
13.123	1.18	0.00	1.18	0	0.93	0.06	0.98	1.0	0.053	43.96	82.89	0.117	2.22	0.95	0.36	0.80	1.13	1.0	0.037	1.72	67.05	0.108	4.73	3.47	2
13.287	1.19	0.00	1.19	0	0.93	0.06	0.98	1.0	0.053	41.49	73.38	0.104	1.97	0.95	0.33	0.80	1.13	1.0	0.037	1.86	59.29	0.099	4.31	3.14	2
13.451	1.20	0.00	1.20	0	0.93	0.06	0.98	1.0	0.052	41.79	74.56	0.105	2.01	0.95	0.33	0.80	1.12	1.0	0.037	1.60	52.27	0.093	4.01	3.01	2
13.615	1.21	0.00	1.21	0	0.93	0.06	0.98	1.0	0.052	41.95	75.17	0.106	2.03	0.95	0.33	0.80	1.12	1.0	0.037	1.47	48.88	0.091	3.86	2.95	2
13.779	1.22	0.00	1.22	0	0.92	0.06	0.98	1.0	0.052	41.76	74.45	0.105	2.01	0.95	0.33	0.80	1.12	1.0	0.037	1.26	41.27	0.084	3.56	2.79	2
13.943	1.23	0.00	1.23	0	0.92	0.06	0.98	1.0	0.052	40.98	71.44	0.101	1.94	0.95	0.32	0.80	1.12	1.0	0.037	1.36	41.55	0.085	3.54	2.74	2
14.107	1.24	0.00	1.24	0	0.92	0.06	0.98	1.0	0.052	39.74	66.66	0.096	1.83	0.95	0.30	0.80	1.12	1.0	0.037	1.84	49.42	0.091	3.78	2.80	2
14.271	1.25	0.00	1.25	0	0.92	0.06	0.98	1.0	0.052	40.50	69.56	0.099	1.90	0.95	0.31	0.80	1.11	1.0	0.038	2.44	71.02	0.113	4.66	3.28	2
14.436	1.26	0.00	1.26	0	0.92	0.06	0.98	1.0	0.052	39.92	67.36	0.096	1.85	0.95	0.30	0.80	1.11	1.0	0.038	2.37	64.97	0.106	4.30	3.07	2
14.600	1.27	0.00	1.27	0	0.92	0.06	0.98	1.0	0.052	40.90	71.12	0.101	1.95	0.95	0.32	0.80	1.11	1.0	0.038	1.92	58.11	0.098	3.97	2.96	2
14.764	1.28	0.00	1.28	0	0.92	0.06	0.98	1.0	0.052	39.37	65.21	0.094	1.81	0.95	0.29	0.80	1.11	1.0	0.038	1.95	50.29	0.092	3.68	2.74	2
14.928	1.29	0.00	1.29	0	0.92	0.06	0.98	1.0	0.052	40.00	67.67	0.097	1.87	0.95	0.30	0.80	1.11	1.0	0.038	3.16	87.53	0.142	5.65	3.76	2
15.092	1.30	0.00	1.30	0	0.91	0.06	0.98	1.0	0.052	39.53	65.85	0.095	1.83	0.95	0.30	0.80	1.10	1.0	0.038	2.44	64.33	0.105	4.12	2.98	2
15.256	1.31	0.00	1.31	0	0.91	0.07	0.97	1.0	0.051	44.75	85.96	0.121	2.36	0.95	0.37	0.80	1.10	1.0	0.038	1.66	68.40	0.110	4.28	3.32	2
15.420	1.32	0.00	1.32	0	0.91	0.06	0.97	1.0	0.051	42.47	77.18	0.109	2.12	0.95	0.34	0.80	1.10	1.0	0.038	2.11	73.21	0.116	4.51	3.31	2
15.584	1.33	0.00	1.33	0	0.91	0.06	0.97	1.0	0.051	41.07	71.78	0.102	1.98	0.95	0.32	0.80	1.10	1.0	0.038	1.98	60.69	0.101	3.87	2.93	2
15.748	1.34	0.00	1.34	0	0.91	0.06	0.97	1.0	0.051	41.92	75.04	0.106	2.07	0.94	0.33	0.80	1.10	1.0	0.038	2.18	72.28	0.115	4.38	3.23	2
15.912	1.35	0.00	1.35	0	0.91	0.06	0.97	1.0	0.051	39.80	66.87	0.096	1.87	0.94	0.30	0.80	1.09	1.0	0.038	2.19	59.36	0.099	3.76	2.81	2
16.076	1.36	0.00	1.36	0	0.91	0.06	0.97	1.0	0.051	41.39	73.00	0.103	2.03	0.94	0.32	0.80	1.09	1.0	0.038	1.82	57.57	0.098	3.66	2.84	2
16.240	1.36	0.00	1.36	0	0.91	0.06	0.97	1.0	0.051	42.43	77.01	0.109	2.13	0.94	0.34	0.80	1.09	1.0	0.038	2.04	70.42	0.112	4.18	3.16	2
16.404	1.37	0.00	1.37	0	0.90	0.06	0.97	1.0	0.051	42.34	76.66	0.108	2.13	0.94	0.34	0.80	1.09	1.0	0.038	2.16	74.09	0.118	4.34	3.24	2
16.568	1.38	0.00	1.38	0	0.90	0.07	0.97	1.0	0.051	45.40	88.45	0.125	2.46	0.94	0.38	0.80	1.09	1.0	0.038	2.04	87.67	0.143	5.22	3.84	2
16.732	1.39	0.00	1.39	0	0.90	0.06	0.97	1.0	0.051	40.44	70.17	0.100	1.97	0.94	0.31	0.80	1.09	1.0	0.038	3.27	97.24	0.166	6.01	3.99	2
16.896	1.40	0.00	1.40	0	0.90	0.06	0.97	1.0	0.051	42.27	76.39	0.108	2.13	0.94	0.34	0.80	1.08	1.0	0.038	2.39	81.44	0.130	4.69	3.41	2
17.060	1.41	0.00	1.41	1	0.90	0.06	0.97	1.0	0.051	42.61	77.71	0.110	2.17	0.94	0.34	0.80	1.08	1.0	0.038	2.49	87.26	0.142	5.06	3.62	2
17.224	1.42	0.01	1.42	1	0.90	0.06	0.97	1.0	0.051	40.58	69.87	0.099	1.96	0.94	0.31	0.80	1.08	1.0	0.039	2.56	74.93	0.119	4.21	3.08	2
17.388	1.43	0.01	1.42	1	0.90	0.07	0.97	1.0	0.051	44.43	84.70	0.119	2.35	0.94	0.37	0.80	1.08	1.0	0.039	1.49	59.88	0.100	3.49	2.92	2
17.552	1.44	0.02	1.42	1	0.90	0.06	0.97	1.0	0.051	43.09	79.56	0.112	2.21	0.94	0.35	0.80	1.08	1.0	0.039	1.31	47.86	0.090	3.10	2.65	2
17.716	1.45	0.02	1.43	1	0.89	0.06	0.97	1.0	0.051	41.74	74.35	0.105	2.06	0.94	0.33	0.80	1.08	1.0	0.039	1.42	46.25	0.089	3.02	2.54	2
17.880	1.46	0.03	1.43	1	0.89	0.06	0.97	1.0	0.051	39.64	66.29	0.095	1.86	0.94	0.30	0.80	1.07	1.0	0.039	1.68	44.88	0.087	2.95	2.41	2

Idriss & Boulanger (2008)

Depth at time of CPT (ft)	CN	qc1 TSF	qc1 MPa	qc1N
12.139	1.688489	16.351	1.5655	18.991
12.303	1.670492	18.557	1.7766	21.553
12.467	1.596709	26.814	2.5672	31.143
12.631	1.490923	46.095	4.4132	53.537
12.795	1.484114	45.406	4.3472	52.737
12.959	1.506858	37.521	3.5923	43.579
13.123	1.515057	33.521	3.2093	38.932
13.287	1.535421	27.461	2.6291	31.894
13.451	1.520751	28.211	2.7009	32.765
13.615	1.508334	28.601	2.7383	33.218
13.779	1.500419	28.139	2.694	32.682
13.943	1.499961	26.224	2.5107	30.458
14.107	1.506034	23.175	2.2188	26.917
14.271	1.485827	25.027	2.3961	29.068
14.436	1.483063	23.621	2.2615	27.435
14.600	1.461241	26.017	2.4908	30.217
14.764	1.470246	22.253	2.1305	25.846
14.928	1.45255	23.822	2.2807	27.667
15.092	1.448658	22.659	2.1694	26.317
15.256	1.388093	35.477	3.3965	41.204
15.420	1.399511	29.884	2.8611	34.709
15.584	1.404285	26.439	2.5313	30.708
15.748	1.387634	28.519	2.7304	33.123
15.912	1.399728	23.308	2.2315	27.071
16.076	1.375706	27.219	2.6059	31.613
16.240	1.358653	29.771	2.8503	34.577
16.404	1.351456	29.553	2.8294	34.324
16.568	1.321846	37.064	3.5485	43.048
16.732	1.349769	25.597	2.4506	29.729
16.896	1.329655	29.376	2.8124	34.118
17.060	1.31966	30.218	2.893	35.096
17.224	1.327489	25.223	2.4148	29.295
17.388	1.293425	34.673	3.3196	40.271
17.552	1.294762	31.399	3.0062	36.469
17.716	1.29659	28.077	2.6881	32.609
17.880	1.304474	22.938	2.1961	26.641

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-2C

Data File: 13-52106_SP3-2C-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Dat

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)

Parameter	Value
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69

Youd, et al (2001)

Parameter	Value
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5605.30	Water surface elevation during CPT investigation (ft
5602.54	Water surface elevation at t_0 (ft amsl)
5591.64	Water surface elevation at t_1 (ft amsl)
5586.64	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earth
7.51	Equiv. Number of Uniform Strain Cycles, N

Value	Parameter
5610.82	Ground Surface Elevation at time of CPT (ft amsl)
5621.51	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after place
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
3.19	Thickness of Random/Platform Fill Layer on top of existing interim cover (ft)
1167.12	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5586.64	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	5621.51	5621.26	5621.01	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
Water Storage/Rooting Zone Layer	5621.01	5619.26	5617.51	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	5617.51	5615.76	5614.01	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320
Platform/Random Fill Layer	5614.01	5612.415	5610.82	3.19	0.050	101	0.585	0.504	0.00	0.00	0.585	0.504

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
0.164	5610.66	9.5	0.818	9.5	10.4	4.49	8.58%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	16.099	223.78	18.83	1153	8.59%	2.2	51%	0.59	0.00	0.59	0
0.328	5610.49	67.8	0.428	67.8	8.7	3.76	0.63%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	115.243	1601.88	133.95	4105	0.63%	1.0	51%	0.60	0.00	0.60	0
0.492	5610.33	104.7	0.603	104.6	7.9	3.44	0.58%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	177.871	2472.41	206.68	4223	0.58%	1.0	51%	0.61	0.00	0.61	0
0.656	5610.16	73.4	0.695	73.3	5.6	2.42	0.95%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	124.661	1732.79	144.86	2219	0.95%	1.2	51%	0.62	0.00	0.62	0
0.820	5610.00	90.8	1.617	90.7	4.4	1.90	1.78%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	154.241	2143.95	179.20	2196	1.78%	1.5	51%	0.62	0.00	0.62	0
0.984	5609.84	98.7	0.951	98.7	4.8	2.06	0.96%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	167.790	2332.28	194.94	1991	0.96%	1.2	51%	0.63	0.00	0.63	0
1.148	5609.67	142.9	1.153	142.9	5.8	2.53	0.81%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	242.879	3376.02	282.16	2470	0.81%	1.1	51%	0.64	0.00	0.64	0
1.312	5609.51	142.3	0.768	142.3	5.6	2.43	0.54%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	241.910	3362.55	281.03	2153	0.54%	1.0	51%	0.65	0.00	0.65	0
1.476	5609.34	150.3	0.964	150.3	3.4	1.49	0.64%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	255.544	3552.06	296.84	2021	0.64%	1.0	51%	0.66	0.00	0.66	0
1.640	5609.18	142.9	0.948	142.9	4.8	2.08	0.66%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	242.862	3375.78	282.13	1729	0.66%	1.1	51%	0.67	0.00	0.67	0
1.804	5609.02	129.8	0.906	129.8	4.9	2.12	0.70%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	220.643	3066.94	256.32	1428	0.70%	1.1	51%	0.67	0.00	0.67	0
1.968	5608.85	134.9	1.437	134.9	3.7	1.61	1.07%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	229.313	3187.45	266.38	1360	1.07%	1.3	51%	0.68	0.00	0.68	0
2.133	5608.69	130.9	0.753	130.9	2.7	1.15	0.58%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	222.496	3092.69	258.45	1218	0.58%	1.1	51%	0.69	0.00	0.69	0
2.297	5608.52	120.4	0.968	120.4	3.4	1.47	0.80%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	204.714	2845.52	237.80	1040	0.80%	1.2	51%	0.70	0.00	0.70	0
2.461	5608.36	98.7	1.136	98.7	3.8	1.64	1.15%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	167.773	2332.04	194.90	796	1.15%	1.4	51%	0.71	0.00	0.71	0
2.625	5608.20	75.5	1.164	75.5	3.5	1.50	1.54%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.70	128.367	1784.30	149.13	570	1.54%	1.6	51%	0.72	0.00	0.72	0
2.789	5608.03	54.0	0.768	54.0	2.0	0.85	1.42%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0	1.70	91.749	1275.31	106.59	383	1.43%	1.6	51%	0.72	0.00	0.72	0
2.953	5607.87	50.1	0.997	50.1	1.2	0.53	1.99%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0	1.70	85.136	1183.39	98.90	336	2.00%	1.8	51%	0.73	0.00	0.73	0
3.117	5607.70	56.9	1.094	56.9	2.7	1.18	1.92%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0	1.70	96.713	1344.31	112.36	362	1.93%	1.8	51%	0.74	0.00	0.74	0
3.281	5607.54	64.2	0.738	64.2	2.1	0.92	1.15%	Sand Tailings	0.051	102.8	0.17	0.00	0.17	0	1.70	109.174	1517.52	126.83	387	1.15%	1.6	18%	0.75	0.00	0.75	0
3.445	5607.38	52.1	0.886	52.1	2.0	0.87	1.70%	Sand-Slime Tailin	0.047	93.3	0.17	0.00	0.17	0	1.70	88.570	1231.12	102.89	300	1.71%	1.8	47%	0.76	0.00	0.76	0
3.609	5607.21	29.1	1.041	29.1	0.7	0.30	3.58%	Slime Tailings	0.041	82.7	0.18	0.00	0.18	0	1.70	49.436	687.16	57.43	161	3.60%	2.2	71%	0.76	0.00	0.76	0
3.773	5607.05	21.5	1.042	21.5	1.5	0.65	4.84%	Slime Tailings	0.041	82.7	0.19	0.00	0.19	0	1.70	36.550	508.05	42.47	114	4.89%	2.4	71%	0.77	0.00	0.77	0
3.937	5606.88	16.3	0.676	16.3	3.3	1.44	4.14%	Slime Tailings	0.041	82.7	0.19	0.00	0.19	0	1.70	27.744	385.64	32.26	83	4.19%	2.4	71%	0.78	0.00	0.78	0
4.101	5606.72	18.3	0.612	18.2	5.0	2.18	3.35%	Slime Tailings	0.041	82.7	0.20	0.00	0.20	0	1.70	31.008	431.01	36.08	90	3.39%	2.3	71%	0.78	0.00	0.78	0
4.265	5606.55	15.1	0.610	15.0	4.1	1.76	4.05%	Slime Tailings	0.041	82.7	0.21	0.00	0.21	0	1.70	25.568	355.40	29.75	72	4.11%	2.4	71%	0.79	0.00	0.79	0
4.429	5606.39	19.3	0.601	19.3	4.8	2.09	3.11%	Slime Tailings	0.041	82.7	0.21	0.00	0.21	0	1.70	32.810	456.06	38.17	89	3.14%	2.3	71%	0.80	0.00	0.80	0
4.593	5606.23	24.6	0.687	24.5	4.0	1.73	2.80%	Sand-Slime Tailin	0.047	93.3	0.22	0.00	0.22	0	1.70	41.701	579.64	48.48	110	2.82%	2.2	47%	0.80	0.00	0.80	0
4.757	5606.06	24.5	0.631	24.5	2.1	0.90	2.57%	Sand-Slime Tailin	0.047	93.3	0.23	0.00	0.23	0	1.70	41.684	579.41	48.44	106	2.60%	2.2	47%	0.81	0.00	0.81	0
4.921	5605.90	23.4	0.399	23.4	5.1	2.21	1.71%	Sand-Slime Tailin	0.047	93.3	0.24	0.00	0.24	0	1.70	39.712	552.00	46.19	98	1.72%	2.1	47%	0.82	0.00	0.82	0
5.085	5605.73	25.5	0.327	25.5	7.2	3.11	1.28%	Sand-Slime Tailin	0.047	93.3	0.24	0.00	0.24	0	1.70	43.282	601.62	50.36	103	1.29%	2.0	47%	0.83	0.00	0.83	0
5.249	5605.57	20.3	0.310	20.3	1.4	0.60	1.53%	Sand-Slime Tailin	0.047	93.3	0.25	0.00	0.25	0	1.70	34.425	478.51	40.00	79	1.55%	2.1	47%	0.84	0.00	0.84	0
5.413	5605.41	11.2	0.265	11.2	0.7	0.29	2.37%	Slime Tailings	0.041	82.7	0.26	0.00	0.26	0	1.70	19.040	264.66	22.12	42	2.42%	2.4	71%	0.84	0.00	0.84	0
5.577	5605.24	7.5	0.141	7.5	0.6	0.27	1.88%	Slime Tailings	0.057	113.1	0.27	0.00	0.27	1	1.70	12.750	177.23	14.82	27	1.95%	2.5	71%	0.85	0.00	0.85	0
5.741	5605.08	7.7	0.089	7.7	1.1	0.47	1.15%	Sand-Slime Tailin	0.059	119.0	0.28	0.01	0.27	1	1.70	13.090	181.95	15.22	27	1.20%	2.4	47%	0.86	0.00	0.86	0
5.905	5604.91	9.9	0.084	9.9	2.9	1.27	0.84%	Sand-Slime Tailin	0.059	119.0	0.29	0.01	0.28	1	1.70	16.881	234.65	19.64	35	0.87%	2.2	47%	0.87	0.00	0.87	0
6.069	5604.75	5.9	0.088	5.9	2.9	1.27	1.50%	Slime Tailings	0.057	113.1	0.30	0.02	0.28	1	1.70	9.962	138.47	11.61	20	1.58%	2.6	71%	0.88	0.00	0.88	0
6.234	5604.59	5.6	0.085	5.5	4.4	1.92	1.53%	Slime Tailings	0.057	113.1	0.31	0.02	0.28	1	1.70	9.418	130.91	10.99	19	1.62%	2.6	71%	0.89	0.00	0.89	0
6.398	5604.42	7.0	0.088	6.9	6.4	2.77	1.26%	Slime Tailings	0.057	113.1	0.32	0.03	0.29	1	1.70	11.798	163.99	13.78	23	1.32%	2.5	71%	0.90	0.00	0.90	0
6.562	5604.26	7.1	0.082	7.1	6.8	2.93	1.15%	Slime Tailings	0.057	113.1	0.32	0.03	0.29	1	1.70	12.019	167.06	14.04	23	1.21%	2.5	71%	0.91	0.00	0.91	0
6.726	5604.09	10.7	0.082	10.6	7.0	3.03	0.77%	Sand-Slime Tailin	0.059	119.0	0.33	0.04	0.30	1	1.70	18.088	251.42	21.09	35	0.79%	2.2	47%	0.92	0.00	0.92	0
6.890	5603.93	13.4	0.114	13.4	5.9	2.54	0.85%	Sand-Slime Tailin	0.059	119.0	0.34	0.04	0.30	1	1.70	22.746	316.17	26.49	43	0.87%	2.2	47%	0.93	0.00	0.93	0
7.054	5603.77	15.0	0.134	14.9	5.2	2.24	0.90%	Sand-Slime Tailin	0.059	119.0	0.35	0.05	0.31	1	1.70	25.364	352.56	29.52	48	0.92%	2.1	47%	0.94	0.00	0.94	0
7.218	5603.60	22.4	0.135	22.4	8.0	3.48	0.60%	Sand-Slime Tailin	0.059	119.0	0.36	0.05	0.31	1	1.70	38.029	528.60	44.27	71	0.61%	1.9	47%	0.95	0.00	0.95	0
7.382	5603.44	17.5	0.162	17.4	10.4	4.51	0.93%	Sand-Slime Tailin	0.059	119.0	0.37	0.06	0.32	1	1.70	29.580	411.16	34.48	54	0.95%	2.1	47%	0.96	0.00	0.96	0
7.546	5603.27	15.5	0.200	15.4	24.6	10.65	1.29%	Sand-Slime Tailin	0.059	119.0	0.38	0.06	0.32	1	1.70	26.112	362.96	30.63	47	1.32%	2.2	47%	0.97	0.00	0.97	0
7.710	5603.11	17.0	0.227	16.8	44.3	19.18	1.33%	Sand-Slime Tailin	0.059	119.0	0.39	0.07	0.32	1	1.70	28.492	396.04	33.64	51	1.36%	2.2	47%	0.98	0.00	0.98	0
7.874	5602.95	17.9	0.174	17.6	42.1	18.26	0.97%	Sand-Slime Tailin	0.059	119.0	0.40	0.07	0.33	1	1.70	29.903	415.65	35.25	53	1.00%	2.1	47%	0.99	0.00	0.99	0
8.038	5602.78	20.6	0.144	20.4	32.2	13.94	0.70%	Sand-Slime Tailin	0.059	119.0	0.41	0.08	0.33	1	1.70	34.680	482.05	40.68	60	0.71%	2.0	47%	1.00	0.00	1.00	0
8.202	5602.62	26.4	0.168	26.2	32.9	14.27	0.64%	Sand-Slime Tailin	0.059	119.0	0.42	0.08	0.34	1	1.70	44.557	619.34	52.16	77	0.65%	1.9	47%	1.01	0.00	1.01	0
8.366	5602.45	29.9	0.252	29.7	36.5	15.81	0.84%	Sand-Slime Tailin	0.059	119.0	0.43	0.09	0.34	1	1.70	50.405	700.63	58.99	86	0.86%	1.9	47%	1.02	0.00	1.02	0
8.530	5602.29	22.3	0.277	22.1	28.4	12.32	1.24%	Sand-Slime Tailin	0.059	119.0	0.44	0.09	0.35	1	1.70	37.621	522.93	44.04	63	1.27%	2.1	47%	1.03	0.00	1.03	0
8.694	5602.13	21.8	0.392	21.5	41.9	18.15	1.80%	Sand-Slime Tailin	0.059	119.0	0.45	0.10	0.35	1	1.70	36.533	507.81	42.95	60	1.84%	2.2	47%	1.04	0.00	1.04	0
8.858	5601.96	21.4	0.248	21.0	63.0	27.28	1.16%	Sand-Slime Tailin	0.059	119.0	0.46	0.10	0.36	1	1.70	35.768	497.18	42.32	59	1.18%	2.1	47%	1.04	0.00	1.04	0
9.022	5601.80	29.7	0.307	29.5	36.3	15.73	1.03%	Sand-Slime Tailin	0.059	119.0	0.47	0.11	0.36	1	1.70	50.044	695.61	58.57	81	1.05%	2.0	47%	1.05	0.00	1.05	0
9.186	5601.63	22.6	0.143	22.5	10.6	4.58	0.63%	Sand-Slime Tailin	0.059	119.0	0.48	0.11	0.37	1	1.70	38.267	531.91	44.58	60	0.65%	2.0	47%	1.06	0.00	1.06	0
9.350	5601.47	17.7	0.143	17.7	4.4	1.92	0.81%	Sand-Slime Tailin	0.059	119.0	0.49	0.12	0.37	1	1.70	30.039	417.54	34.94	46	0.83%	2.1	47%	1.07	0.00	1.07	0
9.514	5601.31	14.2	0.178	14.2	4.4	1.90	1.25%	Sand-Slime Tailin	0.059	119.0	0.50	0.12	0.38	1	1.70	24.072	334.60	28.01	36	1.30%	2.3	47%	1.08	0.00	1.08	0
9.678	5601.14	11.7	0.202	11.6	7.4	3.22	1.73%	Sand-Slime Tailin	0.059	119.0	0.51	0.13	0.38	1	1.70	19.737	274.34	23.01	29	1.81%	2.5	47%	1.09	0.00	1.09	0
9.842	5600.98	11.3	0.120	11.2	13.3	5.76	1.07%	Sand-Slime Tailin	0.059	119.0	0.52	0.13	0.38	1	1.70	18.989	263.95	22.22	28	1.12%	2.4	47%	1.10	0.00	1.10	0
10.006	5600.81	14.4	0.083	14.3	11.9	5.15	0.58%	Sand-Slime Tailin	0.059	119.0	0.53	0.14	0.39	1	1.70	24.293	337.67	28.36	36	0.60%	2.2	47%	1.11	0.00	1.11	0
10.170	5600.65	18.3	0.069	18.3	7.0	3.04	0.38%	Sand-Slime Tailin	0.059	119.0	0.54	0.15	0.39	1	1.70	31.110	432.43	36.22	45	0.39%	2.0	47%	1.12	0.00	1.12	0
10.335	5600.49	20.6	0.093	20.6	5.9	2.55	0.45%	Sand-Slime Tailin	0.059	119.0	0.55	0.15	0.40	1	1.68	34.682	482.08	40.35	50	0.46%	2.0	47%	1.13	0.00	1.13	0
10.499	5600.32	21.3	0.111	21.3	5.5	2.39	0.52%	Sand-Slime Tailin	0.059	119.0	0.56	0.16	0.40	1	1.67	35.475	493.10	41.27	51	0.53%	2.0	47%	1.14	0.00	1.14	0
10.663	5600.16	23.3	0.126	23.3	6.1	2.63	0.54%	Sand-Slime Tailin	0.059	119.0	0.57	0.16	0.41	1	1.64	38.112	529.76	44.34	56	0.55%	2.0	47%	1.15	0.00	1.15	0
10.827	5599.99	23.4	0.148	23.4	6.7	2.88	0.63%	Sand-Slime Tailin	0.059	119.0	0.58	0.17	0.41	1	1.63	38.033	528.66	44.25	55	0.65%	2.0	47%	1.16	0.00	1.16	0
10.991	5599.83	23.4	0.151	23.3	6.8	2.96	0.65%	Sand-Slime Tailin	0.059	119.0	0.59	0.17	0.42	1	1.62	37.699	524.02	43.87	55	0.66%	2.0	47%	1.17	0.00	1.17	0
11.155	5599.67	23.8	0.188	23.7	7.4	3.19	0.79%	Sand-Slime Tailin	0.059	119.0	0.60	0.18	0.42	1	1.60	37.995	528.13	44.21	55	0.81%	2.1	47%	1.18	0.00	1.18	0
11.319	5599.50	20.6	0.235	20.6	7.4	3.21	1.14%	Sand-Slime Tailin	0.059	119.0	0.61	0.18	0.43	1	1.62	33.296	462.82	38.76	47	1.17%	2.2	47%	1.19	0.00	1.19	0
11.483	5599.34	17.6	0.198	17.5	8.1	3.49	1.13%	Sand-Slime Tailin	0.059	119.0	0.62	0.19	0.43	1	1.63	28.640	398.09	33.36	39	1.17%	2.3	47%	1.20	0.00	1.20	0
11.647	5599.17	21.4	0.168	21.3	8.2	3.53	0.79%	Sand-Slime Tailin	0.059	119.0	0.63	0.19	0.44	1	1.59	33.858	470.62	39.42	48	0.81%	2.1	47%	1.21	0.00	1.21	0
11.811	5599.01	21.3	0.146	21.2	7.4	3.21	0.69%	Sand-Slime Tailin	0.059	119.0	0.64	0.20	0.44	1	1.58	33.555	466.42	39.06	47	0.71%	2.1	47%	1.22	0.00	1.22	0
11.975	5598.85	23.0	0.133	23.0	8.9	3.84	0.58%	Sand-Slime Tailin	0.059	119.0	0.65	0.20	0.45	1	1.56	35.751	496.95	41.62	50	0.59%	2.0	47%	1.23	0.00	1.23	0
12.139	5598.68	25.0	0.154	24.9	8.9	3.84	0.62%	Sand-Slime Tailin	0.059	119.0	0.66	0.21	0.45	1	1.53	38.252	531.70	44.53	54	0.63%	2.0	47%	1.24	0.00	1.24	0
12.303	5598.52	23.3	0.135	23.3	8.9	3.84	0.58%	Sand-Slime Tailin	0.059	119.0	0.67	0.21	0.45	1	1.54	35.751	496.94	41.62	50	0.60%	2.0	47%	1.25	0.00	1.25	0

Liquefaction Triggering Analyses — Idriss & Boulanger (2008) / Youd et al. (2001) / Idriss & Boulanger (2008)

Depth at time of CPT (ft)	I&B r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Δqc_{1n}	$qc_{1n\text{-}cs}$	(CRR) M=7.5, s'v=1atm	FoS	Youd r_d	D_r	f	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	$qc_{1n\text{-}cs}$	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	CN	qc1 TSF	qc1 MPa	qc1N
0.164	1.00	0.05	1.02	1.0	0.059	36.93	55.75	0.083	1.41	0.97	0.25	0.80	0.80	2.53	1.0	0.017	1.65	31.02	0.076	183.93	92.67	2	1.7	16.209	1.5519	18.826
0.328	1.00	0.14	1.05	1.0	0.061	77.33	211.28	1.000	16.47	0.97	0.67	0.67	0.67	3.75	1.0	0.011	1.00	133.95	0.304	368.22	192.34	2	1.7	115.34	11.042	133.955
0.492	1.00	0.28	1.10	1.0	0.064	102.85	309.54	1.000	15.74	0.97	0.83	0.58	0.58	4.36	1.0	0.010	1.00	206.68	1.000	809.03	412.39	2	1.7	177.96	17.037	206.684
0.656	1.00	0.15	1.05	1.0	0.061	81.15	226.01	1.000	16.46	0.97	0.69	0.65	0.65	3.10	1.0	0.014	1.00	144.86	0.363	220.15	118.30	2	1.7	124.72	11.941	144.855
0.820	1.00	0.21	1.07	1.0	0.062	93.21	272.40	1.000	16.21	0.97	0.77	0.61	0.61	3.23	1.0	0.013	1.00	179.20	1.000	485.80	251.00	2	1.7	154.29	14.771	179.196
0.984	1.00	0.25	1.08	1.0	0.062	98.73	293.67	1.000	16.07	0.97	0.81	0.60	0.60	3.13	1.0	0.014	1.00	194.94	1.000	404.99	210.53	2	1.7	167.84	16.069	194.937
1.148	1.00	0.30	1.09	1.0	0.063	129.34	411.50	1.000	15.89	0.97	0.97	0.60	0.60	2.95	1.0	0.015	1.00	282.16	1.000	347.27	181.58	2	1.7	242.94	23.259	282.161
1.312	1.00	0.30	1.08	1.0	0.063	128.94	409.98	1.000	15.95	0.97	0.97	0.60	0.60	2.79	1.0	0.015	1.00	281.03	1.000	303.98	159.97	2	1.7	241.97	23.166	281.033
1.476	1.00	0.30	1.08	1.0	0.062	134.49	431.33	1.000	16.01	0.97	0.99	0.60	0.60	2.66	1.0	0.016	1.00	296.84	1.000	270.31	143.16	2	1.7	255.58	24.469	296.841
1.640	1.00	0.30	1.08	1.0	0.062	129.33	411.46	1.000	16.06	0.97	0.97	0.60	0.60	2.55	1.0	0.017	1.00	282.13	1.000	243.38	129.72	2	1.7	242.91	23.256	282.129
1.804	1.00	0.30	1.07	1.0	0.062	120.27	376.60	1.000	16.12	0.97	0.92	0.60	0.60	2.46	1.0	0.017	1.00	256.32	1.000	221.34	118.73	2	1.7	220.69	21.129	256.324
1.968	1.00	0.30	1.07	1.0	0.062	123.80	390.18	1.000	16.19	0.97	0.94	0.60	0.60	2.37	1.0	0.018	1.00	266.38	1.000	202.98	109.58	2	1.7	229.35	21.958	266.379
2.133	1.00	0.30	1.07	1.0	0.062	121.02	379.47	1.000	16.25	0.97	0.93	0.60	0.60	2.30	1.0	0.019	1.00	258.45	1.000	187.44	101.85	2	1.7	222.52	21.304	258.448
2.297	1.00	0.30	1.06	1.0	0.061	113.77	351.58	1.000	16.32	0.97	0.89	0.60	0.60	2.23	1.0	0.019	1.00	237.80	1.000	174.12	95.22	2	1.7	204.75	19.603	237.805
2.461	1.00	0.25	1.05	1.0	0.060	98.72	293.62	1.000	16.55	0.97	0.81	0.60	0.60	2.17	1.0	0.020	1.00	194.90	1.000	162.57	89.56	2	1.7	167.81	16.066	194.905
2.625	1.00	0.16	1.03	1.0	0.059	82.66	231.79	1.000	16.88	0.97	0.71	0.65	0.65	1.94	1.0	0.022	1.00	149.13	0.388	59.23	38.05	2	1.7	128.4	12.293	149.133
2.789	0.99	0.11	1.02	1.0	0.059	67.72	174.31	0.455	7.77	0.97	0.60	0.70	0.70	1.72	1.0	0.025	1.00	106.59	0.193	27.65	17.71	2	1.7	91.77	8.786	106.585
2.953	0.99	0.11	1.02	1.0	0.058	65.03	163.92	0.354	6.06	0.97	0.57	0.71	0.71	1.66	1.0	0.026	1.10	108.69	0.199	27.05	16.55	2	1.7	85.149	8.1522	98.895
3.117	0.99	0.12	1.02	1.0	0.058	69.75	182.11	0.572	9.79	0.97	0.61	0.69	0.69	1.68	1.0	0.025	1.08	121.15	0.245	31.54	20.67	2	1.7	96.742	9.2621	112.360
3.281	0.99	0.13	1.02	1.0	0.058	54.51	181.34	0.558	9.56	0.97	0.65	0.67	0.67	1.71	1.0	0.025	1.00	126.83	0.270	32.92	21.24	2	1.7	109.2	10.454	126.825
3.445	0.99	0.11	1.01	1.0	0.058	66.39	169.28	0.400	6.89	0.97	0.59	0.71	0.71	1.60	1.0	0.027	1.08	110.88	0.207	24.13	15.51	2	1.7	88.591	8.4817	102.893
3.609	0.99	0.08	1.01	1.0	0.058	50.09	107.51	0.155	2.69	0.97	0.44	0.78	0.78	1.41	1.0	0.030	1.62	93.01	0.155	17.39	10.04	2	1.7	49.443	4.7337	57.426
3.773	0.99	0.07	1.01	1.0	0.058	44.88	87.35	0.123	2.13	0.97	0.38	0.80	0.80	1.36	1.0	0.031	2.21	93.92	0.157	17.01	9.57	2	1.7	36.566	3.5008	42.469
3.937	0.99	0.06	1.01	1.0	0.058	41.32	73.59	0.104	1.81	0.97	0.33	0.80	0.80	1.35	1.0	0.032	2.34	75.43	0.120	12.54	7.17	2	1.7	27.779	2.6596	32.264
4.101	0.99	0.06	1.01	1.0	0.057	42.65	78.73	0.111	1.93	0.97	0.35	0.80	0.80	1.34	1.0	0.032	1.99	71.97	0.115	11.59	6.76	2	1.7	31.061	2.9738	36.076
4.265	0.99	0.06	1.01	1.0	0.057	40.45	70.19	0.100	1.74	0.97	0.31	0.80	0.80	1.33	1.0	0.032	2.49	74.20	0.118	11.54	6.64	2	1.7	25.611	2.452	29.746
4.429	0.99	0.06	1.00	1.0	0.057	43.38	81.55	0.115	2.00	0.96	0.36	0.80	0.80	1.32	1.0	0.032	1.92	73.46	0.117	11.07	6.54	2	1.7	32.861	3.1461	38.166
4.593	0.98	0.07	1.00	1.0	0.057	47.31	95.79	0.136	2.37	0.96	0.40	0.80	0.80	1.31	1.0	0.032	1.66	80.63	0.129	11.78	7.07	2	1.7	41.743	3.9965	48.482
4.757	0.98	0.07	1.00	1.0	0.057	47.29	95.73	0.136	2.38	0.96	0.40	0.80	0.80	1.30	1.0	0.033	1.62	78.55	0.125	11.06	6.72	2	1.7	41.706	3.9929	48.439
4.921	0.98	0.07	1.00	1.0	0.057	46.50	92.69	0.131	2.30	0.96	0.39	0.80	0.80	1.29	1.0	0.033	1.41	65.26	0.106	9.06	5.68	2	1.7	39.766	3.8072	46.186
5.085	0.98	0.07	1.00	1.0	0.057	47.96	98.32	0.140	2.46	0.96	0.41	0.80	0.80	1.29	1.0	0.033	1.27	63.77	0.104	8.64	5.55	2	1.7	43.358	4.1511	50.358
5.249	0.98	0.06	1.00	1.0	0.057	44.33	84.33	0.119	2.09	0.96	0.37	0.80	0.80	1.28	1.0	0.033	1.47	58.96	0.099	7.97	5.03	2	1.7	34.44	3.2973	40.000
5.413	0.98	0.05	1.00	1.0	0.057	37.79	59.91	0.088	1.55	0.96	0.27	0.80	0.80	1.27	1.0	0.033	2.50	55.31	0.096	7.51	4.53	2	1.7	19.047	1.8236	22.122
5.577	0.98	0.05	1.00	1.0	0.057	35.25	50.06	0.078	1.37	0.96	0.22	0.80	0.80	1.26	1.0	0.034	2.95	43.70	0.086	6.59	3.98	2	1.7	12.757	1.2213	14.816
5.741	0.98	0.05	1.00	1.0	0.057	35.64	50.85	0.078	1.39	0.96	0.23	0.80	0.80	1.26	1.0	0.034	2.36	35.90	0.080	5.99	3.69	2	1.7	13.102	1.2543	15.217
5.905	0.98	0.05	1.00	1.0	0.056	37.19	56.83	0.084	1.50	0.96	0.26	0.80	0.80	1.26	1.0	0.034	1.79	35.17	0.079	5.85	3.67	2	1.7	16.912	1.6192	19.642
6.069	0.98	0.05	1.00	1.0	0.056	34.13	45.74	0.074	1.30	0.96	0.20	0.80	0.80	1.25	1.0	0.034	3.28	38.05	0.082	5.94	3.62	2	1.7	9.993	0.9567	11.606
6.234	0.98	0.05	1.00	1.0	0.056	33.92	44.91	0.073	1.29	0.96	0.19	0.80	0.80	1.25	1.0	0.034	3.48	38.27	0.082	5.86	3.58	2	1.7	9.4649	0.9062	10.993
6.398	0.97	0.05	1.00	1.0	0.056	34.89	48.67	0.076	1.36	0.96	0.21	0.80	0.80	1.24	1.0	0.034	2.75	37.89	0.082	5.76	3.56	2	1.7	11.866	1.136	13.781
6.562	0.97	0.05	1.00	1.0	0.056	34.98	49.02	0.077	1.36	0.96	0.22	0.80	0.80	1.24	1.0	0.034	2.64	37.10	0.081	5.63	3.50	2	1.7	12.091	1.1576	14.043
6.726	0.97	0.05	1.00	1.0	0.056	37.70	58.79	0.087	1.54	0.96	0.27	0.80	0.80	1.24	1.0	0.034	1.74	36.71	0.081	5.53	3.54	2	1.7	18.162	1.7388	21.094
6.890	0.97	0.06	1.00	1.0	0.056	39.59	66.08	0.095	1.70	0.96	0.30	0.80	0.80	1.23	1.0	0.034	1.60	42.25	0.085	5.75	3.73	2	1.7	22.808	2.1837	26.490
7.054	0.97	0.06	1.00	1.0	0.056	40.66	70.18	0.100	1.79	0.96	0.31	0.80	0.80	1.23	1.0	0.034	1.55	45.64	0.088	5.86	3.82	2	1.7	25.419	2.4336	29.522
7.218	0.97	0.07	0.99	1.0	0.056	45.83	90.09	0.127	2.28	0.96	0.38	0.80	0.80	1.23	1.0	0.034	1.19	52.90	0.094	6.15	4.22	2	1.7	38.114	3.649	44.267
7.382	0.97	0.06	0.99	1.0	0.056	42.40	76.88	0.108	1.95	0.96	0.34	0.80	0.80	1.22	1.0	0.035	1.47	50.71	0.092	5.96	3.95	2	1.7	29.69	2.8426	34.484
7.546	0.97	0.06	0.99	1.0	0.056	41.04	71.67	0.102	1.83	0.96	0.32	0.80	0.80	1.22	1.0	0.035	1.77	54.31	0.095	6.05	3.94	2	1.7	26.373	2.5249	30.630
7.710	0.97	0.06	0.99	1.0	0.055	42.10	75.74	0.107	1.93	0.96	0.33	0.80	0.80	1.22	1.0	0.035	1.72	57.87	0.098	6.16	4.04	2	1.7	28.962	2.7728	33.637
7.874	0.96	0.06	0.99	1.0	0.055	42.66	77.91	0.110	1.99	0.96	0.34	0.80	0.80	1.21	1.0	0.035	1.51	53.23	0.094	5.83	3.91	2	1.7	30.35	2.9057	35.250
8.038	0.96	0.07	0.99	1.0	0.055	44.57	85.24	0.120	2.17	0.96	0.37	0.80	0.80	1.21	1.0	0.035	1.30	52.92	0.094	5.73	3.95	2	1.7	35.021	3.3529	40.675
8.202	0.96	0.07	0.99	1.0	0.055	48.59	100.75	0.144	2.61	0.96	0.42	0.79	0.79	1.21	1.0	0.035	1.18	61.54	0.102	6.13	4.37	2	1.7	44.906	4.2993	52.156
8.366	0.96	0.08	0.99	1.0	0.055	50.99	109.98	0.160	2.91	0.96	0.44	0.78	0.78	1.23	1.0	0.034	1.21	71.32	0.114	6.77	4.84	2	1.7	50.792	4.8629	58.992
8.530	0.96	0.07	0.99	1.0	0.055	45.75	89.79	0.127	2.31	0.96	0.38	0.80	0.80	1.20	1.0	0.035	1.52	66.73	0.108	6.33	4.32	2	1.7	37.923	3.6307	44.045
8.694	0.96	0.07	0.99	1.0	0.055	45.36	88.31	0.124	2.27	0.95	0.38	0.80	0.80	1.20	1.0	0.035	1.79	77.08	0.123	7.11	4.69	2	1.7	36.977	3.5402	42.947
8.858	0.96	0.07	0.99	1.0	0.055	45.14	87.46	0.123	2.25	0.95	0.38	0.80	0.80	1.19	1.0	0.035	1.53	64.55	0.105	6.02	4.13	2	1.7	36.436	3.4884	42.318
9.022	0.96	0.08	0.98	1.0	0.054	50.84	109.41	0.159	2.91	0.95	0.44	0.78	0.78	1.21	1.0	0.035	1.29	75.74	0.120	6.81	4.86	2	1.6952481	50.428	4.828	58.569
9.186	0.96	0.07	0.99	1.0	0.054	45.93	90.51	0.128	2.34	0.95	0.39	0.80	0.80	1.19	1.0	0.035	1.27	56.79	0.097	5.42	3.88	2	1.7	38.379	3.6744	44.575
9.350	0.96	0.06	0.99	1.0	0.054	42.56	77.50	0.109	2.01	0.95	0.34	0.80	0.80	1.18	1.0	0.036	1.52	53.08	0.094	5.18	3.60	2	1.7	30.086	2.8804	34.943
9.514	0.95	0.06	0.99	1.0	0.054	40.13	68.14	0.097	1.79	0.95	0.31	0.80	0.80	1.18	1.0	0.036	2.04	57.25	0.097	5.32	3.55	2	1.7	24.118	2.3091	28.012
9.678	0.95	0.05	0.99	1.0	0.054	38.37	61.39	0.089	1.64	0.95	0.28	0.80	0.80	1.18	1.0	0.036	2.72	62.50	0.103	5.54	3.59	2	1.7	19.816	1.8972	23.015
9.842	0.95	0.05	0.99	1.0	0.054	38.09	60.31	0.088	1.62	0.95	0.27	0.80	0.80	1.17	1.0	0.036	2.27	50.41	0.092	4.90	3.26	2	1.7	19.13	1.8315	22.219
10.006	0.95	0.06	0.99	1.0	0.054	40.25	68.61	0.098	1.81	0.95	0.31	0.80	0.80	1.17	1.0	0.036	1.58	44.88	0.087	4.60	3.20	2	1.7	24.419	2.3379	28.361
10.170	0.95	0.06	0.98	1.0	0.054	43.00	79.22	0.112	2.07	0.95	0.35	0.80	0.80	1.17	1.0	0.036	1.28	46.49	0.089	4.62	3.34	2	1.7	31.185	2.9856	36.219
10.335	0.95	0.07	0.98	1.0	0.054	44.45	84.81	0.119	2.22	0.95	0.37	0.80	0.80	1.17	1.0	0.036	1.27	51.31	0.093	4.76	3.49	2	1.6835791	34.744	3.3264	40.353
10.499	0.95	0.07	0.98	1.0	0.054	44.78	86.04	0.121	2.25	0.95	0.37	0.80	0.80	1.16	1.0	0.036	1.30	53.52	0.094	4.80	3.53	2	1.6654836	35.532	3.4019	41.268
10.663	0.95	0.07	0.98	1.0	0.054	45.85	90.19	0.127	2.37	0.95	0.38	0.80	0.80	1.16	1.0	0.036	1.27	56.24	0.097	4.86	3.62	2	1.6371138	38.174	3.6548	44.337
10.827	0.95	0.07	0.98	1.0	0.054	45.82	90.07	0.127	2.37	0.95	0.38	0.80	0.80	1.16	1.0	0.036	1.31	58.18	0.098	4.90	3.63	2	1.6253497	38.101	3.6478	44.252
10.991	0.94	0.07	0.98	1.0	0.053	45.69	89.55	0.126	2.36	0.95	0.38	0.80	0.80	1.16	1.0	0.036	1.33	58.30	0.098	4.85	3.61	2	1.6152194	37.768	3.6159	43.865
11.155	0.94	0.07	0.98	1.0	0.053	45.81	90.02	0.127	2.38	0.95	0.38	0.80	0.80	1.15	1.0	0.036	1.40	61.77	0.102	4.97	3.67	2	1.6018202	38.069	3.6447	44.214
11.319	0.94	0.06	0.98	1.0	0.053	43.89	82.65	0.116	2.18	0.95	0.36	0.80	0.80	1.15	1.0	0.036	1.70	65.83	0.107	5.14	3.66	2	1.6163248	33.371	3.1949	38.758
11.483	0.94	0.06	0.98	1.0	0.053	42.00	75.36	0.106	2.00	0.95	0.33	0.80	0.80	1.15	1.0	0.036	1.87	62.34	0.103	4.89	3.45	2	1.632818	28.722	2.7498	33.359
11.647	0.94	0.06	0.98	1.0	0.053	44.13	83.54	0.118	2.21	0.95	0.36	0.80	0.80	1.15	1.0	0.036	1.49	58.73	0.099	4.67	3.44	2	1.5895544	33.938	3.2493	39.417
11.811	0.94	0.06	0.98	1.0	0.053	44.00	83.06	0.117	2.20	0.95	0.36	0.80	0.80	1.14	1.0	0.037	1.44	56.33	0.097	4.52	3.36	2	1.5798159	33.628	3.2196	39.057
11.975	0.94	0.07	0.98	1.0	0.053	44.90	86.52	0.122	2.30	0.95	0.37	0.80	0.80	1.14	1.0	0.037	1.34	55.78	0.096	4.45	3.38	2	1.5571208	35.838	3.4311	41.623
12.139	0.94	0.07	0.98	1.0	0.053	45.92	90.44	0.128	2.42	0.95	0.39	0.80	0.80	1.14	1.0	0.037	1.32	58.78	0.099	4.53	3.48	2	1.5343587	38.336	3.6703	44.525
12.303	0.94	0.07	0.98	1.0	0.053	44.90	86.52	0.122	2.31	0.95	0.37	0.80	0.80	1.14	1.0	0.037	1.34	55.97	0.096	4.37	3.34	2	1.5357058	35.836	3.4309	41.621

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-2C

Data File: 13-52106_SP3-2C-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3 Field Data\2013 Field Investigation\Conetec Data

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69

Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5605.30	Water surface elevation during CPT investigation (ft amsl)
5602.54	Water surface elevation at t_0 (ft amsl)
5591.64	Water surface elevation at t_1 (ft amsl)
5586.64	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earthquake
7.51	Equiv. Number of Uniform Strain Cycles, N

5610.82	Ground Surface Elevation at time of CPT (ft amsl)
5621.51	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
3.19	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1167.12	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5586.64	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)		Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	5621.51		5621.26	5621.01	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
Water Storage/Rooting Zone Layer	5621.01		5619.26	5617.51	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	5617.51		5615.76	5614.01	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320
Platform/Random Fill Layer	5614.01		5612.415	5610.82	3.19	0.050	101	0.585	0.504	0.00	0.00	0.585	0.504

Part A: 2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
12.467	5598.35	19.3	0.160	19.2	8.9	3.87	0.83%	Sand-Slime Tailin	0.059	119.0	0.68	0.22	0.46	1	1.56	29.859	415.03	34.78	40	0.86%	2.2	47%	1.26	0.00	1.26	0
12.631	5598.19	20.3	0.143	20.3	8.0	3.47	0.70%	Sand-Slime Tailin	0.059	119.0	0.69	0.22	0.46	1	1.54	31.205	433.74	36.33	42	0.73%	2.1	47%	1.27	0.00	1.27	0
12.795	5598.02	20.0	0.132	19.9	7.5	3.24	0.66%	Sand-Slime Tailin	0.059	119.0	0.70	0.23	0.47	1	1.53	30.469	423.52	35.47	41	0.69%	2.1	47%	1.28	0.00	1.28	0
12.959	5597.86	21.7	0.151	21.6	9.5	4.12	0.70%	Sand-Slime Tailin	0.059	119.0	0.71	0.23	0.47	1	1.51	32.643	453.73	38.02	44	0.72%	2.1	47%	1.29	0.00	1.29	0
13.123	5597.70	20.7	0.179	20.6	8.8	3.79	0.87%	Sand-Slime Tailin	0.059	119.0	0.72	0.24	0.48	1	1.51	31.051	431.61	36.16	42	0.90%	2.2	47%	1.30	0.00	1.30	0
13.287	5597.53	20.4	0.271	20.3	9.5	4.12	1.33%	Sand-Slime Tailin	0.059	119.0	0.72	0.24	0.48	1	1.50	30.438	423.09	35.45	41	1.38%	2.3	47%	1.31	0.00	1.31	0
13.451	5597.37	17.5	0.436	17.4	12.5	5.40	2.49%	Sand-Slime Tailin	0.059	119.0	0.73	0.25	0.49	1	1.51	26.315	365.78	30.70	34	2.60%	2.5	47%	1.32	0.00	1.32	0
13.615	5597.20	16.3	0.451	16.2	16.3	7.05	2.77%	Slime Tailings	0.057	113.1	0.74	0.25	0.49	1	1.51	24.409	339.29	28.53	32	2.91%	2.6	71%	1.33	0.00	1.33	0
13.779	5597.04	20.4	0.353	20.2	19.3	8.35	1.73%	Sand-Slime Tailin	0.059	119.0	0.75	0.26	0.50	1	1.47	29.819	414.48	34.84	40	1.80%	2.4	47%	1.34	0.00	1.34	0
13.943	5596.88	25.7	0.379	25.6	13.1	5.68	1.48%	Sand-Slime Tailin	0.059	119.0	0.76	0.26	0.50	1	1.44	36.753	510.87	42.82	50	1.52%	2.3	47%	1.35	0.00	1.35	0
14.107	5596.71	19.0	0.491	19.0	7.7	3.35	2.58%	Sand-Slime Tailin	0.059	119.0	0.77	0.27	0.51	1	1.46	27.769	385.99	32.33	36	2.69%	2.5	47%	1.36	0.00	1.36	0
14.271	5596.55	14.6	0.427	14.6	5.8	2.51	2.92%	Slime Tailings	0.057	113.1	0.78	0.27	0.51	1	1.49	21.650	300.93	25.21	27	3.09%	2.7	71%	1.37	0.00	1.37	0
14.436	5596.38	9.2	0.378	9.2	7.3	3.14	4.11%	Slime Tailings	0.057	113.1	0.79	0.28	0.51	1	1.50	13.706	190.52	16.00	16	4.50%	2.9	71%	1.38	0.00	1.38	0
14.600	5596.22	10.5	0.412	10.2	45.5	19.71	3.91%	Slime Tailings	0.057	113.1	0.80	0.28	0.52	1	1.49	15.242	211.87	18.19	19	4.24%	2.9	71%	1.38	0.00	1.38	0
14.764	5596.06	12.3	0.360	12.1	42.1	18.25	2.92%	Slime Tailings	0.057	113.1	0.81	0.29	0.52	1	1.48	17.857	248.22	21.19	22	3.12%	2.7	71%	1.39	0.00	1.39	0
14.928	5595.89	11.4	0.381	11.1	52.4	22.72	3.35%	Slime Tailings	0.057	113.1	0.82	0.29	0.53	1	1.47	16.259	226.00	19.44	20	3.61%	2.8	71%	1.40	0.00	1.40	0
15.092	5595.73	10.8	0.299	10.3	74.3	32.20	2.78%	Slime Tailings	0.057	113.1	0.83	0.30	0.53	1	1.46	15.049	209.18	18.27	19	3.01%	2.8	71%	1.41	0.00	1.41	0
15.256	5595.56	19.3	0.291	19.3	9.6	4.14	1.50%	Sand-Slime Tailin	0.059	119.0	0.84	0.30	0.53	1	1.41	27.158	377.49	31.64	35	1.57%	2.4	47%	1.42	0.00	1.42	0
15.420	5595.40	21.0	0.161	20.9	6.0	2.61	0.77%	Sand-Slime Tailin	0.059	119.0	0.85	0.31	0.54	1	1.39	29.142	405.07	33.91	37	0.80%	2.2	47%	1.43	0.00	1.43	0
15.584	5595.24	22.2	0.159	22.2	3.5	1.51	0.72%	Sand-Slime Tailin	0.059	119.0	0.86	0.31	0.54	1	1.38	30.532	424.40	35.50	39	0.75%	2.2	47%	1.44	0.00	1.44	0
15.748	5595.07	20.4	0.160	20.4	2.7	1.19	0.78%	Sand-Slime Tailin	0.059	119.0	0.87	0.32	0.55	1	1.38	28.088	390.43	32.65	36	0.82%	2.2	47%	1.45	0.00	1.45	0
15.912	5594.91	19.5	0.171	19.4	8.7	3.77	0.88%	Sand-Slime Tailin	0.059	119.0	0.88	0.32	0.55	1	1.38	26.698	371.11	31.10	34	0.92%	2.3	47%	1.46	0.00	1.46	0
16.076	5594.74	19.6	0.146	19.5	14.0	6.06	0.74%	Sand-Slime Tailin	0.059	119.0	0.89	0.33	0.56	1	1.37	26.712	371.29	31.16	34	0.78%	2.2	47%	1.47	0.00	1.47	0
16.240	5594.58	22.3	0.122	22.2	15.7	6.79	0.55%	Sand-Slime Tailin	0.059	119.0	0.90	0.33	0.56	1	1.35	29.952	416.34	34.94	38	0.57%	2.1	47%	1.48	0.00	1.48	0
16.404	5594.42	25.7	0.298	25.6	17.8	7.69	1.16%	Sand-Slime Tailin	0.059	119.0	0.91	0.34	0.57	1	1.33	34.002	472.62	39.66	44	1.20%	2.2	47%	1.49	0.00	1.49	0
16.568	5594.25	18.5	0.396	18.4	22.8	9.87	2.14%	Sand-Slime Tailin	0.059	119.0	0.92	0.34	0.57	1	1.35	24.813	344.89	29.04	31	2.25%	2.5	47%	1.50	0.00	1.50	0
16.732	5594.09	15.3	0.462	15.1	35.8	15.50	3.02%	Slime Tailings	0.057	113.1	0.93	0.35	0.58	1	1.36	20.475	284.61	24.13	25	3.21%	2.7	71%	1.51	0.00	1.51	0
16.896	5593.92	15.4	0.350	14.9	88.5	38.34	2.27%	Sand-Slime Tailin	0.059	119.0	0.94	0.35	0.58	1	1.35	20.091	279.26	24.20	25	2.41%	2.6	47%	1.52	0.00	1.52	0
17.060	5593.76	26.3	0.276	25.8	72.4	31.36	1.05%	Sand-Slime Tailin	0.059	119.0	0.95	0.36	0.59	1	1.30	33.545	466.27	39.64	43	1.09%	2.2	47%	1.53	0.00	1.53	0
17.224	5593.60	20.8	0.402	20.7	18.6	8.07	1.93%	Sand-Slime Tailin	0.059	119.0	0.96	0.37	0.59	1	1.31	27.153	377.43	31.71	34	2.02%	2.5	47%	1.54	0.00	1.54	0
17.388	5593.43	15.3	0.334	15.2	21.0	9.11	2.19%	Sand-Slime Tailin	0.059	119.0	0.96	0.37	0.59	1	1.33	20.107	279.49	23.56	24	2.33%	2.6	47%	1.55	0.00	1.55	0
17.552	5593.27	16.5	0.162	16.3	36.5	15.82	0.98%	Sand-Slime Tailin	0.059	119.0	0.97	0.38	0.60	1	1.31	21.424	297.79	25.23	26	1.04%	2.4	47%	1.56	0.00	1.56	0
17.716	5593.10	24.5	0.248	24.3	32.1	13.91	1.01%	Sand-Slime Tailin	0.059	119.0	0.98	0.38	0.60	1	1.28	31.128	432.68	36.45	39	1.05%	2.3	47%	1.57	0.00	1.57	0
17.880	5592.94	17.1	0.328	16.9	29.7	12.85	1.92%	Sand-Slime Tailin	0.059	119.0	0.99	0.39	0.61	1	1.30	21.982	305.54	25.81	27	2.03%	2.6	47%	1.58	0.00	1.58	0
18.044	5592.78	15.0	0.452	14.8	43.2	18.70	3.01%	Slime Tailings	0.057	113.1	1.00	0.39	0.61	1	1.30	19.195	266.82	22.70	23	3.22%	2.7	71%	1.59	0.00	1.59	0
18.208	5592.61	12.2	0.284	11.8	60.5	26.21	2.32%	Slime Tailings	0.057	113.1	1.01	0.40	0.62	1	1.30	15.367	213.60	18.42	18	2.53%	2.7	71%	1.60	0.00	1.60	0
18.372	5592.45	20.9	0.383	20.4	78.0	33.81	1.83%	Sand-Slime Tailin	0.059	119.0	1.02	0.40	0.62	1	1.27	25.871	359.60	30.76	32	1.92%	2.5	47%	1.61	0.00	1.61	0
18.537	5592.28	18.1	0.296	17.9	41.0	17.77	1.63%	Sand-Slime Tailin	0.059	119.0	1.03	0.41	0.63	1	1.27	22.684	315.30	26.72	27	1.73%	2.5	47%	1.62	0.00	1.62	0
18.701	5592.12	21.8	0.387	21.4	62.7	27.18	1.78%	Sand-Slime Tailin	0.059	119.0	1.04	0.41	0.63	1	1.25	26.759	371.95	31.65	33	1.87%	2.5	47%	1.63	0.00	1.63	0
18.865	5591.96	18.8	0.412	18.5	46.5	20.15	2.19%	Sand-Slime Tailin	0.059	119.0	1.05	0.42	0.64	1	1.25	23.212	322.65	27.38	28	2.32%	2.6	47%	1.64	0.00	1.64	0
19.029	5591.79	18.5	0.428	18.4	22.2	9.62	2.31%	Sand-Slime Tailin	0.059	119.0	1.06	0.42	0.64	1	1.25	22.958	319.11	26.86	27	2.45%	2.6	47%	1.65	0.00	1.65	0
19.193	5591.63	13.1	0.382	12.9	32.2	13.96	2.91%	Slime Tailings	0.057	113.1	1.07	0.43	0.64	1	1.25	16.221	225.48	19.13	19	3.17%	2.8	71%	1.65	0.00	1.65	1
19.357	5591.46	11.8	0.318	11.1	110.7	47.96	2.70%	Slime Tailings	0.057	113.1	1.08	0.43	0.65	1	1.25	13.843	192.42	17.08	17	2.97%	2.8	71%	1.66	0.01	1.66	1
19.521	5591.30	14.0	0.235	13.6	73.8	31.99	1.67%	Sand-Slime Tailin	0.059	119.0	1.09	0.44	0.65	1	1.24	16.857	234.31	20.24	20	1.81%	2.6	47%	1.67	0.01	1.66	1
19.685	5591.14	14.0	0.240	13.3	116.1	50.29	1.72%	Sand-Slime Tailin	0.059	119.0	1.10	0.44	0.66	1	1.23	16.369	227.53	20.05	20	1.86%	2.6	47%	1.68	0.02	1.67	1
19.849	5590.97	13.0	0.220	12.4	100.8	43.68	1.69%	Sand-Slime Tailin	0.059	119.0	1.11	0.45	0.66	1	1.23	15.187	211.09	18.54	18	1.85%	2.7	47%	1.69	0.02	1.67	1
20.013	5590.81	12.6	0.337	11.7	147.5	63.92	2.68%	Slime Tailings	0.057	113.1	1.12	0.45	0.67	1	1.22	14.257	198.18	17.87	17	2.94%	2.8	71%	1.70	0.03	1.68	1
20.177	5590.64	16.5	0.337	15.6	147.0	63.70	2.05%	Sand-Slime Tailin	0.059	119.0	1.13	0.46	0.67	1	1.21	18.838	261.85	23.17	23	2.20%	2.6	47%	1.71	0.03	1.68	1
20.341	5590.48	20.1	0.337	19.5	94.3	40.85	1.68%	Sand-Slime Tailin	0.059	119.0	1.14	0.46	0.68	1	1.20	23.344	324.48	27.93	28	1.78%	2.5	47%	1.72	0.04	1.69	1

Part B: Liquefaction Triggering Analyses — Idriss & Boulanger (2008) / Youd et al. (2001); Idriss & Boulanger (2008)

Depth at time of CPT (ft)	I&B CSR r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	CRR Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd CSR r_d	D_r	f	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	CN	qc1 TSF	qc1 MPa	qc1N
12.467	0.93	0.06	0.98	1.0	0.053	42.50	77.28	0.109	2.07	0.95	0.34	0.80	0.80	1.13	1.0	0.037	1.65	57.30	0.097	4.38	3.22	2	1.5551349	29.945	2.867	34.780
12.631	0.93	0.06	0.98	1.0	0.053	43.04	79.37	0.112	2.12	0.95	0.35	0.80	0.80	1.13	1.0	0.037	1.53	55.42	0.096	4.27	3.20	2	1.5371723	31.281	2.9949	36.331
12.795	0.93	0.06	0.98	1.0	0.053	42.74	78.21	0.110	2.10	0.95	0.34	0.80	0.80	1.13	1.0	0.037	1.52	54.00	0.095	4.17	3.14	2	1.5303446	30.541	2.924	35.471
12.959	0.93	0.06	0.97	1.0	0.052	43.63	81.65	0.115	2.19	0.94	0.36	0.80	0.80	1.13	1.0	0.037	1.49	56.54	0.097	4.23	3.21	2	1.5091412	32.732	3.1338	38.017
13.123	0.93	0.06	0.97	1.0	0.052	42.98	79.14	0.111	2.13	0.94	0.35	0.80	0.80	1.13	1.0	0.037	1.64	59.39	0.099	4.31	3.22	2	1.5066131	31.134	2.9807	36.160
13.287	0.93	0.06	0.97	1.0	0.052	42.74	78.19	0.110	2.11	0.94	0.34	0.80	0.80	1.12	1.0	0.037	1.96	69.60	0.111	4.77	3.44	2	1.4994011	30.527	2.9226	35.455
13.451	0.93	0.06	0.97	1.0	0.052	41.07	71.77	0.102	1.95	0.94	0.32	0.80	0.80	1.12	1.0	0.037	2.93	90.06	0.148	6.28	4.12	2	1.5097542	26.432	2.5306	30.700
13.615	0.93	0.06	0.97	1.0	0.052	40.02	68.55	0.098	1.88	0.94	0.31	0.80	0.80	1.12	1.0	0.037	3.28	93.45	0.156	6.57	4.22	2	1.5104631	24.562	2.3516	28.528
13.779	0.92	0.06	0.97	1.0	0.052	42.52	77.36	0.109	2.10	0.94	0.34	0.80	0.80	1.12	1.0	0.037	2.25	78.36	0.125	5.21	3.65	2	1.4732613	29.996	2.8718	34.838
13.943	0.92	0.07	0.97	1.0	0.052	45.32	88.14	0.124	2.40	0.94	0.38	0.80	0.80	1.11	1.0	0.037	1.83	78.27	0.125	5.16	3.78	2	1.4356655	36.871	3.53	42.823
14.107	0.92	0.06	0.97	1.0	0.052	41.64	73.98	0.105	2.02	0.94	0.33	0.80	0.80	1.11	1.0	0.037	2.90	93.82	0.157	6.43	4.23	2	1.4638491	27.84	2.6654	32.334
14.271	0.92	0.06	0.97	1.0	0.052	38.87	64.07	0.092	1.78	0.94	0.29	0.80	0.80	1.11	1.0	0.037	3.71	93.46	0.156	6.35	4.07	2	1.4859142	21.703	2.0779	25.207
14.436	0.92	0.05	0.98	1.0	0.052	35.66	51.66	0.079	1.52	0.94	0.23	0.80	0.80	1.11	1.0	0.037	6.02	96.32	0.163	6.59	4.06	2	1.4979452	13.774	1.3187	15.998
14.600	0.92	0.05	0.98	1.0	0.052	36.42	54.62	0.082	1.59	0.94	0.25	0.80	0.80	1.11	1.0	0.037	5.41	98.39	0.169	6.76	4.17	2	1.4885243	15.665	1.4998	18.194
14.764	0.92	0.05	0.97	1.0	0.052	37.47	58.66	0.086	1.67	0.94	0.27	0.80	0.80	1.11	1.0	0.038	4.23	89.55	0.147	5.84	3.76	2	1.4782492	18.246	1.7469	21.191
14.928	0.92	0.05	0.97	1.0	0.052	36.86	56.30	0.084	1.63	0.94	0.25	0.80	0.80	1.10	1.0	0.038	4.80	93.41	0.156	6.15	3.89	2	1.4700815	16.74	1.6027	19.443
15.092	0.91	0.05	0.97	1.0	0.052	36.45	54.71	0.082	1.60	0.94	0.25	0.80	0.80	1.10	1.0	0.038	4.59	83.90	0.135	5.29	3.44	2	1.4610537	15.727	1.5057	18.266
15.256	0.91	0.06	0.97	1.0	0.051	41.40	73.04	0.103	2.02	0.94	0.32	0.80	0.80	1.10	1.0	0.038	2.29	72.47	0.115	4.49	3.25	2	1.4078566	27.241	2.6081	31.639
15.420	0.91	0.06	0.97	1.0	0.051	42.19	76.10	0.107	2.10	0.94	0.34	0.80	0.80	1.10	1.0	0.038	1.68	56.97	0.097	3.75	2.92	2	1.3916875	29.194	2.7951	33.907
15.584	0.91	0.06	0.97	1.0	0.051	42.75	78.25	0.110	2.16	0.94	0.34	0.80	0.80	1.10	1.0	0.038	1.60	56.82	0.097	3.71	2.94	2	1.3784218	30.562	2.926	35.496
15.748	0.91	0.06	0.97	1.0	0.051	41.75	74.40	0.105	2.07	0.94	0.33	0.80	0.80	1.09	1.0	0.038	1.74	56.81	0.097	3.68	2.87	2	1.3788977	28.112	2.6914	32.650
15.912	0.91	0.06	0.97	1.0	0.051	41.21	72.30	0.102	2.02	0.94	0.32	0.80	0.80	1.09	1.0	0.038	1.87	58.26	0.098	3.70	2.86	2	1.3754991	26.773	2.5633	31.095
16.076	0.91	0.06	0.97	1.0	0.051	41.23	72.39	0.103	2.02	0.94	0.32	0.80	0.80	1.09	1.0	0.038	1.77	55.11	0.096	3.57	2.79	2	1.3670323	26.831	2.5688	31.163
16.240	0.91	0.06	0.97	1.0	0.051	42.56	77.50	0.109	2.16	0.94	0.34	0.80	0.80	1.09	1.0	0.038	1.50	52.57	0.094	3.46	2.81	2	1.3479919	30.084	2.8803	34.941
16.404	0.90	0.06	0.96	1.0	0.050	44.21	83.87	0.118	2.34	0.94	0.36	0.80	0.80	1.09	1.0	0.038	1.78	70.65	0.113	4.15	3.24	2	1.3281917	34.149	3.2694	39.662
16.568	0.90	0.06	0.97	1.0	0.051	40.49	69.53	0.099	1.96	0.94	0.31	0.80	0.80	1.09	1.0	0.038	2.92	84.80	0.137	4.99	3.47	2	1.3492412	25.004	2.3939	29.041
16.732	0.90	0.06	0.97	1.0	0.051	38.49	62.62	0.091	1.80	0.94	0.28	0.80	0.80	1.08	1.0	0.038	3.98	96.07	0.162	5.88	3.84	2	1.3577821	20.779	1.9893	24.133
16.896	0.90	0.06	0.97	1.0	0.050	38.79	62.99	0.091	1.81	0.94	0.28	0.80	0.80	1.08	1.0	0.038	3.45	83.47	0.134	4.82	3.31	2	1.3492937	20.836	1.9949	24.200
17.060	0.90	0.06	0.96	1.0	0.050	44.20	83.85	0.118	2.36	0.94	0.36	0.80	0.80	1.08	1.0	0.038	1.73	68.48	0.110	3.92	3.14	2	1.3001914	34.132	3.2678	39.643
17.224	0.90	0.06	0.97	1.0	0.050	41.42	73.14	0.104	2.07	0.93	0.33	0.80	0.80	1.08	1.0	0.038	2.62	83.22	0.134	4.73	3.40	2	1.3117576	27.306	2.6143	31.714
17.388	0.90	0.05	0.97	1.0	0.050	38.56	62.12	0.090	1.80	0.93	0.28	0.80	0.80	1.08	1.0	0.038	3.47	81.83	0.131	4.60	3.20	2	1.3272144	20.281	1.9417	23.556
17.552	0.90	0.06	0.97	1.0	0.050	39.15	64.38	0.093	1.85	0.93	0.29	0.80	0.80	1.08	1.0	0.038	2.31	58.30	0.098	3.43	2.64	2	1.314342	21.723	2.0798	25.230
17.716	0.89	0.06	0.96	1.0	0.050	43.09	79.54	0.112	2.25	0.93	0.35	0.80	0.80	1.07	1.0	0.038	1.81	65.83	0.107	3.69	2.97	2	1.2794019	31.384	3.0047	36.451
17.880	0.89	0.06	0.97	1.0	0.050	39.35	65.16	0.094	1.88	0.93	0.29	0.80	0.80	1.07	1.0	0.038	3.06	78.92	0.126	4.32	3.10	2	1.2976165	22.222	2.1275	25.809
18.044	0.89	0.05	0.97	1.0	0.050	37.99	60.69	0.089	1.78	0.93	0.28	0.80	0.80	1.07	1.0	0.038	4.20	95.31	0.161	5.48	3.63	2	1.2996199	19.546	1.8713	22.701
18.208	0.89	0.05	0.97	1.0	0.050	36.50	54.92	0.082	1.65	0.93	0.25	0.80	0.80	1.07	1.0	0.038	4.32	79.57	0.127	4.31	2.98	2	1.297855	15.857	1.5181	18.417
18.372	0.89	0.06	0.96	1.0	0.050	41.09	71.85	0.102	2.06	0.93	0.32	0.80	0.80	1.07	1.0	0.038	2.64	81.26	0.130	4.38	3.22	2	1.2656973	26.487	2.5359	30.764
18.537	0.89	0.06	0.96	1.0	0.049	39.67	66.40	0.095	1.92	0.93	0.30	0.80	0.80	1.07	1.0	0.039	2.78	74.25	0.118	3.95	2.94	2	1.2679476	23.008	2.2028	26.723
18.701	0.89	0.06	0.96	1.0	0.049	41.40	73.05	0.103	2.10	0.93	0.32	0.80	0.80	1.06	1.0	0.039	2.56	81.00	0.129	4.30	3.20	2	1.2504122	27.248	2.6088	31.647
18.865	0.89	0.06	0.96	1.0	0.049	39.90	67.29	0.096	1.95	0.93	0.30	0.80	0.80	1.06	1.0	0.039	3.15	86.26	0.140	4.61	3.28	2	1.2526649	23.576	2.2571	27.382
19.029	0.88	0.06	0.96	1.0	0.049	39.72	66.59	0.095	1.94	0.93	0.30	0.80	0.80	1.06	1.0	0.039	3.28	88.21	0.144	4.72	3.33	2	1.2470318	23.131	2.2145	26.865
19.193	0.88	0.05	0.97	1.0	0.049	36.75	55.88	0.083	1.69	0.93	0.25	0.80	0.80	1.06	1.0	0.039	4.71	90.11	0.148	4.82	3.26	2	1.2545588	16.474	1.5772	19.133
19.357	0.88	0.05	0.97	1.0	0.049	36.04	53.12	0.081	1.63	0.93	0.24	0.80	0.80	1.06	1.0	0.039	4.94	84.82	0.136	4.38	3.01	2	1.2482606	14.706	1.4079	17.080
19.521	0.88	0.05	0.97	1.0	0.049	37.40	57.64	0.085	1.73	0.93	0.26	0.80	0.80	1.06	1.0	0.039	3.50	70.92	0.113	3.62	2.67	2	1.2413212	17.429	1.6687	20.243
19.685	0.88	0.05	0.97	1.0	0.050	37.33	57.38	0.085	1.72	0.93	0.26	0.80	0.80	1.06	1.0	0.039	3.57	71.65	0.114	3.62	2.67	2	1.2344691	17.263	1.6528	20.050
19.849	0.88	0.05	0.97	1.0	0.050	36.80	55.34	0.083	1.67	0.93	0.25	0.80	0.80	1.05	1.0	0.039	3.77	69.95	0.112	3.52	2.59	2	1.2277026	15.959	1.5279	18.536
20.013	0.88	0.05	0.97	1.0	0.050	36.31	54.17	0.082	1.64	0.92	0.24	0.80	0.80	1.05	1.0	0.039	4.79	85.49	0.138	4.31	2.98	2	1.2217066	15.382	1.4727	17.866
20.177	0.87	0.05	0.96	1.0	0.050	38.43	61.60	0.090	1.81	0.92	0.28	0.80	0.80	1.05	1.0	0.039	3.49	80.79	0.129	4.00	2.90	2	1.2106766	19.949	1.9099	23.170
20.341	0.87	0.06	0.96	1.0	0.050	40.10	68.03	0.097	1.96	0.92	0.31	0.80	0.80	1.05	1.0	0.040	2.77	77.23	0.123	3.77	2.87	2	1.1958988	24.048	2.3023	27.930

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-3S

Data File: 13-52106_SP3-3S-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3 Field Data\2013 Field Investigation\Conetec Data

Legend:
- Tailings Sands
- Tailings Sand-Slimes
- Tailings Slimes
- Interim Cover
- Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69

Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5605.60	Water surface elevation during CPT investigation (ft amsl)
5601.35	Water surface elevation at t_0 (ft amsl)
5582.14	Water surface elevation at t_1 (ft amsl)
5577.14	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ear
7.51	Equiv. Number of Uniform Strain Cycles, N

5609.63	Ground Surface Elevation at time of CPT (ft amsl)
5620.49	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pl
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
3.36	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1184.24	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5577.14	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thicknes s of Layer (ft)	Unit Weigh t (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5620.24	5619.99	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5618.24	5616.49	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5614.74	5612.99	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320
Platform/Random Fill Layer	######	5611.31	5609.63	3.36	0.050	101	0.593	0.509	0.00	0.00	0.593	0.509

2013 CPT Data from ConeTec									CPT Data Interpretations														Conditions at t_1				Liquefaction Triggering Analyses																					Idriss & Boulanger (2008)			
																											Idriss & Boulanger (2008)									Youd et al. (2001)															
																											Cyclic Stress Ratio					Cyclic Resistance Ratio				Cyclic Stress Ratio															
Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Δqc_{1n}	$qc_{1n\text{-}cs}$	(CRR) M=7.5, s'v=1atm	FoS	r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	$qc_{1n\text{-}cs}$	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	CN	qc1 TSF	qc1 MPa	qc1N
0.164	5609.47	13.9	0.034	13.9	1.5	0.64	0.25%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	23.545	327.28	27.36	1677	0.25%	0.7	51%	0.60	0.00	0.60	0	1.00	0.06	1.02	1.0	0.059	39.92	67.29	0.096	1.63	0.97	0.30	0.80	2.53	1.0	0.017	1.00	27.36	0.073	176.61	89.12	2	1.7	23.561	2.2557	27.364
0.328	5609.30	18.4	0.072	18.4	2.3	1.01	0.39%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	31.246	434.32	36.32	1112	0.39%	0.9	51%	0.61	0.00	0.61	0	1.00	0.06	1.02	1.0	0.059	43.07	79.38	0.112	1.89	0.97	0.35	0.80	2.20	1.0	0.019	1.00	36.32	0.080	97.39	49.64	2	1.7	31.271	2.9938	36.319
0.492	5609.14	58.6	0.077	58.5	4.8	2.06	0.13%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	99.501	1383.06	115.62	2362	0.13%	0.4	51%	0.62	0.00	0.62	0	1.00	0.12	1.04	1.0	0.060	70.90	186.52	0.662	11.01	0.97	0.62	0.69	3.01	1.0	0.014	1.00	115.62	0.224	181.10	96.05	2	1.7	99.552	9.5311	115.623
0.656	5608.97	73.3	0.296	73.3	3.9	1.68	0.40%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	124.644	1732.55	144.81	2218	0.40%	0.8	51%	0.63	0.00	0.63	0	1.00	0.15	1.05	1.0	0.061	81.14	225.95	1.000	16.49	0.97	0.69	0.65	3.10	1.0	0.014	1.00	144.81	0.362	220.09	118.29	2	1.7	124.69	11.937	144.814
0.820	5608.81	81.4	0.267	81.4	3.7	1.62	0.33%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	138.414	1923.95	160.81	1971	0.33%	0.8	51%	0.63	0.00	0.63	0	1.00	0.18	1.05	1.0	0.061	86.75	247.56	1.000	16.41	0.97	0.73	0.63	3.04	1.0	0.014	1.00	160.81	1.000	486.00	251.21	2	1.7	138.45	13.256	160.805
0.984	5608.65	84.2	0.326	84.2	3.9	1.68	0.39%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	143.072	1988.70	166.22	1697	0.39%	0.8	51%	0.64	0.00	0.64	0	1.00	0.19	1.05	1.0	0.061	88.65	254.87	1.000	16.41	0.97	0.74	0.63	2.89	1.0	0.015	1.00	166.22	1.000	405.16	210.78	2	1.7	143.11	13.702	166.217
1.148	5608.48	84.7	0.187	84.7	2.9	1.27	0.22%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	143.939	2000.75	167.21	1463	0.22%	0.6	51%	0.65	0.00	0.65	0	1.00	0.19	1.05	1.0	0.061	89.00	256.21	1.000	16.43	0.97	0.75	0.63	2.74	1.0	0.016	1.00	167.21	1.000	347.42	181.93	2	1.7	143.97	13.784	167.213
1.312	5608.32	73.0	0.231	72.9	3.0	1.31	0.32%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	123.998	1723.57	144.05	1103	0.32%	0.8	51%	0.66	0.00	0.66	0	1.00	0.15	1.04	1.0	0.060	80.87	224.93	1.000	16.62	0.97	0.69	0.65	2.43	1.0	0.018	1.00	144.05	0.358	108.87	62.75	2	1.7	124.03	11.875	144.054
1.476	5608.15	71.2	0.308	71.2	1.7	0.72	0.43%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	120.955	1681.27	140.50	956	0.43%	1.0	51%	0.67	0.00	0.67	0	1.00	0.15	1.04	1.0	0.060	79.63	220.13	1.000	16.67	0.97	0.68	0.66	2.31	1.0	0.019	1.00	140.50	0.338	91.39	54.03	2	1.7	120.97	11.582	140.503
1.640	5607.99	55.2	0.236	55.2	3.7	1.59	0.43%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	93.772	1303.43	108.96	667	0.43%	1.1	51%	0.67	0.00	0.67	0	1.00	0.11	1.03	1.0	0.059	68.56	177.51	0.498	8.38	0.97	0.60	0.70	2.03	1.0	0.021	1.00	108.96	0.200	48.77	28.57	2	1.7	93.811	8.9815	108.956
1.804	5607.83	55.4	0.150	55.4	1.9	0.82	0.27%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	94.095	1307.92	109.31	608	0.27%	0.9	51%	0.68	0.00	0.68	0	1.00	0.11	1.03	1.0	0.059	68.68	177.99	0.505	8.50	0.97	0.60	0.70	1.97	1.0	0.022	1.00	109.31	0.201	44.61	26.56	2	1.7	94.115	9.0106	109.309
1.968	5607.66	54.7	0.208	54.7	1.6	0.70	0.38%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	92.905	1291.38	107.92	550	0.38%	1.1	51%	0.69	0.00	0.69	0	1.00	0.11	1.02	1.0	0.059	68.19	176.12	0.478	8.08	0.97	0.60	0.70	1.91	1.0	0.022	1.00	107.92	0.197	39.98	24.03	2	1.7	92.922	8.8964	107.924
2.133	5607.50	53.2	0.150	53.2	1.9	0.83	0.28%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	90.491	1257.82	105.12	495	0.28%	1.0	51%	0.70	0.00	0.70	0	1.00	0.11	1.02	1.0	0.059	67.21	172.33	0.432	7.32	0.97	0.59	0.70	1.85	1.0	0.023	1.00	105.12	0.188	35.26	21.29	2	1.7	90.511	8.6655	105.123
2.297	5607.33	46.8	0.504	46.8	2.3	1.01	1.08%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	79.560	1105.88	92.43	404	1.08%	1.5	51%	0.71	0.00	0.71	0	1.00	0.10	1.02	1.0	0.059	62.76	155.19	0.297	5.06	0.97	0.56	0.72	1.75	1.0	0.024	1.00	92.43	0.153	26.73	15.89	2	1.7	79.585	7.6194	92.433
2.461	5607.17	59.1	1.594	59.1	3.4	1.48	2.70%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	100.470	1396.53	116.73	476	2.70%	1.8	51%	0.72	0.00	0.72	0	1.00	0.12	1.02	1.0	0.059	71.29	188.02	0.698	11.85	0.97	0.62	0.69	1.83	1.0	0.023	1.13	131.98	0.294	47.78	29.82	2	1.7	100.51	9.6225	116.732
2.625	5607.01	70.3	1.024	70.2	6.0	2.59	1.46%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.70	119.408	1659.77	138.76	531	1.46%	1.6	51%	0.72	0.00	0.72	0	1.00	0.15	1.03	1.0	0.059	79.02	217.77	1.000	16.95	0.97	0.68	0.66	1.89	1.0	0.023	1.00	138.76	0.328	50.10	33.52	2	1.7	119.47	11.438	138.759
2.789	5606.84	132.5	0.906	132.5	6.2	2.67	0.68%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0	1.63	215.362	2993.54	250.20	942	0.68%	1.2	51%	0.73	0.00	0.73	0	0.99	0.30	1.05	1.0	0.060	#####	368.33	1.000	16.58	0.97	0.91	0.60	2.07	1.0	0.021	1.00	250.20	1.000	143.62	80.10	2	1.62599	215.42	20.625	250.203
2.953	5606.68	69.0	0.500	69.0	1.8	0.78	0.72%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0	1.70	117.249	1629.76	136.20	463	0.73%	1.3	51%	0.74	0.00	0.74	0	0.99	0.14	1.02	1.0	0.059	78.12	214.32	1.000	17.04	0.97	0.67	0.66	1.81	1.0	0.024	1.00	136.20	0.315	42.74	29.89	2	1.7	117.27	11.227	136.200
3.117	5606.51	83.8	0.682	83.8	0.9	0.37	0.81%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0	1.70	142.375	1979.01	165.37	533	0.82%	1.4	51%	0.75	0.00	0.75	0	0.99	0.18	1.03	1.0	0.059	88.35	253.72	1.000	16.98	0.97	0.74	0.63	1.88	1.0	0.023	1.00	165.37	1.000	128.60	72.79	2	1.7	142.38	13.632	165.371
3.281	5606.35	49.0	0.298	49.0	3.9	1.69	0.61%	Sand Tailings	0.051	102.8	0.17	0.00	0.17	0	1.70	83.334	1158.34	96.84	296	0.61%	1.4	18%	0.76	0.00	0.76	0	0.99	0.10	1.01	1.0	0.058	46.85	143.68	0.245	4.22	0.97	0.57	0.72	1.60	1.0	0.027	1.00	96.84	0.164	20.08	12.15	2	1.7	83.375	7.9824	96.836
3.445	5606.19	47.2	0.382	47.2	0.2	0.09	0.81%	Sand Tailings	0.051	102.8	0.17	0.00	0.17	0	1.70	80.172	1114.39	93.12	270	0.81%	1.5	18%	0.77	0.00	0.77	0	0.99	0.10	1.01	1.0	0.058	45.89	139.01	0.229	3.95	0.97	0.56	0.72	1.56	1.0	0.027	1.00	93.12	0.155	18.02	10.99	2	1.7	80.174	7.6759	93.117
3.609	5606.02	46.3	0.306	46.3	0.6	0.28	0.66%	Sand Tailings	0.051	102.8	0.18	0.00	0.18	0	1.70	78.761	1094.78	91.48	253	0.66%	1.5	18%	0.77	0.00	0.77	0	0.99	0.10	1.01	1.0	0.058	45.48	136.96	0.223	3.85	0.97	0.55	0.72	1.54	1.0	0.028	1.00	91.48	0.151	16.77	10.31	2	1.7	78.768	7.5412	91.484
3.773	5605.86	55.3	0.508	55.3	1.0	0.42	0.92%	Sand Tailings	0.051	102.8	0.19	0.00	0.19	0	1.70	94.044	1307.21	109.24	289	0.92%	1.6	18%	0.78	0.00	0.78	0	0.99	0.11	1.01	1.0	0.058	50.02	159.25	0.321	5.56	0.97	0.60	0.70	1.58	1.0	0.027	1.00	109.24	0.201	21.33	13.45	2	1.7	94.054	9.0047	109.238
3.937	5605.69	80.4	1.013	80.4	1.5	0.64	1.26%	Sand Tailings	0.051	102.8	0.20	0.00	0.20	0	1.70	136.731	1900.56	158.82	403	1.26%	1.6	18%	0.79	0.00	0.79	0	0.99	0.17	1.01	1.0	0.058	62.69	221.52	1.000	17.25	0.97	0.73	0.64	1.70	1.0	0.025	1.00	158.82	0.453	45.97	31.61	2	1.7	136.75	13.092	158.823
4.101	5605.52	74.3	1.624	74.3	3.7	1.58	2.19%	Sand-Slime Tailin	0.059	119.0	0.21	0.00	0.21	1	1.70	126.310	1755.71	146.75	359	2.19%	1.8	47%	0.80	0.00	0.80	0	0.99	0.16	1.01	1.0	0.058	81.77	228.51	1.000	17.32	0.97	0.70	0.65	1.65	1.0	0.026	1.11	163.40	1.000	97.90	57.61	2	1.7	126.35	12.097	146.746
4.265	5605.36	52.7	1.775	52.6	12.2	5.30	3.37%	Sand-Slime Tailin	0.059	119.0	0.22	0.01	0.21	1	1.70	89.471	1243.65	104.07	248	3.38%	2.1	47%	0.81	0.00	0.81	0	0.99	0.11	1.01	1.0	0.057	66.80	170.86	0.416	7.25	0.96	0.59	0.71	1.51	1.0	0.028	1.38	143.17	0.353	33.80	20.53	2	1.7	89.601	8.5784	104.066
4.429	5605.20	70.0	1.960	69.6	74.7	32.37	2.80%	Sand-Slime Tailin	0.059	119.0	0.23	0.01	0.22	1	1.70	118.286	1644.18	138.30	323	2.81%	1.9	47%	0.82	0.00	0.82	0	0.99	0.14	1.01	1.0	0.057	78.81	217.11	1.000	17.43	0.96	0.68	0.66	1.60	1.0	0.027	1.21	167.80	1.000	93.77	55.60	2	1.7	119.08	11.401	138.303
4.593	5605.04	105.7	1.513	105.3	62.4	27.03	1.43%	Sand Tailings	0.062	123.5	0.24	0.02	0.22	1	1.58	166.632	2316.18	194.25	477	1.43%	1.6	18%	0.83	0.00	0.83	0	0.98	0.25	1.01	1.0	0.057	71.75	266.00	1.000	17.41	0.96	0.80	0.60	1.72	1.0	0.025	1.00	194.25	1.000	91.68	54.55	2	1.581998	167.25	16.012	194.248
4.757	5604.87	102.3	1.285	102.2	16.0	6.92	1.26%	Sand Tailings	0.062	123.5	0.25	0.02	0.23	1	1.59	162.173	2254.20	188.54	452	1.26%	1.6	18%	0.84	0.00	0.84	0	0.98	0.23	1.01	1.0	0.057	70.29	258.83	1.000	17.48	0.96	0.79	0.60	1.70	1.0	0.025	1.00	188.54	1.000	89.68	53.58	2	1.586663	162.33	15.542	188.538
4.921	5604.71	80.0	0.626	80.0	8.5	3.69	0.78%	Sand Tailings	0.062	123.5	0.26	0.03	0.23	1	1.68	134.193	1865.28	155.96	345	0.79%	1.5	18%	0.85	0.00	0.85	0	0.98	0.17	1.00	1.0	0.057	61.96	217.92	1.000	17.56	0.96	0.72	0.64	1.61	1.0	0.026	1.00	155.96	0.433	37.99	27.78	2	1.678463	134.28	12.856	155.961
5.085	5604.54	81.2	0.386	81.2	9.8	4.26	0.48%	Sand Tailings	0.062	123.5	0.27	0.03	0.24	1	1.66	134.859	1874.54	156.75	343	0.48%	1.3	18%	0.86	0.00	0.86	0	0.98	0.17	1.00	1.0	0.057	62.16	218.91	1.000	17.61	0.96	0.72	0.64	1.60	1.0	0.027	1.00	156.75	0.438	37.66	27.64	2	1.661641	134.96	12.921	156.749
5.249	5604.38	87.3	0.391	87.3	7.2	3.11	0.45%	Sand Tailings	0.062	123.5	0.28	0.04	0.24	1	1.62	141.629	1968.64	164.58	361	0.45%	1.3	18%	0.87	0.00	0.87	0	0.98	0.18	1.00	1.0	0.057	64.16	228.74	1.000	17.67	0.96	0.74	0.63	1.60	1.0	0.026	1.00	164.58	1.000	84.19	50.93	2	1.622507	141.7	13.566	164.578
5.413	5604.22	72.7	0.332	72.7	2.6	1.13	0.46%	Sand Tailings	0.062	123.5	0.29	0.04	0.25	1	1.68	122.447	1702.01	142.25	294	0.46%	1.3	18%	0.88	0.00	0.88	0	0.98	0.15	1.00	1.0	0.056	58.45	200.70	1.000	17.71	0.96	0.69	0.66	1.54	1.0	0.028	1.00	142.25	0.348	28.69	23.20	2	1.684504	122.47	11.726	142.246
5.577	5604.05	65.2	0.279	65.2	0.5	0.21	0.43%	Sand Tailings	0.062	123.5	0.30	0.05	0.25	1	1.70	110.874	1541.15	128.78	259	0.43%	1.4	18%	0.89	0.00	0.89	0	0.98	0.13	1.00	1.0	0.056	55.01	183.79	0.604	10.72	0.96	0.66	0.67	1.50	1.0	0.028	1.00	128.78	0.279	22.54	16.63	2	1.7	110.88	10.616	128.779
5.741	5603.89	56.7	0.216	56.7	-0.1	-0.05	0.38%	Sand Tailings	0.062	123.5	0.31	0.05	0.26	1	1.70	96.458	1340.77	112.03	220	0.38%	1.4	18%	0.90	0.00	0.90	0	0.98	0.12	0.99	1.0	0.056	50.73	162.76	0.345	6.14	0.96	0.61	0.69	1.45	1.0	0.029	1.00	112.03	0.211	16.72	11.43	2	1.7	96.457	9.2348	112.029
5.905	5603.72	48.8	0.259	48.8	-0.3	-0.13	0.53%	Sand Tailings	0.062	123.5	0.32	0.06	0.26	1	1.70	83.028	1154.09	96.43	186	0.53%	1.5	18%	0.91	0.00	0.91	0	0.98	0.10	0.99	1.0	0.056	46.74	143.17	0.243	4.34	0.96	0.57	0.72	1.40	1.0	0.030	1.00	96.43	0.163	12.72	8.53	2	1.7	83.025	7.9488	96.428
6.069	5603.56	32.1	0.220	32.1	-0.3	-0.12	0.68%	Sand-Slime Tailin	0.059	119.0	0.33	0.06	0.27	1	1.70	54.621	759.23	63.44	120	0.69%	1.7	47%	0.92	0.00	0.92	0	0.98	0.08	0.99	1.0	0.056	52.55	115.98	0.171	3.05	0.96	0.46	0.77	1.31	1.0	0.032	1.07	67.96	0.109	8.36	5.70	2	1.7	54.618	5.2291	63.436
6.234	5603.40	28.8	0.202	28.8	2.7	1.18	0.70%	Sand-Slime Tailin	0.059	119.0	0.34	0.07	0.27	1	1.70	48.875	679.36	56.80	105	0.71%	1.8	47%	0.93	0.00	0.93	0	0.98	0.08	0.99	1.0	0.056	50.22	107.02	0.154	2.76	0.96	0.44	0.78	1.29	1.0	0.033	1.11	62.92	0.103	7.76	5.26	2	1.7	48.904	4.6821	56.799
6.398	5603.23	33.3	0.244	33.3	9.5	4.10	0.73%	Sand-Slime Tailin	0.059	119.0	0.35	0.07	0.27	1	1.70	56.559	786.17	65.81	120	0.74%	1.8	47%	0.94	0.00	0.94	0	0.97	0.08	0.99	1.0	0.056	53.38	119.19	0.178	3.18	0.96	0.47	0.77	1.31	1.0	0.032	1.08	71.27	0.114	8.41	5.80	2	1.7	56.659	5.4246	65.806
6.562	5603.07	23.8	0.288	23.8	5.0	2.17	1.21%	Sand-Slime Tailin	0.059	119.0	0.36	0.08	0.28	1	1.70	40.392	561.45	46.97	84	1.23%	2.0	47%	0.95	0.00	0.95	0	0.97	0.07	0.99	1.0	0.056	46.78	93.75	0.133	2.37	0.96	0.40	0.80	1.25	1.0	0.034	1.34	62.78	0.103	7.50	4.94	2	1.7	40.445	3.8722	46.974
6.726	5602.90	18.2	0.238	18.1	12.5	5.43	1.31%	Sand-Slime Tailin	0.059	119.0	0.37	0.08	0.28	1	1.70	30.753	427.47	35.87	63	1.34%	2.1	47%	0.96	0.00	0.96	0	0.97	0.06	0.99	1.0	0.056	42.88	78.75	0.111	1.99	0.96	0.35	0.80	1.25	1.0	0.034	1.55	55.52	0.096	6.87	4.43	2	1.7	30.886	2.957	35.872
6.890	5602.74	11.8	0.147	11.7	14.5	6.28	1.25%	Sand-Slime Tailin	0.059	119.0	0.38	0.09	0.29	1	1.70	19.907	276.71	23.30	40	1.29%	2.3	47%	0.97	0.00	0.97	0	0.97	0.05	0.99	1.0	0.056	38.47	61.77	0.090	1.61	0.96	0.28	0.80	1.24	1.0	0.034	1.94	45.17	0.088	6.18	3.90	2	1.7	20.061	1.9206	23.299
7.054	5602.58	9.2	0.122	9.1	23.8	10.33	1.32%	Sand-Slime Tailin	0.059	119.0	0.39	0.09	0.29	1	1.70	15.453	214.80	18.24	30	1.38%	2.4	47%	0.98	0.00	0.98	0	0.97	0.05	0.99	1.0	0.056	36.70	54.94	0.082	1.48	0.96	0.25	0.80	1.24	1.0	0.034	2.36	42.97	0.086	5.96	3.72	2	1.7	15.706	1.5037	18.242
7.218	5602.41	9.2	0.089	9.0	30.6	13.24	0.97%	Sand-Slime Tailin	0.059	119.0	0.40	0.10	0.30	1	1.70	15.232	211.72	18.07	29	1.02%	2.3	47%	0.99	0.00	0.99	0	0.97	0.05	0.99	1.0	0.056	36.64	54.71	0.082	1.48	0.96	0.25	0.80	1.24	1.0	0.034	2.11	38.20	0.082	5.59	3.54	2	1.7	15.556	1.4894	18.068
7.382	5602.25	9.9	0.100	9.7	31.6	13.69	1.01%	Sand-Slime Tailin	0.059	119.0	0.41	0.10	0.30	1	1.70	16.524	229.68	19.58	31	1.05%	2.3	47%	1.00	0.00	1.00	0	0.97	0.05	0.99	1.0	0.056	37.17	56.75	0.084	1.52	0.96	0.26	0.80	1.23	1.0	0.034	2.05	40.20	0.083	5.62	3.57	2	1.7	16.859	1.6141	19.581
7.546	5602.08	8.5	0.080	8.3	34.3	14.88	0.94%	Sand-Slime Tailin	0.059	119.0	0.42	0.11	0.31	1	1.70	14.127	196.37	16.83	26	0.99%	2.4	47%	1.01	0.00	1.01	0	0.97	0.05	0.99	1.0	0.055	36.20	53.04	0.080	1.45	0.96	0.24	0.80	1.23	1.0	0.034	2.24	37.68	0.081	5.40	3.43	2	1.7	14.491	1.3874	16.831
7.710	5601.92	10.2	0.068	10.0	38.1	16.51	0.67%	Sand-Slime Tailin	0.059	119.0	0.43	0.11	0.31	1	1.70	16.932	235.35	20.13	31	0.70%	2.2	47%	1.02	0.00	1.02	0	0.97	0.05	0.99	1.0	0.055	37.36	57.50	0.085	1.54	0.96	0.26	0.80	1.23	1.0	0.034	1.78	35.77	0.080	5.22	3.38	2	1.7	17.336	1.6598	20.135
7.874	5601.76	8.5	0.060	8.2	38.1	16.49	0.71%	Sand-Slime Tailin	0.059	119.0	0.44	0.12	0.32	1	1.70	14.008	194.71	16.74	25	0.75%	2.3	47%	1.03	0.00	1.03	0	0.96	0.05	0.99	1.0	0.055	36.17	52.91	0.080	1.45	0.96	0.24	0.80	1.22	1.0	0.035	2.07	34.68	0.079	5.09	3.27	2	1.7	14.412	1.3798	16.738
8.038	5601.59	7.6	0.064	7.3	45.6	19.77	0.84%	Sand-Slime Tailin	0.059	119.0	0.45	0.13	0.32	1	1.70	12.478	173.44	15.05	22	0.89%	2.4	47%	1.04	0.00	1.04	0	0.96	0.05	0.99	1.0	0.055	35.58	50.64	0.078	1.41	0.96	0.22	0.80	1.22	1.0	0.035	2.41	36.22	0.080	5.10	3.26	2	1.7	12.962	1.241	15.055
8.202	5601.43	8.1	0.076	7.8	53.2	23.04	0.94%	Sand-Slime Tailin	0.059	119.0	0.46	0.13	0.33	1	1.70	13.226	183.84	16.02	23	0.99%	2.4	47%	1.05	0.00	1.05	0	0.96	0.05	0.99	1.0	0.055	35.92	51.94	0.079	1.44	0.96	0.23	0.80	1.21	1.0	0.035	2.42	38.81	0.082	5.16	3.30	2	1.7	13.79	1.3203	16.017
8.366	5601.26	9.0	0.102	8.6	58.4	25.30	1.14%	Sand-Slime Tailin	0.059	119.0	0.47	0.14	0.33	1	1.70	14.637	203.45	17.72	26	1.20%	2.4	47%	1.06	0.00	1.06	0	0.96	0.05	0.99	1.0	0.055	36.52	54.24	0.082	1.49	0.96	0.24	0.80	1.21	1.0	0.035	2.46	43.59	0.086	5.34	3.41	2	1.7	15.257	1.4607	17.720
8.530	5601.10	9.6	0.210	9.2	60.7	26.28	2.18%	Slime Tailings	0.057	113.1	0.48	0.14	0.33	1	1.70	15.708	218.34	18.99	27	2.30%	2.6	71%	1.07	0.00	1.07	0	0.96	0.05	0.99	1.0	0.055	36.70	55.69	0.083	1.52	0.95	0.25	0.80	1.21	1.0	0.035	3.18	60.45	0.101	6.14	3.83	2	1.7	16.352	1.5655	18.991
8.694	5600.94	9.5	0.212	9.1	55.4	24.01	2.24%	Slime Tailings	0.057	113.1	0.49	0.15	0.34	1	1.70	15.487	215.27	18.67	26	2.36%	2.6	71%	1.08	0.00	1.08	0	0.96	0.05	0.99	1.0	0.055	36.59	55.26	0.083	1.51	0.95	0.25	0.80	1.20	1.0	0.035	3.29	61.47	0.102	6.13	3.82	2	1.7	16.075	1.539	18.670
8.858	5600.77	13.5	0.188	13.3	28.4	12.31	1.39%	Sand-Slime Tailin	0.059	119.0	0.49	0.15	0.34	1	1.70	22.610	314.28	26.61	38	1.45%	2.3	47%	1.09	0.00	1.09	0	0.96	0.06	0.99	1.0	0.055	39.63	66.24	0.095	1.74	0.95	0.30	0.80	1.20	1.0	0.035	2.09	55.72	0.096	5.72	3.73	2	1.7	22.912	2.1935	26.610
9.022	5600.61	9.0	0.166	8.9	12.6	5.48	1.85%	Slime Tailings	0.057	113.1	0.50	0.16	0.35	1	1.70	15.130	210.31	17.73	24	1.96%	2.6	71%	1.10	0.00	1.10	0	0.96	0.05	0.99	1.0	0.055	36.26	53.99	0.081	1.49	0.95	0.24	0.80	1.20	1.0	0.035	3.17	56.22	0.097	5.68	3.59	2	1.7	15.264	1.4614	17.728
9.186	5600.44	7.1	0.173	6.9	30.7	13.29	2.45%	Slime Tailings	0.057	113.1	0.51	0.16	0.35	1	1.70	11.662	162.10	13.92	19	2.65%	2.7	71%	1.10	0.00	1.10	0	0.96	0.05	0.99	1.0	0.055	34.94	48.86	0.076	1.40	0.95	0.22	0.80	1.20	1.0	0.035	4.35	60.51	0.101	5.86	3.63	2	1.7	11.987	1.1477	13.923
9.350	5600.28	12.4	0.106	12.1	47.2	20.44	0.86%	Sand-Slime Tailin	0.059	119.0	0.52	0.17	0.36	1	1.70	20.536	285.45	24.43	33	0.89%	2.3	47%	1.11	0.00	1.11	0	0.96	0.06	0.99	1.0	0.054	38.87	63.30	0.092	1.68	0.95	0.29	0.80	1.19	1.0	0.035	1.87	45.60	0.088	5.06	3.37	2	1.7	21.037	2.0141	24.433
9.514	5600.12	15.4	0.097	15.3	14.9	6.47	0.63%	Sand-Slime Tailin	0.059	119.0	0.53	0.17	0.36	1	1.70	25.959	360.83	30.33	41	0.65%	2.1	47%	1.12	0.00	1.12	0	0.95	0.06	0.98	1.0	0.054	40.94	71.27	0.101	1.86	0.95	0.32	0.80	1.19	1.0	0.035	1.50	45.61	0.088	4.99	3.43	2	1.7	26.118	2.5005	30.334
9.678	5599.95	15.1	0.080	15.0	11.2	4.83	0.53%	Sand-Slime Tailin	0.059	119.0	0.54	0.18	0.37	1	1.70	25.517	354.69	29.77	40	0.55%	2.1	47%	1.13	0.00	1.13	0	0.95	0.06	0.98	1.0	0.054	40.74	70.52	0.100	1.85	0.95	0.32	0.80	1.19	1.0	0.035	1.46	43.48	0.086	4.83	3.34	2	1.7	25.635	2.4543	29.774
9.842	5599.79	22.9	0.122	22.8	15.7	6.78	0.53%	Sand-Slime Tailin	0.059	119.0	0.55	0.18	0.37	1	1.70	38.743	538.53	45.19	60	0.55%	1.9	47%	1.14	0.00	1.14	0	0.95	0.07	0.98	1.0	0.054	46.15	91.34	0.129	2.39	0.95	0.39	0.80	1.18	1.0	0.035	1.23	55.64	0.096	5.32	3.85	2	1.7	38.909	3.7252	45.191
10.006	5599.62	18.5	0.100	18.4	10.4	4.49	0.54%	Sand-Slime Tailin	0.059	119.0	0.56	0.19	0.38	1	1.70	31.263	434.56	36.44	48	0.56%	2.0	47%	1.15	0.00	1.15	0	0.95	0.06	0.98	1.0	0.054	43.08	79.52	0.112	2.07	0.95	0.35	0.80	1.18	1.0	0.036	1.35	49.19	0.091	4.98	3.53	2	1.7	31.373	3.0036	36.438
10.170	5599.46	16.5	0.082	16.5	6.1	2.66	0.50%	Sand-Slime Tailin	0.059	119.0	0.57	0.19	0.38	1	1.70	28.050	389.90	32.65	42	0.51%	2.1	47%	1.16	0.00	1.16	0	0.95	0.06	0.98	1.0	0.054	41.75	74.41	0.105	1.95	0.95	0.33	0.80	1.18	1.0	0.036	1.40	45.68	0.088	4.76	3.36	2	1.7	28.115	2.6917	32.654
10.335	5599.30	11.5	0.074	11.5	5.9	2.54	0.64%	Sand-Slime Tailin	0.059	119.0	0.58	0.20	0.38	1	1.70	19.482	270.80	22.70	28	0.68%	2.3	47%	1.17	0.00	1.17	0	0.95	0.05	0.98	1.0	0.054	38.26	60.96	0.089	1.65	0.95	0.28	0.80	1.18	1.0	0.036	1.87	42.42	0.085	4.56	3.10	2	1.7	19.544	1.8712	22.699
10.499	5599.13	8.2	0.078	8.2	6.6	2.85	0.95%	Sand-Slime Tailin	0.059	119.0	0.59	0.20	0.39	1	1.70	13.855	192.58	16.17	20	1.03%	2.5	47%	1.18	0.00	1.18	0	0.95	0.05	0.98	1.0	0.054	35.97	52.15	0.080	1.48	0.95	0.23	0.80	1.17	1.0	0.036	2.78	45.02	0.087	4.62	3.05	2	1.7	13.925	1.3332	16.173
10.663	5598.97	8.3	0.043	8.3	9.0	3.92	0.52%	Sand-Slime Tailin	0.059	119.0	0.60	0.21	0.39	1	1.70	14.059	195.42	16.44	20	0.56%	2.4	47%	1.19	0.00	1.19	0	0.95	0.05	0.98	1.0	0.054	36.07	52.51	0.080	1.49	0.95	0.23	0.80	1.17	1.0	0.036	2.24	36.81	0.081	4.21	2.85	2	1.7	14.155	1.3552	16.440
10.827	5598.80	9.2	0.024	9.2	10.5	4.53	0.26%	Sand-Slime Tailin	0.059	119.0	0.61	0.21	0.40	1	1.70	15.589	216.69	18.23	22	0.28%	2.2	47%	1.20	0.00	1.20	0	0.95	0.05	0.98	1.0	0.054	36.70	54.93	0.082	1.53	0.95	0.25	0.80	1.17	1.0	0.036	1.76	32.06	0.077	3.96	2.75	2	1.7	15.7	1.5031	18.234
10.991	5598.64	8.6	0.074	8.5	13.3	5.75	0.87%	Sand-Slime Tailin	0.059	119.0	0.62	0.22	0.40	1	1.70	14.399	200.15	16.89	20	0.93%	2.5	47%	1.21	0.00	1.21	0	0.94	0.05	0.98	1.0	0.054	36.22	53.11	0.081	1.50	0.95	0.24	0.80	1.16	1.0	0.036	2.67	45.07	0.088	4.47	2.99	2	1.7	14.54	1.392	16.887
11.155	5598.48	6.3	0.099	6.2	15.1	6.52	1.58%	Slime Tailings	0.057	113.1	0.63	0.22	0.41	1	1.70	10.489	145.80	12.37	14	1.76%	2.8	71%	1.22	0.00	1.22	0	0.94	0.05	0.98	1.0	0.054	34.39	46.76	0.074	1.39	0.95	0.20	0.80	1.16	1.0	0.036	4.38	54.23	0.095	4.79	3.09	2	1.7	10.649	1.0195	12.368
11.319	5598.31	5.1	0.105	5.0	18.6	8.07	2.06%	Slime Tailings	0.057	113.1	0.64	0.23	0.41	1	1.70	8.449	117.44	10.04	11	2.36%	2.9	71%	1.23	0.00	1.23	0	0.94	0.05	0.98	1.0	0.054	33.58	43.63	0.072	1.34	0.95	0.18	0.80	1.16	1.0	0.036	5.80	58.28	0.098	4.93	3.13	2	1.7	8.6466	0.8278	10.043
11.483	5598.15	4.3	0.115	4.1	26.9	11.65	2.67%	Slime Tailings	0.057	113.1	0.65	0.23	0.42	1	1.70	7.038	97.83	8.51	9	3.14%	3.1	71%	1.24	0.00	1.24	0	0.94	0.04	0.98	1.0	0.054	33.05	41.56	0.070	1.31	0.95	0.17	0.80	1.16	1.0	0.036	7.36	62.61	0.103	5.10	3.20	2	1.7	7.3233	0.7011	8.506
11.647	5597.98	7.3	0.094	7.1	44.1	19.13	1.28%	Slime Tailings	0.057	113.1	0.66	0.24	0.42	1	1.70	12.019	167.06	14.50	16	1.41%	2.6	71%	1.25	0.00	1.25	0	0.94	0.05	0.98	1.0	0.053	35.14	49.64	0.077	1.45	0.95	0.22	0.80	1.15	1.0	0.036	3.63	52.71	0.094	4.60	3.02	2	1.7	12.487	1.1955	14.503
11.811	5597.82	9.0	0.165	8.8	27.6	11.97	1.84%	Slime Tailings	0.057	113.1	0.67	0.24	0.43	1	1.70	14.943	207.71	17.70	20	1.99%	2.7	71%	1.26	0.00	1.26	0	0.94	0.05	0.98	1.0	0.053	36.25	53.95	0.081	1.53	0.95	0.24	0.80	1.15	1.0	0.036	3.68	65.18	0.106	5.15	3.34	2	1.7	15.236	1.4587	17.696
11.975	5597.66	8.6	0.084	8.5	20.2	8.75	0.98%	Sand-Slime Tailin	0.059	119.0	0.68	0.25	0.43	1	1.70	14.416	200.38	16.99	19	1.06%	2.5	47%	1.27	0.00	1.27	0	0.94	0.05	0.98	1.0	0.053	36.26	53.25	0.081	1.52	0.95	0.24	0.80	1.15	1.0	0.036	2.93	49.71	0.088	4.40	2.96	2	1.7	14.63	1.4007	16.992

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-3S

Data File: 13-52106_SP3-3S-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Dat

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Description
5605.60	Water surface elevation during CPT investigation (ft amsl)
5601.35	Water surface elevation at t_0 (ft amsl)
5582.14	Water surface elevation at t_1 (ft amsl)
5577.14	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ear
7.51	Equiv. Number of Uniform Strain Cycles, N

Value	Description
5609.63	Ground Surface Elevation at time of CPT (ft amsl)
5620.49	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pl
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
3.36	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1184.24	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5577.14	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5620.24	5619.99	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5618.24	5616.49	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5614.74	5612.99	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320
Platform/Random Fill Layer	######	5611.31	5609.63	3.36	0.050	101	0.593	0.509	0.00	0.00	0.593	0.509

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil. Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No
12.139	5597.49	10.5	0.047	10.4	14.1	6.11	0.45%	Sand-Slime Tailin	0.059	119.0	0.69	0.25	0.43	1
12.303	5597.33	10.3	0.077	10.2	9.8	4.26	0.75%	Sand-Slime Tailin	0.059	119.0	0.70	0.26	0.44	1
12.467	5597.16	6.7	0.073	6.6	12.8	5.56	1.09%	Slime Tailings	0.057	113.1	0.71	0.26	0.44	1
12.631	5597.00	8.2	0.034	8.1	16.4	7.12	0.41%	Sand-Slime Tailin	0.059	119.0	0.71	0.27	0.45	1
12.795	5596.83	9.3	0.032	9.2	15.5	6.73	0.34%	Sand-Slime Tailin	0.059	119.0	0.72	0.27	0.45	1
12.959	5596.67	9.4	0.034	9.3	15.5	6.73	0.36%	Sand-Slime Tailin	0.059	119.0	0.73	0.28	0.46	1
13.123	5596.51	9.5	0.043	9.4	15.8	6.83	0.45%	Sand-Slime Tailin	0.059	119.0	0.74	0.28	0.46	1
13.287	5596.34	9.1	0.054	9.0	16.3	7.05	0.59%	Sand-Slime Tailin	0.059	119.0	0.75	0.29	0.47	1
13.451	5596.18	9.2	0.068	9.1	17.0	7.36	0.74%	Sand-Slime Tailin	0.059	119.0	0.76	0.29	0.47	1
13.615	5596.01	9.3	0.080	9.2	17.0	7.38	0.86%	Sand-Slime Tailin	0.059	119.0	0.77	0.30	0.47	1
13.779	5595.85	11.2	0.068	11.1	17.5	7.60	0.61%	Sand-Slime Tailin	0.059	119.0	0.78	0.30	0.48	1
13.943	5595.69	14.4	0.082	14.3	15.5	6.70	0.57%	Sand-Slime Tailin	0.059	119.0	0.79	0.31	0.48	1
14.107	5595.52	11.4	0.115	11.3	15.5	6.72	1.01%	Sand-Slime Tailin	0.059	119.0	0.80	0.31	0.49	1
14.271	5595.36	8.1	0.115	8.0	17.0	7.37	1.43%	Slime Tailings	0.057	113.1	0.81	0.32	0.49	1
14.436	5595.19	7.0	0.051	6.9	19.3	8.34	0.73%	Sand-Slime Tailin	0.059	119.0	0.82	0.32	0.50	1
14.600	5595.03	6.4	0.033	6.3	17.8	7.71	0.52%	Sand-Slime Tailin	0.059	119.0	0.83	0.33	0.50	1
14.764	5594.87	5.4	0.063	5.2	20.0	8.68	1.18%	Slime Tailings	0.057	113.1	0.84	0.33	0.51	1
14.928	5594.70	4.8	0.108	4.6	28.3	12.24	2.27%	Slime Tailings	0.057	113.1	0.85	0.34	0.51	1
15.092	5594.54	4.8	0.126	4.7	28.1	12.16	2.60%	Slime Tailings	0.057	113.1	0.86	0.35	0.51	1
15.256	5594.37	5.7	0.083	5.6	15.5	6.72	1.45%	Slime Tailings	0.057	113.1	0.87	0.35	0.52	1
15.420	5594.21	8.3	0.060	8.2	16.1	6.98	0.72%	Sand-Slime Tailin	0.059	119.0	0.88	0.36	0.52	1
15.584	5594.05	8.5	0.058	8.4	8.8	3.83	0.68%	Sand-Slime Tailin	0.059	119.0	0.89	0.36	0.53	1
15.748	5593.88	7.7	0.056	7.6	10.8	4.66	0.73%	Sand-Slime Tailin	0.059	119.0	0.90	0.37	0.53	1
15.912	5593.72	8.0	0.059	7.9	13.9	6.00	0.74%	Sand-Slime Tailin	0.059	119.0	0.91	0.37	0.54	1
16.076	5593.55	8.8	0.072	8.7	17.5	7.57	0.82%	Sand-Slime Tailin	0.059	119.0	0.92	0.38	0.54	1
16.240	5593.39	9.7	0.120	9.5	20.4	8.83	1.24%	Sand-Slime Tailin	0.059	119.0	0.93	0.38	0.55	1
16.404	5593.23	8.3	0.200	8.1	21.3	9.25	2.42%	Slime Tailings	0.057	113.1	0.94	0.39	0.55	1
16.568	5593.06	7.0	0.183	6.9	21.4	9.27	2.60%	Slime Tailings	0.057	113.1	0.95	0.39	0.55	1
16.732	5592.90	6.2	0.154	6.1	20.6	8.92	2.48%	Slime Tailings	0.057	113.1	0.95	0.40	0.56	1
16.896	5592.73	6.9	0.091	6.7	28.8	12.50	1.32%	Slime Tailings	0.057	113.1	0.96	0.40	0.56	1
17.060	5592.57	9.6	0.063	9.5	22.1	9.56	0.66%	Sand-Slime Tailin	0.059	119.0	0.97	0.41	0.57	1
17.224	5592.41	11.3	0.052	11.2	22.1	9.56	0.46%	Sand-Slime Tailin	0.059	119.0	0.98	0.41	0.57	1
17.388	5592.24	12.6	0.071	12.4	21.2	9.17	0.57%	Sand-Slime Tailin	0.059	119.0	0.99	0.42	0.58	1
17.552	5592.08	13.7	0.092	13.6	19.3	8.35	0.67%	Sand-Slime Tailin	0.059	119.0	1.00	0.42	0.58	1
17.716	5591.91	13.7	0.124	13.6	19.8	8.56	0.91%	Sand-Slime Tailin	0.059	119.0	1.01	0.43	0.59	1
17.880	5591.75	11.4	0.157	11.3	19.8	8.58	1.38%	Sand-Slime Tailin	0.059	119.0	1.02	0.43	0.59	1
18.044	5591.59	10.6	0.162	10.5	21.3	9.25	1.52%	Sand-Slime Tailin	0.059	119.0	1.03	0.44	0.60	1
18.208	5591.42	9.0	0.183	8.9	21.8	9.45	2.03%	Slime Tailings	0.057	113.1	1.04	0.44	0.60	1
18.372	5591.26	8.4	0.100	8.2	27.4	11.89	1.19%	Sand-Slime Tailin	0.059	119.0	1.05	0.45	0.60	1
18.537	5591.09	13.5	0.095	13.4	21.3	9.22	0.70%	Sand-Slime Tailin	0.059	119.0	1.06	0.45	0.61	1
18.701	5590.93	10.1	0.120	10.0	17.8	7.69	1.19%	Sand-Slime Tailin	0.059	119.0	1.07	0.46	0.61	1
18.865	5590.77	9.9	0.116	9.8	18.7	8.10	1.17%	Sand-Slime Tailin	0.059	119.0	1.08	0.46	0.62	1
19.029	5590.60	14.0	0.163	13.9	13.3	5.75	1.17%	Sand-Slime Tailin	0.059	119.0	1.09	0.47	0.62	1
19.193	5590.44	13.6	0.284	13.5	11.7	5.08	2.09%	Sand-Slime Tailin	0.059	119.0	1.10	0.47	0.63	1
19.357	5590.27	10.2	0.200	10.1	14.7	6.36	1.96%	Slime Tailings	0.057	113.1	1.11	0.48	0.63	1
19.521	5590.11	17.8	0.357	17.7	18.6	8.07	2.00%	Sand-Slime Tailin	0.059	119.0	1.12	0.48	0.64	1
19.685	5589.95	22.3	0.302	22.2	25.3	10.96	1.35%	Sand-Slime Tailin	0.059	119.0	1.13	0.49	0.64	1
19.849	5589.78	22.1	0.259	21.8	57.2	24.79	1.17%	Sand-Slime Tailin	0.059	119.0	1.14	0.49	0.65	1
20.013	5589.62	20.9	0.204	20.3	100.3	43.47	0.98%	Sand-Slime Tailin	0.059	119.0	1.15	0.50	0.65	1
20.177	5589.45	18.6	0.237	17.7	151.5	65.65	1.27%	Sand-Slime Tailin	0.059	119.0	1.16	0.50	0.65	1
20.341	5589.29	19.8	0.274	18.9	136.1	58.99	1.39%	Sand-Slime Tailin	0.059	119.0	1.17	0.51	0.66	1
20.505	5589.13	25.1	0.237	24.5	96.6	41.86	0.95%	Sand-Slime Tailin	0.059	119.0	1.18	0.51	0.66	1
20.669	5588.96	31.4	0.092	31.0	58.2	25.23	0.29%	Sand Tailings	0.062	123.5	1.19	0.52	0.67	1
20.833	5588.80	32.9	0.194	32.7	35.6	15.43	0.59%	Sand Tailings	0.062	123.5	1.20	0.52	0.67	1
20.997	5588.63	22.6	0.202	22.3	42.9	18.60	0.90%	Sand-Slime Tailin	0.059	119.0	1.21	0.53	0.68	1
21.161	5588.47	21.0	0.114	20.8	20.1	8.70	0.54%	Sand-Slime Tailin	0.059	119.0	1.22	0.53	0.68	1
21.325	5588.31	21.1	0.201	20.9	37.0	16.04	0.95%	Sand-Slime Tailin	0.059	119.0	1.23	0.54	0.69	1
21.489	5588.14	22.3	0.267	21.9	66.8	28.93	1.20%	Sand-Slime Tailin	0.059	119.0	1.24	0.54	0.69	1
21.653	5587.98	18.5	0.419	18.0	91.4	39.59	2.26%	Sand-Slime Tailin	0.059	119.0	1.25	0.55	0.70	1
21.817	5587.81	22.9	0.248	22.0	149.4	64.72	1.08%	Sand-Slime Tailin	0.059	119.0	1.26	0.55	0.70	1
21.981	5587.65	28.4	0.235	27.8	83.5	36.19	0.83%	Sand-Slime Tailin	0.059	119.0	1.27	0.56	0.71	1
22.145	5587.48	22.2	0.322	21.0	195.5	84.71	1.45%	Sand-Slime Tailin	0.059	119.0	1.28	0.57	0.71	1
22.309	5587.32	25.0	0.216	23.6	231.9	100.47	0.86%	Sand-Slime Tailin	0.059	119.0	1.29	0.57	0.72	1
22.473	5587.16	25.7	0.237	24.6	172.5	74.75	0.92%	Sand-Slime Tailin	0.059	119.0	1.30	0.58	0.72	1
22.638	5586.99	25.4	0.261	24.2	200.2	86.77	1.03%	Sand-Slime Tailin	0.059	119.0	1.31	0.58	0.72	1
22.802	5586.83	25.6	0.229	24.5	184.7	80.05	0.89%	Sand-Slime Tailin	0.059	119.0	1.32	0.59	0.73	1
22.966	5586.66	28.5	0.145	27.4	181.5	78.63	0.51%	Sand-Slime Tailin	0.059	119.0	1.33	0.59	0.73	1
23.130	5586.50	30.4	0.223	29.5	150.3	65.13	0.73%	Sand-Slime Tailin	0.059	119.0	1.33	0.60	0.74	1
23.294	5586.34	35.2	0.314	34.0	190.1	82.37	0.89%	Sand-Slime Tailin	0.059	119.0	1.34	0.60	0.74	1
23.458	5586.17	38.3	0.271	37.3	170.9	74.04	0.71%	Sand Tailings	0.062	123.5	1.35	0.61	0.75	1
23.622	5586.01	38.4	0.271	37.3	171.7	74.40	0.71%	Sand Tailings	0.062	123.5	1.36	0.61	0.75	1
23.786	5585.84	41.4	0.271	40.3	174.7	75.68	0.66%	Sand Tailings	0.062	123.5	1.37	0.62	0.76	1

CPT Data Interpretations / Conditions at t_1

Depth (ft)	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil. Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
12.139	1.70	17.663	245.52	20.69	23	0.48%	2.3	47%	1.28	0.00	1.28	0
12.303	1.70	17.362	241.32	20.29	22	0.80%	2.4	47%	1.29	0.00	1.29	0
12.467	1.68	11.118	154.55	13.07	14	1.22%	2.7	71%	1.30	0.00	1.30	0
12.631	1.67	13.584	188.82	15.98	17	0.45%	2.4	47%	1.31	0.00	1.31	0
12.795	1.66	15.282	212.42	17.94	19	0.37%	2.3	47%	1.32	0.00	1.32	0
12.959	1.64	15.259	212.10	17.91	19	0.39%	2.3	47%	1.33	0.00	1.33	0
13.123	1.63	15.350	213.37	18.02	19	0.49%	2.4	47%	1.34	0.00	1.34	0
13.287	1.62	14.632	203.38	17.18	18	0.64%	2.4	47%	1.35	0.00	1.35	0
13.451	1.61	14.615	203.15	17.17	18	0.81%	2.5	47%	1.36	0.00	1.36	0
13.615	1.59	14.710	204.47	17.28	18	0.93%	2.5	47%	1.37	0.00	1.37	0
13.779	1.58	17.525	243.59	20.55	22	0.65%	2.4	47%	1.38	0.00	1.38	0
13.943	1.54	22.107	307.29	25.85	28	0.60%	2.3	47%	1.39	0.00	1.39	0
14.107	1.56	17.669	245.60	20.70	22	1.08%	2.5	47%	1.39	0.00	1.39	0
14.271	1.55	12.321	171.26	14.50	15	1.59%	2.7	71%	1.40	0.00	1.40	0
14.436	1.54	10.571	146.94	12.49	12	0.83%	2.6	47%	1.41	0.00	1.41	0
14.600	1.53	9.534	132.52	11.27	11	0.60%	2.6	47%	1.42	0.00	1.42	0
14.764	1.52	7.926	110.18	9.43	9	1.40%	2.9	71%	1.43	0.00	1.43	0
14.928	1.51	6.912	96.08	8.34	8	2.76%	3.1	71%	1.44	0.00	1.44	0
15.092	1.50	6.988	97.13	8.42	8	3.16%	3.1	71%	1.45	0.00	1.45	0
15.256	1.49	8.357	116.16	9.87	9	1.71%	2.9	71%	1.46	0.00	1.46	0
15.420	1.48	12.153	168.92	14.29	14	0.81%	2.6	47%	1.47	0.00	1.47	0
15.584	1.47	12.348	171.63	14.44	14	0.76%	2.6	47%	1.48	0.00	1.48	0
15.748	1.46	11.084	154.06	12.99	13	0.83%	2.6	47%	1.49	0.00	1.49	0
15.912	1.45	11.457	159.25	13.45	13	0.83%	2.6	47%	1.50	0.00	1.50	0
16.076	1.44	12.487	173.57	14.68	15	0.91%	2.6	47%	1.51	0.00	1.51	0
16.240	1.43	13.603	189.08	16.01	16	1.37%	2.6	47%	1.52	0.00	1.52	0
16.404	1.42	11.536	160.35	13.62	13	2.73%	2.9	71%	1.53	0.00	1.53	0
16.568	1.41	9.747	135.49	11.54	11	3.00%	3.0	71%	1.54	0.00	1.54	0
16.732	1.40	8.540	118.71	10.13	9	2.93%	3.0	71%	1.55	0.00	1.55	0
16.896	1.39	9.383	130.43	11.19	11	1.53%	2.8	71%	1.56	0.00	1.56	0
17.060	1.39	13.119	182.36	15.46	15	0.73%	2.5	47%	1.57	0.00	1.57	0
17.224	1.38	15.417	214.30	18.13	18	0.50%	2.4	47%	1.58	0.00	1.58	0
17.388	1.37	16.989	236.15	19.94	20	0.61%	2.4	47%	1.59	0.00	1.59	0
17.552	1.36	18.404	255.82	21.57	22	0.73%	2.4	47%	1.60	0.00	1.60	0
17.716	1.35	18.297	254.32	21.44	22	0.98%	2.5	47%	1.61	0.00	1.61	0
17.880	1.34	15.145	210.51	17.78	18	1.51%	2.6	47%	1.61	0.00	1.61	0
18.044	1.33	14.025	194.94	16.50	16	1.69%	2.7	47%	1.62	0.00	1.62	0
18.208	1.33	11.759	163.45	13.87	13	2.30%	2.8	71%	1.63	0.00	1.63	0
18.372	1.32	10.844	150.73	12.86	12	1.36%	2.7	47%	1.64	0.00	1.64	0
18.537	1.31	17.559	244.07	20.60	20	0.76%	2.4	47%	1.65	0.00	1.65	0
18.701	1.30	12.971	180.29	15.23	15	1.33%	2.7	47%	1.66	0.00	1.66	0
18.865	1.30	12.648	175.81	14.87	14	1.32%	2.7	47%	1.67	0.00	1.67	0
19.029	1.29	17.870	248.39	20.88	21	1.27%	2.5	47%	1.68	0.00	1.68	0
19.193	1.28	17.279	240.18	20.18	20	2.28%	2.7	47%	1.69	0.00	1.69	0
19.357	1.27	12.883	179.08	15.10	14	2.20%	2.8	71%	1.70	0.00	1.70	0
19.521	1.25	22.210	308.72	25.96	26	2.14%	2.6	47%	1.71	0.00	1.71	0
19.685	1.24	27.383	380.62	32.03	33	1.43%	2.4	47%	1.72	0.00	1.72	0
19.849	1.23	26.790	372.39	31.63	33	1.23%	2.4	47%	1.73	0.00	1.73	0
20.013	1.23	24.850	345.41	29.75	30	1.03%	2.3	47%	1.74	0.00	1.74	0
20.177	1.23	21.715	301.84	26.57	27	1.36%	2.5	47%	1.75	0.00	1.75	0
20.341	1.22	23.028	320.09	27.95	28	1.47%	2.5	47%	1.76	0.00	1.76	0
20.505	1.20	29.354	408.02	34.93	36	0.99%	2.3	47%	1.77	0.00	1.77	0
20.669	1.18	36.693	510.03	43.12	45	0.30%	1.9	18%	1.78	0.00	1.78	0
20.833	1.17	38.397	533.72	44.90	47	0.61%	2.1	18%	1.79	0.00	1.79	0
20.997	1.19	26.475	368.01	31.12	31	0.95%	2.3	47%	1.80	0.00	1.80	0
21.161	1.18	24.679	343.04	28.84	29	0.58%	2.2	47%	1.81	0.00	1.81	0
21.325	1.18	24.625	342.29	28.92	29	1.01%	2.4	47%	1.82	0.00	1.82	0
21.489	1.17	25.657	356.63	30.37	30	1.27%	2.4	47%	1.83	0.00	1.83	0
21.653	1.17	21.059	292.72	25.24	25	2.42%	2.6	47%	1.84	0.00	1.84	0
21.817	1.16	25.478	354.15	30.85	31	1.15%	2.4	47%	1.85	0.00	1.85	0
21.981	1.15	31.904	443.46	37.75	38	0.87%	2.2	47%	1.86	0.00	1.86	0
22.145	1.15	24.097	334.94	29.62	29	1.54%	2.4	47%	1.87	0.00	1.87	0
22.309	1.14	26.878	373.60	33.13	33	0.91%	2.3	47%	1.88	0.00	1.88	0
22.473	1.13	27.896	387.75	33.82	34	0.97%	2.3	47%	1.89	0.00	1.89	0
22.638	1.13	27.284	379.24	33.33	33	1.08%	2.3	47%	1.90	0.00	1.90	0
22.802	1.12	27.506	382.34	33.45	33	0.94%	2.3	47%	1.91	0.00	1.91	0
22.966	1.12	30.592	425.22	37.00	37	0.53%	2.1	47%	1.92	0.00	1.92	0
23.130	1.11	32.742	455.12	39.24	39	0.77%	2.2	47%	1.93	0.00	1.93	0
23.294	1.10	37.465	520.76	45.03	46	0.93%	2.2	47%	1.94	0.00	1.94	0
23.458	1.09	40.792	567.01	48.73	49	0.73%	2.1	18%	1.95	0.00	1.95	0
23.622	1.09	40.621	564.64	48.54	49	0.73%	2.1	18%	1.96	0.00	1.96	0
23.786	1.08	43.621	606.34	52.04	53	0.68%	2.0	18%	1.97	0.00	1.97	0

Liquefaction Triggering Analyses

Depth (ft)	I&B (2008) CSR: r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	I&B CRR: Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd et al. (2001) CSR: r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	Idriss & Boulanger (2008): CN	qc1 TSF	qc1 MPa	qc1N
12.139	0.94	0.05	0.98	1.0	0.053	37.56	58.25	0.086	1.62	0.95	0.26	0.80	1.15	1.0	0.036	1.95	40.29	0.084	3.98	2.80	2	1.7	17.813	1.7054	20.688
12.303	0.94	0.05	0.98	1.0	0.053	37.42	57.70	0.085	1.61	0.95	0.26	0.80	1.14	1.0	0.036	2.34	47.56	0.090	4.23	2.92	2	1.697117	17.466	1.6722	20.285
12.467	0.93	0.05	0.98	1.0	0.053	34.64	47.71	0.075	1.42	0.95	0.21	0.80	1.14	1.0	0.036	3.85	50.30	0.092	4.29	2.86	2	1.684611	11.253	1.0774	13.070
12.631	0.93	0.05	0.98	1.0	0.053	35.90	51.88	0.079	1.50	0.95	0.23	0.80	1.14	1.0	0.037	2.35	37.50	0.081	3.76	2.63	2	1.670909	13.756	1.317	15.977
12.795	0.93	0.05	0.98	1.0	0.053	36.59	54.53	0.082	1.56	0.94	0.24	0.80	1.14	1.0	0.037	2.04	36.66	0.081	3.69	2.62	2	1.657459	15.442	1.4785	17.935
12.959	0.93	0.05	0.98	1.0	0.053	36.58	54.49	0.082	1.56	0.94	0.24	0.80	1.14	1.0	0.037	2.08	37.23	0.081	3.68	2.62	2	1.644253	15.418	1.4761	17.907
13.123	0.93	0.05	0.98	1.0	0.053	36.62	54.63	0.082	1.56	0.94	0.25	0.80	1.13	1.0	0.037	2.20	39.68	0.083	3.73	2.65	2	1.631284	15.511	1.485	18.015
13.287	0.93	0.05	0.98	1.0	0.052	36.33	53.51	0.081	1.54	0.94	0.24	0.80	1.13	1.0	0.037	2.49	42.76	0.086	3.81	2.68	2	1.618546	14.796	1.4166	17.185
13.451	0.93	0.05	0.98	1.0	0.052	36.32	53.50	0.081	1.55	0.94	0.24	0.80	1.13	1.0	0.037	2.69	46.27	0.089	3.90	2.72	2	1.606033	14.785	1.4155	17.172
13.615	0.93	0.05	0.98	1.0	0.052	36.36	53.64	0.081	1.55	0.94	0.24	0.80	1.13	1.0	0.037	2.84	49.02	0.091	3.97	2.76	2	1.593738	14.88	1.4246	17.282
13.779	0.92	0.05	0.98	1.0	0.052	37.51	58.07	0.086	1.65	0.94	0.26	0.80	1.12	1.0	0.037	2.20	45.17	0.088	3.79	2.72	2	1.581655	17.698	1.6944	20.555
13.943	0.92	0.06	0.97	1.0	0.052	39.37	65.22	0.094	1.81	0.94	0.29	0.80	1.12	1.0	0.037	1.81	46.71	0.089	3.81	2.81	2	1.54164	22.256	2.1308	25.849
14.107	0.92	0.05	0.97	1.0	0.052	37.56	58.26	0.086	1.65	0.94	0.26	0.80	1.12	1.0	0.037	2.64	54.59	0.095	4.04	2.85	2	1.558105	17.82	1.7061	20.696
14.271	0.92	0.05	0.98	1.0	0.052	35.14	49.64	0.077	1.48	0.94	0.22	0.80	1.12	1.0	0.037	4.03	58.43	0.099	4.15	2.82	2	1.547803	12.485	1.1953	14.500
14.436	0.92	0.05	0.98	1.0	0.052	34.68	47.17	0.075	1.44	0.94	0.20	0.80	1.12	1.0	0.037	3.54	44.20	0.087	3.62	2.53	2	1.536496	10.756	1.0298	12.492
14.600	0.92	0.05	0.98	1.0	0.052	34.25	45.52	0.073	1.41	0.94	0.19	0.80	1.11	1.0	0.037	3.48	39.19	0.083	3.42	2.42	2	1.525376	9.703	0.929	11.269
14.764	0.92	0.04	0.98	1.0	0.052	33.37	42.80	0.071	1.37	0.94	0.18	0.80	1.11	1.0	0.037	5.37	50.59	0.092	3.78	2.57	2	1.515559	8.116	0.777	9.426
14.928	0.92	0.04	0.98	1.0	0.052	32.99	41.33	0.070	1.35	0.94	0.17	0.80	1.11	1.0	0.037	7.58	63.21	0.103	4.22	2.78	2	1.505884	7.1776	0.6872	8.336
15.092	0.91	0.04	0.98	1.0	0.052	33.02	41.44	0.070	1.35	0.94	0.17	0.80	1.11	1.0	0.037	7.94	66.87	0.108	4.36	2.85	2	1.49635	7.25	0.6941	8.420
15.256	0.91	0.05	0.98	1.0	0.052	33.53	43.40	0.071	1.39	0.94	0.18	0.80	1.11	1.0	0.037	5.61	55.39	0.096	3.84	2.62	2	1.486952	8.5006	0.8139	9.873
15.420	0.91	0.05	0.97	1.0	0.051	35.31	49.60	0.077	1.50	0.94	0.22	0.80	1.10	1.0	0.037	3.18	45.42	0.088	3.49	2.50	2	1.476628	12.301	1.1777	14.287
15.584	0.91	0.05	0.97	1.0	0.051	35.36	49.80	0.077	1.51	0.94	0.22	0.80	1.10	1.0	0.038	3.10	44.78	0.087	3.44	2.48	2	1.466466	12.429	1.1899	14.435
15.748	0.91	0.05	0.97	1.0	0.051	34.86	47.84	0.075	1.47	0.94	0.21	0.80	1.10	1.0	0.038	3.48	45.16	0.088	3.43	2.45	2	1.456463	11.182	1.0705	12.987
15.912	0.91	0.05	0.97	1.0	0.051	35.02	48.47	0.076	1.49	0.94	0.21	0.80	1.10	1.0	0.038	3.39	45.63	0.088	3.41	2.45	2	1.446613	11.582	1.1089	13.452
16.076	0.91	0.05	0.97	1.0	0.051	35.45	50.14	0.078	1.52	0.94	0.22	0.80	1.10	1.0	0.038	3.28	48.10	0.090	3.47	2.49	2	1.436914	12.643	1.2105	14.685
16.240	0.91	0.05	0.97	1.0	0.051	35.92	51.93	0.079	1.56	0.94	0.23	0.80	1.10	1.0	0.038	3.59	57.55	0.098	3.73	2.64	2	1.427362	13.784	1.3197	16.010
16.404	0.90	0.05	0.97	1.0	0.051	34.83	48.45	0.076	1.49	0.94	0.21	0.80	1.09	1.0	0.038	5.42	73.86	0.117	4.45	2.97	2	1.418919	11.725	1.1225	13.618
16.568	0.90	0.05	0.97	1.0	0.051	34.11	45.65	0.073	1.45	0.94	0.20	0.80	1.09	1.0	0.038	6.34	73.18	0.116	4.38	2.91	2	1.410589	9.9355	0.9512	11.540
16.732	0.90	0.05	0.97	1.0	0.051	33.61	43.74	0.072	1.41	0.94	0.18	0.80	1.09	1.0	0.038	6.88	69.68	0.111	4.16	2.79	2	1.40237	8.7206	0.8349	10.128
16.896	0.90	0.05	0.97	1.0	0.051	33.98	45.17	0.073	1.44	0.94	0.19	0.80	1.09	1.0	0.038	4.96	55.55	0.096	3.56	2.50	2	1.394258	9.6344	0.9224	11.190
17.060	0.90	0.05	0.97	1.0	0.050	35.72	51.18	0.079	1.56	0.93	0.23	0.80	1.09	1.0	0.038	2.93	45.31	0.088	3.23	2.39	2	1.385338	13.31	1.2743	15.459
17.224	0.90	0.05	0.97	1.0	0.050	36.66	54.79	0.082	1.63	0.93	0.25	0.80	1.09	1.0	0.038	2.30	41.65	0.085	3.09	2.36	2	1.376546	15.607	1.4942	18.127
17.388	0.90	0.05	0.97	1.0	0.050	37.30	57.24	0.085	1.69	0.93	0.26	0.80	1.08	1.0	0.038	2.28	45.39	0.088	3.18	2.44	2	1.367881	17.17	1.6438	19.942
17.552	0.90	0.05	0.97	1.0	0.050	37.86	59.43	0.087	1.74	0.93	0.27	0.80	1.08	1.0	0.038	2.27	48.98	0.091	3.27	2.50	2	1.357251	18.568	1.7777	21.565
17.716	0.89	0.05	0.97	1.0	0.050	37.82	59.27	0.087	1.74	0.93	0.27	0.80	1.08	1.0	0.038	2.55	54.65	0.095	3.40	2.57	2	1.349318	18.463	1.7677	21.444
17.880	0.89	0.05	0.97	1.0	0.050	36.54	54.32	0.082	1.64	0.93	0.24	0.80	1.08	1.0	0.038	3.51	62.37	0.103	3.63	2.64	2	1.342614	15.311	1.4658	17.782
18.044	0.89	0.05	0.97	1.0	0.050	36.09	52.58	0.080	1.60	0.93	0.23	0.80	1.08	1.0	0.038	3.89	64.15	0.105	3.68	2.64	2	1.334426	14.203	1.3598	16.495
18.208	0.89	0.05	0.97	1.0	0.050	34.92	48.78	0.076	1.53	0.93	0.21	0.80	1.08	1.0	0.038	5.05	70.01	0.112	3.91	2.72	2	1.32718	11.939	1.1431	13.867
18.372	0.89	0.05	0.97	1.0	0.050	34.81	47.67	0.075	1.51	0.93	0.21	0.80	1.07	1.0	0.038	4.32	55.55	0.096	3.33	2.42	2	1.319204	11.07	1.0598	12.857
18.537	0.89	0.05	0.97	1.0	0.050	37.52	58.12	0.086	1.73	0.93	0.26	0.80	1.07	1.0	0.038	2.41	49.69	0.091	3.15	2.44	2	1.311337	17.733	1.6977	20.596
18.701	0.89	0.05	0.97	1.0	0.050	35.64	50.88	0.078	1.58	0.93	0.23	0.80	1.07	1.0	0.038	3.77	57.42	0.098	3.34	2.46	2	1.303575	13.115	1.2556	15.232
18.865	0.89	0.05	0.97	1.0	0.050	35.52	50.38	0.078	1.57	0.93	0.22	0.80	1.07	1.0	0.038	3.83	56.90	0.097	3.30	2.44	2	1.295918	12.799	1.2254	14.866
19.029	0.88	0.05	0.96	1.0	0.049	37.62	58.50	0.086	1.75	0.93	0.26	0.80	1.07	1.0	0.038	2.92	60.91	0.101	3.41	2.58	2	1.288362	17.976	1.7211	20.878
19.193	0.88	0.05	0.96	1.0	0.049	37.38	57.56	0.085	1.73	0.93	0.26	0.80	1.07	1.0	0.038	3.88	78.37	0.125	4.18	2.96	2	1.280906	17.373	1.6633	20.178
19.357	0.88	0.05	0.97	1.0	0.049	35.35	50.44	0.078	1.58	0.93	0.22	0.80	1.06	1.0	0.038	4.70	70.98	0.113	3.77	2.68	2	1.274303	13	1.2446	15.099
19.521	0.88	0.06	0.96	1.0	0.049	39.41	65.37	0.094	1.92	0.93	0.29	0.80	1.06	1.0	0.038	3.15	81.85	0.131	4.34	3.13	2	1.254795	22.356	2.1403	25.965
19.685	0.88	0.06	0.96	1.0	0.049	41.53	73.56	0.104	2.14	0.93	0.33	0.80	1.06	1.0	0.038	2.26	72.25	0.115	3.79	2.96	2	1.235675	27.578	2.6403	32.030
19.849	0.88	0.06	0.96	1.0	0.049	41.39	73.02	0.103	2.13	0.92	0.32	0.80	1.06	1.0	0.038	2.14	67.74	0.109	3.57	2.85	2	1.230044	27.23	2.607	31.626
20.013	0.88	0.06	0.96	1.0	0.049	40.74	70.49	0.100	2.06	0.92	0.31	0.80	1.06	1.0	0.038	2.08	62.00	0.102	3.33	2.69	2	1.227142	25.618	2.4527	29.754
20.177	0.87	0.06	0.96	1.0	0.049	39.62	66.19	0.095	1.96	0.92	0.30	0.80	1.06	1.0	0.038	2.53	67.18	0.108	3.50	2.73	2	1.226825	22.875	2.1901	26.568
20.341	0.87	0.06	0.96	1.0	0.048	40.10	68.05	0.097	2.01	0.92	0.31	0.80	1.05	1.0	0.038	2.53	70.78	0.113	3.64	2.82	2	1.217786	24.063	2.3038	27.948
20.505	0.87	0.06	0.96	1.0	0.048	42.55	77.49	0.109	2.27	0.92	0.34	0.80	1.05	1.0	0.038	1.85	64.63	0.105	3.36	2.82	2	1.200092	30.078	2.8797	34.934
20.669	0.87	0.07	0.95	1.0	0.048	33.11	76.23	0.108	2.25	0.92	0.38	0.80	1.05	1.0	0.038	1.24	53.32	0.094	2.99	2.62	2	1.182877	37.123	3.5541	43.116
20.833	0.87	0.07	0.95	1.0	0.048	33.57	78.47	0.111	2.31	0.92	0.39	0.80	1.05	1.0	0.038	1.39	62.28	0.102	3.24	2.78	2	1.174936	38.658	3.7011	44.899
20.997	0.87	0.06	0.96	1.0	0.048	41.22	72.33	0.103	2.14	0.91	0.32	0.80	1.05	1.0	0.038	1.97	61.27	0.101	3.19	2.66	2	1.187235	26.793	2.5652	31.119
21.161	0.87	0.06	0.96	1.0	0.048	40.41	69.25	0.099	2.06	0.91	0.31	0.80	1.05	1.0	0.038	1.76	50.76	0.092	2.88	2.47	2	1.18478	24.827	2.377	28.836
21.325	0.87	0.06	0.96	1.0	0.048	40.44	69.36	0.099	2.06	0.91	0.31	0.80	1.05	1.0	0.038	2.13	61.57	0.102	3.17	2.62	2	1.178797	24.897	2.3837	28.917
21.489	0.86	0.06	0.96	1.0	0.048	40.95	71.32	0.101	2.12	0.91	0.32	0.80	1.04	1.0	0.038	2.26	68.55	0.110	3.40	2.76	2	1.170998	26.145	2.5031	30.365
21.653	0.86	0.06	0.96	1.0	0.048	39.15	64.39	0.093	1.94	0.91	0.29	0.80	1.04	1.0	0.038	3.47	87.68	0.143	4.39	3.17	2	1.172557	21.728	2.0802	25.236
21.817	0.86	0.06	0.95	1.0	0.048	41.12	71.97	0.102	2.15	0.91	0.32	0.80	1.04	1.0	0.038	2.15	66.25	0.107	3.28	2.71	2	1.159148	26.559	2.5427	30.847
21.981	0.86	0.06	0.95	1.0	0.047	43.54	81.29	0.114	2.42	0.91	0.35	0.80	1.04	1.0	0.038	1.70	64.18	0.105	3.19	2.80	2	1.145975	32.501	3.1117	37.748
22.145	0.86	0.06	0.95	1.0	0.047	40.69	70.30	0.100	2.11	0.91	0.31	0.80	1.04	1.0	0.038	2.51	74.48	0.118	3.59	2.85	2	1.149648	25.5	2.4413	29.616
22.309	0.86	0.06	0.95	1.0	0.047	41.92	75.06	0.106	2.25	0.90	0.33	0.80	1.04	1.0	0.038	1.88	62.32	0.103	3.09	2.67	2	1.140343	28.528	2.7313	33.134
22.473	0.86	0.06	0.95	1.0	0.047	42.16	75.98	0.107	2.28	0.90	0.34	0.80	1.04	1.0	0.038	1.90	64.40	0.105	3.15	2.71	2	1.134432	29.117	2.7877	33.818
22.638	0.85	0.06	0.95	1.0	0.047	41.99	75.32	0.106	2.26	0.90	0.33	0.80	1.03	1.0	0.038	2.01	66.86	0.108	3.22	2.74	2	1.129763	28.696	2.7474	33.329
22.802	0.85	0.06	0.95	1.0	0.047	42.03	75.49	0.107	2.27	0.90	0.33	0.80	1.03	1.0	0.038	1.90	63.56	0.104	3.09	2.68	2	1.124545	28.803	2.7576	33.453
22.966	0.85	0.06	0.95	1.0	0.047	43.28	80.28	0.113	2.42	0.90	0.35	0.80	1.03	1.0	0.038	1.50	55.48	0.096	2.84	2.63	2	1.116484	31.856	3.0499	36.999
23.130	0.85	0.06	0.95	1.0	0.047	44.06	83.30	0.117	2.51	0.90	0.36	0.80	1.03	1.0	0.038	1.61	63.15	0.103	3.05	2.78	2	1.109913	33.784	3.2345	39.238
23.294	0.85	0.07	0.94	1.0	0.046	46.09	91.13	0.129	2.77	0.90	0.39	0.80	1.03	1.0	0.038	1.59	71.48	0.114	3.34	3.06	2	1.101255	38.772	3.712	45.031
23.458	0.85	0.07	0.94	1.0	0.046	34.55	83.28	0.117	2.54	0.89	0.40	0.80	1.03	1.0	0.038	1.42	69.29	0.111	3.23	2.88	2	1.094205	41.959	4.0172	48.733
23.622	0.85	0.07	0.94	1.0	0.046	34.50	83.03	0.117	2.53	0.89	0.40	0.80	1.03	1.0	0.038	1.43	69.22	0.111	3.22	2.87	2	1.089628	41.789	4.0009	48.536
23.786	0.85	0.07	0.94	1.0	0.046	35.39	87.43	0.123	2.68	0.89	0.42	0.79	1.03	1.0	0.038	1.36	70.53	0.113	3.25	2.96	2	1.083221	44.802	4.2894	52.035

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-4N

Data File: 13-52106_SP3-4N-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Parameter
5606.00	Water surface elevation during CPT investigation (ft
5600.42	Water surface elevation at t_0 (ft amsl)
5583.71	Water surface elevation at t_1 (ft amsl)
5578.71	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ear
7.51	Equiv. Number of Uniform Strain Cycles, N
5608.70	Ground Surface Elevation at time of CPT (ft amsl)
5623.35	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pl
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
7.15	Thickness of Random/Platform Fill on top of existing interim cover (ft)
1565.99	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5578.71	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5623.1	5622.85	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5621.1	5619.35	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5617.6	5615.85	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320
Platform/Random Fill Layer	######	5612.28	5608.70	7.15	0.050	101	0.784	0.604	0.00	0.00	0.784	0.604

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
0.164	5608.54	29.3	0.127	29.3	1.0	0.44	0.43%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	49.810	692.36	57.86	3546	0.43%	0.9	51%	0.79	0.00	0.79	0
0.328	5608.37	57.0	0.266	57.0	1.3	0.55	0.47%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	96.951	1347.62	112.62	3451	0.47%	0.9	51%	0.80	0.00	0.80	0
0.492	5608.21	65.8	0.294	65.8	3.7	1.58	0.45%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	111.894	1555.33	130.00	2656	0.45%	0.9	51%	0.81	0.00	0.81	0
0.656	5608.04	65.5	0.343	65.4	1.6	0.71	0.52%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	111.248	1546.35	129.23	1980	0.52%	1.0	51%	0.82	0.00	0.82	0
0.820	5607.88	64.9	0.350	64.9	2.1	0.89	0.54%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	110.279	1532.88	128.11	1570	0.54%	1.0	51%	0.82	0.00	0.82	0
0.984	5607.72	63.6	0.317	63.6	-0.1	-0.04	0.50%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	108.103	1502.63	125.55	1282	0.50%	1.0	51%	0.83	0.00	0.83	0
1.148	5607.55	65.1	0.361	65.1	0.3	0.12	0.55%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	110.704	1538.79	128.58	1125	0.55%	1.1	51%	0.84	0.00	0.84	0
1.312	5607.39	54.3	0.552	54.3	0.6	0.24	1.02%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	92.293	1282.87	107.20	820	1.02%	1.3	51%	0.85	0.00	0.85	0
1.476	5607.22	52.5	0.448	52.5	1.4	0.61	0.85%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	89.250	1240.58	103.68	705	0.85%	1.3	51%	0.86	0.00	0.86	0
1.640	5607.06	62.6	0.320	62.6	0.2	0.10	0.51%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	106.369	1478.53	123.54	756	0.51%	1.1	51%	0.87	0.00	0.87	0
1.804	5606.90	50.3	0.452	50.3	0.5	0.20	0.90%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	85.459	1187.88	99.26	552	0.90%	1.4	51%	0.87	0.00	0.87	0
1.968	5606.73	47.8	0.549	47.8	1.6	0.68	1.15%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	81.243	1129.28	94.38	481	1.15%	1.5	51%	0.88	0.00	0.88	0
2.133	5606.57	63.2	0.574	63.2	4.1	1.77	0.91%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	107.355	1492.23	124.74	587	0.91%	1.4	51%	0.89	0.00	0.89	0
2.297	5606.40	106.2	0.582	106.2	6.9	2.99	0.55%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	180.489	2508.80	209.71	917	0.55%	1.1	51%	0.90	0.00	0.90	0
2.461	5606.24	97.4	0.552	97.4	1.7	0.72	0.57%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	165.546	2301.09	192.29	785	0.57%	1.1	51%	0.91	0.00	0.91	0
2.625	5606.08	86.1	0.510	86.1	0.3	0.11	0.59%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.70	146.370	2034.54	170.00	650	0.59%	1.2	51%	0.92	0.00	0.92	0
2.789	5605.91	76.9	0.485	76.9	0.2	0.09	0.63%	Interim Cover	0.050	100.7	0.14	0.00	0.14	1	1.70	130.764	1817.62	151.88	558	0.63%	1.3	51%	0.92	0.00	0.92	0
2.953	5605.75	71.5	0.471	71.5	0.3	0.11	0.66%	Interim Cover	0.050	100.7	0.15	0.01	0.14	1	1.70	121.567	1689.78	141.20	507	0.66%	1.3	51%	0.93	0.00	0.93	0
3.117	5605.58	59.8	0.416	59.8	-0.4	-0.18	0.70%	Interim Cover	0.050	100.7	0.16	0.01	0.14	1	1.70	101.728	1414.02	118.15	415	0.70%	1.4	51%	0.94	0.00	0.94	0
3.281	5605.42	51.6	0.323	51.6	-0.5	-0.22	0.63%	Sand Tailings	0.062	123.5	0.17	0.02	0.15	1	1.70	87.652	1218.36	101.80	345	0.63%	1.4	18%	0.95	0.00	0.95	0
3.445	5605.26	44.7	0.266	44.7	-0.6	-0.26	0.60%	Sand Tailings	0.062	123.5	0.18	0.02	0.15	1	1.70	75.956	1055.79	88.21	289	0.60%	1.4	18%	0.96	0.00	0.96	0
3.609	5605.09	39.4	0.205	39.4	-0.5	-0.22	0.52%	Sand Tailings	0.062	123.5	0.19	0.03	0.16	1	1.70	66.963	930.79	77.77	247	0.52%	1.4	18%	0.97	0.00	0.97	0
3.773	5604.93	37.6	0.191	37.6	-0.5	-0.22	0.51%	Sand Tailings	0.062	123.5	0.20	0.03	0.16	1	1.70	63.937	888.72	74.25	228	0.51%	1.4	18%	0.98	0.00	0.98	0
3.937	5604.76	39.1	0.168	39.1	1.0	0.43	0.43%	Sand Tailings	0.062	123.5	0.21	0.04	0.17	1	1.70	66.538	924.88	77.29	230	0.43%	1.4	18%	0.99	0.00	0.99	0
4.101	5604.60	40.3	0.180	40.4	-0.4	-0.16	0.45%	Sand Tailings	0.062	123.5	0.22	0.04	0.17	1	1.70	68.595	953.47	79.66	231	0.45%	1.4	18%	1.00	0.00	1.00	0
4.265	5604.43	39.7	0.206	39.7	0.2	0.07	0.52%	Sand Tailings	0.062	123.5	0.23	0.05	0.18	1	1.70	67.507	938.35	78.41	221	0.52%	1.5	18%	1.01	0.00	1.01	0
4.429	5604.27	38.6	0.225	38.6	0.9	0.39	0.58%	Sand Tailings	0.062	123.5	0.24	0.05	0.18	1	1.70	65.552	911.17	76.15	208	0.59%	1.5	18%	1.02	0.00	1.02	0
4.593	5604.11	38.4	0.229	38.4	1.2	0.52	0.60%	Sand Tailings	0.062	123.5	0.25	0.06	0.19	1	1.70	65.348	908.34	75.91	202	0.60%	1.5	18%	1.03	0.00	1.03	0
4.757	5603.94	38.8	0.235	38.8	1.1	0.48	0.61%	Sand Tailings	0.062	123.5	0.26	0.06	0.19	1	1.70	65.994	917.32	76.66	199	0.61%	1.5	18%	1.04	0.00	1.04	0
4.921	5603.78	37.7	0.214	37.7	1.2	0.54	0.57%	Sand Tailings	0.062	123.5	0.27	0.07	0.20	1	1.70	64.039	890.14	74.39	188	0.57%	1.5	18%	1.05	0.00	1.05	0
5.085	5603.61	35.6	0.246	35.6	1.2	0.52	0.69%	Sand Tailings	0.062	123.5	0.28	0.07	0.20	1	1.70	60.554	841.70	70.34	173	0.70%	1.6	18%	1.06	0.00	1.06	0
5.249	5603.45	30.5	0.236	30.5	0.3	0.13	0.77%	Sand-Slime Tailing	0.059	119.0	0.29	0.08	0.21	1	1.70	51.850	720.72	60.22	145	0.78%	1.7	47%	1.07	0.00	1.07	0
5.413	5603.29	27.1	0.216	27.1	1.1	0.48	0.80%	Sand-Slime Tailing	0.059	119.0	0.30	0.08	0.21	1	1.70	46.121	641.08	53.58	126	0.80%	1.8	47%	1.08	0.00	1.08	0
5.577	5603.12	26.7	0.176	26.7	1.6	0.68	0.66%	Sand-Slime Tailing	0.059	119.0	0.31	0.09	0.22	1	1.70	45.356	630.45	52.70	121	0.67%	1.7	47%	1.09	0.00	1.09	0
5.741	5602.96	25.2	0.169	25.2	1.8	0.76	0.67%	Sand-Slime Tailing	0.059	119.0	0.32	0.09	0.22	1	1.70	42.857	595.71	49.80	112	0.68%	1.8	47%	1.10	0.00	1.10	0
5.905	5602.79	22.4	0.156	22.3	1.8	0.78	0.70%	Sand-Slime Tailing	0.059	119.0	0.33	0.10	0.23	1	1.70	37.978	527.89	44.13	97	0.71%	1.8	47%	1.11	0.00	1.11	0
6.069	5602.63	20.9	0.135	20.9	2.6	1.11	0.64%	Sand-Slime Tailing	0.059	119.0	0.34	0.11	0.23	1	1.70	35.581	494.58	41.36	89	0.66%	1.8	47%	1.12	0.00	1.12	0
6.234	5602.47	20.2	0.127	20.2	2.1	0.93	0.63%	Sand-Slime Tailing	0.059	119.0	0.35	0.11	0.24	1	1.70	34.289	476.62	39.85	84	0.64%	1.9	47%	1.13	0.00	1.13	0
6.398	5602.30	20.6	0.117	20.6	2.6	1.13	0.57%	Sand-Slime Tailing	0.059	119.0	0.36	0.12	0.24	1	1.70	34.935	485.60	40.61	84	0.58%	1.8	47%	1.14	0.00	1.14	0
6.562	5602.14	22.3	0.113	22.3	2.7	1.16	0.51%	Sand-Slime Tailing	0.059	119.0	0.37	0.12	0.25	1	1.70	37.859	526.24	44.00	89	0.52%	1.8	47%	1.15	0.00	1.15	0
6.726	5601.97	22.1	0.120	22.1	2.6	1.14	0.54%	Sand-Slime Tailing	0.059	119.0	0.38	0.13	0.25	1	1.70	37.621	522.93	43.73	87	0.55%	1.8	47%	1.16	0.00	1.16	0
6.890	5601.81	21.1	0.125	21.1	3.5	1.52	0.59%	Sand-Slime Tailing	0.059	119.0	0.39	0.13	0.26	1	1.70	35.785	497.41	41.61	81	0.60%	1.9	47%	1.17	0.00	1.17	0
7.054	5601.65	19.4	0.130	19.3	4.1	1.77	0.67%	Sand-Slime Tailing	0.059	119.0	0.40	0.14	0.26	1	1.70	32.861	456.77	38.22	73	0.69%	1.9	47%	1.18	0.00	1.18	0
7.218	5601.48	18.3	0.128	18.3	4.2	1.81	0.70%	Sand-Slime Tailing	0.059	119.0	0.41	0.14	0.26	1	1.70	31.025	431.25	36.09	68	0.72%	2.0	47%	1.19	0.00	1.19	0
7.382	5601.32	17.3	0.127	17.3	4.7	2.05	0.73%	Sand-Slime Tailing	0.059	119.0	0.42	0.15	0.27	1	1.70	29.393	408.56	34.20	63	0.75%	2.0	47%	1.20	0.00	1.20	0
7.546	5601.15	16.0	0.118	16.0	4.7	2.05	0.74%	Sand-Slime Tailing	0.059	119.0	0.42	0.15	0.27	1	1.70	27.234	378.55	31.69	57	0.76%	2.0	47%	1.21	0.00	1.21	0
7.710	5600.99	15.9	0.100	15.8	4.8	2.10	0.63%	Sand-Slime Tailing	0.059	119.0	0.43	0.16	0.28	1	1.70	26.894	373.83	31.30	55	0.65%	2.0	47%	1.22	0.00	1.22	0
7.874	5600.83	14.1	0.079	14.0	5.5	2.40	0.56%	Sand-Slime Tailing	0.059	119.0	0.44	0.16	0.28	1	1.70	23.868	331.77	27.79	48	0.58%	2.0	47%	1.23	0.00	1.23	0
8.038	5600.66	12.3	0.079	12.3	7.0	3.05	0.64%	Sand-Slime Tailing	0.059	119.0	0.45	0.17	0.29	1	1.70	20.842	289.70	24.29	41	0.67%	2.1	47%	1.24	0.00	1.24	0
8.202	5600.50	10.1	0.079	10.1	7.8	3.40	0.78%	Sand-Slime Tailing	0.059	119.0	0.46	0.17	0.29	1	1.70	17.153	238.43	20.02	33	0.82%	2.3	47%	1.25	0.00	1.25	0
8.366	5600.33	10.5	0.074	10.5	7.9	3.42	0.70%	Sand-Slime Tailing	0.059	119.0	0.47	0.18	0.30	1	1.70	17.782	247.17	20.75	34	0.74%	2.2	47%	1.26	0.00	1.26	0
8.530	5600.17	11.2	0.094	11.1	7.1	3.07	0.84%	Sand-Slime Tailing	0.059	119.0	0.48	0.18	0.30	1	1.70	18.887	262.53	22.02	35	0.88%	2.2	47%	1.27	0.00	1.27	0
8.694	5600.01	9.4	0.107	9.4	7.9	3.44	1.13%	Sand-Slime Tailing	0.059	119.0	0.49	0.19	0.31	1	1.70	15.946	221.65	18.62	29	1.20%	2.4	47%	1.28	0.00	1.28	0
8.858	5599.84	8.8	0.081	8.7	12.4	5.35	0.92%	Sand-Slime Tailing	0.059	119.0	0.50	0.19	0.31	1	1.70	14.756	205.11	17.29	27	0.98%	2.4	47%	1.29	0.00	1.29	0
9.022	5599.68	11.1	0.076	11.1	5.6	2.43	0.68%	Sand-Slime Tailing	0.059	119.0	0.51	0.20	0.32	1	1.70	18.870	262.29	21.99	34	0.72%	2.2	47%	1.30	0.00	1.30	0
9.186	5599.51	9.6	0.061	9.6	2.1	0.91	0.63%	Sand-Slime Tailing	0.059	119.0	0.52	0.20	0.32	1	1.70	16.337	227.08	19.00	28	0.67%	2.3	47%	1.31	0.00	1.31	0
9.350	5599.35	12.2	0.050	12.2	2.4	1.04	0.41%	Sand-Slime Tailing	0.059	119.0	0.53	0.21	0.32	1	1.70	20.672	287.34	24.04	36	0.43%	2.1	47%	1.32	0.00	1.32	0
9.514	5599.19	10.4	0.053	10.4	2.6	1.12	0.51%	Sand-Slime Tailing	0.059	119.0	0.54	0.21	0.33	1	1.70	17.646	245.28	20.53	30	0.54%	2.2	47%	1.32	0.00	1.32	0
9.678	5599.02	8.2	0.072	8.2	6.3	2.75	0.87%	Sand-Slime Tailing	0.059	119.0	0.55	0.22	0.33	1	1.70	13.957	194.00	16.29	23	0.94%	2.4	47%	1.33	0.00	1.33	0
9.842	5598.86	6.7	0.056	6.7	7.3	3.18	0.83%	Slime Tailings	0.057	113.1	0.56	0.22	0.34	1	1.70	11.356	157.85	13.28	18	0.91%	2.5	71%	1.34	0.00	1.34	0
10.006	5598.69	5.1	0.106	5.0	9.4	4.07	2.09%	Slime Tailings	0.057	113.1	0.57	0.23	0.34	1	1.70	8.534	118.62	10.03	13	2.35%	2.8	71%	1.35	0.00	1.35	0
10.170	5598.53	3.9	0.092	3.9	4.9	2.13	2.36%	Slime Tailings	0.057	113.1	0.58	0.23	0.35	1	1.70	6.562	91.21	7.68	10	2.78%	3.0	71%	1.36	0.00	1.36	0
10.335	5598.37	5.5	0.171	5.5	6.9	2.99	3.11%	Slime Tailings	0.057	113.1	0.59	0.24	0.35	1	1.70	9.265	128.78	10.85	14	3.49%	2.9	71%	1.37	0.00	1.37	0
10.499	5598.20	10.4	0.222	10.4	3.4	1.48	2.14%	Slime Tailings	0.057	113.1	0.60	0.24	0.35	1	1.70	17.612	244.81	20.50	28	2.27%	2.6	71%	1.38	0.00	1.38	0
10.663	5598.04	4.3	0.241	4.2	13.2	5.72	5.67%	Slime Tailings	0.057	113.1	0.61	0.25	0.36	1	1.70	7.089	98.54	8.40	10	6.61%	3.2	71%	1.39	0.00	1.39	0
10.827	5597.87	5.7	0.239	5.6	23.2	10.07	4.17%	Slime Tailings	0.057	113.1	0.62	0.25	0.36	1	1.70	9.486	131.86	11.30	14	4.68%	3.0	71%	1.40	0.00	1.40	0
10.991	5597.71	11.2	0.225	11.1	15.4	6.69	2.01%	Slime Tailings	0.057	113.1	0.63	0.26	0.37	1	1.70	18.904	262.77	22.15	29	2.12%	2.5	71%	1.41	0.00	1.41	0
11.155	5597.55	3.0	0.253	2.9	12.9	5.59	8.49%	Slime Tailings	0.057	113.1	0.64	0.26	0.37	1	1.70	4.930	68.53	5.88	6	10.79%	3.5	71%	1.42	0.00	1.42	0
11.319	5597.38	2.8	0.251	2.7	7.9	3.44	9.10%	Slime Tailings	0.057	113.1	0.64	0.27	0.38	1	1.70	4.607	64.04	5.45	6	11.87%	3.6	71%	1.43	0.00	1.43	0
11.483	5597.22	12.0	0.174	12.0	3.9	1.69	1.45%	Sand-Slime Tailing	0.059	119.0	0.65	0.27	0.38	1	1.70	20.417	283.80	23.76	30	1.53%	2.4	47%	1.44	0.00	1.44	0
11.647	5597.05	28.9	0.523	28.8	10.2	4.41	1.81%	Sand-Slime Tailing	0.059	119.0	0.66	0.28	0.38	1	1.65	47.502	660.28	55.29	73	1.85%	2.2	47%	1.45	0.00	1.45	0
11.811	5596.89	85.4	0.752	85.2	32.0	13.87	0.88%	Sand Tailings	0.062	123.5	0.67	0.28	0.39	1	1.40	119.039	1654.64	138.58	217	0.89%	1.6	18%	1.46	0.00	1.46	0
11.975	5596.73	141.3	0.619	140.6	118.3	51.27	0.44%	Sand Tailings	0.062	123.5	0.68	0.29	0.39	1	1.28	179.877	2500.28	210.01	356	0.44%	1.3	18%	1.47	0.00	1.47	0

Liquefaction Triggering Analyses

Depth at time of CPT (ft)	Idriss & Boulanger (2008) Cyclic Stress Ratio r_d	C_σ	K_σ	K_α	CSR M=7.5, s'v=1atm	Cyclic Resistance Ratio Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd et al. (2001) Cyclic Stress Ratio r_d	D_r	f	K_σ	K_α	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	Idriss & Boulanger (2008) CN	qc1 TSF	qc1 MPa	qc1N
0.164	1.00	0.08	1.01	1.0	0.058	50.63	108.49	0.157	2.70	0.97	0.44	0.78	2.77	1.0	0.015	1.00	57.86	0.098	239.99	121.34	2	1.7	49.821	4.7698	57.864
0.328	1.00	0.12	1.01	1.0	0.058	69.84	182.46	0.578	9.92	0.97	0.61	0.69	3.36	1.0	0.013	1.00	112.62	0.213	260.65	135.29	2	1.7	96.964	9.2834	112.618
0.492	1.00	0.14	1.01	1.0	0.058	75.94	205.95	1.000	17.15	0.96	0.66	0.67	3.21	1.0	0.013	1.00	130.00	0.284	232.24	124.69	2	1.7	111.93	10.716	130.003
0.656	1.00	0.13	1.01	1.0	0.058	75.67	204.90	1.000	17.17	0.96	0.66	0.67	2.92	1.0	0.015	1.00	129.23	0.281	172.02	94.60	2	1.7	111.27	10.653	129.228
0.820	1.00	0.13	1.01	1.0	0.058	75.28	203.39	1.000	17.20	0.96	0.65	0.67	2.70	1.0	0.016	1.00	128.11	0.276	135.13	76.17	2	1.7	110.3	10.56	128.108
0.984	1.00	0.13	1.00	1.0	0.058	74.38	199.94	1.000	17.22	0.96	0.65	0.68	2.52	1.0	0.017	1.00	125.55	0.264	107.97	62.60	2	1.7	108.1	10.35	125.554
1.148	1.00	0.13	1.00	1.0	0.058	75.44	204.02	1.000	17.24	0.96	0.65	0.67	2.42	1.0	0.018	1.00	128.58	0.278	97.36	57.30	2	1.7	110.71	10.599	128.579
1.312	1.00	0.11	1.00	1.0	0.058	67.94	175.14	0.466	8.04	0.96	0.60	0.70	2.15	1.0	0.020	1.00	107.20	0.195	59.71	33.88	2	1.7	92.299	8.8367	107.200
1.476	1.00	0.11	1.00	1.0	0.058	66.70	170.38	0.411	7.11	0.96	0.59	0.71	2.05	1.0	0.021	1.00	103.68	0.184	50.12	28.61	2	1.7	89.265	8.5462	103.676
1.640	1.00	0.13	1.00	1.0	0.058	73.68	197.22	1.000	17.31	0.96	0.64	0.68	2.12	1.0	0.020	1.00	123.54	0.255	62.75	40.03	2	1.7	106.37	10.184	123.544
1.804	1.00	0.11	1.00	1.0	0.058	65.15	164.42	0.358	6.20	0.96	0.58	0.71	1.91	1.0	0.022	1.00	99.26	0.171	38.20	22.20	2	1.7	85.464	8.1823	99.261
1.968	1.00	0.10	1.00	1.0	0.058	63.44	157.82	0.312	5.42	0.96	0.56	0.72	1.83	1.0	0.023	1.00	94.38	0.158	32.42	18.92	2	1.7	81.26	7.7798	94.378
2.133	1.00	0.13	1.00	1.0	0.057	74.09	198.83	1.000	17.40	0.96	0.64	0.68	1.96	1.0	0.022	1.00	124.74	0.260	49.30	33.35	2	1.7	107.4	10.282	124.737
2.297	1.00	0.30	0.99	1.0	0.057	#####	313.63	1.000	17.56	0.96	0.84	0.60	2.23	1.0	0.019	1.00	209.71	1.000	175.79	96.68	2	1.7	180.56	17.287	209.712
2.461	1.00	0.24	0.99	1.0	0.057	97.80	290.09	1.000	17.58	0.96	0.80	0.60	2.17	1.0	0.019	1.00	192.29	1.000	164.14	90.86	2	1.7	165.56	15.851	192.292
2.625	1.00	0.19	0.99	1.0	0.057	89.98	259.98	1.000	17.58	0.96	0.75	0.62	2.02	1.0	0.021	1.00	170.00	1.000	153.94	85.76	2	1.7	146.37	14.014	170.003
2.789	0.99	0.16	0.99	1.0	0.057	83.62	235.50	1.000	17.59	0.96	0.71	0.64	1.92	1.0	0.022	1.00	151.88	0.406	60.00	38.79	2	1.7	130.77	12.52	151.877
2.953	0.99	0.15	0.99	1.0	0.057	79.87	221.07	1.000	17.61	0.96	0.69	0.66	1.86	1.0	0.023	1.00	141.20	0.342	49.43	33.52	2	1.7	121.57	11.639	141.196
3.117	0.99	0.12	0.99	1.0	0.057	71.78	189.93	0.749	13.18	0.96	0.63	0.69	1.75	1.0	0.024	1.00	118.15	0.233	33.02	23.10	2	1.7	101.72	9.739	118.146
3.281	0.99	0.11	0.99	1.0	0.057	48.11	149.91	0.271	4.77	0.96	0.58	0.71	1.67	1.0	0.025	1.00	101.80	0.178	24.37	14.57	2	1.7	87.647	8.3913	101.796
3.445	0.99	0.10	0.99	1.0	0.057	44.64	132.85	0.211	3.72	0.96	0.54	0.73	1.59	1.0	0.026	1.00	88.21	0.144	19.04	11.38	2	1.7	75.95	7.2714	88.211
3.609	0.99	0.09	0.99	1.0	0.057	41.97	119.74	0.179	3.16	0.96	0.51	0.75	1.54	1.0	0.027	1.00	77.77	0.124	15.87	9.52	2	1.7	66.958	6.4105	77.767
3.773	0.99	0.09	0.99	1.0	0.057	41.07	115.32	0.170	3.01	0.96	0.50	0.75	1.51	1.0	0.028	1.00	74.25	0.118	14.69	8.85	2	1.7	63.932	6.1208	74.253
3.937	0.99	0.09	0.99	1.0	0.056	41.85	119.14	0.178	3.15	0.96	0.51	0.75	1.51	1.0	0.028	1.00	77.29	0.123	14.85	9.00	2	1.7	66.549	6.3714	77.292
4.101	0.99	0.09	0.99	1.0	0.056	42.46	122.12	0.184	3.27	0.96	0.52	0.74	1.51	1.0	0.028	1.00	79.66	0.127	14.91	9.09	2	1.7	68.591	6.5669	79.665
4.265	0.99	0.09	0.99	1.0	0.056	42.13	120.54	0.181	3.21	0.96	0.51	0.74	1.49	1.0	0.028	1.00	78.41	0.125	14.24	8.73	2	1.7	67.509	6.4633	78.407
4.429	0.99	0.09	0.98	1.0	0.056	41.56	117.70	0.175	3.11	0.96	0.50	0.75	1.48	1.0	0.029	1.00	76.15	0.121	13.44	8.28	2	1.7	65.562	6.2769	76.146
4.593	0.98	0.09	0.98	1.0	0.056	41.50	117.41	0.174	3.11	0.96	0.50	0.75	1.46	1.0	0.029	1.00	75.91	0.121	13.05	8.08	2	1.7	65.361	6.2576	75.912
4.757	0.98	0.09	0.98	1.0	0.056	41.69	118.35	0.176	3.15	0.95	0.51	0.75	1.46	1.0	0.029	1.00	76.66	0.122	12.85	8.00	2	1.7	66.006	6.3194	76.662
4.921	0.98	0.09	0.98	1.0	0.056	41.11	115.50	0.170	3.05	0.95	0.50	0.75	1.44	1.0	0.029	1.00	74.39	0.118	12.16	7.60	2	1.7	64.052	6.1324	74.393
5.085	0.98	0.08	0.98	1.0	0.056	40.07	110.42	0.161	2.88	0.95	0.48	0.76	1.42	1.0	0.030	1.00	70.34	0.112	11.27	7.08	2	1.7	60.567	5.7986	70.344
5.249	0.98	0.08	0.98	1.0	0.056	51.42	111.65	0.163	2.92	0.95	0.45	0.78	1.37	1.0	0.031	1.05	63.25	0.104	10.16	6.54	2	1.7	51.853	4.9644	60.224
5.413	0.98	0.07	0.98	1.0	0.056	49.09	102.67	0.147	2.64	0.95	0.42	0.79	1.34	1.0	0.031	1.09	58.28	0.098	9.45	6.04	2	1.7	46.133	4.4167	53.580
5.577	0.98	0.07	0.98	1.0	0.056	48.78	101.48	0.145	2.61	0.95	0.42	0.79	1.33	1.0	0.032	1.06	55.98	0.096	9.06	5.83	2	1.7	45.373	4.344	52.698
5.741	0.98	0.07	0.98	1.0	0.056	47.77	97.56	0.139	2.49	0.95	0.41	0.80	1.32	1.0	0.032	1.08	53.98	0.095	8.71	5.60	2	1.7	42.876	4.1049	49.798
5.905	0.98	0.07	0.98	1.0	0.056	45.78	89.91	0.127	2.28	0.95	0.38	0.80	1.31	1.0	0.032	1.13	49.81	0.091	8.26	5.27	2	1.7	37.997	3.6379	44.131
6.069	0.98	0.07	0.98	1.0	0.055	44.81	86.16	0.121	2.19	0.95	0.37	0.80	1.30	1.0	0.032	1.14	47.05	0.089	7.89	5.04	2	1.7	35.608	3.4091	41.357
6.234	0.98	0.06	0.98	1.0	0.055	44.28	84.13	0.118	2.14	0.95	0.36	0.80	1.29	1.0	0.032	1.15	45.83	0.088	7.65	4.89	2	1.7	34.312	3.285	39.851
6.398	0.97	0.07	0.98	1.0	0.055	44.54	85.15	0.120	2.17	0.95	0.37	0.80	1.29	1.0	0.033	1.13	45.93	0.088	7.51	4.84	2	1.7	34.963	3.3473	40.607
6.562	0.97	0.07	0.98	1.0	0.055	45.73	89.74	0.127	2.29	0.95	0.38	0.80	1.28	1.0	0.033	1.09	48.16	0.090	7.53	4.91	2	1.7	37.887	3.6273	44.004
6.726	0.97	0.07	0.98	1.0	0.055	45.64	89.36	0.126	2.29	0.95	0.38	0.80	1.28	1.0	0.033	1.11	48.64	0.091	7.43	4.86	2	1.7	37.649	3.6045	43.727
6.890	0.97	0.07	0.98	1.0	0.055	44.89	86.50	0.122	2.21	0.95	0.37	0.80	1.28	1.0	0.033	1.15	47.80	0.090	7.24	4.73	2	1.7	35.822	3.4296	41.605
7.054	0.97	0.06	0.98	1.0	0.055	43.70	81.92	0.115	2.10	0.95	0.36	0.80	1.27	1.0	0.033	1.21	46.28	0.089	7.01	4.55	2	1.7	32.904	3.1503	38.216
7.218	0.97	0.06	0.98	1.0	0.055	42.96	79.04	0.111	2.03	0.95	0.35	0.80	1.27	1.0	0.033	1.25	45.19	0.088	6.82	4.42	2	1.7	31.069	2.9746	36.085
7.382	0.97	0.06	0.98	1.0	0.055	42.29	76.49	0.108	1.97	0.95	0.34	0.80	1.26	1.0	0.033	1.30	44.41	0.087	6.66	4.31	2	1.7	29.443	2.8189	34.196
7.546	0.97	0.06	0.98	1.0	0.055	41.42	73.10	0.104	1.89	0.95	0.33	0.80	1.26	1.0	0.033	1.35	42.74	0.086	6.44	4.17	2	1.7	27.284	2.6122	31.689
7.710	0.97	0.06	0.98	1.0	0.055	41.28	72.57	0.103	1.88	0.95	0.32	0.80	1.25	1.0	0.033	1.32	41.16	0.084	6.24	4.06	2	1.7	26.945	2.5797	31.295
7.874	0.96	0.06	0.98	1.0	0.055	40.05	67.84	0.097	1.77	0.95	0.30	0.80	1.25	1.0	0.033	1.36	37.67	0.081	5.93	3.85	2	1.7	23.927	2.2908	27.790
8.038	0.96	0.06	0.98	1.0	0.055	38.82	63.12	0.091	1.67	0.95	0.28	0.80	1.25	1.0	0.034	1.51	36.66	0.081	5.77	3.72	2	1.7	20.917	2.0026	24.293
8.202	0.96	0.05	0.98	1.0	0.055	37.32	57.34	0.085	1.56	0.95	0.26	0.80	1.24	1.0	0.034	1.81	36.27	0.080	5.66	3.61	2	1.7	17.236	1.6502	20.019
8.366	0.96	0.05	0.98	1.0	0.054	37.58	58.33	0.086	1.58	0.95	0.26	0.80	1.24	1.0	0.034	1.73	35.90	0.080	5.55	3.57	2	1.7	17.866	1.7105	20.750
8.530	0.96	0.05	0.98	1.0	0.054	38.03	60.05	0.088	1.62	0.95	0.27	0.80	1.23	1.0	0.034	1.79	39.40	0.083	5.67	3.64	2	1.7	18.962	1.8154	22.024
8.694	0.96	0.05	0.98	1.0	0.054	36.83	55.45	0.083	1.53	0.95	0.25	0.80	1.23	1.0	0.034	2.27	42.18	0.085	5.74	3.63	2	1.7	16.03	1.5347	18.618
8.858	0.96	0.05	0.98	1.0	0.054	36.37	53.66	0.081	1.49	0.95	0.24	0.80	1.23	1.0	0.034	2.22	38.45	0.082	5.45	3.47	2	1.7	14.887	1.4253	17.290
9.022	0.96	0.05	0.98	1.0	0.054	38.01	60.00	0.088	1.62	0.94	0.27	0.80	1.22	1.0	0.034	1.72	37.76	0.081	5.34	3.48	2	1.7	18.929	1.8123	21.985
9.186	0.96	0.05	0.98	1.0	0.054	36.97	55.97	0.084	1.54	0.94	0.25	0.80	1.22	1.0	0.034	1.86	35.35	0.079	5.13	3.34	2	1.7	16.359	1.5662	19.000
9.350	0.96	0.06	0.98	1.0	0.054	38.73	62.77	0.091	1.69	0.94	0.28	0.80	1.22	1.0	0.034	1.45	34.83	0.079	5.03	3.36	2	1.7	20.697	1.9816	24.039
9.514	0.95	0.05	0.98	1.0	0.054	37.50	58.03	0.086	1.59	0.94	0.26	0.80	1.21	1.0	0.034	1.69	34.67	0.079	4.96	3.27	2	1.7	17.673	1.6921	20.527
9.678	0.95	0.05	0.98	1.0	0.054	36.01	52.30	0.080	1.48	0.94	0.23	0.80	1.21	1.0	0.034	2.40	39.07	0.083	5.12	3.30	2	1.7	14.024	1.3427	16.288
9.842	0.95	0.05	0.98	1.0	0.054	34.71	47.99	0.076	1.40	0.94	0.21	0.80	1.21	1.0	0.034	2.79	37.02	0.081	4.95	3.18	2	1.7	11.434	1.0947	13.280
10.006	0.95	0.05	0.98	1.0	0.054	33.58	43.61	0.072	1.33	0.94	0.18	0.80	1.20	1.0	0.035	5.12	51.34	0.093	5.60	3.47	2	1.7	8.6337	0.8266	10.027
10.170	0.95	0.04	0.98	1.0	0.054	32.76	40.44	0.069	1.28	0.94	0.16	0.80	1.20	1.0	0.035	6.68	51.34	0.093	5.54	3.41	2	1.7	6.6142	0.6332	7.682
10.335	0.95	0.05	0.98	1.0	0.054	33.86	44.71	0.073	1.35	0.94	0.19	0.80	1.20	1.0	0.035	5.87	63.62	0.104	6.15	3.75	2	1.7	9.3382	0.894	10.846
10.499	0.95	0.05	0.98	1.0	0.053	37.23	57.72	0.085	1.60	0.94	0.26	0.80	1.19	1.0	0.035	3.14	64.46	0.105	6.13	3.87	2	1.7	17.648	1.6896	20.497
10.663	0.95	0.04	0.98	1.0	0.054	33.01	41.41	0.070	1.30	0.94	0.17	0.80	1.19	1.0	0.035	9.23	77.49	0.123	7.13	4.21	2	1.7	7.229	0.6921	8.396
10.827	0.95	0.05	0.98	1.0	0.053	34.02	45.33	0.073	1.37	0.94	0.19	0.80	1.19	1.0	0.035	6.68	75.46	0.120	6.86	4.11	2	1.7	9.7325	0.9318	11.304
10.991	0.94	0.05	0.97	1.0	0.053	37.80	59.95	0.088	1.65	0.94	0.27	0.80	1.19	1.0	0.035	2.96	65.57	0.106	6.01	3.83	2	1.7	19.068	1.8256	22.146
11.155	0.94	0.04	0.98	1.0	0.053	32.14	38.02	0.067	1.26	0.94	0.14	0.80	1.18	1.0	0.035	13.96	82.18	0.132	7.36	4.31	2	1.7	5.0669	0.4851	5.885
11.319	0.94	0.04	0.98	1.0	0.053	31.99	37.43	0.067	1.25	0.94	0.13	0.80	1.18	1.0	0.035	15.18	82.68	0.133	7.34	4.29	2	1.7	4.6912	0.4491	5.448
11.483	0.94	0.05	0.97	1.0	0.053	38.63	62.40	0.091	1.71	0.94	0.28	0.80	1.18	1.0	0.035	2.48	58.88	0.099	5.41	3.56	2	1.7	20.458	1.9587	23.761
11.647	0.94	0.07	0.96	1.0	0.052	49.69	104.99	0.151	2.89	0.94	0.43	0.79	1.19	1.0	0.035	1.64	90.56	0.149	8.06	5.47	2	1.647094	47.607	4.5579	55.293
11.811	0.94	0.14	0.92	1.0	0.050	57.52	196.10	0.958	19.11	0.94	0.68	0.66	1.31	1.0	0.032	1.00	138.58	0.328	17.48	18.30	2	1.397659	119.32	11.423	138.580
11.975	0.94	0.30	0.84	1.0	0.046	75.78	285.79	1.000	21.92	0.94	0.84	0.60	1.37	1.0	0.030	1.00	210.01	1.000	52.72	37.32	2	1.279714	180.82	17.312	210.014

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-4N

Data File: 13-52106_SP3-4N-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

- Tailings Sands
- Tailings Sand-Slimes
- Tailings Slimes
- Interim Cover
- Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5606.00	Water surface elevation during CPT investigation (ft
5600.42	Water surface elevation at t_0 (ft amsl)
5583.71	Water surface elevation at t_1 (ft amsl)
5578.71	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ear
7.51	Equiv. Number of Uniform Strain Cycles, N

5608.70	Ground Surface Elevation at time of CPT (ft amsl)
5623.35	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pl
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
7.15	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1565.99	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5578.71	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5623.1	5622.85	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5621.1	5619.35	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5617.6	5615.85	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320
Platform/Random Fill Layer	######	5612.28	5608.70	7.15	0.050	101	0.784	0.604	0.00	0.00	0.784	0.604

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No
12.139	5596.56	153.1	1.039	152.7	76.3	33.05	0.68%	Sand Tailings	0.062	123.5	0.69	0.29	0.40	1
12.303	5596.40	126.4	0.970	126.3	17.7	7.67	0.77%	Sand Tailings	0.062	123.5	0.70	0.30	0.40	1
12.467	5596.23	12.1	0.808	12.0	22.2	9.64	6.66%	Slime Tailings	0.057	113.1	0.71	0.30	0.41	1
12.631	5596.07	18.2	0.402	18.1	12.5	5.41	2.21%	Sand-Slime Tailing	0.059	119.0	0.72	0.31	0.41	1
12.795	5595.90	26.5	0.286	26.5	1.9	0.81	1.08%	Sand-Slime Tailing	0.059	119.0	0.73	0.31	0.42	1
12.959	5595.74	36.4	0.258	36.4	1.4	0.59	0.71%	Sand Tailings	0.062	123.5	0.74	0.32	0.42	1
13.123	5595.58	11.0	0.376	10.9	16.2	7.02	3.43%	Slime Tailings	0.057	113.1	0.75	0.33	0.43	1
13.287	5595.41	24.7	0.375	24.6	16.4	7.12	1.52%	Sand-Slime Tailing	0.059	119.0	0.76	0.33	0.43	1
13.451	5595.25	8.9	0.177	8.8	15.2	6.59	1.99%	Slime Tailings	0.057	113.1	0.77	0.34	0.44	1
13.615	5595.08	3.6	0.140	3.4	36.3	15.72	3.88%	Slime Tailings	0.057	113.1	0.78	0.34	0.44	1
13.779	5594.92	4.3	0.102	4.0	46.1	19.97	2.37%	Slime Tailings	0.057	113.1	0.79	0.35	0.44	1
13.943	5594.76	4.7	0.064	4.4	49.6	21.48	1.35%	Slime Tailings	0.057	113.1	0.80	0.35	0.45	1
14.107	5594.59	5.1	0.026	4.8	50.7	21.98	0.51%	Slime Tailings	0.057	113.1	0.81	0.36	0.45	1
14.271	5594.43	9.8	0.045	9.6	29.9	12.96	0.46%	Sand-Slime Tailing	0.059	119.0	0.82	0.36	0.46	1
14.436	5594.26	8.9	0.082	8.9	8.8	3.82	0.92%	Sand-Slime Tailing	0.059	119.0	0.83	0.37	0.46	1
14.600	5594.10	6.1	0.065	6.0	10.0	4.33	1.07%	Slime Tailings	0.057	113.1	0.84	0.37	0.47	1
14.764	5593.94	6.3	0.071	6.2	13.9	6.00	1.13%	Slime Tailings	0.057	113.1	0.85	0.38	0.47	1
14.928	5593.77	9.5	0.050	9.4	12.9	5.57	0.53%	Sand-Slime Tailing	0.059	119.0	0.86	0.38	0.48	1
15.092	5593.61	8.2	0.031	8.1	11.9	5.14	0.38%	Sand-Slime Tailing	0.059	119.0	0.87	0.39	0.48	1
15.256	5593.44	12.5	0.026	12.4	11.9	5.14	0.21%	Sand-Slime Tailing	0.059	119.0	0.88	0.39	0.48	1
15.420	5593.28	13.4	0.032	13.4	10.3	4.47	0.24%	Sand-Slime Tailing	0.059	119.0	0.89	0.40	0.49	1
15.584	5593.12	13.2	0.032	13.1	11.4	4.95	0.24%	Sand-Slime Tailing	0.059	119.0	0.90	0.40	0.49	1
15.748	5592.95	12.9	0.034	12.9	12.5	5.42	0.26%	Sand-Slime Tailing	0.059	119.0	0.91	0.41	0.50	1
15.912	5592.79	13.3	0.033	13.2	12.9	5.61	0.25%	Sand-Slime Tailing	0.059	119.0	0.92	0.41	0.50	1
16.076	5592.62	12.7	0.033	12.6	12.9	5.58	0.26%	Sand-Slime Tailing	0.059	119.0	0.93	0.42	0.51	1
16.240	5592.46	12.7	0.036	12.6	13.1	5.68	0.28%	Sand-Slime Tailing	0.059	119.0	0.93	0.42	0.51	1
16.404	5592.30	13.4	0.038	13.3	13.6	5.91	0.28%	Sand-Slime Tailing	0.059	119.0	0.94	0.43	0.52	1
16.568	5592.13	14.1	0.045	14.0	13.7	5.93	0.32%	Sand-Slime Tailing	0.059	119.0	0.95	0.43	0.52	1
16.732	5591.97	13.5	0.052	13.4	13.7	5.93	0.39%	Sand-Slime Tailing	0.059	119.0	0.96	0.44	0.53	1
16.896	5591.80	13.5	0.050	13.5	14.1	6.13	0.37%	Sand-Slime Tailing	0.059	119.0	0.97	0.44	0.53	1
17.060	5591.64	14.2	0.052	14.1	14.4	6.25	0.37%	Sand-Slime Tailing	0.059	119.0	0.98	0.45	0.54	1
17.224	5591.48	15.7	0.057	15.6	14.5	6.26	0.36%	Sand-Slime Tailing	0.059	119.0	0.99	0.45	0.54	1
17.388	5591.31	16.7	0.068	16.6	14.7	6.37	0.41%	Sand-Slime Tailing	0.059	119.0	1.00	0.46	0.54	1
17.552	5591.15	17.4	0.079	17.3	15.0	6.49	0.45%	Sand-Slime Tailing	0.059	119.0	1.01	0.46	0.55	1
17.716	5590.98	17.4	0.085	17.3	15.1	6.52	0.49%	Sand-Slime Tailing	0.059	119.0	1.02	0.47	0.55	1
17.880	5590.82	16.7	0.082	16.7	15.2	6.57	0.49%	Sand-Slime Tailing	0.059	119.0	1.03	0.47	0.56	1
18.044	5590.66	15.6	0.083	15.5	15.5	6.70	0.53%	Sand-Slime Tailing	0.059	119.0	1.04	0.48	0.56	1
18.208	5590.49	15.5	0.082	15.4	15.8	6.83	0.53%	Sand-Slime Tailing	0.059	119.0	1.05	0.48	0.57	1
18.372	5590.33	15.5	0.076	15.4	15.9	6.89	0.49%	Sand-Slime Tailing	0.059	119.0	1.06	0.49	0.57	1
18.537	5590.16	15.0	0.075	14.9	15.9	6.90	0.50%	Sand-Slime Tailing	0.059	119.0	1.07	0.49	0.58	1
18.701	5590.00	14.3	0.060	14.2	15.9	6.90	0.42%	Sand-Slime Tailing	0.059	119.0	1.08	0.50	0.58	1
18.865	5589.84	14.4	0.060	14.3	15.9	6.90	0.42%	Sand-Slime Tailing	0.059	119.0	1.09	0.50	0.59	1
19.029	5589.67	13.4	0.061	13.3	15.9	6.87	0.46%	Sand-Slime Tailing	0.059	119.0	1.10	0.51	0.59	1
19.193	5589.51	13.3	0.066	13.2	16.5	7.15	0.50%	Sand-Slime Tailing	0.059	119.0	1.11	0.51	0.60	1
19.357	5589.34	13.3	0.073	13.2	16.6	7.18	0.55%	Sand-Slime Tailing	0.059	119.0	1.12	0.52	0.60	1
19.521	5589.18	13.2	0.076	13.1	16.9	7.33	0.58%	Sand-Slime Tailing	0.059	119.0	1.13	0.52	0.61	1
19.685	5589.02	13.3	0.078	13.2	17.3	7.51	0.59%	Sand-Slime Tailing	0.059	119.0	1.14	0.53	0.61	1
19.849	5588.85	14.4	0.075	14.3	17.5	7.57	0.52%	Sand-Slime Tailing	0.059	119.0	1.15	0.54	0.61	1
20.013	5588.69	17.2	0.080	17.1	18.1	7.83	0.47%	Sand-Slime Tailing	0.059	119.0	1.16	0.54	0.62	1
20.177	5588.52	20.3	0.100	20.2	18.0	7.79	0.49%	Sand-Slime Tailing	0.059	119.0	1.17	0.55	0.62	1
20.341	5588.36	21.7	0.131	21.6	18.0	7.79	0.60%	Sand-Slime Tailing	0.059	119.0	1.18	0.55	0.63	1
20.505	5588.20	22.7	0.153	22.6	18.4	7.99	0.67%	Sand-Slime Tailing	0.059	119.0	1.19	0.56	0.63	1
20.669	5588.03	23.1	0.172	23.0	18.7	8.09	0.74%	Sand-Slime Tailing	0.059	119.0	1.20	0.56	0.64	1
20.833	5587.87	23.6	0.180	23.5	18.7	8.09	0.76%	Sand-Slime Tailing	0.059	119.0	1.21	0.57	0.64	1
20.997	5587.70	23.1	0.180	23.0	18.8	8.16	0.78%	Sand-Slime Tailing	0.059	119.0	1.22	0.57	0.65	1
21.161	5587.54	23.7	0.180	23.6	19.2	8.33	0.76%	Sand-Slime Tailing	0.059	119.0	1.23	0.58	0.65	1

CPT Data Interpretations / Conditions at t_1 / Liquefaction Triggering Analyses – Idriss & Boulanger (2008)

Depth (ft)	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	r_d	C_σ	K_σ	K_a	CSR M=7.5, s'v=1atm	Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS
12.139	1.26	192.043	2669.40	223.74	381	0.68%	1.4	18%	1.48	0.00	1.48	0	0.94	0.30	0.84	1.0	0.045	79.29	303.03	1.000	22.05
12.303	1.30	163.560	2273.49	190.13	310	0.77%	1.5	18%	1.49	0.00	1.49	0	0.94	0.24	0.87	1.0	0.047	70.70	260.83	1.000	21.23
12.467	1.70	20.400	283.56	23.97	28	7.07%	2.9	71%	1.50	0.00	1.50	0	0.93	0.06	0.97	1.0	0.052	38.43	62.40	0.091	1.73
12.631	1.67	30.267	420.71	35.30	42	2.30%	2.4	47%	1.51	0.00	1.51	0	0.93	0.06	0.97	1.0	0.052	42.68	77.99	0.110	2.11
12.795	1.59	42.092	585.08	48.91	62	1.11%	2.1	47%	1.52	0.00	1.52	0	0.93	0.07	0.96	1.0	0.052	47.45	96.36	0.137	2.64
12.959	1.52	55.289	768.51	64.23	84	0.72%	1.9	18%	1.53	0.00	1.53	0	0.93	0.08	0.95	1.0	0.051	38.51	102.74	0.147	2.87
13.123	1.70	18.462	256.62	21.64	24	3.68%	2.8	71%	1.54	0.00	1.54	0	0.93	0.05	0.97	1.0	0.052	37.62	59.27	0.087	1.67
13.287	1.57	38.712	538.09	45.15	55	1.57%	2.2	47%	1.55	0.00	1.55	0	0.93	0.07	0.96	1.0	0.052	46.14	91.28	0.129	2.50
13.451	1.70	14.960	207.94	17.56	19	2.18%	2.7	71%	1.55	0.00	1.55	0	0.93	0.05	0.97	1.0	0.052	36.20	53.77	0.081	1.56
13.615	1.69	5.708	79.34	7.07	6	4.95%	3.3	71%	1.56	0.00	1.56	0	0.93	0.04	0.97	1.0	0.052	32.55	39.62	0.068	1.31
13.779	1.68	6.739	93.67	8.39	8	2.90%	3.1	71%	1.57	0.00	1.57	0	0.92	0.04	0.97	1.0	0.052	33.01	41.40	0.070	1.34
13.943	1.66	7.355	102.24	9.14	9	1.63%	2.9	71%	1.58	0.00	1.58	0	0.92	0.04	0.97	1.0	0.052	33.27	42.41	0.071	1.36
14.107	1.65	7.897	109.77	9.78	9	0.61%	2.7	71%	1.59	0.00	1.59	0	0.92	0.05	0.97	1.0	0.052	33.49	43.27	0.071	1.38
14.271	1.64	15.784	219.40	18.69	20	0.50%	2.4	47%	1.60	0.00	1.60	0	0.92	0.05	0.97	1.0	0.052	36.86	55.54	0.083	1.61
14.436	1.63	14.408	200.27	16.84	17	1.01%	2.5	47%	1.61	0.00	1.61	0	0.92	0.05	0.97	1.0	0.051	36.21	53.04	0.080	1.56
14.600	1.61	9.689	134.68	11.37	11	1.24%	2.8	71%	1.62	0.00	1.62	0	0.92	0.05	0.97	1.0	0.052	34.05	45.42	0.073	1.42
14.764	1.60	9.927	137.98	11.69	12	1.31%	2.8	71%	1.63	0.00	1.63	0	0.92	0.05	0.97	1.0	0.051	34.16	45.85	0.074	1.43
14.928	1.59	15.023	208.82	17.60	18	0.58%	2.4	47%	1.64	0.00	1.64	0	0.92	0.05	0.97	1.0	0.051	36.47	54.07	0.082	1.59
15.092	1.58	12.809	178.04	15.01	15	0.42%	2.4	47%	1.65	0.00	1.65	0	0.91	0.05	0.97	1.0	0.051	35.57	50.58	0.078	1.52
15.256	1.56	19.333	268.72	22.59	24	0.22%	2.2	47%	1.66	0.00	1.66	0	0.91	0.05	0.96	1.0	0.051	38.22	60.81	0.089	1.74
15.420	1.54	20.554	285.71	23.99	26	0.26%	2.2	47%	1.67	0.00	1.67	0	0.91	0.06	0.96	1.0	0.051	38.71	62.70	0.091	1.79
15.584	1.53	20.065	278.90	23.43	25	0.26%	2.2	47%	1.68	0.00	1.68	0	0.91	0.05	0.96	1.0	0.051	38.52	61.95	0.090	1.77
15.748	1.52	19.566	271.97	22.86	24	0.28%	2.2	47%	1.69	0.00	1.69	0	0.91	0.05	0.96	1.0	0.051	38.32	61.18	0.089	1.76
15.912	1.51	19.983	277.76	23.35	25	0.27%	2.2	47%	1.70	0.00	1.70	0	0.91	0.05	0.96	1.0	0.051	38.49	61.84	0.090	1.78
16.076	1.50	18.976	263.76	22.18	23	0.28%	2.2	47%	1.71	0.00	1.71	0	0.91	0.05	0.96	1.0	0.051	38.08	60.26	0.088	1.75
16.240	1.49	18.852	262.04	22.04	23	0.31%	2.2	47%	1.72	0.00	1.72	0	0.91	0.05	0.96	1.0	0.050	38.03	60.07	0.088	1.74
16.404	1.48	19.694	273.75	23.02	24	0.31%	2.2	47%	1.73	0.00	1.73	0	0.90	0.05	0.96	1.0	0.050	38.38	61.39	0.089	1.78
16.568	1.46	20.524	285.29	23.98	25	0.34%	2.2	47%	1.74	0.00	1.74	0	0.90	0.06	0.96	1.0	0.050	38.71	62.70	0.091	1.81
16.732	1.46	19.527	271.42	22.82	24	0.42%	2.3	47%	1.75	0.00	1.75	0	0.90	0.05	0.96	1.0	0.050	38.31	61.13	0.089	1.78
16.896	1.45	19.512	271.22	22.81	24	0.40%	2.3	47%	1.76	0.00	1.76	0	0.90	0.05	0.96	1.0	0.050	38.30	61.11	0.089	1.78
17.060	1.44	20.251	281.48	23.67	25	0.39%	2.2	47%	1.77	0.00	1.77	0	0.90	0.05	0.96	1.0	0.050	38.60	62.27	0.090	1.81
17.224	1.42	22.160	308.02	25.89	27	0.39%	2.2	47%	1.78	0.00	1.78	0	0.90	0.06	0.96	1.0	0.050	39.38	65.27	0.094	1.88
17.388	1.40	23.276	323.53	27.18	29	0.43%	2.2	47%	1.79	0.00	1.79	0	0.90	0.06	0.96	1.0	0.050	39.84	67.02	0.096	1.93
17.552	1.39	24.051	334.31	28.09	30	0.48%	2.2	47%	1.80	0.00	1.80	0	0.90	0.06	0.96	1.0	0.050	40.15	68.24	0.097	1.96
17.716	1.38	24.003	333.64	28.03	30	0.52%	2.2	47%	1.81	0.00	1.81	0	0.89	0.06	0.96	1.0	0.050	40.13	68.16	0.097	1.97
17.880	1.38	22.974	319.34	26.83	28	0.52%	2.2	47%	1.82	0.00	1.82	0	0.89	0.06	0.96	1.0	0.049	39.71	66.55	0.095	1.93
18.044	1.38	21.358	296.87	24.96	26	0.57%	2.3	47%	1.83	0.00	1.83	0	0.89	0.06	0.96	1.0	0.049	39.06	64.02	0.092	1.87
18.208	1.37	21.066	292.82	24.62	25	0.57%	2.3	47%	1.83	0.00	1.83	0	0.89	0.06	0.96	1.0	0.049	38.94	63.56	0.092	1.86
18.372	1.36	21.021	292.19	24.57	25	0.53%	2.3	47%	1.84	0.00	1.84	0	0.89	0.06	0.96	1.0	0.049	38.92	63.49	0.092	1.86
18.537	1.36	20.261	281.63	23.69	24	0.54%	2.3	47%	1.85	0.00	1.85	0	0.89	0.05	0.96	1.0	0.049	38.61	62.30	0.090	1.84
18.701	1.35	19.251	267.59	22.51	23	0.45%	2.3	47%	1.86	0.00	1.86	0	0.89	0.05	0.96	1.0	0.049	38.20	60.71	0.089	1.80
18.865	1.34	19.229	267.28	22.49	23	0.45%	2.3	47%	1.87	0.00	1.87	0	0.89	0.05	0.96	1.0	0.049	38.19	60.68	0.089	1.81
19.029	1.34	17.843	248.02	20.88	21	0.50%	2.3	47%	1.88	0.00	1.88	0	0.88	0.05	0.96	1.0	0.049	37.62	58.50	0.086	1.76
19.193	1.33	17.561	244.10	20.56	20	0.54%	2.4	47%	1.89	0.00	1.89	0	0.88	0.05	0.96	1.0	0.049	37.51	58.07	0.086	1.75
19.357	1.33	17.469	242.81	20.45	20	0.60%	2.4	47%	1.90	0.00	1.90	0	0.88	0.05	0.96	1.0	0.049	37.47	57.92	0.086	1.75
19.521	1.32	17.192	238.98	20.13	20	0.63%	2.4	47%	1.91	0.00	1.91	0	0.88	0.05	0.96	1.0	0.049	37.36	57.49	0.085	1.75
19.685	1.31	17.260	239.92	20.21	20	0.64%	2.4	47%	1.92	0.00	1.92	0	0.88	0.05	0.96	1.0	0.049	37.39	57.60	0.085	1.75
19.849	1.30	18.534	257.63	21.69	22	0.57%	2.3	47%	1.93	0.00	1.93	0	0.88	0.05	0.96	1.0	0.049	37.91	59.60	0.087	1.80
20.013	1.28	21.877	304.09	25.58	26	0.50%	2.3	47%	1.94	0.00	1.94	0	0.88	0.06	0.95	1.0	0.048	39.27	64.85	0.093	1.93
20.177	1.26	25.566	355.37	29.86	31	0.52%	2.2	47%	1.95	0.00	1.95	0	0.87	0.06	0.95	1.0	0.048	40.77	70.63	0.100	2.09
20.341	1.25	27.037	375.81	31.57	33	0.64%	2.2	47%	1.96	0.00	1.96	0	0.87	0.06	0.95	1.0	0.048	41.37	72.94	0.103	2.15
20.505	1.24	28.112	390.75	32.82	34	0.71%	2.2	47%	1.97	0.00	1.97	0	0.87	0.06	0.95	1.0	0.048	41.81	74.63	0.105	2.20
20.669	1.24	28.492	396.03	33.26	34	0.78%	2.2	47%	1.98	0.00	1.98	0	0.87	0.06	0.95	1.0	0.048	41.97	75.22	0.106	2.22
20.833	1.23	28.892	401.60	33.72	35	0.80%	2.2	47%	1.99	0.00	1.99	0	0.87	0.06	0.95	1.0	0.048	42.13	75.85	0.107	2.24
20.997	1.23	28.155	391.36	32.87	34	0.82%	2.2	47%	2.00	0.00	2.00	0	0.87	0.06	0.95	1.0	0.048	41.83	74.70	0.106	2.22
21.161	1.22	28.695	398.86	33.50	34	0.80%	2.2	47%	2.01	0.00	2.01	0	0.87	0.06	0.95	1.0	0.048	42.05	75.55	0.107	2.24

Liquefaction Triggering Analyses – Youd et al. (2001) / Idriss & Boulanger (2008)

Depth (ft)	r_d	D_r	f	K_σ	K_a	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	CN	qc1 TSF	qc1 MPa	qc1N
12.139	0.94	0.86	0.60	1.36	1.0	0.030	1.00	223.74	1.000	52.09	37.07	2	1.257897	192.64	18.444	223.742
12.303	0.94	0.80	0.60	1.35	1.0	0.031	1.00	190.13	1.000	51.46	36.35	2	1.29522	163.7	15.673	190.132
12.467	0.94	0.28	0.80	1.16	1.0	0.036	5.65	135.34	0.311	15.83	8.78	2	1.7	20.636	1.9757	23.967
12.631	0.94	0.34	0.80	1.16	1.0	0.036	2.44	86.07	0.139	7.02	4.57	2	1.670343	30.397	2.9102	35.304
12.795	0.94	0.40	0.80	1.16	1.0	0.036	1.46	71.51	0.114	5.69	4.16	2	1.59017	42.11	4.0317	48.909
12.959	0.94	0.46	0.77	1.18	1.0	0.035	1.18	75.48	0.120	5.92	4.39	2	1.521009	55.302	5.2946	64.229
13.123	0.94	0.27	0.80	1.15	1.0	0.036	4.38	94.82	0.159	7.78	4.73	2	1.7	18.634	1.784	21.642
13.287	0.93	0.39	0.80	1.15	1.0	0.036	1.75	78.95	0.126	6.08	4.29	2	1.573002	38.873	3.7217	45.149
13.451	0.93	0.24	0.80	1.15	1.0	0.036	3.97	69.67	0.111	5.34	3.45	2	1.7	15.121	1.4477	17.563
13.615	0.93	0.15	0.80	1.14	1.0	0.036	10.41	73.64	0.117	5.56	3.43	2	1.688661	6.0901	0.5831	7.073
13.779	0.93	0.17	0.80	1.14	1.0	0.036	7.60	63.70	0.104	4.89	3.12	2	1.676296	7.221	0.6913	8.387
13.943	0.93	0.17	0.80	1.14	1.0	0.036	5.75	52.54	0.093	4.36	2.86	2	1.664136	7.8703	0.7535	9.141
14.107	0.93	0.18	0.80	1.14	1.0	0.036	3.91	38.23	0.082	3.78	2.58	2	1.652174	8.4206	0.8062	9.780
14.271	0.93	0.25	0.80	1.13	1.0	0.036	2.17	40.47	0.084	3.83	2.72	2	1.639063	16.09	1.5405	18.688
14.436	0.93	0.24	0.80	1.13	1.0	0.036	2.99	50.37	0.092	4.16	2.86	2	1.626187	14.498	1.388	16.838
14.600	0.93	0.19	0.80	1.13	1.0	0.036	4.41	50.17	0.092	4.12	2.77	2	1.614836	9.7898	0.9373	11.370
14.764	0.93	0.20	0.80	1.13	1.0	0.036	4.41	51.51	0.093	4.13	2.78	2	1.603663	10.065	0.9637	11.690
14.928	0.93	0.24	0.80	1.13	1.0	0.036	2.38	41.96	0.085	3.75	2.67	2	1.591409	15.151	1.4505	17.597
15.092	0.93	0.22	0.80	1.12	1.0	0.037	2.48	37.18	0.081	3.54	2.53	2	1.579367	12.926	1.2375	15.012
15.256	0.93	0.27	0.80	1.12	1.0	0.037	1.59	35.90	0.080	3.46	2.60	2	1.55782	19.448	1.862	22.588
15.420	0.93	0.28	0.80	1.12	1.0	0.037	1.56	37.47	0.081	3.49	2.64	2	1.5385	20.653	1.9774	23.988
15.584	0.93	0.28	0.80	1.12	1.0	0.037	1.59	37.37	0.081	3.46	2.62	2	1.5305	20.174	1.9315	23.431
15.748	0.93	0.28	0.80	1.12	1.0	0.037	1.65	37.72	0.081	3.44	2.60	2	1.522657	19.685	1.8846	22.863
15.912	0.93	0.28	0.80	1.11	1.0	0.037	1.61	37.58	0.081	3.41	2.59	2	1.509265	20.105	1.9248	23.350
16.076	0.92	0.27	0.80	1.11	1.0	0.037	1.69	37.43	0.081	3.38	2.56	2	1.504808	19.097	1.8283	22.180
16.240	0.92	0.27	0.80	1.11	1.0	0.037	1.73	38.09	0.082	3.38	2.56	2	1.494996	18.974	1.8166	22.037
16.404	0.92	0.28	0.80	1.11	1.0	0.037	1.68	38.59	0.082	3.37	2.57	2	1.479659	19.82	1.8976	23.020
16.568	0.92	0.28	0.80	1.11	1.0	0.037	1.67	40.09	0.083	3.39	2.60	2	1.464979	20.649	1.977	23.983
16.732	0.92	0.28	0.80	1.10	1.0	0.037	1.82	41.47	0.085	3.42	2.60	2	1.460499	19.652	1.8814	22.824
16.896	0.92	0.28	0.80	1.10	1.0	0.037	1.80	41.05	0.084	3.38	2.58	2	1.450728	19.64	1.8804	22.811
17.060	0.92	0.28	0.80	1.10	1.0	0.037	1.75	41.43	0.085	3.36	2.59	2	1.437236	20.38	1.9512	23.670
17.224	0.91	0.29	0.80	1.10	1.0	0.037	1.64	42.48	0.085	3.38	2.63	2	1.418689	22.288	2.1338	25.886
17.388	0.91	0.30	0.80	1.10	1.0	0.037	1.63	44.44	0.087	3.42	2.67	2	1.404698	23.405	2.2408	27.183
17.552	0.91	0.31	0.80	1.09	1.0	0.037	1.65	46.24	0.089	3.45	2.71	2	1.392652	24.181	2.3151	28.085
17.716	0.91	0.31	0.80	1.09	1.0	0.037	1.68	47.14	0.089	3.45	2.71	2	1.384238	24.133	2.3105	28.029
17.880	0.91	0.30	0.80	1.09	1.0	0.037	1.74	46.63	0.089	3.42	2.67	2	1.379835	23.105	2.212	26.835
18.044	0.91	0.29	0.80	1.09	1.0	0.037	1.88	46.89	0.089	3.40	2.64	2	1.377916	21.491	2.0575	24.960
18.208	0.91	0.29	0.80	1.09	1.0	0.037	1.90	46.75	0.089	3.37	2.62	2	1.370589	21.201	2.0298	24.623
18.372	0.91	0.29	0.80	1.08	1.0	0.037	1.86	45.70	0.088	3.32	2.59	2	1.362343	21.156	2.0255	24.572
18.537	0.90	0.28	0.80	1.08	1.0	0.037	1.93	45.62	0.088	3.29	2.57	2	1.357054	20.396	1.9527	23.688
18.701	0.90	0.27	0.80	1.08	1.0	0.037	1.91	42.96	0.086	3.19	2.50	2	1.352831	19.385	1.8559	22.515
18.865	0.90	0.27	0.80	1.08	1.0	0.037	1.91	42.95	0.086	3.17	2.49	2	1.34466	19.362	1.8537	22.488
19.029	0.90	0.26	0.80	1.08	1.0	0.037	2.08	43.40	0.086	3.16	2.46	2	1.341616	17.976	1.721	20.878
19.193	0.90	0.26	0.80	1.08	1.0	0.037	2.16	44.45	0.087	3.17	2.46	2	1.333442	17.699	1.6945	20.556
19.357	0.90	0.26	0.80	1.07	1.0	0.037	2.24	45.86	0.088	3.20	2.47	2	1.32538	17.606	1.6856	20.448
19.521	0.90	0.26	0.80	1.07	1.0	0.037	2.31	46.52	0.089	3.20	2.47	2	1.317429	17.332	1.6593	20.130
19.685	0.89	0.26	0.80	1.07	1.0	0.037	2.32	46.87	0.089	3.19	2.47	2	1.309586	17.402	1.6661	20.211
19.849	0.89	0.27	0.80	1.07	1.0	0.037	2.11	45.87	0.088	3.14	2.47	2	1.299751	18.676	1.7881	21.691
20.013	0.89	0.29	0.80	1.07	1.0	0.037	1.81	46.18	0.088	3.13	2.53	2	1.281587	22.021	2.1083	25.576
20.177	0.89	0.32	0.80	1.07	1.0	0.037	1.65	49.26	0.091	3.20	2.64	2	1.264406	25.708	2.4613	29.859
20.341	0.89	0.32	0.80	1.07	1.0	0.037	1.69	53.33	0.094	3.29	2.72	2	1.254035	27.178	2.602	31.565
20.505	0.89	0.33	0.80	1.06	1.0	0.037	1.71	55.97	0.096	3.35	2.77	2	1.244973	28.255	2.7051	32.816
20.669	0.89	0.33	0.80	1.06	1.0	0.037	1.75	58.12	0.098	3.39	2.81	2	1.23769	28.636	2.7416	33.259
20.833	0.89	0.34	0.80	1.06	1.0	0.037	1.75	58.98	0.099	3.40	2.82	2	1.230504	29.036	2.7799	33.723
20.997	0.88	0.33	0.80	1.06	1.0	0.037	1.79	58.98	0.099	3.38	2.80	2	1.225743	28.299	2.7094	32.868
21.161	0.88	0.33	0.80	1.06	1.0	0.037	1.76	58.94	0.099	3.36	2.80	2	1.218455	28.841	2.7612	33.497

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-6N

Data File: 13-52106_SP3-6N-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5604.20	Water surface elevation during CPT investigation (ft a
5599.16	Water surface elevation at t_0 (ft amsl)
5590.44	Water surface elevation at t_1 (ft amsl)
5585.44	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earth
7.51	Equiv. Number of Uniform Strain Cycles, N

5607.44	Ground Surface Elevation at time of CPT (ft amsl)
5623.62	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
8.68	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1720.10	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5585.44	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5623.37	5623.12	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5621.37	5619.62	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5617.87	5616.12	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320
Platform/Random Fill Layer	######	5611.78	5607.44	8.68	0.050	101	0.861	0.643	0.00	0.00	0.861	0.643

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
0.164	5607.28	10.8	0.029	10.8	8.7	3.75	0.27%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	18.326	254.73	21.39	1310	0.27%	0.7	51%	0.87	0.00	0.87	0
0.328	5607.11	17.1	0.110	17.0	4.0	1.74	0.64%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	28.968	402.66	33.69	1032	0.65%	1.1	51%	0.88	0.00	0.88	0
0.492	5606.95	38.1	0.119	38.1	2.8	1.21	0.31%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	64.804	900.78	75.30	1538	0.31%	0.8	51%	0.88	0.00	0.88	0
0.656	5606.78	56.7	0.134	56.7	2.8	1.21	0.24%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	96.339	1339.11	111.93	1714	0.24%	0.6	51%	0.89	0.00	0.89	0
0.820	5606.62	78.5	0.600	78.5	2.0	0.88	0.76%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	133.399	1854.25	154.96	1899	0.76%	1.1	51%	0.90	0.00	0.90	0
0.984	5606.46	88.8	0.411	88.8	7.3	3.17	0.46%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	150.909	2097.64	175.36	1791	0.46%	0.9	51%	0.91	0.00	0.91	0
1.148	5606.29	97.1	0.455	97.1	6.7	2.89	0.47%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	165.002	2293.53	191.72	1678	0.47%	0.9	51%	0.92	0.00	0.92	0
1.312	5606.13	120.3	0.621	120.3	5.6	2.42	0.52%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	204.459	2841.98	237.54	1819	0.52%	1.0	51%	0.93	0.00	0.93	0
1.476	5605.96	117.5	1.100	117.5	6.9	2.99	0.94%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	199.682	2775.58	232.00	1579	0.94%	1.2	51%	0.93	0.00	0.93	0
1.640	5605.80	118.4	1.817	118.4	11.4	4.95	1.53%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	201.212	2796.85	233.84	1433	1.54%	1.4	51%	0.94	0.00	0.94	0
1.804	5605.64	123.5	2.268	123.4	21.1	9.14	1.84%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	209.780	2915.94	243.91	1358	1.84%	1.5	51%	0.95	0.00	0.95	0
1.968	5605.47	160.8	1.984	160.8	3.6	1.57	1.23%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	273.394	3800.18	317.58	1621	1.23%	1.3	51%	0.96	0.00	0.96	0
2.133	5605.31	176.8	1.510	176.8	2.1	0.90	0.85%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	300.577	4178.02	349.13	1645	0.85%	1.2	51%	0.97	0.00	0.97	0
2.297	5605.14	139.6	1.524	139.5	6.6	2.87	1.09%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	236.977	3293.98	275.32	1206	1.09%	1.3	51%	0.98	0.00	0.98	0
2.461	5604.98	107.1	1.707	107.0	5.4	2.32	1.59%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	181.951	2529.12	211.39	863	1.60%	1.5	51%	0.98	0.00	0.98	0
2.625	5604.82	84.4	1.333	84.4	6.6	2.87	1.58%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.70	143.480	1994.37	166.72	638	1.58%	1.6	51%	0.99	0.00	0.99	0
2.789	5604.65	89.6	1.432	89.6	-4.7	-2.02	1.60%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0	1.70	152.388	2118.19	176.93	637	1.60%	1.6	51%	1.00	0.00	1.00	0
2.953	5604.49	77.3	1.421	77.3	-4.6	-2.00	1.84%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0	1.70	131.376	1826.13	152.53	518	1.84%	1.7	51%	1.01	0.00	1.01	0
3.117	5604.32	57.2	1.269	57.2	-3.2	-1.37	2.22%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0	1.70	97.240	1351.64	112.90	363	2.23%	1.8	51%	1.02	0.00	1.02	0
3.281	5604.16	57.1	1.231	57.1	-3.1	-1.33	2.16%	Sand-Slime Tailing	0.059	119.0	0.17	0.00	0.17	1	1.70	97.019	1348.56	112.64	344	2.16%	1.8	47%	1.03	0.00	1.03	0
3.445	5604.00	105.1	0.904	105.1	-2.7	-1.16	0.86%	Sand Tailings	0.062	123.5	0.18	0.01	0.17	1	1.68	177.110	2461.83	205.67	616	0.86%	1.3	18%	1.04	0.00	1.04	0
3.609	5603.83	60.4	0.451	60.5	-1.3	-0.55	0.75%	Sand Tailings	0.062	123.5	0.19	0.01	0.18	1	1.70	102.765	1428.43	119.34	343	0.75%	1.4	18%	1.05	0.00	1.05	0
3.773	5603.67	36.8	0.568	36.8	-6.9	-2.99	1.55%	Sand-Slime Tailing	0.059	119.0	0.20	0.02	0.18	1	1.70	62.560	869.58	72.57	203	1.55%	1.8	47%	1.06	0.00	1.06	0
3.937	5603.50	18.3	0.393	18.4	-6.8	-2.95	2.14%	Sand-Slime Tailing	0.059	119.0	0.21	0.02	0.18	1	1.70	31.246	434.32	36.21	98	2.17%	2.1	47%	1.07	0.00	1.07	0
4.101	5603.34	6.8	0.370	6.8	-1.7	-0.72	5.47%	Slime Tailings	0.057	113.1	0.22	0.03	0.19	1	1.70	11.526	160.21	13.37	35	5.65%	2.8	71%	1.08	0.00	1.08	0
4.265	5603.17	7.9	0.213	7.9	1.0	0.42	2.68%	Slime Tailings	0.057	113.1	0.23	0.03	0.19	1	1.70	13.481	187.39	15.67	40	2.76%	2.5	71%	1.09	0.00	1.09	0
4.429	5603.01	9.1	0.198	9.1	0.7	0.29	2.18%	Slime Tailings	0.057	113.1	0.23	0.04	0.20	1	1.70	15.436	214.56	17.94	45	2.24%	2.4	71%	1.09	0.00	1.09	0
4.593	5602.85	7.9	0.200	7.9	1.4	0.59	2.54%	Slime Tailings	0.057	113.1	0.24	0.04	0.20	1	1.70	13.362	185.73	15.54	38	2.62%	2.5	71%	1.10	0.00	1.10	0
4.757	5602.68	14.7	0.112	14.6	6.6	2.87	0.76%	Sand-Slime Tailing	0.059	119.0	0.25	0.05	0.21	1	1.70	24.837	345.23	28.93	70	0.78%	2.0	47%	1.11	0.00	1.11	0
4.921	5602.52	29.5	0.077	29.5	0.6	0.26	0.26%	Sand-Slime Tailing	0.059	119.0	0.26	0.05	0.21	1	1.70	50.201	697.79	58.31	139	0.26%	1.5	47%	1.12	0.00	1.12	0
5.085	5602.35	24.5	0.105	24.5	-1.1	-0.49	0.43%	Sand-Slime Tailing	0.059	119.0	0.27	0.06	0.22	1	1.70	41.633	578.70	48.34	112	0.43%	1.7	47%	1.13	0.00	1.13	0
5.249	5602.19	21.8	0.186	21.8	2.1	0.91	0.85%	Sand-Slime Tailing	0.059	119.0	0.28	0.06	0.22	1	1.70	37.094	515.61	43.11	98	0.86%	1.9	47%	1.14	0.00	1.14	0
5.413	5602.03	13.2	0.258	13.2	3.3	1.43	1.95%	Sand-Slime Tailing	0.059	119.0	0.29	0.07	0.22	1	1.70	22.474	312.39	26.14	58	1.99%	2.3	47%	1.15	0.00	1.15	0
5.577	5601.86	10.1	0.292	10.0	11.1	4.81	2.89%	Slime Tailings	0.057	113.1	0.30	0.07	0.23	1	1.70	17.068	237.25	19.96	43	2.98%	2.5	71%	1.16	0.00	1.16	0
5.741	5601.70	8.4	0.248	8.3	11.7	5.07	2.95%	Slime Tailings	0.057	113.1	0.31	0.08	0.23	1	1.70	14.144	196.60	16.57	35	3.07%	2.6	71%	1.17	0.00	1.17	0
5.905	5601.53	7.3	0.202	7.2	12.6	5.46	2.76%	Slime Tailings	0.057	113.1	0.32	0.08	0.24	1	1.70	12.308	171.08	14.45	30	2.89%	2.6	71%	1.18	0.00	1.18	0
6.069	5601.37	11.4	0.159	11.3	23.0	9.95	1.40%	Sand-Slime Tailing	0.059	119.0	0.33	0.09	0.24	1	1.70	19.125	265.84	22.50	46	1.44%	2.3	47%	1.19	0.00	1.19	0
6.234	5601.21	13.4	0.202	13.4	8.1	3.51	1.51%	Sand-Slime Tailing	0.059	119.0	0.34	0.09	0.25	1	1.70	22.712	315.70	26.48	53	1.55%	2.2	47%	1.20	0.00	1.20	0
6.398	5601.04	17.4	0.135	17.4	8.8	3.83	0.77%	Sand-Slime Tailing	0.059	119.0	0.35	0.10	0.25	1	1.70	29.529	410.45	34.41	68	0.79%	2.0	47%	1.21	0.00	1.21	0
6.562	5600.88	33.6	0.152	33.5	8.1	3.50	0.45%	Sand Tailings	0.062	123.5	0.36	0.10	0.26	1	1.70	56.967	791.84	66.26	130	0.46%	1.6	18%	1.22	0.00	1.22	0
6.726	5600.71	25.5	0.167	25.5	1.3	0.57	0.65%	Sand-Slime Tailing	0.059	119.0	0.37	0.11	0.26	1	1.70	43.418	603.51	50.44	97	0.66%	1.8	47%	1.23	0.00	1.23	0
6.890	5600.55	13.1	0.130	13.1	2.1	0.90	0.99%	Sand-Slime Tailing	0.059	119.0	0.38	0.11	0.27	1	1.70	22.287	309.79	25.91	48	1.02%	2.2	47%	1.24	0.00	1.24	0
7.054	5600.39	6.0	0.125	5.9	15.6	6.76	2.08%	Slime Tailings	0.057	113.1	0.39	0.12	0.27	1	1.70	10.047	139.65	11.86	21	2.22%	2.7	71%	1.25	0.00	1.25	0
7.218	5600.22	6.6	0.062	6.4	28.5	12.36	0.94%	Slime Tailings	0.057	113.1	0.40	0.12	0.27	1	1.70	10.914	151.70	13.03	23	1.00%	2.4	71%	1.26	0.00	1.26	0
7.382	5600.06	19.6	0.120	19.5	19.3	8.36	0.61%	Sand-Slime Tailing	0.059	119.0	0.41	0.13	0.28	1	1.70	33.133	460.55	38.72	69	0.62%	1.9	47%	1.27	0.00	1.27	0
7.546	5599.89	11.8	0.165	11.8	7.7	3.32	1.40%	Sand-Slime Tailing	0.059	119.0	0.42	0.13	0.28	1	1.70	20.009	278.13	23.33	40	1.45%	2.3	47%	1.28	0.00	1.28	0
7.710	5599.73	11.2	0.230	11.1	15.6	6.75	2.06%	Slime Tailings	0.057	113.1	0.43	0.14	0.29	1	1.70	18.819	261.58	22.05	37	2.14%	2.5	71%	1.29	0.00	1.29	0
7.874	5599.57	9.4	0.185	9.3	9.2	4.00	1.98%	Slime Tailings	0.057	113.1	0.44	0.14	0.29	1	1.70	15.810	219.76	18.48	31	2.07%	2.5	71%	1.30	0.00	1.30	0
8.038	5599.40	7.2	0.119	7.1	13.2	5.73	1.66%	Slime Tailings	0.057	113.1	0.45	0.15	0.30	1	1.70	12.019	167.06	14.12	23	1.77%	2.6	71%	1.31	0.00	1.31	0
8.202	5599.24	6.0	0.067	5.9	26.0	11.28	1.11%	Slime Tailings	0.057	113.1	0.45	0.15	0.30	1	1.70	9.962	138.47	11.89	19	1.20%	2.6	71%	1.31	0.00	1.31	0
8.366	5599.07	6.1	0.081	5.9	31.3	13.56	1.34%	Slime Tailings	0.057	113.1	0.46	0.16	0.30	1	1.70	9.962	138.47	11.96	18	1.45%	2.6	71%	1.32	0.00	1.32	0
8.530	5598.91	13.2	0.065	12.9	48.6	21.04	0.49%	Sand-Slime Tailing	0.059	119.0	0.47	0.17	0.31	1	1.70	21.981	305.54	26.13	41	0.51%	2.1	47%	1.33	0.00	1.33	0
8.694	5598.75	13.3	0.116	13.3	8.9	3.84	0.87%	Sand-Slime Tailing	0.059	119.0	0.48	0.17	0.31	1	1.70	22.525	313.10	26.27	41	0.90%	2.2	47%	1.34	0.00	1.34	0
8.858	5598.58	6.7	0.132	6.6	9.6	4.14	1.98%	Slime Tailings	0.057	113.1	0.49	0.18	0.32	1	1.70	11.254	156.43	13.19	20	2.13%	2.7	71%	1.35	0.00	1.35	0
9.022	5598.42	3.7	0.117	3.6	7.2	3.11	3.20%	Slime Tailings	0.057	113.1	0.50	0.18	0.32	1	1.70	6.137	85.30	7.22	10	3.71%	3.1	71%	1.36	0.00	1.36	0
9.186	5598.25	2.3	0.054	2.2	18.5	8.01	2.32%	Slime Tailings	0.057	113.1	0.51	0.19	0.33	1	1.70	3.757	52.22	4.59	6	2.98%	3.2	71%	1.37	0.00	1.37	0
9.350	5598.09	2.4	0.024	2.2	24.5	10.62	1.02%	Slime Tailings	0.057	113.1	0.52	0.19	0.33	1	1.70	3.757	52.22	4.67	6	1.30%	3.0	71%	1.38	0.00	1.38	0
9.514	5597.93	2.6	0.011	2.4	34.3	14.85	0.42%	Slime Tailings	0.057	113.1	0.53	0.20	0.33	1	1.70	4.080	56.71	5.16	6	0.53%	2.8	71%	1.39	0.00	1.39	0
9.678	5597.76	2.8	0.016	2.6	37.8	16.39	0.57%	Slime Tailings	0.057	113.1	0.54	0.20	0.34	1	1.70	4.403	61.20	5.58	7	0.70%	2.8	71%	1.40	0.00	1.40	0
9.842	5597.60	3.2	0.010	2.9	39.6	17.14	0.32%	Slime Tailings	0.057	113.1	0.55	0.21	0.34	1	1.70	4.947	68.76	6.23	8	0.38%	2.7	71%	1.41	0.00	1.41	0
10.006	5597.43	4.5	0.016	4.3	44.0	19.08	0.35%	Slime Tailings	0.057	113.1	0.56	0.21	0.35	1	1.70	7.225	100.43	8.93	11	0.40%	2.5	71%	1.42	0.00	1.42	0
10.170	5597.27	22.4	0.010	22.4	7.4	3.19	0.04%	Sand-Slime Tailing	0.059	119.0	0.57	0.22	0.35	1	1.70	37.995	528.13	44.22	62	0.05%	1.7	47%	1.43	0.00	1.43	0
10.335	5597.11	9.5	0.106	9.4	6.7	2.89	1.12%	Sand-Slime Tailing	0.059	119.0	0.58	0.22	0.36	1	1.70	15.997	222.36	18.66	25	1.19%	2.4	47%	1.44	0.00	1.44	0
10.499	5596.94	7.7	0.177	7.6	9.0	3.88	2.30%	Slime Tailings	0.057	113.1	0.59	0.23	0.36	1	1.70	12.971	180.30	15.18	20	2.49%	2.7	71%	1.45	0.00	1.45	0
10.663	5596.78	6.4	0.128	6.3	17.8	7.70	2.00%	Slime Tailings	0.057	113.1	0.60	0.23	0.36	1	1.70	10.693	148.63	12.64	16	2.20%	2.8	71%	1.46	0.00	1.46	0
10.827	5596.61	4.4	0.090	4.2	34.3	14.84	2.04%	Slime Tailings	0.057	113.1	0.60	0.24	0.37	1	1.70	7.123	99.01	8.70	10	2.37%	2.9	71%	1.46	0.00	1.46	0
10.991	5596.45	5.0	0.031	4.7	52.3	22.65	0.62%	Slime Tailings	0.057	113.1	0.61	0.24	0.37	1	1.70	7.990	111.06	9.92	12	0.70%	2.6	71%	1.47	0.00	1.47	0
11.155	5596.29	3.9	0.027	3.6	49.3	21.35	0.70%	Slime Tailings	0.057	113.1	0.62	0.25	0.38	1	1.70	6.052	84.12	7.64	9	0.83%	2.8	71%	1.48	0.00	1.48	0
11.319	5596.12	3.6	0.014	3.2	58.6	25.37	0.39%	Slime Tailings	0.057	113.1	0.63	0.25	0.38	1	1.70	5.508	76.56	7.12	8	0.47%	2.7	71%	1.49	0.00	1.49	0
11.483	5595.96	3.7	0.010	3.3	65.7	28.48	0.27%	Slime Tailings	0.057	113.1	0.64	0.26	0.38	1	1.70	5.610	77.98	7.33	8	0.33%	2.7	71%	1.50	0.00	1.50	0
11.647	5595.79	3.5	0.010	3.1	63.3	27.45	0.29%	Slime Tailings	0.057	113.1	0.65	0.26	0.39	1	1.70	5.270	73.25	6.90	7	0.35%	2.7	71%	1.51	0.00	1.51	0
11.811	5595.63	3.3	0.010	2.9	65.8	28.52	0.31%	Slime Tailings	0.057	113.1	0.66	0.27	0.39	1	1.70	4.862	67.58	6.46	7	0.38%	2.8	71%	1.52	0.00	1.52	0
11.975	5595.47	3.0	0.010	2.6	62.5	27.10	0.33%	Slime Tailings	0.057	113.1	0.67	0.27	0.40	1	1.70	4.420	61.44	5.90	6	0.43%	2.8	71%	1.53	0.00	1.53	0

Liquefaction Triggering Analyses — Idriss & Boulanger (2008) / Youd et al. (2001); Idriss & Boulanger (2008)

Depth at time of CPT (ft)	I&B r_d	I&B C_σ	I&B K_σ	I&B K_α	I&B CSR M=7.5, s'v=1atm	Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Youd r_d	D_r	f	Youd K_σ	Youd K_α	Youd CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	CN	qc1 TSF	qc1 MPa	qc1N
0.164	1.00	0.05	1.00	1.0	0.058	37.83	59.22	0.087	1.51	0.96	0.27	0.80	2.53	1.0	0.017	1.00	21.39	0.068	166.66	84.08	2	1.7	18.418	1.7633	21.391
0.328	1.00	0.06	1.00	1.0	0.058	42.14	75.84	0.107	1.85	0.96	0.34	0.80	2.20	1.0	0.019	1.00	33.69	0.078	95.96	48.91	2	1.7	29.011	2.7775	33.694
0.492	1.00	0.09	1.00	1.0	0.058	56.75	132.05	0.208	3.61	0.96	0.50	0.75	2.43	1.0	0.017	1.00	75.30	0.120	98.14	50.88	2	1.7	64.834	6.2072	75.300
0.656	1.00	0.12	1.00	1.0	0.058	69.60	181.53	0.561	9.75	0.96	0.61	0.69	2.71	1.0	0.016	1.00	111.93	0.210	129.42	69.59	2	1.7	96.369	9.2263	111.926
0.820	1.00	0.17	0.99	1.0	0.057	84.70	239.66	1.000	17.43	0.96	0.72	0.64	2.98	1.0	0.014	1.00	154.96	0.426	209.74	113.58	2	1.7	133.42	12.774	154.960
0.984	1.00	0.20	0.99	1.0	0.057	91.86	267.22	1.000	17.49	0.96	0.76	0.62	2.98	1.0	0.014	1.00	175.36	1.000	410.39	213.94	2	1.7	150.99	14.455	175.362
1.148	1.00	0.24	0.98	1.0	0.057	97.60	289.32	1.000	17.57	0.96	0.80	0.60	2.94	1.0	0.014	1.00	191.72	1.000	351.91	184.74	2	1.7	165.07	15.804	191.722
1.312	1.00	0.30	0.98	1.0	0.057	113.68	351.21	1.000	17.69	0.96	0.89	0.60	2.79	1.0	0.015	1.00	237.54	1.000	308.04	162.86	2	1.7	204.52	19.581	237.536
1.476	1.00	0.30	0.98	1.0	0.056	111.74	343.74	1.000	17.73	0.96	0.88	0.60	2.66	1.0	0.016	1.00	232.00	1.000	273.92	145.83	2	1.7	199.76	19.125	232.004
1.640	1.00	0.30	0.97	1.0	0.056	112.38	346.22	1.000	17.78	0.96	0.88	0.60	2.55	1.0	0.017	1.00	233.84	1.000	246.63	132.21	2	1.7	201.33	19.276	233.836
1.804	1.00	0.30	0.97	1.0	0.056	115.92	359.82	1.000	17.83	0.96	0.90	0.60	2.46	1.0	0.017	1.00	243.91	1.000	224.30	121.06	2	1.7	210	20.106	243.907
1.968	1.00	0.30	0.97	1.0	0.056	141.77	459.34	1.000	17.89	0.96	1.03	0.60	2.37	1.0	0.018	1.00	317.58	1.000	205.69	111.79	2	1.7	273.43	26.178	317.575
2.133	1.00	0.30	0.97	1.0	0.056	152.84	501.97	1.000	17.96	0.96	1.08	0.60	2.30	1.0	0.018	1.00	349.13	1.000	189.94	103.95	2	1.7	300.6	28.779	349.128
2.297	1.00	0.30	0.96	1.0	0.055	126.94	402.25	1.000	18.02	0.96	0.96	0.60	2.23	1.0	0.019	1.00	275.32	1.000	176.45	97.23	2	1.69827	237.05	22.695	275.316
2.461	1.00	0.30	0.96	1.0	0.055	104.50	315.90	1.000	18.08	0.96	0.84	0.60	2.17	1.0	0.019	1.00	211.39	1.000	164.75	91.41	2	1.7	182.01	17.425	211.391
2.625	1.00	0.19	0.97	1.0	0.056	88.83	255.55	1.000	17.84	0.96	0.75	0.63	2.01	1.0	0.021	1.00	166.72	1.000	154.51	86.18	2	1.7	143.55	13.744	166.725
2.789	0.99	0.21	0.97	1.0	0.056	92.41	269.34	1.000	17.94	0.96	0.77	0.62	2.01	1.0	0.021	1.00	176.93	1.000	145.48	81.71	2	1.7	152.34	14.585	176.932
2.953	0.99	0.16	0.97	1.0	0.056	83.85	236.38	1.000	17.87	0.96	0.71	0.64	1.87	1.0	0.023	1.01	154.81	0.425	58.42	38.14	2	1.7	131.33	12.573	152.528
3.117	0.99	0.12	0.98	1.0	0.056	69.94	182.84	0.585	10.40	0.96	0.61	0.69	1.69	1.0	0.025	1.12	125.96	0.266	34.64	22.52	2	1.7	97.207	9.3066	112.900
3.281	0.99	0.12	0.98	1.0	0.056	69.81	182.45	0.578	10.29	0.95	0.61	0.69	1.66	1.0	0.025	1.12	125.82	0.265	32.80	21.54	2	1.7	96.987	9.2855	112.644
3.445	0.99	0.28	0.95	1.0	0.054	74.67	280.34	1.000	18.41	0.95	0.83	0.60	1.91	1.0	0.022	1.00	205.67	1.000	120.06	69.23	2	1.684674	177.08	16.954	205.670
3.609	0.99	0.12	0.98	1.0	0.056	52.60	171.94	0.428	7.66	0.95	0.63	0.68	1.65	1.0	0.025	1.00	119.34	0.238	27.78	17.72	2	1.7	102.75	9.8374	119.340
3.773	0.99	0.09	0.98	1.0	0.056	55.75	128.33	0.199	3.54	0.95	0.49	0.75	1.47	1.0	0.029	1.13	81.86	0.131	14.90	9.22	2	1.7	62.487	5.9825	72.574
3.937	0.99	0.06	0.99	1.0	0.056	43.00	79.21	0.112	1.98	0.95	0.35	0.80	1.36	1.0	0.031	1.54	55.93	0.096	10.68	6.33	2	1.7	31.174	2.9846	36.206
4.101	0.99	0.05	0.99	1.0	0.056	34.74	48.11	0.076	1.34	0.95	0.21	0.80	1.35	1.0	0.031	4.45	59.42	0.100	10.80	6.07	2	1.7	11.508	1.1018	13.366
4.265	0.99	0.05	0.99	1.0	0.056	35.54	51.21	0.079	1.40	0.95	0.23	0.80	1.35	1.0	0.031	2.77	43.40	0.086	9.15	5.27	2	1.7	13.491	1.2917	15.669
4.429	0.99	0.05	0.99	1.0	0.056	36.33	54.27	0.082	1.45	0.95	0.24	0.80	1.34	1.0	0.031	2.32	41.62	0.085	8.81	5.13	2	1.7	15.443	1.4785	17.936
4.593	0.98	0.05	0.99	1.0	0.056	35.50	51.03	0.078	1.40	0.95	0.23	0.80	1.34	1.0	0.031	2.78	43.24	0.086	8.77	5.08	2	1.7	13.376	1.2807	15.536
4.757	0.98	0.06	0.99	1.0	0.056	40.45	69.38	0.099	1.76	0.95	0.31	0.80	1.33	1.0	0.032	1.26	36.49	0.080	8.01	4.89	2	1.7	24.907	2.3846	28.928
4.921	0.98	0.08	0.98	1.0	0.056	50.75	109.07	0.158	2.84	0.95	0.44	0.78	1.36	1.0	0.031	1.00	58.31	0.098	9.60	6.22	2	1.7	50.207	4.8069	58.313
5.085	0.98	0.07	0.98	1.0	0.056	47.26	95.60	0.135	2.43	0.95	0.40	0.80	1.32	1.0	0.032	1.01	48.77	0.091	8.65	5.54	2	1.7	41.621	3.9848	48.340
5.249	0.98	0.07	0.98	1.0	0.056	45.42	88.53	0.125	2.24	0.95	0.38	0.80	1.31	1.0	0.032	1.17	50.35	0.092	8.59	5.41	2	1.7	37.116	3.5535	43.108
5.413	0.98	0.06	0.98	1.0	0.056	39.47	65.61	0.094	1.69	0.95	0.30	0.80	1.31	1.0	0.032	1.91	49.87	0.092	8.38	5.04	2	1.7	22.509	2.155	26.143
5.577	0.98	0.05	0.98	1.0	0.056	37.04	57.00	0.085	1.52	0.95	0.26	0.80	1.30	1.0	0.032	2.76	55.19	0.096	8.60	5.06	2	1.7	17.186	1.6454	19.960
5.741	0.98	0.05	0.98	1.0	0.056	35.86	52.43	0.080	1.43	0.95	0.24	0.80	1.30	1.0	0.032	3.18	52.77	0.094	8.28	4.86	2	1.7	14.268	1.366	16.572
5.905	0.98	0.05	0.98	1.0	0.056	35.12	49.57	0.077	1.39	0.95	0.22	0.80	1.29	1.0	0.032	3.40	49.16	0.091	7.90	4.64	2	1.7	12.442	1.1912	14.450
6.069	0.98	0.05	0.98	1.0	0.055	38.19	60.69	0.089	1.60	0.95	0.27	0.80	1.29	1.0	0.032	1.87	42.03	0.085	7.24	4.42	2	1.7	19.369	1.8544	22.496
6.234	0.98	0.06	0.98	1.0	0.055	39.59	66.07	0.095	1.71	0.95	0.30	0.80	1.28	1.0	0.033	1.78	47.10	0.089	7.46	4.59	2	1.7	22.798	2.1827	26.478
6.398	0.97	0.06	0.98	1.0	0.055	42.37	76.77	0.108	1.96	0.95	0.34	0.80	1.28	1.0	0.033	1.28	43.97	0.087	7.11	4.54	2	1.7	29.623	2.8361	34.405
6.562	0.97	0.08	0.97	1.0	0.055	39.03	105.29	0.151	2.77	0.95	0.47	0.77	1.33	1.0	0.031	1.00	66.26	0.107	8.62	5.70	2	1.7	57.053	5.4622	66.263
6.726	0.97	0.07	0.97	1.0	0.055	47.99	98.44	0.140	2.56	0.95	0.41	0.79	1.28	1.0	0.033	1.12	56.34	0.097	7.65	5.10	2	1.7	43.432	4.1582	50.444
6.890	0.97	0.06	0.98	1.0	0.055	39.39	65.30	0.094	1.71	0.95	0.29	0.80	1.27	1.0	0.033	1.60	41.35	0.084	6.57	4.14	2	1.7	22.309	2.1359	25.911
7.054	0.97	0.05	0.98	1.0	0.055	34.22	46.08	0.074	1.34	0.95	0.20	0.80	1.26	1.0	0.033	3.72	44.16	0.087	6.65	3.99	2	1.7	10.212	0.9777	11.861
7.218	0.97	0.05	0.98	1.0	0.055	34.62	47.65	0.075	1.37	0.95	0.21	0.80	1.26	1.0	0.033	2.49	32.43	0.077	5.81	3.59	2	1.7	11.217	1.0739	13.028
7.382	0.97	0.06	0.98	1.0	0.055	43.88	82.60	0.116	2.13	0.95	0.36	0.80	1.25	1.0	0.033	1.21	46.84	0.089	6.61	4.37	2	1.7	33.338	3.1918	38.720
7.546	0.97	0.05	0.98	1.0	0.055	38.48	61.82	0.090	1.64	0.94	0.28	0.80	1.25	1.0	0.033	2.02	47.02	0.089	6.52	4.08	2	1.7	20.09	1.9234	23.334
7.710	0.97	0.05	0.98	1.0	0.055	37.77	59.82	0.088	1.60	0.94	0.27	0.80	1.25	1.0	0.033	2.53	55.75	0.096	6.92	4.26	2	1.7	18.984	1.8176	22.049
7.874	0.96	0.05	0.98	1.0	0.055	36.52	55.00	0.082	1.51	0.94	0.25	0.80	1.24	1.0	0.034	2.82	52.03	0.093	6.61	4.06	2	1.7	15.908	1.523	18.476
8.038	0.96	0.05	0.98	1.0	0.055	35.01	49.13	0.077	1.40	0.94	0.22	0.80	1.24	1.0	0.034	3.17	44.79	0.087	6.12	3.76	2	1.7	12.159	1.1641	14.122
8.202	0.96	0.05	0.98	1.0	0.055	34.23	46.12	0.074	1.35	0.94	0.20	0.80	1.24	1.0	0.034	3.07	36.49	0.080	5.56	3.46	2	1.7	10.238	0.9802	11.891
8.366	0.96	0.05	0.98	1.0	0.054	34.25	46.21	0.074	1.36	0.94	0.20	0.80	1.23	1.0	0.034	3.34	39.89	0.083	5.68	3.52	2	1.7	10.294	0.9856	11.956
8.530	0.96	0.06	0.98	1.0	0.054	39.47	65.59	0.094	1.74	0.94	0.30	0.80	1.23	1.0	0.034	1.41	36.75	0.081	5.42	3.58	2	1.7	22.496	2.1538	26.128
8.694	0.96	0.06	0.97	1.0	0.054	39.52	65.79	0.094	1.75	0.94	0.30	0.80	1.22	1.0	0.034	1.66	43.71	0.086	5.72	3.74	2	1.7	22.619	2.1655	26.271
8.858	0.96	0.05	0.98	1.0	0.054	34.68	47.87	0.075	1.39	0.94	0.21	0.80	1.22	1.0	0.034	3.81	50.27	0.092	6.00	3.70	2	1.7	11.355	1.0872	13.189
9.022	0.96	0.04	0.98	1.0	0.054	32.60	39.82	0.068	1.26	0.94	0.16	0.80	1.22	1.0	0.034	7.40	53.38	0.094	6.08	3.67	2	1.7	6.2132	0.5949	7.216
9.186	0.96	0.04	0.98	1.0	0.054	31.69	36.28	0.066	1.21	0.94	0.12	0.80	1.21	1.0	0.034	9.35	42.94	0.086	5.47	3.34	2	1.7	3.9532	0.3785	4.591
9.350	0.96	0.04	0.98	1.0	0.054	31.71	36.38	0.066	1.21	0.94	0.12	0.80	1.21	1.0	0.034	7.11	33.17	0.078	4.89	3.05	2	1.7	4.017	0.3846	4.666
9.514	0.95	0.04	0.98	1.0	0.054	31.88	37.05	0.066	1.23	0.94	0.13	0.80	1.21	1.0	0.034	5.10	26.30	0.072	4.48	2.85	2	1.7	4.4436	0.4254	5.161
9.678	0.95	0.04	0.98	1.0	0.054	32.03	37.61	0.067	1.24	0.94	0.14	0.80	1.21	1.0	0.034	5.19	28.96	0.074	4.56	2.90	2	1.7	4.8045	0.46	5.580
9.842	0.95	0.04	0.98	1.0	0.054	32.26	38.49	0.067	1.25	0.94	0.14	0.80	1.20	1.0	0.034	4.07	25.35	0.071	4.32	2.79	2	1.7	5.3668	0.5138	6.233
10.006	0.95	0.04	0.98	1.0	0.054	33.20	42.13	0.070	1.31	0.94	0.17	0.80	1.20	1.0	0.035	3.02	27.02	0.073	4.36	2.83	2	1.7	7.6922	0.7364	8.934
10.170	0.95	0.07	0.97	1.0	0.053	45.81	90.03	0.127	2.39	0.94	0.38	0.80	1.20	1.0	0.035	1.02	45.30	0.088	5.20	3.80	2	1.7	38.073	3.6451	44.220
10.335	0.95	0.05	0.97	1.0	0.053	36.85	55.51	0.083	1.55	0.94	0.25	0.80	1.19	1.0	0.035	2.51	46.77	0.089	5.21	3.38	2	1.7	16.068	1.5383	18.662
10.499	0.95	0.05	0.97	1.0	0.053	35.37	50.55	0.078	1.46	0.94	0.22	0.80	1.19	1.0	0.035	4.07	61.73	0.102	5.90	3.68	2	1.7	13.066	1.2509	15.175
10.663	0.95	0.05	0.98	1.0	0.053	34.49	47.13	0.075	1.40	0.94	0.21	0.80	1.19	1.0	0.035	4.41	55.68	0.096	5.50	3.45	2	1.7	10.882	1.0418	12.638
10.827	0.95	0.04	0.98	1.0	0.053	33.12	41.81	0.070	1.31	0.94	0.17	0.80	1.19	1.0	0.035	5.98	52.01	0.093	5.27	3.29	2	1.7	7.4865	0.7168	8.695
10.991	0.94	0.05	0.98	1.0	0.053	33.54	43.47	0.072	1.34	0.94	0.18	0.80	1.18	1.0	0.035	3.47	34.43	0.079	4.41	2.88	2	1.7	8.5447	0.8181	9.924
11.155	0.94	0.04	0.98	1.0	0.053	32.75	40.38	0.069	1.29	0.94	0.16	0.80	1.18	1.0	0.035	4.61	35.20	0.079	4.40	2.85	2	1.7	6.5749	0.6295	7.636
11.319	0.94	0.04	0.98	1.0	0.053	32.57	39.69	0.068	1.29	0.94	0.15	0.80	1.18	1.0	0.035	4.20	29.90	0.075	4.11	2.70	2	1.7	6.1294	0.5868	7.119
11.483	0.94	0.04	0.98	1.0	0.053	32.64	39.96	0.069	1.29	0.94	0.16	0.80	1.17	1.0	0.035	3.79	27.75	0.073	3.97	2.63	2	1.7	6.3076	0.6039	7.326
11.647	0.94	0.04	0.98	1.0	0.053	32.49	39.39	0.068	1.28	0.94	0.15	0.80	1.17	1.0	0.035	4.11	28.39	0.074	3.96	2.62	2	1.7	5.9422	0.5689	6.902
11.811	0.94	0.04	0.98	1.0	0.053	32.34	38.79	0.068	1.28	0.93	0.15	0.80	1.17	1.0	0.035	4.51	29.12	0.074	3.95	2.61	2	1.7	5.5605	0.5324	6.458
11.975	0.94	0.04	0.98	1.0	0.053	32.14	38.05	0.067	1.27	0.93	0.14	0.80	1.17	1.0	0.035	5.09	30.06	0.075	3.95	2.61	2	1.7	5.0837	0.4867	5.904

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-6N

Data File: 13-52106_SP3-6N-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)
- Max. Horiz. Acceleration, Amax/g: 0.15
- Earthquake Moment Magnitude, M: 5.5
- Magnitude Scaling Factor, MSF: 1.69

Youd, et al (2001)
- Max. Horiz. Acceleration, Amax/g: 0.15
- Earthquake Moment Magnitude, M: 5.5
- Magnitude Scaling Factor, MSF: 2.21

5604.20	Water surface elevation during CPT investigation (ft a
5599.16	Water surface elevation at t_0 (ft amsl)
5590.44	Water surface elevation at t_1 (ft amsl)
5585.44	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earth
7.51	Equiv. Number of Uniform Strain Cycles, N

5607.44	Ground Surface Elevation at time of CPT (ft amsl)
5623.62	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
8.68	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1720.10	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5585.44	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5623.37	5623.12	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5621.37	5619.62	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5617.87	5616.12	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320
Platform/Random Fill Layer	######	5611.78	5607.44	8.68	0.050	101	0.861	0.643	0.00	0.00	0.861	0.643

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No
12.139	5595.30	3.0	0.010	2.6	63.4	27.46	0.33%	Slime Tailings	0.057	113.1	0.68	0.28	0.40	1
12.303	5595.14	3.8	0.019	3.3	76.0	32.92	0.50%	Slime Tailings	0.057	113.1	0.69	0.28	0.41	1
12.467	5594.97	8.7	0.151	8.2	74.0	32.08	1.74%	Slime Tailings	0.057	113.1	0.70	0.29	0.41	1
12.631	5594.81	7.3	0.133	7.1	27.0	11.70	1.82%	Slime Tailings	0.057	113.1	0.71	0.29	0.41	1
12.795	5594.64	3.8	0.056	3.5	42.3	18.33	1.49%	Slime Tailings	0.057	113.1	0.72	0.30	0.42	1
12.959	5594.48	3.5	0.039	3.2	47.7	20.68	1.12%	Slime Tailings	0.057	113.1	0.73	0.30	0.42	1
13.123	5594.32	3.6	0.039	3.3	47.0	20.38	1.08%	Slime Tailings	0.057	113.1	0.73	0.31	0.43	1
13.287	5594.15	3.8	0.053	3.5	53.2	23.07	1.38%	Slime Tailings	0.057	113.1	0.74	0.31	0.43	1
13.451	5593.99	4.6	0.055	4.3	58.0	25.13	1.19%	Slime Tailings	0.057	113.1	0.75	0.32	0.43	1
13.615	5593.82	5.4	0.050	5.1	51.5	22.33	0.92%	Slime Tailings	0.057	113.1	0.76	0.32	0.44	1
13.779	5593.66	4.7	0.059	4.3	53.8	23.30	1.26%	Slime Tailings	0.057	113.1	0.77	0.33	0.44	1
13.943	5593.50	4.5	0.065	4.2	53.8	23.33	1.45%	Slime Tailings	0.057	113.1	0.78	0.33	0.45	1
14.107	5593.33	4.6	0.067	4.3	54.2	23.47	1.45%	Slime Tailings	0.057	113.1	0.79	0.34	0.45	1
14.271	5593.17	4.6	0.064	4.3	55.3	23.95	1.38%	Slime Tailings	0.057	113.1	0.80	0.34	0.46	1
14.436	5593.00	4.7	0.050	4.3	52.5	22.75	1.07%	Slime Tailings	0.057	113.1	0.81	0.35	0.46	1
14.600	5592.84	3.9	0.045	3.6	48.9	21.19	1.14%	Slime Tailings	0.057	113.1	0.82	0.35	0.46	1
14.764	5592.68	3.7	0.025	3.4	47.0	20.37	0.68%	Slime Tailings	0.057	113.1	0.83	0.36	0.47	1
14.928	5592.51	3.7	0.014	3.5	43.2	18.70	0.38%	Slime Tailings	0.057	113.1	0.84	0.36	0.47	1
15.092	5592.35	4.0	0.031	3.7	46.9	20.31	0.77%	Slime Tailings	0.057	113.1	0.85	0.37	0.48	1
15.256	5592.18	6.6	0.057	6.5	28.1	12.19	0.86%	Slime Tailings	0.057	113.1	0.86	0.37	0.48	1
15.420	5592.02	6.4	0.065	6.1	51.6	22.37	1.02%	Slime Tailings	0.057	113.1	0.86	0.38	0.48	1
15.584	5591.86	6.4	0.063	6.0	64.8	28.06	0.98%	Slime Tailings	0.057	113.1	0.87	0.39	0.49	1
15.748	5591.69	6.6	0.049	6.2	68.5	29.69	0.74%	Sand-Slime Tailings	0.059	119.0	0.88	0.39	0.49	1
15.912	5591.53	7.0	0.046	6.5	70.8	30.66	0.66%	Sand-Slime Tailings	0.059	119.0	0.89	0.40	0.50	1
16.076	5591.36	7.2	0.048	6.7	83.5	36.19	0.67%	Sand-Slime Tailings	0.059	119.0	0.90	0.40	0.50	1
16.240	5591.20	7.2	0.050	6.7	88.8	38.47	0.69%	Sand-Slime Tailings	0.059	119.0	0.91	0.41	0.51	1
16.404	5591.04	9.0	0.044	8.4	98.8	42.80	0.49%	Sand-Slime Tailings	0.059	119.0	0.92	0.41	0.51	1
16.568	5590.87	9.0	0.056	8.4	104.5	45.27	0.62%	Sand-Slime Tailings	0.059	119.0	0.93	0.42	0.52	1
16.732	5590.71	8.9	0.052	8.3	94.1	40.78	0.58%	Sand-Slime Tailings	0.059	119.0	0.94	0.42	0.52	1
16.896	5590.54	8.2	0.074	7.6	99.3	43.01	0.90%	Sand-Slime Tailings	0.059	119.0	0.95	0.43	0.53	1
17.060	5590.38	8.3	0.057	7.7	101.1	43.83	0.68%	Sand-Slime Tailings	0.059	119.0	0.96	0.43	0.53	1
17.224	5590.22	8.1	0.045	7.5	92.6	40.14	0.56%	Sand-Slime Tailings	0.059	119.0	0.97	0.44	0.54	1
17.388	5590.05	6.7	0.047	6.0	104.9	45.45	0.70%	Sand-Slime Tailings	0.059	119.0	0.98	0.44	0.54	1
17.552	5589.89	6.6	0.046	6.0	96.3	41.71	0.70%	Sand-Slime Tailings	0.059	119.0	0.99	0.45	0.54	1
17.716	5589.72	6.0	0.052	5.5	92.4	40.06	0.86%	Slime Tailings	0.057	113.1	1.00	0.45	0.55	1
17.880	5589.56	5.7	0.042	5.2	93.9	40.69	0.73%	Slime Tailings	0.057	113.1	1.01	0.46	0.55	1
18.044	5589.40	6.1	0.034	5.6	77.5	33.57	0.56%	Slime Tailings	0.057	113.1	1.02	0.46	0.56	1
18.208	5589.23	5.2	0.036	4.7	84.2	36.50	0.69%	Slime Tailings	0.057	113.1	1.03	0.47	0.56	1
18.372	5589.07	5.4	0.036	4.9	84.8	36.76	0.66%	Slime Tailings	0.057	113.1	1.04	0.47	0.57	1
18.537	5588.90	6.0	0.036	5.4	86.7	37.59	0.60%	Slime Tailings	0.057	113.1	1.05	0.48	0.57	1

CPT Data Interpretations / Conditions at t_1 / Liquefaction Triggering Analyses – Idriss & Boulanger (2008)

Depth (ft)	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	CSR: r_d	CSR: C_σ	CSR: K_σ	CSR: K_a	CSR M=7.5, s'v=1atm	CRR: Δqc_{1n}	CRR: qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS
12.139	1.70	4.420	61.44	5.91	6	0.43%	2.8	71%	1.54	0.00	1.54	0	0.94	0.04	0.98	1.0	0.053	32.15	38.06	0.067	1.27
12.303	1.70	5.610	77.98	7.45	8	0.62%	2.8	71%	1.55	0.00	1.55	0	0.94	0.04	0.97	1.0	0.053	32.68	40.13	0.069	1.30
12.467	1.70	13.957	194.00	17.12	19	1.89%	2.6	71%	1.56	0.00	1.56	0	0.93	0.05	0.97	1.0	0.052	36.05	53.17	0.081	1.54
12.631	1.70	12.121	168.48	14.41	16	2.02%	2.7	71%	1.57	0.00	1.57	0	0.93	0.05	0.97	1.0	0.052	35.11	49.52	0.077	1.47
12.795	1.70	5.950	82.71	7.43	7	1.84%	3.0	71%	1.58	0.00	1.58	0	0.93	0.04	0.97	1.0	0.052	32.68	40.11	0.069	1.31
12.959	1.70	5.423	75.38	6.89	7	1.41%	3.0	71%	1.59	0.00	1.59	0	0.93	0.04	0.97	1.0	0.052	32.49	39.37	0.068	1.30
13.123	1.70	5.627	78.22	7.12	7	1.36%	3.0	71%	1.59	0.00	1.59	0	0.93	0.04	0.97	1.0	0.052	32.57	39.68	0.068	1.31
13.287	1.70	5.950	82.71	7.57	7	1.72%	3.0	71%	1.60	0.00	1.60	0	0.93	0.04	0.97	1.0	0.052	32.72	40.29	0.069	1.32
13.451	1.70	7.259	100.90	9.15	9	1.42%	2.9	71%	1.61	0.00	1.61	0	0.93	0.04	0.97	1.0	0.052	33.27	42.42	0.071	1.36
13.615	1.69	8.639	120.08	10.67	11	1.07%	2.7	71%	1.62	0.00	1.62	0	0.93	0.05	0.97	1.0	0.052	33.80	44.47	0.072	1.39
13.779	1.68	7.298	101.44	9.13	9	1.51%	2.9	71%	1.63	0.00	1.63	0	0.92	0.04	0.97	1.0	0.052	33.27	42.40	0.071	1.36
13.943	1.67	6.927	96.29	8.70	8	1.75%	2.9	71%	1.64	0.00	1.64	0	0.92	0.04	0.97	1.0	0.052	33.12	41.81	0.070	1.35
14.107	1.66	7.093	98.59	8.89	8	1.75%	2.9	71%	1.65	0.00	1.65	0	0.92	0.04	0.97	1.0	0.052	33.18	42.07	0.070	1.36
14.271	1.65	7.042	97.88	8.84	8	1.67%	2.9	71%	1.66	0.00	1.66	0	0.92	0.04	0.97	1.0	0.052	33.17	42.00	0.070	1.36
14.436	1.63	7.090	98.55	8.86	8	1.30%	2.9	71%	1.67	0.00	1.67	0	0.92	0.04	0.97	1.0	0.052	33.17	42.03	0.070	1.36
14.600	1.62	5.905	82.08	7.43	7	1.44%	3.0	71%	1.68	0.00	1.68	0	0.92	0.04	0.97	1.0	0.052	32.68	40.11	0.069	1.33
14.764	1.61	5.477	76.13	6.91	6	0.87%	2.9	71%	1.69	0.00	1.69	0	0.92	0.04	0.97	1.0	0.051	32.49	39.40	0.068	1.32
14.928	1.60	5.535	76.94	6.93	6	0.48%	2.8	71%	1.70	0.00	1.70	0	0.92	0.04	0.97	1.0	0.051	32.50	39.43	0.068	1.33
15.092	1.59	5.911	82.16	7.40	7	0.98%	2.9	71%	1.71	0.00	1.71	0	0.91	0.04	0.97	1.0	0.051	32.67	40.07	0.069	1.34
15.256	1.58	10.179	141.48	12.14	12	0.99%	2.7	71%	1.72	0.00	1.72	0	0.91	0.05	0.97	1.0	0.051	34.32	46.46	0.074	1.45
15.420	1.57	9.515	132.25	11.64	11	1.18%	2.7	71%	1.72	0.00	1.72	0	0.91	0.05	0.97	1.0	0.051	34.14	45.78	0.074	1.44
15.584	1.56	9.358	130.07	11.60	11	1.14%	2.7	71%	1.73	0.00	1.73	0	0.91	0.05	0.97	1.0	0.051	34.13	45.73	0.074	1.44
15.748	1.55	9.583	133.20	11.90	12	0.85%	2.7	47%	1.74	0.00	1.74	0	0.91	0.05	0.97	1.0	0.051	34.47	46.37	0.074	1.46
15.912	1.53	10.004	139.05	12.41	12	0.76%	2.6	47%	1.75	0.00	1.75	0	0.91	0.05	0.97	1.0	0.051	34.65	47.06	0.075	1.47
16.076	1.52	10.129	140.80	12.69	12	0.77%	2.6	47%	1.76	0.00	1.76	0	0.91	0.05	0.97	1.0	0.051	34.75	47.44	0.075	1.48
16.240	1.51	10.072	140.00	12.67	12	0.79%	2.6	47%	1.77	0.00	1.77	0	0.91	0.05	0.97	1.0	0.051	34.75	47.42	0.075	1.48
16.404	1.50	12.583	174.91	15.69	16	0.54%	2.5	47%	1.78	0.00	1.78	0	0.90	0.05	0.96	1.0	0.050	35.80	51.49	0.079	1.57
16.568	1.49	12.495	173.68	15.64	16	0.69%	2.5	47%	1.79	0.00	1.79	0	0.90	0.05	0.96	1.0	0.050	35.79	51.43	0.079	1.57
16.732	1.48	12.319	171.23	15.32	15	0.65%	2.5	47%	1.80	0.00	1.80	0	0.90	0.05	0.96	1.0	0.050	35.67	50.99	0.078	1.56
16.896	1.47	11.205	155.74	14.07	14	1.02%	2.6	47%	1.81	0.00	1.81	0	0.90	0.05	0.96	1.0	0.050	35.24	49.31	0.077	1.53
17.060	1.46	11.230	156.10	14.11	14	0.77%	2.6	47%	1.82	0.00	1.82	1	0.90	0.05	0.96	1.0	0.050	35.25	49.37	0.077	1.53
17.224	1.45	10.878	151.21	13.61	13	0.63%	2.6	47%	1.83	0.01	1.82	1	0.90	0.05	0.96	1.0	0.050	35.07	48.68	0.076	1.52
17.388	1.44	8.687	120.75	11.19	11	0.82%	2.7	47%	1.84	0.01	1.83	1	0.90	0.05	0.97	1.0	0.050	34.22	45.41	0.073	1.45
17.552	1.43	8.544	118.76	10.92	10	0.82%	2.7	47%	1.85	0.02	1.83	1	0.90	0.05	0.97	1.0	0.050	34.13	45.05	0.073	1.45
17.716	1.42	7.782	108.16	9.99	9	1.03%	2.8	71%	1.86	0.02	1.84	1	0.89	0.05	0.97	1.0	0.051	33.57	43.56	0.072	1.42
17.880	1.41	7.283	101.24	9.42	9	0.89%	2.8	71%	1.87	0.03	1.84	1	0.89	0.04	0.97	1.0	0.051	33.37	42.79	0.071	1.40
18.044	1.41	7.873	109.44	9.93	9	0.67%	2.7	71%	1.88	0.03	1.85	1	0.89	0.05	0.97	1.0	0.051	33.55	43.48	0.072	1.41
18.208	1.40	6.570	91.32	8.48	7	0.86%	2.8	71%	1.89	0.04	1.85	1	0.89	0.04	0.97	1.0	0.051	33.04	41.53	0.070	1.38
18.372	1.39	6.824	94.85	8.78	8	0.82%	2.8	71%	1.90	0.04	1.85	1	0.89	0.04	0.97	1.0	0.051	33.15	41.93	0.070	1.38
18.537	1.38	7.489	104.10	9.57	9	0.73%	2.8	71%	1.91	0.05	1.86	1	0.89	0.04	0.97	1.0	0.051	33.42	42.99	0.071	1.40

Liquefaction Triggering Analyses – Youd et al. (2001) / Idriss & Boulanger (2008)

Depth (ft)	r_d	D_r	f	K_σ	K_a	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	CN	qc1 TSF	qc1 MPa	qc1N
12.139	0.93	0.14	0.80	1.16	1.0	0.035	5.14	30.39	0.075	3.92	2.60	2	1.7	5.0926	0.4876	5.915
12.303	0.93	0.16	0.80	1.16	1.0	0.035	4.60	34.31	0.079	4.05	2.68	2	1.7	6.4161	0.6143	7.452
12.467	0.93	0.24	0.80	1.16	1.0	0.035	3.62	61.90	0.102	5.21	3.38	2	1.7	14.743	1.4115	17.123
12.631	0.93	0.22	0.80	1.16	1.0	0.036	4.24	61.11	0.101	5.12	3.30	2	1.7	12.408	1.1879	14.411
12.795	0.93	0.16	0.80	1.16	1.0	0.036	6.74	50.12	0.092	4.60	2.95	2	1.7	6.3988	0.6126	7.432
12.959	0.93	0.15	0.80	1.15	1.0	0.036	6.60	45.43	0.088	4.36	2.83	2	1.7	5.9295	0.5677	6.887
13.123	0.93	0.15	0.80	1.15	1.0	0.036	6.40	45.53	0.088	4.32	2.82	2	1.7	6.1261	0.5865	7.115
13.287	0.93	0.16	0.80	1.15	1.0	0.036	6.65	50.32	0.092	4.47	2.90	2	1.7	6.5149	0.6237	7.567
13.451	0.93	0.17	0.80	1.15	1.0	0.036	5.40	49.36	0.091	4.40	2.88	2	1.7	7.8745	0.7539	9.146
13.615	0.93	0.19	0.80	1.14	1.0	0.036	4.34	46.27	0.089	4.24	2.81	2	1.693906	9.1838	0.8793	10.666
13.779	0.93	0.17	0.80	1.14	1.0	0.036	5.57	50.85	0.092	4.37	2.87	2	1.681453	7.862	0.7527	9.131
13.943	0.93	0.17	0.80	1.14	1.0	0.036	6.12	53.22	0.094	4.42	2.89	2	1.669208	7.4881	0.7169	8.697
14.107	0.93	0.17	0.80	1.14	1.0	0.036	6.02	53.54	0.094	4.40	2.88	2	1.657163	7.6529	0.7327	8.888
14.271	0.93	0.17	0.80	1.14	1.0	0.036	5.96	52.69	0.094	4.33	2.85	2	1.645315	7.6096	0.7285	8.838
14.436	0.92	0.17	0.80	1.13	1.0	0.036	5.44	48.21	0.090	4.14	2.75	2	1.633658	7.6255	0.7301	8.857
14.600	0.92	0.16	0.80	1.13	1.0	0.036	6.51	48.41	0.090	4.12	2.73	2	1.622188	6.3999	0.6127	7.433
14.764	0.92	0.15	0.80	1.13	1.0	0.036	5.93	40.97	0.084	3.81	2.57	2	1.6109	5.9497	0.5696	6.910
14.928	0.92	0.15	0.80	1.13	1.0	0.036	5.06	35.03	0.079	3.56	2.44	2	1.599789	5.9662	0.5712	6.929
15.092	0.92	0.16	0.80	1.13	1.0	0.036	5.81	42.99	0.086	3.83	2.58	2	1.588851	6.3753	0.6104	7.405
15.256	0.92	0.20	0.80	1.12	1.0	0.036	3.86	46.90	0.089	3.94	2.70	2	1.578083	10.456	1.001	12.144
15.420	0.92	0.20	0.80	1.12	1.0	0.036	4.27	49.65	0.091	4.02	2.73	2	1.567479	10.02	0.9593	11.637
15.584	0.92	0.20	0.80	1.12	1.0	0.036	4.23	49.10	0.091	3.97	2.71	2	1.557036	9.9872	0.9562	11.599
15.748	0.91	0.20	0.80	1.12	1.0	0.036	3.75	44.62	0.087	3.77	2.62	2	1.545575	10.244	0.9807	11.897
15.912	0.91	0.20	0.80	1.12	1.0	0.036	3.49	43.25	0.086	3.70	2.58	2	1.534305	10.681	1.0226	12.406
16.076	0.91	0.21	0.80	1.11	1.0	0.036	3.44	43.65	0.086	3.68	2.58	2	1.52322	10.924	1.0458	12.687
16.240	0.91	0.21	0.80	1.11	1.0	0.036	3.49	44.25	0.087	3.67	2.58	2	1.512317	10.91	1.0445	12.671
16.404	0.91	0.23	0.80	1.11	1.0	0.036	2.60	40.77	0.084	3.52	2.55	2	1.501589	13.509	1.2934	15.690
16.568	0.91	0.23	0.80	1.11	1.0	0.036	2.82	44.05	0.087	3.61	2.59	2	1.491034	13.467	1.2894	15.642
16.732	0.91	0.23	0.80	1.11	1.0	0.036	2.81	43.12	0.086	3.55	2.56	2	1.480646	13.189	1.2627	15.318
16.896	0.90	0.22	0.80	1.10	1.0	0.036	3.53	49.61	0.091	3.75	2.64	2	1.470421	12.116	1.16	14.072
17.060	0.90	0.22	0.80	1.10	1.0	0.036	3.20	45.13	0.088	3.57	2.55	2	1.460356	12.152	1.1635	14.114
17.224	0.90	0.21	0.80	1.10	1.0	0.036	3.09	42.01	0.085	3.43	2.47	2	1.450447	11.717	1.1218	13.609
17.388	0.90	0.19	0.80	1.10	1.0	0.036	3.97	44.45	0.087	3.47	2.46	2	1.440689	9.6307	0.922	11.185
17.552	0.90	0.19	0.80	1.10	1.0	0.037	4.06	44.36	0.087	3.44	2.44	2	1.43108	9.4034	0.9003	10.922
17.716	0.90	0.18	0.80	1.09	1.0	0.037	4.73	47.21	0.089	3.50	2.46	2	1.422587	8.6025	0.8236	9.991
17.880	0.90	0.18	0.80	1.09	1.0	0.037	4.73	44.60	0.087	3.38	2.39	2	1.414208	8.1121	0.7767	9.422
18.044	0.90	0.18	0.80	1.09	1.0	0.037	4.15	41.21	0.084	3.25	2.33	2	1.405941	8.5532	0.8189	9.934
18.208	0.89	0.17	0.80	1.09	1.0	0.037	5.14	43.60	0.086	3.29	2.33	2	1.397782	7.3045	0.6993	8.484
18.372	0.89	0.17	0.80	1.09	1.0	0.037	4.92	43.24	0.086	3.25	2.32	2	1.389731	7.5595	0.7238	8.780
18.537	0.89	0.18	0.80	1.09	1.0	0.037	4.42	42.33	0.085	3.20	2.30	2	1.381785	8.2375	0.7887	9.567

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-8N

Data File: 13-52106_SP3-8N-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69
Youd, et al (2001)	
Max Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5604.90	Water surface elevation during CPT investigation (f
5600.09	Water surface elevation at t_0 (ft amsl)
5595.24	Water surface elevation at t_1 (ft amsl)
5590.24	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ea
7.51	Equiv. Number of Uniform Strain Cycles, N

5608.37	Ground Surface Elevation at time of CPT (ft amsl)
5623.82	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
7.95	Thickness of Random/Platform Fill on top of existing interim cover (ft)
1646.57	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5590.24	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5623.57	5623.32	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
ater Storage/Rooting Zone Layer	######	5621.57	5619.82	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5618.07	5616.32	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320
Platform/Random Fill Layer	######	5612.35	5608.37	7.95	0.050	101	0.825	0.624	0.00	0.00	0.825	0.624

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
0.164	5608.21	4.6	0.040	4.6	1.7	0.73	0.87%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	7.837	108.93	9.12	558	0.87%	1.4	51%	0.83	0.00	0.83	0
0.328	5608.04	22.0	0.044	22.0	2.8	1.22	0.20%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	37.315	518.68	43.37	1329	0.20%	0.6	51%	0.84	0.00	0.84	0
0.492	5607.88	41.2	0.114	41.1	4.2	1.81	0.28%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	69.938	972.14	81.28	1660	0.28%	0.7	51%	0.85	0.00	0.85	0
0.656	5607.71	59.5	0.362	59.4	4.7	2.05	0.61%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	101.031	######	117.40	1798	0.61%	1.0	51%	0.86	0.00	0.86	0
0.820	5607.55	65.8	0.430	65.7	4.5	1.93	0.65%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	111.758	######	129.86	1591	0.65%	1.1	51%	0.86	0.00	0.86	0
0.984	5607.39	69.7	0.402	69.6	3.8	1.66	0.58%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	118.371	######	137.53	1404	0.58%	1.0	51%	0.87	0.00	0.87	0
1.148	5607.22	68.4	0.655	68.4	3.8	1.64	0.96%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	116.314	######	135.14	1183	0.96%	1.3	51%	0.88	0.00	0.88	0
1.312	5607.06	77.9	0.651	77.9	3.0	1.29	0.84%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	132.464	######	153.89	1178	0.84%	1.2	51%	0.89	0.00	0.89	0
1.476	5606.89	71.1	0.676	71.0	6.8	2.96	0.95%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	120.768	######	140.35	955	0.95%	1.3	51%	0.90	0.00	0.90	0
1.640	5606.73	61.8	0.871	61.7	6.0	2.61	1.41%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	104.941	######	121.96	747	1.41%	1.5	51%	0.91	0.00	0.91	0
1.804	5606.57	70.3	1.290	70.3	5.1	2.22	1.83%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	119.476	######	138.83	773	1.84%	1.6	51%	0.91	0.00	0.91	0
1.968	5606.40	106.9	2.471	106.9	8.4	3.62	2.31%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	181.679	######	211.11	1078	2.31%	1.6	51%	0.92	0.00	0.92	0
2.133	5606.24	99.5	2.832	99.4	11.5	4.99	2.85%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	168.997	######	196.42	925	2.85%	1.7	51%	0.93	0.00	0.93	0
2.297	5606.07	93.6	3.017	93.6	6.8	2.93	3.22%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	159.035	######	184.79	808	3.23%	1.8	51%	0.94	0.00	0.94	0
2.461	5605.91	68.6	2.531	68.6	1.4	0.62	3.69%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	116.569	######	135.41	552	3.70%	1.9	51%	0.95	0.00	0.95	0
2.625	5605.75	95.3	2.541	95.3	9.0	3.88	2.67%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.70	161.976	######	188.24	720	2.67%	1.8	51%	0.96	0.00	0.96	0
2.789	5605.58	99.4	3.003	99.4	5.2	2.27	3.02%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0	1.70	168.912	######	196.25	707	3.03%	1.8	51%	0.96	0.00	0.96	0
2.953	5605.42	96.2	3.312	96.2	12.2	5.30	3.44%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0	1.70	163.489	######	190.03	646	3.45%	1.9	51%	0.97	0.00	0.97	0
3.117	5605.25	92.1	3.557	92.0	12.7	5.51	3.86%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0	1.70	156.451	######	181.87	586	3.87%	1.9	51%	0.98	0.00	0.98	0
3.281	5605.09	80.8	3.387	80.6	37.5	16.27	4.19%	Slime Tailings	0.041	82.7	0.16	0.00	0.16	0	1.70	137.037	######	159.62	493	4.20%	2.0	71%	0.99	0.00	0.99	0
3.445	5604.93	122.2	2.584	121.9	40.5	17.53	2.12%	Sand Tailings	0.051	102.8	0.17	0.00	0.17	0	1.61	195.753	######	227.83	708	2.12%	1.7	18%	1.00	0.00	1.00	0
3.609	5604.76	107.6	2.292	107.6	12.0	5.18	2.13%	Sand-Slime Tailing	0.059	119.0	0.18	0.00	0.18	1	1.66	178.278	######	207.20	605	2.13%	1.7	47%	1.01	0.00	1.01	0
3.773	5604.60	78.1	1.653	78.1	6.0	2.59	2.12%	Sand-Slime Tailing	0.059	119.0	0.19	0.01	0.18	1	1.70	132.702	######	154.20	427	2.12%	1.8	47%	1.01	0.00	1.01	0
3.937	5604.43	66.3	1.592	66.2	9.0	3.89	2.40%	Sand-Slime Tailing	0.059	119.0	0.20	0.01	0.19	1	1.70	112.540	######	130.82	353	2.41%	1.8	47%	1.02	0.00	1.02	0
4.101	5604.27	57.7	1.714	57.7	8.7	3.75	2.97%	Sand-Slime Tailing	0.059	119.0	0.21	0.02	0.19	1	1.70	98.005	######	113.93	300	2.98%	2.0	47%	1.03	0.00	1.03	0
4.265	5604.10	99.5	1.694	99.3	20.2	8.74	1.70%	Sand Tailings	0.062	123.5	0.22	0.02	0.20	1	1.66	164.464	######	191.26	505	1.71%	1.6	18%	1.04	0.00	1.04	0
4.429	5603.94	96.3	1.854	96.2	10.5	4.55	1.93%	Sand Tailings	0.062	123.5	0.23	0.03	0.20	1	1.66	159.735	######	185.65	477	1.93%	1.7	18%	1.05	0.00	1.05	0
4.593	5603.78	87.1	1.742	87.0	10.5	4.55	2.00%	Sand-Slime Tailing	0.059	119.0	0.24	0.04	0.21	1	1.70	147.593	######	171.55	421	2.01%	1.7	47%	1.06	0.00	1.06	0
4.757	5603.61	81.0	1.555	81.0	10.4	4.50	1.92%	Sand-Slime Tailing	0.059	119.0	0.25	0.04	0.21	1	1.70	137.632	######	159.98	383	1.93%	1.7	47%	1.07	0.00	1.07	0
4.921	5603.45	82.4	1.088	82.4	10.5	4.56	1.32%	Sand Tailings	0.062	123.5	0.26	0.05	0.22	1	1.70	139.914	######	162.63	381	1.32%	1.6	18%	1.08	0.00	1.08	0
5.085	5603.28	81.0	1.231	80.9	13.0	5.62	1.52%	Sand Tailings	0.062	123.5	0.27	0.05	0.22	1	1.70	137.217	######	159.53	366	1.52%	1.7	18%	1.09	0.00	1.09	0
5.249	5603.12	70.7	1.164	70.7	9.2	3.98	1.65%	Sand Tailings	0.062	123.5	0.28	0.06	0.23	1	1.70	120.105	######	139.61	312	1.65%	1.7	18%	1.10	0.00	1.10	0
5.413	5602.96	85.1	0.966	85.1	8.1	3.51	1.14%	Sand Tailings	0.062	123.5	0.29	0.06	0.23	1	1.65	140.603	######	163.40	367	1.14%	1.6	18%	1.11	0.00	1.11	0
5.577	5602.79	64.0	0.689	64.0	6.3	2.74	1.08%	Sand Tailings	0.062	123.5	0.30	0.07	0.24	1	1.70	108.817	######	126.46	270	1.08%	1.6	18%	1.12	0.00	1.12	0
5.741	5602.63	47.9	0.475	47.9	3.6	1.57	0.99%	Sand Tailings	0.062	123.5	0.31	0.07	0.24	1	1.70	81.396	######	94.58	198	1.00%	1.7	18%	1.14	0.00	1.14	0
5.905	5602.46	40.9	0.332	40.9	2.7	1.18	0.81%	Sand Tailings	0.062	123.5	0.32	0.08	0.25	1	1.70	69.462	965.52	80.71	165	0.82%	1.7	18%	1.15	0.00	1.15	0
6.069	5602.30	39.0	0.287	39.0	2.6	1.11	0.74%	Sand Tailings	0.062	123.5	0.33	0.08	0.25	1	1.70	66.317	921.81	77.05	154	0.74%	1.7	18%	1.16	0.00	1.16	0
6.234	5602.14	40.0	0.341	40.0	2.0	0.85	0.85%	Sand Tailings	0.062	123.5	0.34	0.09	0.26	1	1.70	67.932	944.25	78.92	155	0.86%	1.7	18%	1.17	0.00	1.17	0
6.398	5601.97	40.0	0.355	40.0	2.8	1.20	0.89%	Sand Tailings	0.062	123.5	0.35	0.09	0.26	1	1.70	67.915	944.02	78.91	152	0.90%	1.7	18%	1.18	0.00	1.18	0
6.562	5601.81	40.0	0.387	40.0	3.0	1.30	0.97%	Sand Tailings	0.062	123.5	0.36	0.10	0.27	1	1.70	67.915	944.02	78.92	149	0.98%	1.8	18%	1.19	0.00	1.19	0
6.726	5601.64	43.0	0.411	42.9	3.4	1.47	0.96%	Sand Tailings	0.062	123.5	0.37	0.10	0.27	1	1.70	72.998	######	84.82	157	0.97%	1.8	18%	1.20	0.00	1.20	0
6.890	5601.48	43.2	0.434	43.2	4.0	1.72	1.00%	Sand Tailings	0.062	123.5	0.38	0.11	0.28	1	1.70	73.406	######	85.31	155	1.01%	1.8	18%	1.21	0.00	1.21	0
7.054	5601.32	39.0	0.417	39.0	3.6	1.56	1.07%	Sand-Slime Tailing	0.059	119.0	0.39	0.11	0.28	1	1.70	66.249	920.86	76.99	138	1.08%	1.8	47%	1.22	0.00	1.22	0
7.218	5601.15	35.2	0.330	35.2	3.4	1.46	0.94%	Sand-Slime Tailing	0.059	119.0	0.40	0.12	0.29	1	1.70	59.840	831.78	69.54	122	0.95%	1.8	47%	1.23	0.00	1.23	0
7.382	5600.99	32.9	0.239	32.9	3.5	1.53	0.73%	Sand-Slime Tailing	0.059	119.0	0.41	0.12	0.29	1	1.70	55.845	776.25	64.90	112	0.74%	1.8	47%	1.24	0.00	1.24	0
7.546	5600.82	30.1	0.219	30.0	3.5	1.51	0.73%	Sand-Slime Tailing	0.059	119.0	0.42	0.13	0.29	1	1.70	51.051	709.61	59.34	101	0.74%	1.8	47%	1.24	0.00	1.24	0
7.710	5600.66	27.5	0.248	27.5	4.2	1.82	0.90%	Sand-Slime Tailing	0.059	119.0	0.43	0.13	0.30	1	1.70	46.716	649.35	54.31	91	0.92%	1.9	47%	1.25	0.00	1.25	0
7.874	5600.50	19.6	0.239	19.6	6.2	2.68	1.22%	Sand-Slime Tailing	0.059	119.0	0.44	0.14	0.30	1	1.70	33.269	462.44	38.72	63	1.25%	2.1	47%	1.26	0.00	1.26	0
8.038	5600.33	18.1	0.197	18.0	10.3	4.48	1.09%	Sand-Slime Tailing	0.059	119.0	0.45	0.14	0.31	1	1.70	30.651	426.05	35.73	57	1.12%	2.1	47%	1.27	0.00	1.27	0
8.202	5600.17	23.6	0.205	23.5	21.5	9.32	0.87%	Sand-Slime Tailing	0.059	119.0	0.46	0.15	0.31	1	1.70	39.865	554.12	46.57	74	0.89%	2.0	47%	1.28	0.00	1.28	0
8.366	5600.00	25.6	0.288	25.5	14.2	6.17	1.13%	Sand-Slime Tailing	0.059	119.0	0.47	0.15	0.32	1	1.70	43.316	602.09	50.48	79	1.15%	2.0	47%	1.29	0.00	1.29	0
8.530	5599.84	29.3	0.323	29.2	8.4	3.65	1.10%	Sand-Slime Tailing	0.059	119.0	0.48	0.16	0.32	1	1.70	49.708	690.94	57.84	89	1.12%	2.0	47%	1.30	0.00	1.30	0
8.694	5599.68	30.7	0.209	30.7	6.5	2.83	0.68%	Sand-Slime Tailing	0.059	119.0	0.49	0.16	0.33	1	1.70	52.173	725.20	60.68	92	0.69%	1.8	47%	1.31	0.00	1.31	0
8.858	5599.51	33.0	0.238	32.9	7.2	3.11	0.72%	Sand-Slime Tailing	0.059	119.0	0.50	0.17	0.33	1	1.70	55.964	777.90	65.09	98	0.73%	1.8	47%	1.32	0.00	1.32	0
9.022	5599.35	32.8	0.289	32.7	11.2	4.85	0.88%	Sand-Slime Tailing	0.059	119.0	0.51	0.17	0.34	1	1.70	55.573	772.46	64.68	96	0.90%	1.9	47%	1.33	0.00	1.33	0
9.186	5599.18	31.3	0.342	31.3	6.6	2.86	1.09%	Sand-Slime Tailing	0.059	119.0	0.52	0.18	0.34	1	1.70	53.193	739.38	61.86	90	1.11%	2.0	47%	1.34	0.00	1.34	0
9.350	5599.02	29.8	0.381	29.8	8.8	3.81	1.28%	Sand-Slime Tailing	0.059	119.0	0.53	0.18	0.35	1	1.70	50.575	702.99	58.85	85	1.30%	2.0	47%	1.35	0.00	1.35	0
9.514	5598.86	25.7	0.381	25.6	10.2	4.40	1.48%	Sand-Slime Tailing	0.059	119.0	0.54	0.19	0.35	1	1.70	43.537	605.16	50.69	72	1.52%	2.1	47%	1.36	0.00	1.36	0
9.678	5598.69	21.5	0.318	21.5	11.1	4.80	1.48%	Sand-Slime Tailing	0.059	119.0	0.55	0.19	0.35	1	1.70	36.482	507.10	42.51	59	1.52%	2.2	47%	1.37	0.00	1.37	0
9.842	5598.53	16.4	0.157	16.3	10.5	4.54	0.96%	Sand-Slime Tailing	0.059	119.0	0.56	0.20	0.36	1	1.70	27.693	384.93	32.29	44	0.99%	2.2	47%	1.38	0.00	1.38	0
10.006	5598.36	14.2	0.105	14.1	11.9	5.14	0.74%	Sand-Slime Tailing	0.059	119.0	0.57	0.20	0.36	1	1.70	24.004	333.66	28.03	37	0.77%	2.2	47%	1.39	0.00	1.39	0
10.170	5598.20	15.4	0.103	15.4	7.0	3.05	0.67%	Sand-Slime Tailing	0.059	119.0	0.58	0.21	0.37	1	1.70	26.180	363.90	30.49	40	0.69%	2.1	47%	1.40	0.00	1.40	0
10.335	5598.04	16.1	0.128	16.1	4.8	2.09	0.79%	Sand-Slime Tailing	0.059	119.0	0.59	0.21	0.37	1	1.70	27.370	380.44	31.85	42	0.82%	2.2	47%	1.41	0.00	1.41	0
10.499	5597.87	14.5	0.162	14.4	6.6	2.86	1.12%	Sand-Slime Tailing	0.059	119.0	0.60	0.22	0.38	1	1.70	24.548	341.22	28.59	37	1.17%	2.3	47%	1.42	0.00	1.42	0
10.663	5597.71	14.4	0.178	14.4	8.8	3.80	1.23%	Sand-Slime Tailing	0.059	119.0	0.61	0.22	0.38	1	1.70	24.446	339.80	28.50	36	1.29%	2.3	47%	1.43	0.00	1.43	0
10.827	5597.54	16.9	0.242	16.8	10.1	4.39	1.44%	Sand-Slime Tailing	0.059	119.0	0.62	0.23	0.39	1	1.70	28.560	396.98	33.30	42	1.49%	2.3	47%	1.44	0.00	1.44	0
10.991	5597.38	15.0	0.248	14.9	10.7	4.62	1.66%	Sand-Slime Tailing	0.059	119.0	0.63	0.23	0.39	1	1.70	25.313	351.85	29.53	37	1.73%	2.4	47%	1.45	0.00	1.45	0
11.155	5597.22	12.9	0.198	12.8	12.5	5.43	1.54%	Sand-Slime Tailing	0.059	119.0	0.64	0.24	0.40	1	1.70	21.726	301.99	25.39	31	1.62%	2.4	47%	1.46	0.00	1.46	0
11.319	5597.05	11.6	0.168	11.5	17.1	7.40	1.45%	Sand-Slime Tailing	0.059	119.0	0.65	0.24	0.40	1	1.70	19.567	271.98	22.94	27	1.53%	2.5	47%	1.47	0.00	1.47	0
11.483	5596.89	11.7	0.133	11.5	23.8	10.31	1.14%	Sand-Slime Tailing	0.059	119.0	0.66	0.25	0.41	1	1.70	19.567	271.98	23.02	27	1.21%	2.4	47%	1.48	0.00	1.48	0
11.647	5596.72	12.6	0.172	12.4	30.6	13.24	1.37%	Sand-Slime Tailing	0.059	119.0	0.67	0.26	0.41	1	1.70	21.080	293.01	24.86	29	1.44%	2.4	47%	1.49	0.00	1.49	0
11.811	5596.56	15.5	0.198	15.4	20.6	8.94	1.28%	Sand-Slime Tailing	0.059	119.0	0.68	0.26	0.42	1	1.70	26.110	362.93	30.58	36	1.33%	2.3	47%	1.50	0.00	1.50	0
11.975	5596.40	18.6	0.272	18.5	20.1	8.70	1.46%	Sand-Slime Tailing	0.059	119.0	0.69	0.27	0.42	1	1.65	30.471	423.55	35.63	43	1.52%	2.3	47%	1.51	0.00	1.51	0

Liquefaction Triggering Analyses

Depth (ft)	Idriss & Boulanger (2008) Cyclic Stress Ratio r_d	C_σ	K_σ	K_a	CSR M=7.5, s'v=1atm	Cyclic Resistance Ratio Δqc_{1n}	$qc_{1n\text{-}cs}$	(CRR) M=7.5, s'v=1atm	FoS	Youd et al. (2001) Cyclic Stress Ratio r_d	D_r	f	K_σ	K_a	CSR M=7.5, s'v=1atm	Kc	$qc_{1n\text{-}cs}$	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
0.164	1.00	0.04	1.00	1.0	0.058	33.52	42.65	0.071	1.22	0.96	0.17	0.80	2.53	1.0	0.017	1.00	9.12	0.058	141.30	71.26	2
0.328	1.00	0.07	1.00	1.0	0.058	45.54	88.92	0.125	2.16	0.96	0.38	0.80	2.20	1.0	0.019	1.00	43.37	0.086	105.69	53.93	2
0.492	1.00	0.09	1.00	1.0	0.058	58.84	140.12	0.233	4.02	0.96	0.52	0.74	2.52	1.0	0.017	1.00	81.28	0.130	106.34	55.18	2
0.656	1.00	0.12	1.00	1.0	0.058	71.52	188.92	0.721	12.47	0.96	0.63	0.69	2.77	1.0	0.015	1.00	117.40	0.230	141.52	76.99	2
0.820	1.00	0.13	1.00	1.0	0.058	75.89	205.75	1.000	17.31	0.96	0.66	0.67	2.72	1.0	0.016	1.00	129.86	0.284	139.38	78.34	2
0.984	1.00	0.14	1.00	1.0	0.058	78.58	216.11	1.000	17.33	0.96	0.68	0.66	2.63	1.0	0.016	1.00	137.53	0.322	131.88	74.60	2
1.148	1.00	0.14	1.00	1.0	0.058	77.74	212.88	1.000	17.35	0.96	0.67	0.66	2.48	1.0	0.017	1.00	135.14	0.310	108.73	63.04	2
1.312	1.00	0.17	0.99	1.0	0.057	84.32	238.21	1.000	17.39	0.96	0.72	0.64	2.51	1.0	0.017	1.00	153.89	0.419	128.81	73.10	2
1.476	1.00	0.15	0.99	1.0	0.057	79.57	219.92	1.000	17.41	0.96	0.68	0.66	2.31	1.0	0.018	1.00	140.35	0.337	92.18	54.79	2
1.640	1.00	0.13	0.99	1.0	0.057	73.12	195.08	0.917	15.97	0.96	0.64	0.68	2.11	1.0	0.020	1.00	121.96	0.249	61.23	38.60	2
1.804	1.00	0.15	0.99	1.0	0.057	79.04	217.87	1.000	17.45	0.96	0.68	0.66	2.15	1.0	0.020	1.00	138.83	0.329	73.63	45.54	2
1.968	1.00	0.30	0.98	1.0	0.057	104.41	315.52	1.000	17.68	0.96	0.84	0.60	2.37	1.0	0.018	1.00	210.84	1.000	205.32	111.50	2
2.133	1.00	0.25	0.98	1.0	0.057	99.25	295.67	1.000	17.67	0.96	0.81	0.60	2.30	1.0	0.018	1.07	210.34	1.000	189.61	103.64	2
2.297	1.00	0.22	0.98	1.0	0.057	95.17	279.96	1.000	17.68	0.96	0.78	0.61	2.20	1.0	0.019	1.12	206.98	1.000	176.13	96.91	2
2.461	1.00	0.14	0.99	1.0	0.057	77.84	213.24	1.000	17.59	0.96	0.67	0.66	1.92	1.0	0.022	1.22	165.03	1.000	164.46	91.02	2
2.625	1.00	0.23	0.98	1.0	0.056	96.38	284.61	1.000	17.80	0.96	0.79	0.60	2.10	1.0	0.020	1.08	202.56	1.000	154.24	86.02	2
2.789	0.99	0.25	0.97	1.0	0.056	99.19	295.43	1.000	17.90	0.96	0.81	0.60	2.07	1.0	0.020	1.11	218.70	1.000	145.22	81.56	2
2.953	0.99	0.24	0.97	1.0	0.056	97.01	287.04	1.000	17.91	0.96	0.80	0.60	2.01	1.0	0.021	1.17	221.96	1.000	137.21	77.56	2
3.117	0.99	0.22	0.97	1.0	0.056	94.14	276.01	1.000	17.92	0.96	0.78	0.61	1.94	1.0	0.022	1.23	223.34	1.000	130.04	73.98	2
3.281	0.99	0.17	0.98	1.0	0.056	85.67	245.30	1.000	17.86	0.96	0.73	0.64	1.83	1.0	0.023	1.30	207.57	1.000	124.71	71.28	2
3.445	0.99	0.30	0.96	1.0	0.055	80.33	308.16	1.000	18.24	0.96	0.87	0.60	1.90	1.0	0.022	1.01	231.08	1.000	118.64	68.44	2
3.609	0.99	0.29	0.96	1.0	0.055	102.97	310.17	1.000	18.28	0.96	0.83	0.60	1.88	1.0	0.022	1.03	214.34	1.000	115.07	66.67	2
3.773	0.99	0.17	0.97	1.0	0.056	84.38	238.58	1.000	17.97	0.96	0.72	0.64	1.74	1.0	0.024	1.08	166.26	1.000	112.18	65.08	2
3.937	0.99	0.14	0.98	1.0	0.056	76.18	207.00	1.000	17.92	0.95	0.66	0.67	1.66	1.0	0.025	1.14	149.61	0.391	42.84	30.38	2
4.101	0.99	0.12	0.98	1.0	0.056	70.26	184.19	0.612	10.95	0.95	0.62	0.69	1.59	1.0	0.026	1.26	143.03	0.352	37.62	24.29	2
4.265	0.99	0.24	0.95	1.0	0.054	70.98	262.24	1.000	18.38	0.95	0.80	0.60	1.80	1.0	0.023	1.00	190.83	1.000	104.15	61.26	2
4.429	0.99	0.22	0.95	1.0	0.054	69.55	255.20	1.000	18.38	0.95	0.79	0.61	1.77	1.0	0.024	1.04	192.83	1.000	101.60	59.99	2
4.593	0.98	0.19	0.96	1.0	0.055	90.47	262.02	1.000	18.32	0.95	0.76	0.62	1.72	1.0	0.024	1.07	182.82	1.000	99.36	58.84	2
4.757	0.98	0.17	0.96	1.0	0.055	86.41	246.39	1.000	18.29	0.95	0.73	0.63	1.67	1.0	0.025	1.07	171.03	1.000	97.21	57.75	2
4.921	0.98	0.18	0.96	1.0	0.054	63.67	226.30	1.000	18.36	0.95	0.74	0.63	1.66	1.0	0.025	1.00	162.63	1.000	94.99	56.67	2
5.085	0.98	0.17	0.96	1.0	0.054	62.87	222.40	1.000	18.38	0.95	0.73	0.64	1.64	1.0	0.026	1.02	162.38	1.000	92.87	55.63	2
5.249	0.98	0.15	0.96	1.0	0.055	57.78	197.39	1.000	18.30	0.95	0.68	0.66	1.58	1.0	0.027	1.06	148.48	0.384	34.93	26.61	2
5.413	0.98	0.18	0.95	1.0	0.054	63.86	227.26	1.000	18.51	0.95	0.74	0.63	1.63	1.0	0.026	1.00	163.40	1.000	88.91	53.71	2
5.577	0.98	0.13	0.96	1.0	0.055	54.42	180.88	0.550	10.08	0.95	0.65	0.68	1.52	1.0	0.028	1.00	126.46	0.268	23.34	16.71	2
5.741	0.98	0.10	0.97	1.0	0.055	46.27	140.85	0.235	4.28	0.95	0.56	0.72	1.43	1.0	0.029	1.03	97.70	0.167	14.22	9.25	2
5.905	0.98	0.09	0.97	1.0	0.055	42.72	123.43	0.187	3.40	0.95	0.52	0.74	1.38	1.0	0.030	1.03	83.17	0.134	11.16	7.28	2
6.069	0.98	0.09	0.97	1.0	0.055	41.79	118.84	0.177	3.22	0.95	0.51	0.75	1.37	1.0	0.031	1.03	79.07	0.126	10.32	6.77	2
6.234	0.98	0.09	0.97	1.0	0.055	42.27	121.19	0.182	3.32	0.95	0.51	0.74	1.36	1.0	0.031	1.05	83.18	0.134	10.73	7.03	2
6.398	0.97	0.09	0.97	1.0	0.055	42.26	121.18	0.182	3.33	0.95	0.51	0.74	1.36	1.0	0.031	1.07	84.14	0.135	10.68	7.00	2
6.562	0.97	0.09	0.97	1.0	0.055	42.26	121.18	0.182	3.33	0.95	0.51	0.74	1.35	1.0	0.031	1.09	85.86	0.139	10.75	7.04	2
6.726	0.97	0.09	0.97	1.0	0.054	43.77	128.60	0.199	3.66	0.95	0.53	0.73	1.36	1.0	0.031	1.07	91.07	0.150	11.42	7.54	2
6.890	0.97	0.09	0.97	1.0	0.054	43.90	129.20	0.201	3.70	0.95	0.53	0.73	1.35	1.0	0.031	1.09	92.69	0.154	11.50	7.60	2
7.054	0.97	0.09	0.97	1.0	0.054	57.30	134.29	0.215	3.95	0.95	0.51	0.75	1.33	1.0	0.031	1.13	86.86	0.141	10.35	7.15	2
7.218	0.97	0.08	0.97	1.0	0.054	54.69	124.23	0.189	3.47	0.95	0.48	0.76	1.30	1.0	0.032	1.13	78.48	0.125	9.03	6.25	2
7.382	0.97	0.08	0.97	1.0	0.054	53.06	117.97	0.175	3.23	0.95	0.47	0.77	1.29	1.0	0.032	1.10	71.31	0.114	8.09	5.66	2
7.546	0.97	0.08	0.97	1.0	0.054	51.11	110.45	0.161	2.96	0.95	0.44	0.78	1.27	1.0	0.033	1.13	66.87	0.108	7.55	5.26	2
7.710	0.97	0.07	0.97	1.0	0.054	49.35	103.66	0.149	2.74	0.95	0.43	0.79	1.25	1.0	0.033	1.21	65.63	0.106	7.33	5.04	2
7.874	0.96	0.06	0.98	1.0	0.054	43.88	82.60	0.116	2.14	0.95	0.36	0.80	1.23	1.0	0.034	1.50	58.23	0.098	6.69	4.41	2
8.038	0.96	0.06	0.98	1.0	0.054	42.83	78.56	0.111	2.04	0.95	0.35	0.80	1.23	1.0	0.034	1.51	54.07	0.095	6.34	4.19	2
8.202	0.96	0.07	0.97	1.0	0.054	46.63	93.20	0.132	2.43	0.94	0.39	0.80	1.22	1.0	0.034	1.28	59.48	0.100	6.57	4.50	2
8.366	0.96	0.07	0.97	1.0	0.054	48.01	98.49	0.140	2.59	0.94	0.41	0.79	1.23	1.0	0.034	1.34	67.52	0.109	7.07	4.83	2
8.530	0.96	0.08	0.97	1.0	0.054	50.59	108.42	0.157	2.92	0.94	0.44	0.78	1.24	1.0	0.034	1.27	73.69	0.117	7.52	5.22	2
8.694	0.96	0.08	0.97	1.0	0.054	51.58	112.26	0.164	3.06	0.94	0.45	0.78	1.24	1.0	0.033	1.14	68.98	0.111	6.99	5.03	2
8.858	0.96	0.08	0.97	1.0	0.053	53.13	118.22	0.176	3.29	0.94	0.47	0.77	1.25	1.0	0.033	1.13	73.73	0.117	7.32	5.30	2
9.022	0.96	0.08	0.96	1.0	0.053	52.99	117.67	0.175	3.27	0.94	0.46	0.77	1.24	1.0	0.033	1.18	76.56	0.122	7.50	5.38	2
9.186	0.96	0.08	0.97	1.0	0.053	52.00	113.86	0.167	3.13	0.94	0.45	0.77	1.23	1.0	0.034	1.27	78.34	0.125	7.58	5.36	2
9.350	0.96	0.08	0.97	1.0	0.053	50.94	109.79	0.159	2.99	0.94	0.44	0.78	1.22	1.0	0.034	1.35	79.72	0.127	7.63	5.31	2
9.514	0.95	0.07	0.97	1.0	0.053	48.08	98.77	0.141	2.63	0.94	0.41	0.79	1.20	1.0	0.035	1.53	77.35	0.123	7.29	4.96	2
9.678	0.95	0.07	0.97	1.0	0.053	45.21	87.72	0.124	2.31	0.94	0.38	0.80	1.19	1.0	0.035	1.67	70.98	0.113	6.62	4.47	2
9.842	0.95	0.06	0.97	1.0	0.053	41.63	73.92	0.105	1.96	0.94	0.33	0.80	1.19	1.0	0.035	1.66	53.47	0.094	5.44	3.70	2
10.006	0.95	0.06	0.97	1.0	0.053	40.13	68.16	0.097	1.82	0.94	0.31	0.80	1.19	1.0	0.035	1.66	46.45	0.089	5.06	3.44	2
10.170	0.95	0.06	0.97	1.0	0.053	41.00	71.49	0.101	1.90	0.94	0.32	0.80	1.18	1.0	0.035	1.54	47.04	0.089	5.02	3.46	2
10.335	0.95	0.06	0.97	1.0	0.053	41.47	73.32	0.104	1.95	0.94	0.33	0.80	1.18	1.0	0.035	1.60	50.94	0.092	5.14	3.54	2
10.499	0.95	0.06	0.97	1.0	0.053	40.33	68.92	0.098	1.85	0.94	0.31	0.80	1.18	1.0	0.035	1.95	55.63	0.096	5.28	3.56	2
10.663	0.95	0.06	0.97	1.0	0.053	40.30	68.80	0.098	1.85	0.94	0.31	0.80	1.18	1.0	0.035	2.05	58.29	0.098	5.35	3.60	2
10.827	0.95	0.06	0.97	1.0	0.053	41.98	75.27	0.106	2.01	0.94	0.33	0.80	1.17	1.0	0.035	1.99	66.37	0.107	5.76	3.88	2
10.991	0.94	0.06	0.97	1.0	0.053	40.66	70.19	0.100	1.89	0.94	0.31	0.80	1.17	1.0	0.035	2.31	68.36	0.110	5.83	3.86	2
11.155	0.94	0.06	0.97	1.0	0.053	39.21	64.59	0.093	1.76	0.94	0.29	0.80	1.17	1.0	0.035	2.50	63.39	0.104	5.44	3.60	2
11.319	0.94	0.05	0.97	1.0	0.053	38.35	61.28	0.089	1.69	0.94	0.28	0.80	1.16	1.0	0.035	2.63	60.28	0.100	5.21	3.45	2
11.483	0.94	0.05	0.97	1.0	0.053	38.37	61.39	0.089	1.69	0.94	0.28	0.80	1.16	1.0	0.036	2.39	54.92	0.095	4.90	3.30	2
11.647	0.94	0.06	0.97	1.0	0.053	39.02	63.88	0.092	1.75	0.94	0.29	0.80	1.16	1.0	0.036	2.46	61.18	0.101	5.14	3.45	2
11.811	0.94	0.06	0.97	1.0	0.052	41.03	71.60	0.102	1.94	0.94	0.32	0.80	1.16	1.0	0.036	2.09	63.85	0.104	5.23	3.59	2
11.975	0.94	0.06	0.97	1.0	0.052	42.80	78.43	0.111	2.11	0.94	0.34	0.80	1.15	1.0	0.036	1.99	71.01	0.113	5.63	3.87	2

Idriss & Boulanger (2008)

Depth (ft)	CN	qc1 TSF	qc1 MPa	qc1N
0.164	1.7	7.8549	0.752	9.123
0.328	1.7	37.345	3.5754	43.374
0.492	1.7	69.982	6.7001	81.280
0.656	1.7	101.08	9.6775	117.400
0.820	1.7	111.81	10.704	129.855
0.984	1.7	118.41	11.337	137.528
1.148	1.7	116.35	11.14	135.138
1.312	1.7	132.5	12.685	153.886
1.476	1.7	120.84	11.569	140.349
1.640	1.7	105	10.053	121.957
1.804	1.7	119.53	11.444	138.827
1.968	1.7	181.77	17.402	211.112
2.133	1.7	169.12	16.191	196.422
2.297	1.7	159.11	15.233	184.793
2.461	1.7	116.58	11.162	135.406
2.625	1.7	162.07	15.517	188.236
2.789	1.7	168.97	16.177	196.246
2.953	1.7	163.62	15.665	190.033
3.117	1.7	156.59	14.992	181.865
3.281	1.7	137.44	13.158	159.623
3.445	1.605714	196.16	18.78	227.826
3.609	1.657319	178.4	17.08	207.203
3.773	1.7	132.77	12.711	154.199
3.937	1.7	112.64	10.784	130.819
4.101	1.7	98.097	9.3918	113.934
4.265	1.655735	164.67	15.766	191.257
4.429	1.660272	159.84	15.303	185.649
4.593	1.695881	147.7	14.141	171.549
4.757	1.7	137.74	13.187	159.979
4.921	1.699019	140.03	13.406	162.632
5.085	1.695288	137.35	13.15	159.528
5.249	1.7	120.2	11.508	139.608
5.413	1.653181	140.69	13.469	163.399
5.577	1.7	108.88	10.425	126.462
5.741	1.7	81.434	7.7965	94.581
5.905	1.7	69.491	6.6531	80.710
6.069	1.7	66.344	6.3518	77.055
6.234	1.7	67.953	6.5058	78.923
6.398	1.7	67.944	6.505	78.913
6.562	1.7	67.947	6.5052	78.916
6.726	1.7	73.034	6.9923	84.825
6.890	1.7	73.448	7.0319	85.306
7.054	1.7	66.287	6.3463	76.989
7.218	1.7	59.876	5.7325	69.542
7.382	1.7	55.882	5.3502	64.904
7.546	1.7	51.088	4.8912	59.336
7.710	1.7	46.761	4.4769	54.310
7.874	1.7	33.335	3.1915	38.716
8.038	1.7	30.761	2.945	35.727
8.202	1.7	40.093	3.8385	46.566
8.366	1.7	43.467	4.1615	50.484
8.530	1.7	49.797	4.7676	57.837
8.694	1.7	52.242	5.0017	60.676
8.858	1.7	56.04	5.3653	65.087
9.022	1.7	55.692	5.3319	64.683
9.186	1.7	53.263	5.0994	61.862
9.350	1.7	50.668	4.851	58.848
9.514	1.7	43.645	4.1786	50.691
9.678	1.7	36.599	3.504	42.508
9.842	1.7	27.804	2.662	32.293
10.006	1.7	24.13	2.3102	28.026
10.170	1.7	26.255	2.5136	30.493
10.335	1.7	27.421	2.6253	31.848
10.499	1.7	24.618	2.3569	28.592
10.663	1.7	24.539	2.3494	28.501
10.827	1.7	28.668	2.7446	33.296
10.991	1.7	25.426	2.4343	29.531
11.155	1.7	21.859	2.0928	25.388
11.319	1.7	19.748	1.8907	22.936
11.483	1.7	19.819	1.8975	23.019
11.647	1.7	21.404	2.0492	24.860
11.811	1.695444	26.328	2.5207	30.579
11.975	1.651564	30.678	2.9371	35.631

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-8N

Data File: 13-52106_SP3-8N-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Da

Legend:
- Tailings Sands
- Tailings Sand-Slimes
- Tailings Slimes
- Interim Cover
- Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69

Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5604.90	Water surface elevation during CPT investigation (f
5600.09	Water surface elevation at t_0 (ft amsl)
5595.24	Water surface elevation at t_1 (ft amsl)
5590.24	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Ea
7.51	Equiv. Number of Uniform Strain Cycles, N

5608.37	Ground Surface Elevation at time of CPT (ft amsl)
5623.82	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
7.95	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1646.57	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5590.24	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	######	5623.57	5623.32	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
Water Storage/Rooting Zone Layer	######	5621.57	5619.82	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	######	5618.07	5616.32	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320
Platform/Random Fill Layer	######	5612.35	5608.37	7.95	0.050	101	0.825	0.624	0.00	0.00	0.825	0.624

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No
12.139	5596.23	20.8	0.332	20.7	20.6	8.93	1.59%	Sand-Slime Tailin	0.059	119.0	0.69	0.27	0.42	1
12.303	5596.07	20.6	0.354	20.4	21.5	9.33	1.72%	Sand-Slime Tailin	0.059	119.0	0.70	0.28	0.43	1
12.467	5595.90	21.7	0.293	21.6	21.5	9.33	1.35%	Sand-Slime Tailin	0.059	119.0	0.71	0.28	0.43	1
12.631	5595.74	19.6	0.242	19.4	23.8	10.31	1.24%	Sand-Slime Tailin	0.059	119.0	0.72	0.29	0.44	1
12.795	5595.57	25.2	0.298	25.1	16.3	7.06	1.18%	Sand-Slime Tailin	0.059	119.0	0.73	0.29	0.44	1
12.959	5595.41	21.9	0.407	21.8	10.3	4.45	1.86%	Sand-Slime Tailin	0.059	119.0	0.74	0.30	0.45	1
13.123	5595.25	15.7	0.413	15.6	13.9	6.04	2.63%	Slime Tailings	0.057	113.1	0.75	0.30	0.45	1
13.287	5595.08	12.5	0.244	12.3	29.1	12.59	1.95%	Sand-Slime Tailin	0.059	119.0	0.76	0.31	0.46	1
13.451	5594.92	23.9	0.277	23.7	39.2	16.99	1.16%	Sand-Slime Tailin	0.059	119.0	0.77	0.31	0.46	1
13.615	5594.75	17.1	0.257	16.9	21.6	9.34	1.51%	Sand-Slime Tailin	0.059	119.0	0.78	0.32	0.47	1
13.779	5594.59	13.5	0.216	13.4	24.5	10.62	1.60%	Sand-Slime Tailin	0.059	119.0	0.79	0.32	0.47	1
13.943	5594.43	12.3	0.109	12.1	31.7	13.73	0.89%	Sand-Slime Tailin	0.059	119.0	0.80	0.33	0.47	1
14.107	5594.26	13.7	0.109	13.5	35.9	15.56	0.80%	Sand-Slime Tailin	0.059	119.0	0.81	0.33	0.48	1
14.271	5594.10	14.3	0.105	14.1	40.0	17.33	0.73%	Sand-Slime Tailin	0.059	119.0	0.82	0.34	0.48	1
14.436	5593.93	15.6	0.141	15.4	38.1	16.50	0.90%	Sand-Slime Tailin	0.059	119.0	0.83	0.34	0.49	1
14.600	5593.77	13.6	0.133	13.4	36.6	15.87	0.98%	Sand-Slime Tailin	0.059	119.0	0.84	0.35	0.49	1
14.764	5593.61	12.7	0.142	12.5	36.6	15.85	1.11%	Sand-Slime Tailin	0.059	119.0	0.85	0.35	0.50	1
14.928	5593.44	11.6	0.159	11.4	38.9	16.85	1.37%	Sand-Slime Tailin	0.059	119.0	0.86	0.36	0.50	1
15.092	5593.28	12.1	0.159	11.8	38.7	16.79	1.32%	Sand-Slime Tailin	0.059	119.0	0.87	0.36	0.51	1
15.256	5593.11	18.8	0.159	18.6	31.2	13.52	0.85%	Sand-Slime Tailin	0.059	119.0	0.88	0.37	0.51	1

CPT Data Interpretations / Conditions at t_1 / Liquefaction Triggering Analyses – Idriss & Boulanger (2008)

Depth at time of CPT (ft)	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No	Cyclic Stress Ratio r_d	C_σ	K_σ	K_a	CSR M=7.5, s'v=1atm	Cyclic Resistance Ratio Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS
12.139	1.62	33.523	465.97	39.18	47	1.65%	2.3	47%	1.52	0.00	1.52	0	0.94	0.06	0.96	1.0	0.052	44.04	83.22	0.117	2.25
12.303	1.61	32.926	457.68	38.49	46	1.78%	2.3	47%	1.53	0.00	1.53	0	0.94	0.06	0.96	1.0	0.052	43.80	82.30	0.116	2.22
12.467	1.59	34.352	477.50	40.15	48	1.40%	2.2	47%	1.54	0.00	1.54	0	0.93	0.07	0.96	1.0	0.052	44.38	84.53	0.119	2.29
12.631	1.60	31.035	431.38	36.32	43	1.28%	2.3	47%	1.55	0.00	1.55	0	0.93	0.06	0.96	1.0	0.052	43.04	79.36	0.112	2.15
12.795	1.55	38.791	539.19	45.24	55	1.22%	2.2	47%	1.56	0.00	1.56	0	0.93	0.07	0.96	1.0	0.052	46.17	91.40	0.129	2.50
12.959	1.56	34.046	473.24	39.66	47	1.93%	2.3	47%	1.57	0.00	1.57	0	0.93	0.06	0.96	1.0	0.052	44.21	83.87	0.118	2.28
13.123	1.60	25.057	348.29	29.26	33	2.76%	2.6	71%	1.58	0.00	1.58	0	0.93	0.06	0.96	1.0	0.052	40.28	69.54	0.099	1.91
13.287	1.62	20.028	278.39	23.60	26	2.08%	2.6	47%	1.59	0.00	1.58	1	0.93	0.05	0.97	1.0	0.052	38.58	62.18	0.090	1.74
13.451	1.52	35.953	499.74	42.19	50	1.20%	2.2	47%	1.60	0.01	1.59	1	0.93	0.07	0.96	1.0	0.052	45.10	87.29	0.123	2.38
13.615	1.56	26.372	366.57	30.87	35	1.58%	2.4	47%	1.61	0.02	1.59	1	0.93	0.06	0.96	1.0	0.052	41.13	72.00	0.102	1.96
13.779	1.58	21.097	293.25	24.78	27	1.70%	2.5	47%	1.62	0.02	1.60	1	0.92	0.06	0.97	1.0	0.052	38.99	63.78	0.092	1.76
13.943	1.58	19.096	265.43	22.54	24	0.95%	2.4	47%	1.63	0.03	1.60	1	0.92	0.05	0.97	1.0	0.052	38.21	60.75	0.089	1.69
14.107	1.56	20.976	291.56	24.77	27	0.85%	2.3	47%	1.63	0.03	1.60	1	0.92	0.06	0.97	1.0	0.052	38.99	63.76	0.092	1.76
14.271	1.54	21.657	301.03	25.60	28	0.78%	2.3	47%	1.64	0.04	1.61	1	0.92	0.06	0.96	1.0	0.052	39.28	64.88	0.093	1.78
14.436	1.52	23.383	325.02	27.58	30	0.95%	2.3	47%	1.65	0.04	1.61	1	0.92	0.06	0.96	1.0	0.053	39.97	67.55	0.097	1.84
14.600	1.53	20.462	284.42	24.17	26	1.04%	2.4	47%	1.66	0.05	1.62	1	0.92	0.06	0.97	1.0	0.053	38.78	62.95	0.091	1.73
14.764	1.52	19.076	265.16	22.56	24	1.19%	2.5	47%	1.67	0.05	1.62	1	0.92	0.05	0.97	1.0	0.053	38.21	60.77	0.089	1.68
14.928	1.52	17.298	240.44	20.52	21	1.48%	2.6	47%	1.68	0.06	1.63	1	0.92	0.05	0.97	1.0	0.053	37.50	58.02	0.086	1.62
15.092	1.51	17.844	248.04	21.15	22	1.42%	2.5	47%	1.69	0.06	1.63	1	0.91	0.05	0.97	1.0	0.053	37.72	58.87	0.087	1.63
15.256	1.45	26.955	374.67	31.63	35	0.89%	2.3	47%	1.70	0.07	1.64	1	0.91	0.06	0.96	1.0	0.053	41.40	73.03	0.103	1.96

Liquefaction Triggering Analyses – Youd et al. (2001) / Idriss & Boulanger (2008)

Depth at time of CPT (ft)	Cyclic Stress Ratio r_d	D_r	f	K_σ	K_a	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No	CN	qc1 TSF	qc1 MPa	qc1N
12.139	0.94	0.36	0.80	1.15	1.0	0.036	1.95	76.21	0.121	5.96	4.10	2	1.620237	33.731	3.2294	39.177
12.303	0.94	0.36	0.80	1.15	1.0	0.036	2.04	78.62	0.125	6.09	4.16	2	1.611669	33.143	3.1731	38.494
12.467	0.93	0.37	0.80	1.15	1.0	0.036	1.79	71.84	0.114	5.51	3.90	2	1.59186	34.566	3.3094	40.147
12.631	0.93	0.35	0.80	1.14	1.0	0.036	1.85	67.11	0.108	5.15	3.65	2	1.598899	31.272	2.994	36.321
12.795	0.93	0.39	0.80	1.14	1.0	0.036	1.59	71.85	0.114	5.40	3.95	2	1.547297	38.948	3.7289	45.236
12.959	0.93	0.36	0.80	1.14	1.0	0.036	2.09	83.02	0.133	6.22	4.25	2	1.5603	34.146	3.2691	39.658
13.123	0.93	0.31	0.80	1.14	1.0	0.036	3.10	90.60	0.149	6.91	4.41	2	1.602078	25.196	2.4123	29.264
13.287	0.93	0.28	0.80	1.14	1.0	0.036	3.15	74.30	0.118	5.40	3.57	2	1.624325	20.323	1.9457	23.603
13.451	0.93	0.38	0.80	1.13	1.0	0.037	1.65	69.75	0.112	5.03	3.71	2	1.518912	36.324	3.4777	42.189
13.615	0.93	0.32	0.80	1.13	1.0	0.037	2.28	70.46	0.113	5.01	3.49	2	1.558637	26.582	2.5449	30.873
13.779	0.93	0.29	0.80	1.13	1.0	0.037	2.78	68.81	0.110	4.85	3.31	2	1.580327	21.339	2.043	24.784
13.943	0.93	0.27	0.80	1.13	1.0	0.037	2.34	52.74	0.094	4.07	2.88	2	1.58209	19.409	1.8582	22.542
14.107	0.93	0.29	0.80	1.12	1.0	0.037	2.09	51.73	0.093	3.99	2.87	2	1.557223	21.325	2.0416	24.768
14.271	0.93	0.29	0.80	1.12	1.0	0.037	1.98	50.75	0.092	3.91	2.84	2	1.541392	22.041	2.1102	25.600
14.436	0.93	0.30	0.80	1.12	1.0	0.038	2.02	55.83	0.096	4.03	2.93	2	1.520342	23.744	2.2733	27.578
14.600	0.93	0.28	0.80	1.12	1.0	0.038	2.31	55.88	0.096	3.98	2.86	2	1.527025	20.811	1.9925	24.171
14.764	0.93	0.27	0.80	1.12	1.0	0.038	2.58	58.26	0.098	4.03	2.85	2	1.52486	19.424	1.8597	22.560
14.928	0.93	0.26	0.80	1.11	1.0	0.038	3.05	62.52	0.103	4.16	2.89	2	1.522673	17.667	1.6915	20.519
15.092	0.93	0.27	0.80	1.11	1.0	0.038	2.93	62.03	0.102	4.10	2.87	2	1.510945	18.21	1.7434	21.149
15.256	0.92	0.32	0.80	1.11	1.0	0.038	1.81	57.25	0.097	3.86	2.91	2	1.45231	27.238	2.6077	31.635

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-8S

Data File: 13-52106_SP3-8S-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Data

Legend: Tailings Sands; Tailings Sand-Slimes; Tailings Slimes; Interim Cover; Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69

Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

5603.50	Water surface elevation during CPT investigation (ft amsl)
5600.42	Water surface elevation at t_0 (ft amsl)
5590.63	Water surface elevation at t_1 (ft amsl)
5585.63	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ratio, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earthq
7.51	Equiv. Number of Uniform Strain Cycles, N

5608.70	Ground Surface Elevation at time of CPT (ft amsl)
5620.45	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after pla
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
4.25	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1273.89	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5585.63	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)	Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	5620.45	5620.2	5619.95	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
Water Storage/Rooting Zone Layer	5619.95	5618.2	5616.45	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	5616.45	5614.7	5612.95	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320
Platform/Random Fill Layer	5612.95	5610.825	5608.70	4.25	0.050	101	0.638	0.531	0.00	0.00	0.638	0.531

2013 CPT Data from ConeTec / CPT Data Interpretations / Conditions at t_1

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines)	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of CPT (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F, (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
0.164	5608.54	17.2	0.175	17.2	1.2	0.54	1.02%	Interim Cover	0.050	100.7	0.01	0.00	0.01	0	1.70	29.240	406.44	33.98	2082	1.02%	1.2	51%	0.65	0.00	0.65	0
0.328	5608.37	63.5	0.285	63.5	10.1	4.36	0.45%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	107.899	1499.80	125.44	3844	0.45%	0.9	51%	0.65	0.00	0.65	0
0.492	5608.21	90.9	0.503	90.8	10.4	4.50	0.55%	Interim Cover	0.050	100.7	0.02	0.00	0.02	0	1.70	154.394	2146.08	179.45	3666	0.55%	1.0	51%	0.66	0.00	0.66	0
0.656	5608.04	111.9	0.700	111.9	7.7	3.35	0.63%	Interim Cover	0.050	100.7	0.03	0.00	0.03	0	1.70	190.145	2643.02	220.94	3385	0.63%	1.0	51%	0.67	0.00	0.67	0
0.820	5607.88	126.5	0.864	126.4	5.8	2.51	0.68%	Interim Cover	0.050	100.7	0.04	0.00	0.04	0	1.70	214.948	2987.78	249.72	3061	0.68%	1.1	51%	0.68	0.00	0.68	0
0.984	5607.72	125.0	0.813	125.0	3.0	1.31	0.65%	Interim Cover	0.050	100.7	0.05	0.00	0.05	0	1.70	212.466	2953.28	246.80	2521	0.65%	1.0	51%	0.69	0.00	0.69	0
1.148	5607.55	117.6	0.695	117.6	1.1	0.48	0.59%	Interim Cover	0.050	100.7	0.06	0.00	0.06	0	1.70	199.903	2778.65	232.19	2032	0.59%	1.0	51%	0.69	0.00	0.69	0
1.312	5607.39	104.2	0.601	104.2	1.5	0.66	0.58%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	177.140	2462.25	205.76	1576	0.58%	1.0	51%	0.70	0.00	0.70	0
1.476	5607.22	81.5	0.591	81.5	0.0	0.01	0.73%	Interim Cover	0.050	100.7	0.07	0.00	0.07	0	1.70	138.465	1924.66	160.82	1094	0.73%	1.2	51%	0.71	0.00	0.71	0
1.640	5607.06	72.9	0.416	72.9	-0.0	-0.01	0.57%	Interim Cover	0.050	100.7	0.08	0.00	0.08	0	1.70	123.947	1722.86	143.96	882	0.57%	1.1	51%	0.72	0.00	0.72	0
1.804	5606.90	64.8	0.713	64.8	0.1	0.05	1.10%	Interim Cover	0.050	100.7	0.09	0.00	0.09	0	1.70	110.075	1530.04	127.85	712	1.10%	1.4	51%	0.73	0.00	0.73	0
1.968	5606.73	61.1	0.519	61.1	0.6	0.27	0.85%	Interim Cover	0.050	100.7	0.10	0.00	0.10	0	1.70	103.887	1444.03	120.67	615	0.85%	1.3	51%	0.74	0.00	0.74	0
2.133	5606.57	57.5	0.435	57.5	2.3	0.98	0.76%	Interim Cover	0.050	100.7	0.11	0.00	0.11	0	1.70	97.801	1359.43	113.62	535	0.76%	1.3	51%	0.74	0.00	0.74	0
2.297	5606.40	54.3	0.512	54.3	5.3	2.29	0.94%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	92.276	1282.64	107.24	469	0.94%	1.4	51%	0.75	0.00	0.75	0
2.461	5606.24	53.3	1.269	53.3	2.3	0.99	2.38%	Interim Cover	0.050	100.7	0.12	0.00	0.12	0	1.70	90.542	1258.53	105.19	429	2.39%	1.8	51%	0.76	0.00	0.76	0
2.625	5606.08	76.9	1.662	76.9	5.5	2.37	2.16%	Interim Cover	0.050	100.7	0.13	0.00	0.13	0	1.70	130.747	1817.38	151.92	581	2.16%	1.7	51%	0.77	0.00	0.77	0
2.789	5605.91	222.0	2.940	221.9	14.3	6.21	1.32%	Interim Cover	0.050	100.7	0.14	0.00	0.14	0	1.61	358.013	4976.38	415.98	1580	1.33%	1.4	51%	0.78	0.00	0.78	0
2.953	5605.75	222.9	2.175	222.9	15.8	6.86	0.98%	Interim Cover	0.050	100.7	0.15	0.00	0.15	0	1.59	354.180	4923.11	411.54	1498	0.98%	1.2	51%	0.79	0.00	0.79	0
3.117	5605.58	213.5	2.265	213.3	28.9	12.50	1.06%	Interim Cover	0.050	100.7	0.16	0.00	0.16	0	1.57	334.170	4644.96	388.45	1359	1.06%	1.3	51%	0.79	0.00	0.79	0
3.281	5605.42	207.8	1.697	207.7	13.6	5.90	0.82%	Sand Tailings	0.051	102.8	0.17	0.00	0.17	0	1.55	320.918	4460.77	372.88	1255	0.82%	1.2	18%	0.80	0.00	0.80	0
3.445	5605.26	155.2	1.444	155.1	11.4	4.92	0.93%	Sand Tailings	0.051	102.8	0.17	0.00	0.17	0	1.53	236.617	3288.98	274.94	892	0.93%	1.3	18%	0.81	0.00	0.81	0
3.609	5605.09	125.3	1.613	125.3	6.9	2.98	1.29%	Sand Tailings	0.051	102.8	0.18	0.00	0.18	0	1.57	197.324	2742.80	229.26	687	1.29%	1.5	18%	0.82	0.00	0.82	0
3.773	5604.93	100.1	0.839	100.1	7.6	3.29	0.84%	Sand Tailings	0.051	102.8	0.19	0.00	0.19	0	1.66	166.576	2315.41	193.56	524	0.84%	1.4	18%	0.83	0.00	0.83	0
3.937	5604.76	82.6	1.213	82.5	16.4	7.12	1.47%	Sand Tailings	0.051	102.8	0.20	0.00	0.20	0	1.70	140.267	1949.71	163.11	414	1.47%	1.6	18%	0.84	0.00	0.84	0
4.101	5604.60	116.5	1.585	116.5	3.6	1.57	1.36%	Sand Tailings	0.051	102.8	0.21	0.00	0.21	0	1.56	182.193	2532.48	211.65	560	1.36%	1.5	18%	0.84	0.00	0.84	0
4.265	5604.43	95.5	1.860	95.4	10.8	4.68	1.95%	Sand Tailings	0.051	102.8	0.22	0.00	0.22	0	1.63	155.946	2167.64	181.25	441	1.95%	1.7	18%	0.85	0.00	0.85	0
4.429	5604.27	82.7	1.658	82.6	23.5	10.20	2.00%	Sand-Slime Tailin	0.047	93.3	0.22	0.00	0.22	0	1.68	138.765	1928.83	161.45	369	2.01%	1.8	47%	0.86	0.00	0.86	0
4.593	5604.11	86.3	1.621	85.5	118.1	51.17	1.88%	Sand-Slime Tailin	0.047	93.3	0.23	0.00	0.23	0	1.65	140.841	1957.68	164.99	372	1.88%	1.7	47%	0.87	0.00	0.87	0
4.757	5603.94	76.9	1.353	76.5	64.1	27.77	1.76%	Sand Tailings	0.051	102.8	0.24	0.00	0.24	0	1.68	128.249	1782.67	149.73	320	1.76%	1.8	18%	0.88	0.00	0.88	0
4.921	5603.78	61.2	1.819	60.2	164.5	71.28	2.97%	Sand-Slime Tailin	0.047	93.3	0.25	0.00	0.25	0	1.70	102.374	1423.00	120.93	247	2.98%	2.0	47%	0.88	0.00	0.88	0
5.085	5603.61	58.0	1.686	56.9	179.6	77.81	2.91%	Sand-Slime Tailin	0.047	93.3	0.26	0.00	0.26	0	1.70	96.747	1344.78	114.58	227	2.92%	2.0	47%	0.89	0.00	0.89	0
5.249	5603.45	60.7	1.440	60.7	-1.3	-0.55	2.37%	Sand-Slime Tailin	0.059	119.0	0.26	0.00	0.26	1	1.70	103.139	1433.63	119.77	229	2.38%	1.9	47%	0.90	0.00	0.90	0
5.413	5603.29	46.9	1.368	46.8	16.1	6.96	2.92%	Sand-Slime Tailin	0.059	119.0	0.27	0.01	0.27	1	1.70	79.509	1105.18	92.54	174	2.94%	2.1	47%	0.91	0.00	0.91	0
5.577	5603.12	43.9	1.137	43.5	70.6	30.59	2.59%	Sand-Slime Tailin	0.059	119.0	0.28	0.01	0.27	1	1.70	73.882	1026.96	86.68	160	2.61%	2.1	47%	0.92	0.00	0.92	0
5.741	5602.96	101.5	1.244	99.3	344.3	#####	1.23%	Sand Tailings	0.062	123.5	0.29	0.02	0.28	1	1.50	149.486	2077.86	177.38	365	1.23%	1.6	18%	0.93	0.00	0.93	0
5.905	5602.79	130.7	1.385	130.5	35.7	15.48	1.06%	Sand Tailings	0.062	123.5	0.30	0.02	0.28	1	1.41	184.468	2564.11	214.62	462	1.06%	1.5	18%	0.94	0.00	0.94	0
6.069	5602.63	99.5	1.248	99.5	9.3	4.02	1.25%	Sand Tailings	0.062	123.5	0.31	0.03	0.29	1	1.50	148.832	2068.77	172.96	345	1.26%	1.6	18%	0.95	0.00	0.95	0
6.234	5602.47	80.3	0.821	80.3	4.9	2.11	1.02%	Sand Tailings	0.062	123.5	0.32	0.03	0.29	1	1.56	125.079	1738.59	145.33	273	1.03%	1.6	18%	0.96	0.00	0.96	0
6.398	5602.30	62.4	0.678	62.4	1.2	0.50	1.09%	Sand Tailings	0.062	123.5	0.33	0.04	0.30	1	1.63	101.688	1413.46	118.12	208	1.09%	1.7	18%	0.97	0.00	0.97	0
6.562	5602.14	65.4	0.430	65.4	1.8	0.78	0.66%	Sand Tailings	0.062	123.5	0.35	0.04	0.30	1	1.61	105.030	1459.92	122.01	215	0.66%	1.5	18%	0.98	0.00	0.98	0
6.726	5601.97	100.8	0.407	100.8	5.9	2.54	0.40%	Sand Tailings	0.062	123.5	0.36	0.05	0.31	1	1.46	147.482	2050.01	171.35	327	0.41%	1.3	18%	0.99	0.00	0.99	0
6.890	5601.81	94.6	0.393	94.5	3.2	1.37	0.42%	Sand Tailings	0.062	123.5	0.37	0.05	0.31	1	1.48	139.500	1939.05	162.05	301	0.42%	1.3	18%	1.00	0.00	1.00	0
7.054	5601.65	89.5	0.390	89.5	2.8	1.22	0.44%	Sand Tailings	0.062	123.5	0.38	0.06	0.32	1	1.48	132.877	1846.99	154.36	281	0.44%	1.3	18%	1.01	0.00	1.01	0
7.218	5601.48	87.6	0.521	87.5	3.6	1.56	0.60%	Sand Tailings	0.062	123.5	0.39	0.06	0.32	1	1.48	129.857	1805.02	150.86	270	0.60%	1.4	18%	1.02	0.00	1.02	0
7.382	5601.32	81.6	0.625	81.5	3.4	1.48	0.77%	Sand Tailings	0.062	123.5	0.40	0.07	0.33	1	1.50	122.012	1695.96	141.75	248	0.77%	1.5	18%	1.03	0.00	1.03	0
7.546	5601.15	73.8	0.669	73.8	2.8	1.20	0.91%	Sand Tailings	0.062	123.5	0.41	0.07	0.33	1	1.52	111.871	1555.01	129.96	221	0.91%	1.6	18%	1.04	0.00	1.04	0
7.710	5600.99	67.0	0.509	67.0	2.8	1.20	0.76%	Sand Tailings	0.062	123.5	0.42	0.08	0.34	1	1.53	102.854	1429.67	119.49	197	0.76%	1.6	18%	1.05	0.00	1.05	0
7.874	5600.83	74.0	0.388	74.0	2.7	1.16	0.52%	Sand Tailings	0.062	123.5	0.43	0.08	0.34	1	1.50	111.005	1542.97	128.95	215	0.53%	1.5	18%	1.06	0.00	1.06	0
8.038	5600.66	73.6	0.370	73.6	3.4	1.48	0.50%	Sand Tailings	0.062	123.5	0.44	0.09	0.35	1	1.49	109.856	1527.01	127.63	210	0.51%	1.5	18%	1.07	0.00	1.07	0
8.202	5600.50	70.8	0.387	70.8	3.7	1.61	0.55%	Sand Tailings	0.062	123.5	0.45	0.09	0.35	1	1.50	105.908	1472.12	123.05	200	0.55%	1.5	18%	1.08	0.00	1.08	0
8.366	5600.33	61.3	0.408	61.3	4.3	1.88	0.67%	Sand Tailings	0.062	123.5	0.46	0.10	0.36	1	1.52	93.454	1299.01	108.59	170	0.67%	1.6	18%	1.09	0.00	1.09	0
8.530	5600.17	54.8	0.384	54.8	3.9	1.69	0.70%	Sand Tailings	0.062	123.5	0.47	0.10	0.36	1	1.54	84.591	1175.81	98.29	150	0.71%	1.7	18%	1.10	0.00	1.10	0
8.694	5600.01	51.9	0.384	51.9	4.9	2.12	0.74%	Sand Tailings	0.062	123.5	0.48	0.11	0.37	1	1.55	80.294	1116.09	93.31	140	0.75%	1.7	18%	1.11	0.00	1.11	0
8.858	5599.84	50.9	0.369	50.9	5.6	2.43	0.73%	Sand Tailings	0.062	123.5	0.49	0.11	0.37	1	1.54	78.492	1091.04	91.23	135	0.73%	1.7	18%	1.12	0.00	1.12	0
9.022	5599.68	49.7	0.378	49.7	5.8	2.50	0.76%	Sand Tailings	0.062	123.5	0.50	0.12	0.38	1	1.54	76.518	1063.60	88.94	130	0.77%	1.7	18%	1.13	0.00	1.13	0
9.186	5599.51	42.3	0.401	42.3	5.9	2.56	0.95%	Sand Tailings	0.062	123.5	0.51	0.12	0.38	1	1.57	66.297	921.53	77.07	109	0.96%	1.9	18%	1.14	0.00	1.14	0
9.350	5599.35	35.3	0.359	35.3	5.1	2.19	1.02%	Sand-Slime Tailin	0.059	119.0	0.52	0.13	0.39	1	1.60	56.332	783.02	65.48	90	1.03%	2.0	47%	1.15	0.00	1.15	0
9.514	5599.19	31.3	0.268	31.2	5.2	2.24	0.86%	Sand-Slime Tailin	0.059	119.0	0.53	0.13	0.39	1	1.61	50.398	700.54	58.60	78	0.87%	2.0	47%	1.16	0.00	1.16	0
9.678	5599.02	41.5	0.241	41.4	6.6	2.87	0.58%	Sand Tailings	0.062	123.5	0.54	0.14	0.40	1	1.54	63.961	889.06	74.36	103	0.59%	1.8	18%	1.17	0.00	1.17	0
9.842	5598.86	40.4	0.177	40.3	6.1	2.63	0.44%	Sand Tailings	0.062	123.5	0.55	0.14	0.40	1	1.54	62.123	863.51	72.22	99	0.44%	1.7	18%	1.18	0.00	1.18	0
10.006	5598.69	28.6	0.177	28.5	5.9	2.55	0.62%	Sand-Slime Tailin	0.059	119.0	0.56	0.15	0.41	1	1.60	45.687	635.05	53.13	69	0.63%	1.9	47%	1.19	0.00	1.19	0
10.170	5598.53	30.6	0.160	30.5	5.3	2.29	0.52%	Sand-Slime Tailin	0.059	119.0	0.57	0.16	0.41	1	1.58	48.157	669.38	55.99	73	0.53%	1.9	47%	1.20	0.00	1.20	0
10.335	5598.37	30.2	0.173	30.1	5.8	2.51	0.57%	Sand-Slime Tailin	0.059	119.0	0.58	0.16	0.42	1	1.57	47.326	657.83	55.03	71	0.58%	1.9	47%	1.21	0.00	1.21	0
10.499	5598.20	28.4	0.178	28.4	6.7	2.89	0.63%	Sand-Slime Tailin	0.059	119.0	0.59	0.17	0.42	1	1.57	44.580	619.66	51.85	66	0.64%	1.9	47%	1.22	0.00	1.22	0
10.663	5598.04	24.0	0.188	24.0	6.8	2.94	0.78%	Sand-Slime Tailin	0.059	119.0	0.60	0.17	0.43	1	1.59	38.157	530.38	44.40	55	0.80%	2.1	47%	1.23	0.00	1.23	0
10.827	5597.87	22.1	0.178	22.0	7.3	3.16	0.81%	Sand-Slime Tailin	0.059	119.0	0.61	0.18	0.43	1	1.60	35.208	489.40	40.98	50	0.83%	2.1	47%	1.24	0.00	1.24	0
10.991	5597.71	19.0	0.177	19.0	8.1	3.53	0.93%	Sand-Slime Tailin	0.059	119.0	0.62	0.18	0.43	1	1.61	30.600	425.34	35.64	42	0.96%	2.2	47%	1.25	0.00	1.25	0
11.155	5597.55	14.9	0.165	14.8	11.6	5.03	1.11%	Sand-Slime Tailin	0.059	119.0	0.63	0.19	0.44	1	1.64	24.349	338.45	28.42	33	1.15%	2.3	47%	1.26	0.00	1.26	0
11.319	5597.38	13.9	0.096	13.8	17.0	7.37	0.69%	Sand-Slime Tailin	0.059	119.0	0.63	0.19	0.44	1	1.64	22.664	315.02	26.52	30	0.72%	2.3	47%	1.27	0.00	1.27	0
11.483	5597.22	19.1	0.146	19.1	12.4	5.36	0.76%	Sand-Slime Tailin	0.059	119.0	0.64	0.20	0.45	1	1.58	30.094	418.31	35.09	41	0.79%	2.2	47%	1.28	0.00	1.28	0
11.647	5597.05	13.8	0.173	13.8	11.9	5.15	1.25%	Sand-Slime Tailin	0.059	119.0	0.65	0.20	0.45	1	1.62	22.264	309.47	26.00	29	1.31%	2.4	47%	1.29	0.00	1.29	0
11.811	5596.89	11.6	0.154	11.5	16.0	6.92	1.33%	Sand-Slime Tailin	0.059	119.0	0.66	0.21	0.46	1	1.63	18.706	260.01	21.91	24	1.41%	2.5	47%	1.30	0.00	1.30	0
11.975	5596.73	15.5	0.105	15.4	21.0	9.12	0.68%	Sand-Slime Tailin	0.059	119.0	0.67	0.21	0.46	1	1.58	24.265	337.29	28.42	32	0.71%	2.2	47%	1.31	0.00	1.31	0
12.139	5596.56	15.7	0.104	15.6	11.4	4.93	0.66%	Sand-Slime Tailin	0.059	119.0	0.68	0.22	0.47	1	1.57	24.469	340.12	28.55	32	0.69%	2.2	47%	1.32	0.00	1.32	0
12.303	5596.40	14.7	0.073	14.6	11.8	5.11	0.50%	Sand-Slime Tailin	0.059	119.0	0.69	0.22	0.47	1	1.57	22.852	317.64	26.67	30	0.52%	2.2	47%	1.33	0.00	1.33	0

Liquefaction Triggering Analyses — Idriss & Boulanger (2008)

Depth (ft)	r_d	C_σ	K_σ	K_α	CSR M=7.5, σ'v=1atm	Δqc_{1n}	$qc_{1n\text{-}cs}$	(CRR) M=7.5, σ'v=1atm	FoS
0.164	1.00	0.06	1.02	1.0	0.059	42.24	76.22	0.108	1.83
0.328	1.00	0.13	1.04	1.0	0.060	74.34	199.78	1.000	16.70
0.492	1.00	0.21	1.06	1.0	0.061	93.29	272.74	1.000	16.39
0.656	1.00	0.30	1.08	1.0	0.062	#####	328.79	1.000	16.09
0.820	1.00	0.30	1.07	1.0	0.062	#####	367.68	1.000	16.14
0.984	1.00	0.30	1.07	1.0	0.062	#####	363.74	1.000	16.20
1.148	1.00	0.30	1.06	1.0	0.062	#####	343.99	1.000	16.25
1.312	1.00	0.28	1.06	1.0	0.061	#####	308.28	1.000	16.36
1.476	1.00	0.18	1.03	1.0	0.060	86.76	247.58	1.000	16.74
1.640	1.00	0.15	1.03	1.0	0.059	80.84	224.80	1.000	16.84
1.804	1.00	0.13	1.02	1.0	0.059	75.19	203.03	1.000	16.92
1.968	1.00	0.13	1.02	1.0	0.059	72.67	193.33	0.854	14.50
2.133	1.00	0.12	1.02	1.0	0.059	70.19	183.81	0.604	10.29
2.297	1.00	0.11	1.02	1.0	0.059	67.95	175.19	0.466	7.97
2.461	1.00	0.11	1.02	1.0	0.058	67.23	172.42	0.433	7.42
2.625	1.00	0.16	1.02	1.0	0.059	83.63	235.56	1.000	17.06
2.789	0.99	0.30	1.03	1.0	0.059	#####	592.28	1.000	16.87
2.953	0.99	0.30	1.03	1.0	0.059	#####	586.29	1.000	16.94
3.117	0.99	0.30	1.02	1.0	0.059	#####	555.08	1.000	17.00
3.281	0.99	0.30	1.02	1.0	0.059	#####	490.30	1.000	17.07
3.445	0.99	0.30	1.02	1.0	0.058	92.38	367.32	1.000	17.14
3.609	0.99	0.30	1.01	1.0	0.058	80.70	309.96	1.000	17.21
3.773	0.99	0.24	1.01	1.0	0.058	71.57	265.13	1.000	17.31
3.937	0.99	0.18	1.01	1.0	0.057	63.79	226.90	1.000	17.41
4.101	0.99	0.30	1.01	1.0	0.057	76.20	287.84	1.000	17.41
4.265	0.99	0.21	1.00	1.0	0.057	68.43	249.68	1.000	17.50
4.429	0.99	0.18	1.00	1.0	0.057	86.93	248.38	1.000	17.55
4.593	0.98	0.18	1.00	1.0	0.057	88.16	253.15	1.000	17.59
4.757	0.98	0.16	1.00	1.0	0.057	60.37	210.10	1.000	17.63
4.921	0.98	0.13	1.00	1.0	0.057	72.71	193.64	0.865	15.27
5.085	0.98	0.12	1.00	1.0	0.057	70.49	185.07	0.630	11.14
5.249	0.98	0.12	0.99	1.0	0.056	72.31	192.08	0.813	14.42
5.413	0.98	0.10	0.99	1.0	0.056	62.76	155.30	0.298	5.29
5.577	0.98	0.10	0.99	1.0	0.056	60.70	147.38	0.260	4.62
5.741	0.98	0.21	0.98	1.0	0.056	67.44	244.81	1.000	17.98
5.905	0.98	0.30	0.98	1.0	0.055	76.96	291.57	1.000	18.19
6.069	0.98	0.20	0.98	1.0	0.055	66.31	239.27	1.000	18.08
6.234	0.98	0.15	0.98	1.0	0.055	59.24	204.57	1.000	18.04
6.398	0.97	0.12	0.99	1.0	0.055	52.29	170.40	0.412	7.42
6.562	0.97	0.13	0.98	1.0	0.055	53.28	175.29	0.468	8.45
6.726	0.97	0.19	0.97	1.0	0.055	65.90	237.25	1.000	18.30
6.890	0.97	0.18	0.97	1.0	0.055	63.52	225.57	1.000	18.31
7.054	0.97	0.17	0.97	1.0	0.055	61.55	215.91	1.000	18.32
7.218	0.97	0.16	0.97	1.0	0.054	60.66	211.52	1.000	18.36
7.382	0.97	0.15	0.97	1.0	0.054	58.33	200.07	1.000	18.37
7.546	0.97	0.13	0.97	1.0	0.054	55.31	185.28	0.634	11.65
7.710	0.97	0.12	0.98	1.0	0.054	52.64	172.13	0.430	7.89
7.874	0.96	0.13	0.97	1.0	0.054	55.06	184.01	0.608	11.22
8.038	0.96	0.13	0.97	1.0	0.054	54.72	182.35	0.576	10.65
8.202	0.96	0.13	0.97	1.0	0.054	53.55	176.59	0.485	8.97
8.366	0.96	0.11	0.97	1.0	0.054	49.85	158.44	0.316	5.84
8.530	0.96	0.10	0.97	1.0	0.054	47.22	145.51	0.252	4.66
8.694	0.96	0.10	0.97	1.0	0.054	45.94	139.26	0.230	4.25
8.858	0.96	0.10	0.97	1.0	0.054	45.41	136.64	0.222	4.11
9.022	0.96	0.10	0.97	1.0	0.054	44.83	133.76	0.213	3.96
9.186	0.96	0.09	0.97	1.0	0.054	41.79	118.86	0.177	3.29
9.350	0.96	0.08	0.98	1.0	0.054	53.27	118.75	0.177	3.28
9.514	0.95	0.08	0.98	1.0	0.054	50.85	109.45	0.159	2.95
9.678	0.95	0.09	0.97	1.0	0.054	41.10	115.46	0.170	3.18
9.842	0.95	0.09	0.97	1.0	0.054	40.55	112.77	0.165	3.08
10.006	0.95	0.07	0.98	1.0	0.054	48.94	102.07	0.146	2.72
10.170	0.95	0.07	0.97	1.0	0.054	49.94	105.93	0.153	2.85
10.335	0.95	0.07	0.97	1.0	0.053	49.60	104.63	0.150	2.81
10.499	0.95	0.07	0.97	1.0	0.053	48.49	100.34	0.143	2.68
10.663	0.95	0.06	0.98	1.0	0.053	45.87	90.27	0.127	2.38
10.827	0.95	0.06	0.98	1.0	0.053	44.67	85.65	0.121	2.26
10.991	0.94	0.06	0.98	1.0	0.053	42.80	78.43	0.111	2.07
11.155	0.94	0.06	0.98	1.0	0.053	40.27	68.69	0.098	1.84
11.319	0.94	0.06	0.98	1.0	0.053	39.60	66.13	0.095	1.78
11.483	0.94	0.06	0.98	1.0	0.053	42.61	77.70	0.110	2.06
11.647	0.94	0.06	0.98	1.0	0.053	39.42	65.42	0.094	1.77
11.811	0.94	0.05	0.98	1.0	0.053	37.99	59.90	0.088	1.65
11.975	0.94	0.06	0.98	1.0	0.053	40.27	68.69	0.098	1.85
12.139	0.94	0.06	0.98	1.0	0.053	40.31	68.86	0.098	1.86
12.303	0.94	0.06	0.98	1.0	0.053	39.66	66.33	0.095	1.80

Liquefaction Triggering Analyses — Youd et al. (2001)

Depth (ft)	r_d	D_r	f	f	K_σ	K_α	CSR M=7.5, σ'v=1atm	Kc	$qc_{1n\text{-}cs}$	(CRR) M=7.5, σ'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
0.164	0.97	0.34	0.80	0.80	2.53	1.0	0.017	1.00	33.98	0.078	190.38	96.10	2
0.328	0.97	0.65	0.68	0.68	3.59	1.0	0.012	1.00	125.44	0.264	320.55	168.62	2
0.492	0.97	0.77	0.61	0.61	3.94	1.0	0.011	1.00	179.45	1.000	811.09	413.74	2
0.656	0.97	0.86	0.60	0.60	3.68	1.0	0.012	1.00	220.94	1.000	608.56	312.32	2
0.820	0.97	0.91	0.60	0.60	3.37	1.0	0.013	1.00	249.72	1.000	487.04	251.59	2
0.984	0.97	0.91	0.60	0.60	3.13	1.0	0.014	1.00	246.80	1.000	406.03	211.11	2
1.148	0.97	0.88	0.60	0.60	2.95	1.0	0.015	1.00	232.19	1.000	348.16	182.21	2
1.312	0.97	0.83	0.60	0.60	2.79	1.0	0.015	1.00	205.76	1.000	304.76	160.56	2
1.476	0.97	0.73	0.63	0.63	2.45	1.0	0.017	1.00	160.82	1.000	271.00	143.87	2
1.640	0.97	0.69	0.65	0.65	2.25	1.0	0.019	1.00	143.96	0.357	87.22	52.03	2
1.804	0.97	0.65	0.67	0.67	2.08	1.0	0.020	1.00	127.85	0.274	60.88	38.90	2
1.968	0.97	0.63	0.68	0.68	1.98	1.0	0.022	1.00	120.67	0.243	49.53	32.02	2
2.133	0.97	0.62	0.69	0.69	1.90	1.0	0.022	1.00	113.62	0.216	40.67	25.48	2
2.297	0.97	0.60	0.70	0.70	1.82	1.0	0.023	1.00	107.24	0.195	33.99	20.98	2
2.461	0.97	0.59	0.70	0.70	1.78	1.0	0.024	1.11	116.73	0.228	37.15	22.28	2
2.625	0.97	0.71	0.64	0.64	1.95	1.0	0.022	1.04	158.48	0.450	68.81	42.94	2
2.789	0.97	1.18	0.60	0.60	2.07	1.0	0.021	1.00	415.98	1.000	143.93	80.40	2
2.953	0.97	1.17	0.60	0.60	2.02	1.0	0.021	1.00	411.54	1.000	135.98	76.46	2
3.117	0.97	1.14	0.60	0.60	1.98	1.0	0.022	1.00	388.45	1.000	128.88	72.94	2
3.281	0.96	1.11	0.60	0.60	1.93	1.0	0.022	1.00	372.88	1.000	122.36	69.71	2
3.445	0.96	0.96	0.60	0.60	1.90	1.0	0.022	1.00	274.94	1.000	116.47	66.80	2
3.609	0.96	0.87	0.60	0.60	1.86	1.0	0.023	1.00	229.26	1.000	111.12	64.17	2
3.773	0.96	0.80	0.60	0.60	1.83	1.0	0.023	1.00	193.56	1.000	106.25	61.78	2
3.937	0.96	0.74	0.63	0.63	1.72	1.0	0.025	1.00	163.11	1.000	101.79	59.60	2
4.101	0.96	0.84	0.60	0.60	1.77	1.0	0.024	1.00	211.65	1.000	97.69	57.55	2
4.265	0.96	0.78	0.61	0.61	1.71	1.0	0.025	1.05	190.74	1.000	93.92	55.71	2
4.429	0.96	0.73	0.63	0.63	1.64	1.0	0.026	1.09	175.31	1.000	90.74	54.14	2
4.593	0.96	0.74	0.63	0.63	1.63	1.0	0.026	1.07	176.22	1.000	87.77	52.68	2
4.757	0.96	0.71	0.65	0.65	1.57	1.0	0.027	1.08	161.01	1.000	84.72	51.18	2
4.921	0.96	0.63	0.68	0.68	1.49	1.0	0.029	1.31	158.55	0.451	37.01	26.14	2
5.085	0.96	0.62	0.69	0.69	1.46	1.0	0.029	1.33	152.13	0.407	32.47	21.81	2
5.249	0.96	0.63	0.68	0.68	1.45	1.0	0.029	1.23	147.82	0.380	29.38	21.90	2
5.413	0.96	0.56	0.72	0.72	1.38	1.0	0.031	1.43	132.68	0.297	22.57	13.93	2
5.577	0.96	0.54	0.73	0.73	1.36	1.0	0.031	1.40	121.40	0.246	18.40	11.51	2
5.741	0.96	0.77	0.62	0.62	1.55	1.0	0.027	1.00	177.38	1.000	73.35	45.66	2
5.905	0.96	0.85	0.60	0.60	1.56	1.0	0.027	1.00	214.62	1.000	72.08	45.14	2
6.069	0.96	0.76	0.62	0.62	1.52	1.0	0.028	1.00	172.96	1.000	70.85	44.47	2
6.234	0.96	0.70	0.65	0.65	1.46	1.0	0.029	1.00	145.33	0.365	25.46	21.75	2
6.398	0.96	0.63	0.69	0.69	1.40	1.0	0.030	1.04	123.04	0.253	17.35	12.38	2
6.562	0.96	0.64	0.68	0.68	1.40	1.0	0.030	1.00	122.01	0.249	16.78	12.62	2
6.726	0.96	0.76	0.62	0.62	1.48	1.0	0.029	1.00	171.35	1.000	66.34	42.32	2
6.890	0.96	0.73	0.63	0.63	1.45	1.0	0.029	1.00	162.05	1.000	65.31	41.81	2
7.054	0.96	0.72	0.64	0.64	1.43	1.0	0.029	1.00	154.36	0.422	27.14	22.73	2
7.218	0.96	0.71	0.65	0.65	1.42	1.0	0.030	1.00	150.86	0.399	25.29	21.82	2
7.382	0.96	0.69	0.66	0.66	1.39	1.0	0.030	1.00	141.75	0.345	21.51	19.94	2
7.546	0.96	0.66	0.67	0.67	1.37	1.0	0.031	1.00	129.96	0.284	17.47	14.56	2
7.710	0.95	0.63	0.68	0.68	1.34	1.0	0.031	1.00	119.49	0.239	14.46	11.18	2
7.874	0.95	0.66	0.67	0.67	1.35	1.0	0.031	1.00	128.95	0.279	16.69	13.95	2
8.038	0.95	0.65	0.67	0.67	1.34	1.0	0.031	1.00	127.63	0.273	16.10	13.37	2
8.202	0.95	0.64	0.68	0.68	1.33	1.0	0.032	1.00	123.05	0.253	14.71	11.84	2
8.366	0.95	0.60	0.70	0.70	1.30	1.0	0.032	1.00	108.59	0.199	11.40	8.62	2
8.530	0.95	0.57	0.71	0.71	1.28	1.0	0.033	1.02	100.58	0.175	9.87	7.27	2
8.694	0.95	0.56	0.72	0.72	1.27	1.0	0.033	1.05	97.92	0.167	9.33	6.79	2
8.858	0.95	0.55	0.72	0.72	1.26	1.0	0.033	1.05	96.09	0.163	8.95	6.53	2
9.022	0.95	0.54	0.73	0.73	1.25	1.0	0.034	1.07	95.21	0.160	8.71	6.33	2
9.186	0.95	0.51	0.75	0.75	1.23	1.0	0.034	1.16	89.46	0.147	7.86	5.57	2
9.350	0.95	0.47	0.77	0.77	1.21	1.0	0.035	1.25	81.59	0.131	6.92	5.10	2
9.514	0.95	0.44	0.78	0.78	1.19	1.0	0.035	1.25	73.12	0.116	6.10	4.52	2
9.678	0.95	0.50	0.75	0.75	1.21	1.0	0.035	1.08	80.27	0.128	6.63	4.90	2
9.842	0.95	0.49	0.75	0.75	1.21	1.0	0.035	1.05	75.47	0.120	6.14	4.61	2
10.006	0.95	0.42	0.79	0.79	1.17	1.0	0.036	1.21	64.44	0.105	5.31	4.01	2
10.170	0.95	0.43	0.78	0.78	1.17	1.0	0.036	1.16	64.84	0.105	5.27	4.06	2
10.335	0.95	0.43	0.79	0.79	1.17	1.0	0.036	1.18	65.18	0.106	5.23	4.02	2
10.499	0.95	0.42	0.79	0.79	1.16	1.0	0.036	1.23	63.89	0.104	5.11	3.89	2
10.663	0.95	0.38	0.80	0.80	1.15	1.0	0.036	1.39	61.79	0.102	4.94	3.66	2
10.827	0.95	0.37	0.80	0.80	1.15	1.0	0.036	1.46	60.03	0.100	4.80	3.53	2
10.991	0.95	0.34	0.80	0.80	1.15	1.0	0.036	1.67	59.45	0.100	4.72	3.40	2
11.155	0.95	0.31	0.80	0.80	1.14	1.0	0.036	2.09	59.25	0.099	4.67	3.25	2
11.319	0.95	0.30	0.80	0.80	1.14	1.0	0.037	1.85	48.98	0.091	4.22	3.00	2
11.483	0.95	0.34	0.80	0.80	1.14	1.0	0.037	1.59	55.68	0.096	4.42	3.24	2
11.647	0.95	0.29	0.80	0.80	1.14	1.0	0.037	2.36	61.36	0.101	4.63	3.20	2
11.811	0.95	0.27	0.80	0.80	1.13	1.0	0.037	2.78	60.88	0.101	4.56	3.11	2
11.975	0.94	0.31	0.80	0.80	1.13	1.0	0.037	1.76	50.09	0.092	4.10	2.98	2
12.139	0.94	0.31	0.80	0.80	1.13	1.0	0.037	1.75	49.90	0.092	4.05	2.96	2
12.303	0.94	0.30	0.80	0.80	1.13	1.0	0.037	1.69	44.97	0.087	3.84	2.82	2

Idriss & Boulanger (2008)

Depth (ft)	CN	qc1 TSF	qc1 MPa	qc1N
0.164	1.7	29.253	2.8007	33.976
0.328	1.7	108.01	10.34	125.442
0.492	1.7	154.5	14.792	179.447
0.656	1.7	190.23	18.212	220.937
0.820	1.7	215.01	20.585	249.720
0.984	1.7	212.5	20.345	246.804
1.148	1.7	199.91	19.14	232.189
1.312	1.7	177.16	16.961	205.756
1.476	1.7	138.47	13.257	160.819
1.640	1.7	123.95	11.867	143.957
1.804	1.7	110.08	10.539	127.847
1.968	1.7	103.89	9.9468	120.666
2.133	1.7	97.825	9.3658	113.618
2.297	1.7	92.332	8.8399	107.238
2.461	1.7	90.566	8.6708	105.187
2.625	1.7	130.81	12.523	151.922
2.789	1.6134701	358.16	34.29	415.978
2.953	1.5893219	354.34	33.924	411.542
3.117	1.5668124	334.45	32.02	388.446
3.281	1.5453286	321.05	30.737	372.880
3.445	1.5251865	236.73	22.664	274.942
3.609	1.5748132	197.39	18.898	229.259
3.773	1.6649266	166.65	15.956	193.559
3.937	1.7	140.44	13.446	163.114
4.101	1.5638874	182.23	17.447	211.647
4.265	1.6346491	156.06	14.941	181.249
4.429	1.6801632	139.01	13.309	161.453
4.593	1.6466803	142.05	13.6	164.988
4.757	1.6755875	128.92	12.343	149.733
4.921	1.7	104.12	9.9684	120.929
5.085	1.7	98.653	9.445	114.579
5.249	1.7	103.13	9.8732	119.774
5.413	1.7	79.679	7.6285	92.543
5.577	1.7	74.631	7.1452	86.680
5.741	1.5047946	152.72	14.622	177.376
5.905	1.4134425	184.78	17.691	214.615
6.069	1.4962526	148.92	14.257	172.960
6.234	1.5584195	125.13	11.98	145.326
6.398	1.630915	101.7	9.7367	118.118
6.562	1.6057202	105.05	10.057	122.007
6.726	1.4632651	147.54	14.125	171.354
6.890	1.4755629	139.53	13.358	162.054
7.054	1.4844968	132.9	12.724	154.359
7.218	1.4835763	129.89	12.436	150.860
7.382	1.4963405	122.04	11.684	141.746
7.546	1.5166927	111.9	10.713	129.962
7.710	1.5349015	102.88	9.8497	119.489
7.874	1.4996592	111.03	10.63	128.954
8.038	1.493427	109.89	10.521	127.629
8.202	1.4954504	105.94	10.143	123.046
8.366	1.5240349	93.485	8.9512	108.589
8.530	1.5433477	84.629	8.1023	98.291
8.694	1.5476904	80.342	7.6919	93.312
8.858	1.5433018	78.546	7.52	91.227
9.022	1.539604	76.574	7.3312	88.936
9.186	1.5669354	66.355	6.3528	77.067
9.350	1.5980729	56.383	5.3981	65.485
9.514	1.6142974	50.45	4.8301	58.595
9.678	1.5442154	64.025	6.1298	74.361
9.842	1.5403705	62.182	5.9533	72.220
10.006	1.6008107	45.746	4.3797	53.131
10.170	1.5778694	48.209	4.6155	55.991
10.335	1.5707235	47.383	4.5364	55.032
10.499	1.5724903	44.646	4.2744	51.853
10.663	1.5931884	38.224	3.6596	44.395
10.827	1.5974781	35.281	3.3778	40.977
10.991	1.6122245	30.682	2.9375	35.635
11.155	1.6407745	24.468	2.3426	28.418
11.319	1.6399091	22.838	2.1865	26.525
11.483	1.5797597	30.216	2.8929	35.094
11.647	1.6180172	22.384	2.143	25.998
11.811	1.6322579	18.868	1.8065	21.915
11.975	1.5797785	24.473	2.343	28.424
12.139	1.5675475	24.581	2.3534	28.549
12.303	1.5662713	22.967	2.1989	26.675

WHITE MESA TAILINGS REPOSITORY LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSES - 3-8S

Data File: 13-52106_SP3-8S-BSC-CPT
Location: White Mesa 2013 CPT Investigation
..\..\..\6.2.3_Field Data\2013 Field Investigation\Conetec Data

Legend
Tailings Sands
Tailings Sand-Slimes
Tailings Slimes
Interim Cover
Cells Requiring User Input/Manipulation

Idriss and Boulanger (2008)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	1.69

Youd, et al (2001)	
Max. Horiz. Acceleration, Amax/g:	0.15
Earthquake Moment Magnitude, M:	5.5
Magnitude Scaling Factor, MSF:	2.21

Value	Description
5603.50	Water surface elevation during CPT investigation (ft amsl)
5600.42	Water surface elevation at t_0 (ft amsl)
5590.63	Water surface elevation at t_1 (ft amsl)
5585.63	Water surface elevation at t_2 (ft amsl)
1.44	Scaling Factor for stress ration, r_m
0.47	Volumetric Strain Ratio for Site-Specific Design Earthquake
7.51	Equiv. Number of Uniform Strain Cycles, N

Value	Description
5608.70	Ground Surface Elevation at time of CPT (ft amsl)
5620.45	Ground Surface Elevation Immediately after Placement of Final Cover (ft amsl)
0.50	Thickness of Erosion Protection Layer (rock mulch/topsoils) Immediately after placement
3.50	Thickness of Water Storage/Rooting Zone (ft)
3.50	Thickness of High Compaction Layer (ft)
4.25	Thickness of Random/Platform Fill on on top of existing interim cover (ft)
1273.89	Additional Stress due to Final Cover Placement, $\Delta\sigma_{FC}$ (psf)
5585.63	Elevation of bottom of tailings (liner) (ft amsl)

FINAL COVER	Elev. at Top of Layer (ft)		Elev. At Midpoint of Layer (ft)	Bottom of Layer (ft)	Thickness of Layer (ft)	Unit Weight (tcf)	Unit Weight (pcf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)	Pressure at Bottom of Layer (tsf)	Equil Pore Pressure at Midpoint of Layer (tsf)	Stress at Bottom of Layer (tsf)	Stress at Midpoint of Layer (tsf)
Erosion Protection Layer	5620.45		5620.2	5619.95	0.50	0.055	110	0.028	0.014	0.00	0.00	0.028	0.014
Water Storage/Rooting Zone Layer	5619.95		5618.2	5616.45	3.50	0.054	107	0.215	0.121	0.00	0.00	0.215	0.121
High Compaction Layer	5616.45		5614.7	5612.95	3.50	0.060	120	0.424	0.320	0.00	0.00	0.424	0.320
Platform/Random Fill Layer	5612.95		5610.825	5608.70	4.25	0.050	101	0.638	0.531	0.00	0.00	0.638	0.531

2013 CPT Data from ConeTec / CPT Data Interpretations

Depth at time of CPT (ft)	Elevation (ft amsl)	qt TSF	fs TSF	qc TSF	Pw (u2) (ft)	Pw (u2) PSI	fs/qt (%)	Material Type (as determined by fines	Unit Weight (tcf)	Unit Weight (pcf)	Total Stress at time of CPT (tsf)	Equil Pore Pressure at time of (tsf)	Effective Stress at time of CPT (tsf)	Saturated at time of CPT 1=Yes 0=No
12.467	5596.23	12.9	0.081	12.8	12.1	5.25	0.63%	Sand-Slime Tailin	0.059	119.0	0.70	0.23	0.48	1
12.631	5596.07	13.9	0.074	13.8	9.8	4.25	0.53%	Sand-Slime Tailin	0.059	119.0	0.71	0.23	0.48	1
12.795	5595.90	13.8	0.074	13.8	10.5	4.55	0.53%	Sand-Slime Tailin	0.059	119.0	0.72	0.24	0.49	1
12.959	5595.74	14.6	0.071	14.5	12.1	5.22	0.49%	Sand-Slime Tailin	0.059	119.0	0.73	0.24	0.49	1
13.123	5595.58	15.1	0.085	15.0	12.9	5.59	0.56%	Sand-Slime Tailin	0.059	119.0	0.74	0.25	0.49	1
13.287	5595.41	18.1	0.188	18.0	15.1	6.54	1.04%	Sand-Slime Tailin	0.059	119.0	0.75	0.25	0.50	1
13.451	5595.25	14.3	0.276	14.2	17.2	7.45	1.93%	Sand-Slime Tailin	0.059	119.0	0.76	0.26	0.50	1
13.615	5595.08	12.3	0.228	12.1	23.3	10.08	1.86%	Sand-Slime Tailin	0.059	119.0	0.77	0.26	0.51	1
13.779	5594.92	10.8	0.190	10.7	27.0	11.70	1.75%	Sand-Slime Tailin	0.059	119.0	0.78	0.27	0.51	1
13.943	5594.76	8.0	0.181	7.7	47.3	20.48	2.26%	Slime Tailings	0.057	113.1	0.79	0.27	0.52	1
14.107	5594.59	10.0	0.115	9.6	60.9	26.40	1.15%	Sand-Slime Tailin	0.059	119.0	0.80	0.28	0.52	1
14.271	5594.43	12.7	0.137	12.5	34.5	14.95	1.08%	Sand-Slime Tailin	0.059	119.0	0.81	0.28	0.53	1
14.436	5594.26	8.1	0.129	7.9	39.8	17.23	1.59%	Slime Tailings	0.057	113.1	0.82	0.29	0.53	1
14.600	5594.10	6.3	0.101	6.0	61.5	26.64	1.59%	Slime Tailings	0.057	113.1	0.83	0.29	0.54	1
14.764	5593.94	6.0	0.095	5.6	71.3	30.89	1.58%	Slime Tailings	0.057	113.1	0.84	0.30	0.54	1
14.928	5593.77	5.9	0.056	5.5	66.0	28.61	0.95%	Slime Tailings	0.057	113.1	0.85	0.30	0.54	1
15.092	5593.61	6.8	0.056	6.5	47.2	20.44	0.82%	Sand-Slime Tailin	0.059	119.0	0.86	0.31	0.55	1
15.256	5593.44	9.0	0.056	8.7	40.6	17.59	0.63%	Sand-Slime Tailin	0.059	119.0	0.87	0.31	0.55	1

CPT Data Interpretations (cont.) / Conditions at t_1

Depth at time of CPT (ft)	CN	qc1 TSF	qc1 MPa	qc1N	Normalized Cone Penetration Resistance, Q_t	Normalized Friction Ratio, F_r (%)	Type Index, I_c	FC %	Total Stress at t_1 (tsf)	Equil Pore Pressure at t_1 (tsf)	Effective Stress at t_1 (tsf)	Saturated at t_1 1=Yes 0=No
12.467	1.57	20.146	280.04	23.54	26	0.66%	2.3	47%	1.34	0.00	1.34	0
12.631	1.55	21.485	298.64	25.06	27	0.56%	2.3	47%	1.35	0.00	1.35	0
12.795	1.54	21.243	295.27	24.79	27	0.56%	2.3	47%	1.36	0.00	1.36	0
12.959	1.53	22.185	308.37	25.90	28	0.51%	2.2	47%	1.37	0.00	1.37	0
13.123	1.51	22.654	314.89	26.45	29	0.59%	2.2	47%	1.38	0.00	1.38	0
13.287	1.48	26.626	370.11	31.09	35	1.09%	2.3	47%	1.39	0.00	1.39	0
13.451	1.50	21.326	296.43	24.96	27	2.03%	2.5	47%	1.40	0.00	1.40	0
13.615	1.51	18.270	253.95	21.47	23	1.98%	2.6	47%	1.41	0.00	1.41	0
13.779	1.50	15.970	221.98	18.84	20	1.89%	2.6	47%	1.42	0.00	1.42	0
13.943	1.49	11.507	159.95	13.88	14	2.50%	2.8	71%	1.43	0.00	1.43	0
14.107	1.48	14.251	198.09	17.20	18	1.25%	2.6	47%	1.44	0.00	1.44	0
14.271	1.46	18.326	254.73	21.65	23	1.15%	2.5	47%	1.45	0.00	1.45	0
14.436	1.46	11.483	159.62	13.76	14	1.77%	2.8	71%	1.46	0.00	1.46	0
14.600	1.45	8.629	119.94	10.67	10	1.83%	2.9	71%	1.47	0.00	1.47	0
14.764	1.44	8.029	111.61	10.07	10	1.83%	2.9	71%	1.47	0.00	1.47	0
14.928	1.43	7.895	109.74	9.86	9	1.10%	2.8	71%	1.48	0.00	1.48	0
15.092	1.42	9.295	129.20	11.28	11	0.94%	2.7	47%	1.49	0.00	1.49	0
15.256	1.41	12.302	171.00	14.70	15	0.69%	2.5	47%	1.50	0.00	1.50	0

Liquefaction Triggering Analyses — Idriss & Boulanger (2008)

Depth at time of CPT (ft)	Cyclic Stress Ratio r_d	C_σ	K_σ	K_a	CSR M=7.5, s'v=1atm	Cyclic Resistance Ratio Δqc_{1n}	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS
12.467	0.93	0.05	0.98	1.0	0.053	38.56	62.09	0.090	1.71
12.631	0.93	0.06	0.97	1.0	0.053	39.09	64.16	0.093	1.76
12.795	0.93	0.06	0.97	1.0	0.052	39.00	63.79	0.092	1.76
12.959	0.93	0.06	0.97	1.0	0.052	39.39	65.28	0.094	1.79
13.123	0.93	0.06	0.97	1.0	0.052	39.58	66.03	0.095	1.81
13.287	0.93	0.06	0.97	1.0	0.052	41.20	72.29	0.102	1.97
13.451	0.93	0.06	0.97	1.0	0.052	39.05	64.01	0.092	1.77
13.615	0.93	0.05	0.97	1.0	0.052	37.83	59.31	0.087	1.67
13.779	0.92	0.05	0.97	1.0	0.052	36.91	55.75	0.083	1.60
13.943	0.92	0.05	0.98	1.0	0.052	34.92	48.80	0.076	1.47
14.107	0.92	0.05	0.97	1.0	0.052	36.34	53.54	0.081	1.56
14.271	0.92	0.05	0.97	1.0	0.052	37.89	59.55	0.087	1.69
14.436	0.92	0.05	0.97	1.0	0.052	34.88	48.64	0.076	1.47
14.600	0.92	0.05	0.98	1.0	0.052	33.80	44.47	0.072	1.40
14.764	0.92	0.05	0.98	1.0	0.052	33.59	43.67	0.072	1.39
14.928	0.92	0.05	0.98	1.0	0.052	33.52	43.38	0.071	1.38
15.092	0.91	0.05	0.97	1.0	0.052	34.26	45.54	0.073	1.42
15.256	0.91	0.05	0.97	1.0	0.051	35.46	50.16	0.078	1.51

Liquefaction Triggering Analyses — Youd et al. (2001)

Depth at time of CPT (ft)	Cyclic Stress Ratio r_d	D_r	f	f	K_σ	K_a	CSR M=7.5, s'v=1atm	Kc	qc_{1n-cs}	(CRR) M=7.5, s'v=1atm	FoS	Avg FoS	Liquefiable? 1=Yes 2=No
12.467	0.94	0.28	0.80	0.80	1.13	1.0	0.037	1.98	46.69	0.089	3.86	2.79	2
12.631	0.94	0.29	0.80	0.80	1.12	1.0	0.037	1.80	45.15	0.088	3.77	2.77	2
12.795	0.94	0.29	0.80	0.80	1.12	1.0	0.037	1.82	45.16	0.088	3.74	2.75	2
12.959	0.94	0.29	0.80	0.80	1.12	1.0	0.037	1.72	44.57	0.087	3.68	2.74	2
13.123	0.94	0.30	0.80	0.80	1.12	1.0	0.037	1.77	46.90	0.089	3.73	2.77	2
13.287	0.94	0.32	0.80	0.80	1.12	1.0	0.037	1.96	60.82	0.101	4.19	3.08	2
13.451	0.94	0.29	0.80	0.80	1.11	1.0	0.037	3.03	75.54	0.120	4.94	3.36	2
13.615	0.94	0.27	0.80	0.80	1.11	1.0	0.037	3.35	71.88	0.115	4.67	3.17	2
13.779	0.94	0.25	0.80	0.80	1.11	1.0	0.037	3.60	67.84	0.109	4.41	3.00	2
13.943	0.94	0.22	0.80	0.80	1.11	1.0	0.037	5.07	70.29	0.112	4.51	2.99	2
14.107	0.94	0.24	0.80	0.80	1.11	1.0	0.037	3.23	55.51	0.096	3.82	2.69	2
14.271	0.94	0.27	0.80	0.80	1.10	1.0	0.038	2.64	57.06	0.097	3.84	2.76	2
14.436	0.94	0.21	0.80	0.80	1.10	1.0	0.038	4.42	60.74	0.101	3.95	2.71	2
14.600	0.94	0.19	0.80	0.80	1.10	1.0	0.038	5.42	57.80	0.098	3.81	2.60	2
14.764	0.94	0.18	0.80	0.80	1.10	1.0	0.038	5.66	57.05	0.097	3.75	2.57	2
14.928	0.94	0.18	0.80	0.80	1.10	1.0	0.038	4.79	47.20	0.089	3.42	2.40	2
15.092	0.94	0.19	0.80	0.80	1.09	1.0	0.038	4.07	45.87	0.088	3.35	2.39	2
15.256	0.94	0.22	0.80	0.80	1.09	1.0	0.038	2.96	43.56	0.086	3.25	2.38	2

Idriss & Boulanger (2008)

Depth at time of CPT (ft)	CN	qc1 TSF	qc1 MPa	qc1N
12.467	1.572711	20.265	1.9402	23.537
12.631	1.5523965	21.58	2.0661	25.064
12.795	1.542676	21.344	2.0435	24.789
12.959	1.5257894	22.3	2.135	25.900
13.123	1.5122892	22.776	2.1806	26.453
13.287	1.480883	26.766	2.5626	31.087
13.451	1.4986703	21.487	2.0572	24.956
13.615	1.506168	18.489	1.7701	21.473
13.779	1.4981009	16.222	1.5531	18.841
13.943	1.4886778	11.947	1.1438	13.875
14.107	1.478327	14.813	1.4182	17.205
14.271	1.4648967	18.641	1.7847	21.651
14.436	1.4591381	11.846	1.1341	13.758
14.600	1.4502622	9.1857	0.8794	10.669
14.764	1.4415084	8.6707	0.8301	10.071
14.928	1.4328741	8.4858	0.8124	9.856
15.092	1.4233829	9.7137	0.93	11.282
15.256	1.4140338	12.66	1.2121	14.704

APPENDIX G

EROSIONAL STABILITY EVALUATION

G.1 INTRODUCTION

This appendix presents the hydrologic analysis and evaluation of erosion protection for the cover surface of the White Mesa Mill tailings disposal cells, and for the discharge channel and sedimentation basin. These analyses are an update to the analyses presented in MWH (2011) to incorporate revisions to the analyses to address State of Utah, Division of Waste Management and Radiation Control (DWMRC) (formerly Utah Division of Radiation Control, DRC) interrogatories (DRC, 2012) and review comments on EFRI responses to 2012 interrogatories (DRC, 2013). These analyses also incorporate the revised cover grading design and results of cover material testing conducted in 2010 and 2012 (summarized in Attachment B of EFRI, 2012). These analyses have been conducted in a manner consistent with Nuclear Regulatory Commission (NRC) guidelines documented in NRC (1990) and Johnson (2002). The analyses include the tasks listed below.

1. Selection of the Probable Maximum Precipitation (PMP) as the design event for the site.
2. Calculation of the peak discharge (due to the PMP) from the surfaces of Cells 1, 2, 3, 4A and 4B for the cover surface, and for the drainage basin for the discharge channel.
3. Evaluation of reclaimed tailings disposal cell surfaces for erosional stability (the top surfaces and the reclaimed embankment slopes) and evaluation of the discharge channel and sedimentation basin for erosional stability.
4. Evaluation of the need for filter material between erosional protection riprap and underlying soil layers on the reclaimed embankment slopes and the rock aprons.
5. Evaluation of the need for a rock apron at the toe of the reclaimed embankment slopes to accommodate flow transitioning from embankment slopes to native ground.
6. Evaluation of surface sheet erosion of top surface of cells due to action of surface water and wind.

These tasks are presented in the following sections of this appendix.

G.2 CONCEPTUAL EROSIONAL PROTECTION DESIGN

Erosional protection was evaluated for the proposed monolithic ET cover design based on the following proposed cover surface of the tailings disposal cells, as well as for the sedimentation basin and diversion channel:

- Cells 2 and 3 top surfaces graded to 0.5 percent slope: Erosional protection is provided by 6 inches of topsoil vegetated with a grass mixture providing poor or better vegetated conditions with a minimum of 30 percent plant coverage (conservative vegetation conditions for erosional stability calculations).
- Portions of Cell 1 and 2 with top surfaces graded at 1 percent slope and Cells 4A and 4B with top surfaces at 0.8 percent slope: Erosional protection is provided by 6 inches of topsoil mixed with 25 percent (by weight) of 1-inch minus (D_{100} = 1 inch) gravel, vegetated with a grass mixture providing poor or better vegetated conditions with a minimum of 30 percent plant coverage (conservative vegetation conditions for erosional stability calculations).

- External side slopes graded to 5 horizontal to 1 vertical (5H:1V): Erosional protection is provided by various sized angular and rounded riprap with thicknesses ranging from 6 to 8 inches and minimum D_{50}'s ranging from 1.7 to 5.3 inches. Filter material will be placed between the erosional protection and the underlying soil layer in locations with riprap greater than 1.7 inches. A narrow zone of this filter will also be placed at the interface between the riprap on the external side slopes and the cover surface erosion protection layer.
- A rock apron at the toe of 5H:1V slopes: Erosional protection and scour protection on the west and east sides of the cells is provided by a rock apron measuring 10.2 inches deep and 4.25 feet in width, with a D_{50} of 3.4 inches. On the south side of cells 4A and 4B, and east side of Cell 4A, the rock apron measures 2.7 feet in depth, 13.2 feet in width, and has a D_{50} of 10.6 inches. On the north side slope of the Cell 1 disposal area, the rock apron measures 2.3 feet deep, 11.3 feet wide, and contains a minimum D_{50} of 9.0 inches.
- Sedimentation Basin area graded to 0.1 percent slope: Erosional protection is provided by 6 inches of topsoil vegetated with a grass mixture providing poor or better vegetated conditions with a minimum of 30 percent plant coverage (conservative vegetation conditions for erosional stability calculations).
- Diversion Channel: The diversion channel will be excavated into bedrock.

G.3 PROBABLE MAXIMUM PRECIPITATION EVENT

As outlined in NRC (1990) and Johnson (2002), the design event for evaluation of long-term erosional stability of the reclaimed tailings disposal cells is the PMP. The selected PMP events used to calculate the peak discharges for evaluation of erosional stability were the six-hour duration PMP (with a precipitation total of 9.6 inches) and the one-hour duration PMP (with a precipitation total of 8.3 inches). These events were determined for the site area using "Hydrometeorological Report (HMR) No. 49: Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages (Hansen et al. 1984) , as well as Jensen (1995). Rainfall depth versus duration for short-term events (less than 1 hour) was developed using procedures in HMR 49 and NUREG/CR-4620 (Nelson et al., 1986). PMP calculations were provided in Denison (2009) and updated in Denison (2012). The calculations are provided in Attachment G.1.

G.4 CALCULATION OF PEAK DISCHARGE

The peak discharge calculations were made using the Rational Method as described in Johnson (2002) and Nelson et al. (1986). The time of concentration was calculated for the longest flow path (see Figure G.1) across the tailings disposal cells using procedures by Kirpich, Soil Conservation Service (SCS) and Brant and Oberman as presented in Nelson et al. (1986) and DOE (1989). Equal weight was given to each of the three methods. A runoff coefficient of 1.0 was used to represent PMP conditions (DOE, 1989). These characteristics represent high runoff quantities and peak flow velocities.

The PMP discharge results across the tailings disposal cells are presented in Table G.1. These discharges represent flow across a unit-width across the slope.

Table G.1. Peak Reclaimed Surface Discharges

Location	Slope Length (feet)	Time of Concentration (min)	Rainfall Intensity (in/hr)	Runoff Coefficient	Peak Unit Discharge (cfs/ft)
Upper reach of Cell 2 at 1 % slope	900	9.4	32.7	1.0	0.68
Lower reach of Cell 2 at 0.5 % slope	550	18.5	21.4	1.0	0.71
Cell 3 at 0.5 % slope	830	30.0	14.8	1.0	0.78
Cell 4A at 0.8 % slope	1200	42.2	11.2	1.0	0.90
Cell 4A side slopes at 20% slope	100	42.2	11.2	1.0	0.92

Note: Flow accumulates as it flows from Cell 2 to Cell 4A

The unit discharge values in Table G.1 above were used to evaluate the erosional stability of the reclaimed surfaces and size erosion protection materials where necessary. These evaluations are presented in Sections G.5 and G.6.

G.5 EROSIONAL STABILITY OF VEGETATED SLOPES

The surface of the reclaimed tailings disposal cells was evaluated for erosional stability using the methods recommended in NRC (1990) and Johnson (2002).

Temple Method. Temple et al. (1987) outlines procedures for grass-lined channel design. These procedures are recommended in Johnson (2002) for areas of vegetated cover and include methods for estimating stresses on channel vegetation as well as the channel surface soils. The evaluation for the tailings disposal cells used the peak discharge values from the PMP (summarized in Table G.1) to conservatively represent the effective stresses from runoff on the cover surface. The stresses on both the vegetation and the soil were evaluated.

The erosional stability of the cover surface for the tailings disposal cells was evaluated by calculating a factor of safety against erosion due to the peak runoff from the PMP. Factor-of-safety values were calculated as the ratio of the allowable stresses (the resisting strength of the cover vegetation or soils) to the effective stresses (the stresses impacted by the runoff flowing over the cover). Two factors of safety were calculated for each analysis to evaluate both the resistance of the vegetation, and the resistance of the silty topsoil layer. The peak unit discharge flow for the tailings disposal cells (from Table G.1) was conservatively multiplied by a concentration factor of 3 to account for channelization of flow.

Allowable stresses. Allowable stresses for the cover soils were calculated using the equations in Temple et al. (1987). Material planned for the upper layer of the cover system is the on-site stockpiled topsoil. Laboratory testing of the topsoil conducted in 2010 (see Appendix A) indicates the topsoil classifies as either a silty clay with sand or a sandy silty clay. The D_{75} (diameter of which 75 percent of the material is finer) is approximately 0.08 mm to 0.1 mm (.003 in to .004 in) with a plasticity index (PI) of approximately 4 to 7. The resistance of a silty soil with a PI less than 10 is estimated to be approximately 0.02 psf (Temple et al., 1987). For noncohesive soils with a D_{75} greater than 0.05 in., the resistance is calculated as follows:

$$\tau_a = 0.4D_{75}$$, for soils with D_{75}>0.05 in,
$$\tau_a = 0.02,$$ for noncohesive soils with D_{75}≤0.05 in.

Where

τ_a = allowable shear strength (psf), and
D_{75} = particle diameter in which 75 percent of the soil is finer (inch).

For areas where 1-inch gravel is added to the topsoil (25 percent by weight), the D_{75} of the topsoil mixture will increase to approximately 0.2 inches.

As discussed in Appendix J of this report, the cover will be vegetated with a mixture of perennial grasses (primarily wheatgrass, ricegrass, squirreltail, and fescue) and forbs (yarrow and sage). The allowable vegetation shear strength is calculated as:

$$\tau_{va} = 0.75C_I$$

Where

τ_{va} = allowable vegetation shear strength (in psf),
C_I =cover index = 2.5 $[h(M)^{1/2}]^{1/3}$,
h = stem length (ft), and
M = stem density factor (stems per square ft).

Conservatively using poor vegetation conditions, h=1.0, M=67, and C_I=5.03, the resulting vegetation shear strength value is 3.78 psf.

Effective stresses. The effective shear stress on soil due to peak runoff from the PMP was calculated as:

$$\tau_e = \gamma dS(1 - C_f)(n_s/n)^2$$

Where

τ_e = effective shear stress (psf),
γ = unit weight of water = 62.4 pcf,
d = depth of flow (ft), from Table G.2,
S = slope of cover surface (ft/ft), from Table G.1,
C_f = cover factor (0.375 for poor vegetation),
n_s = soil roughness factor (0.0156 for soils with D_{75}≤0.05 in., or $0.0256(D_{75})^{1/6}$ for D_{75} > 0.05 in), and
n = Manning's roughness coefficient for vegetated surface.

$$n = e^{C_i(0.0133[\ln q]^2 - 0.0954 \ln q + 0.297) - 4.16}$$

The effective shear stress on vegetation is calculated as:

$$\tau_v = \gamma dS - \tau_e$$

Where

τ_v = effective vegetal stress (psf).

Conservatively using poor vegetation conditions, the effective shear stresses on soil and vegetation on the tailings cover surfaces are summarized in Table G.2.

Table G.2. Effective Shear Stresses on Soil and Vegetation

Location	Description of Erosion Protection	Depth of Flow[1] (ft)	Soil			Vegetation		
			Effective Shear Stress (psf)	Allowable Shear Stress (psf)	Factor of Safety	Effective Shear Stress (psf)	Allowable Shear Stress (psf)	Factor of Safety
Cell 1 at 1% slope	Vegetation and Gravel (D_{75}=0.2 in)	0.80	0.040	0.08	2.0	0.449	3.78	8.4
Cell 2 at 0.5 % slope	Vegetation (D_{75} = 0.003 in)	1.01	0.019	0.02	1.1	0.297	3.78	12.7
Cell 2 at 1 % slope	Vegetation and gravel (D_{75} = 0.2 in)	0.82	0.044	0.08	1.8	0.467	3.78	8.1
Cell 3 at 0.5 % slope	Vegetation (D_{75} = 0.003 in)	1.05	0.021	0.02	1.0	0.306	3.78	12.4
Cells 4A and 4B at 0.8 % slope	Vegetation and gravel (D_{75} = 0.2 in)	0.97	0.050	0.08	1.6	0.433	3.78	8.7

[1] Calculated using a concentration factor of 3 for peak unit discharge

The calculated factors of safety above show that for poor vegetation conditions, the allowable shear strengths are equal to or higher than the effective shear stresses on both the vegetation and the soil during peak discharge from the PMP. When vegetation conditions are good or better, the soil factor of safety improves significantly, while the vegetation factor of safety decreases slightly, but remains well above 1.0. Further details of calculations can be found in Attachment G.2.

These analyses indicate that the cover on the top surface of the tailings disposal cells can be constructed as a vegetated slope. Top slopes at 0.5 percent slopes are adequately stable without the addition of gravel, while the 1 percent slope in Cell 2, and the 0.8 percent slope in Cells 4A and 4B will require the addition of approximately 25 percent of 1-inch-minus gravel.

G.6 EROSIONAL STABILITY OF ROCK-PROTECTED SIDE-SLOPES

Because of the difficulty in maintaining vegetation on side slopes, the 5:1 side slopes have been designed for erosional protection assuming vegetation is minimal. The maximum unit discharge value from Table G.1 was used to size riprap for the embankment slopes. The Johnson and Abt method referenced in Johnson (2002) was used for the side slopes. The required angular rock size is calculated as follows:

$$D_{50} = 5.23S^{0.43}q_{design}^{\ \ 0.56}$$

Where

D_{50} = median particle diameter of which 50 percent of the soil is finer (inch),
S = slope (ft/ft), and
q_{design} = design flow (cfs/ft).

Flow Characteristics. The peak unit discharge values from Table G.1 were used to represent flow conditions across the cover surface and down the embankment side slopes south of Cells 4A and 4B. Concentration factors of 3 were used to account for channelization of flow.

Rock Characteristics. A specific gravity of 2.65 was assumed for the riprap. The overall erosion protection design uses rounded and angular rock for the embankment side slopes. Angular rock was selected for slopes where the required minimum D_{50} for rounded rock was too large to produce. For areas where rounded rock was selected, the minimum D_{50} was increased by 40 percent in the design to account for rounded rock characteristics (Abt and Johnson, 1991). The results of the riprap sizing for the embankment slopes are summarized in Table G.3 below.

Table G.3. Results of Riprap Sizing

Location	Design Unit Discharge (cfs/ft)	Slope (ft/ft)	Concentration Factor	Median Rock Size (inches)
Non-Accumulating Side Slopes (Rounded Rock)	0.06	0.20	3	1.7
Cell 4A and 4B southern side slopes(Angular Rock)	0.87	0.20	3	5.3
Cell 1 Disposal Area side slope (Angular Rock)	0.65	0.20	3	4.5

Filter Requirements. NUREG-1623 (Johnson, 2002) recommends a filter or bedding layer be placed under the erosion protection if interstitial velocities are greater than 1 ft/s, in order to prevent erosion of the underlying soils. Bedding is not required if interstitial velocities are less than 0.5 ft/s, and are recommended depending on the characteristics of the underlying soil if velocities are between 0.5 and 1.0 ft/s.

Interstitial velocities are calculated by procedures presented by Abt et al. (1991) as given in the following equation:

$$V_i = 0.23(g \times D_{10} \times S)^{0.5}$$

Where

Vi = interstitial velocities (ft/s),
G = acceleration due to gravity (ft/s^2),
D_{10} = stone diameter at which 10 percent is finer (inches), and
S = gradient in decimal form.

The maximum D_{10} of the erosion protection is estimated based on the D_{50} required for erosion protection, assuming the erosion protection will have a coefficient of uniformity (CU) of 6 and a band width of 5. Band width refers to the ratio of the minimum and maximum allowed particle sizes acceptable for any given percent finer designation. USDA (1994) recommends CU to be a maximum of 6 in order to prevent gap-grading of filters. Table G.4 summarizes the results for the side slopes.

Table G.4. Results of Filter Requirements for Side Slopes

Location	Non-Accumulating Side Slopes (Rounded Rock)	Cell 4A and 4B southern side slopes(Angular Rock)	Cell 1 Disposal Area side slope (Angular Rock)
Minimum D_{50} (inches)	1.7	5.3	4.5
Maximum D_{10} (inches)	0.53	1.65	1.40
Slope (%)	20	20	20
Interstitial Velocity (ft/s)	0.43	0.75	0.69
Filter Requirement	No	Recommended	Recommended

Based on the results in Table G.4 and the fine-grained nature of the top soil, it is recommended that a filter be placed between the soil and the rock protection for the side slope areas that require angular riprap. These areas include the southern side slopes of Cells 4A and 4B as well as the northern side slope of the Cell 1 disposal area as shown in Figure G.1. A narrow zone of this filter will also be placed at the interface between the riprap on the external side slopes and the cover surface erosion protection layer. The interstitial velocity results confirm that a filter is not necessary for the non-accumulating side slopes where rounded rock is proposed on the west and east sides of Cells 2, 3 and 4.

Gradation for proposed Filter. The procedure from USDA (1994) for determining the gradation limits for a sand or gravel filter was used to evaluate the type of material needed to satisfy filter requirements between the soil and rock protection for the side slopes. The method details twelve steps to determine an appropriate gradation range for the filter layer. The steps can be found in Chapter 26 of the USDA Handbook and are shown in the Attachment G.2 for supporting calculations. In addition, Equation 5.3 from Cedegren (1989) and Equation 4.36 from Nelson et al. (1986) were used to determine the filter gradation requirements. Table G.5 presents the recommended gradation.

Table G.5. Results of Filter Gradation Requirements

Diameter (mm)	Sieve Sizes	Percent Passing
76.2	3"	100
4.75	No. 4	70-100
0.85	No. 20	40-60
0.075	No. 200	0-5

Based on the results of Table G.5, the filter material should be a medium sand that will be placed between the erosion protection and the base layer on the side slopes.

Sheet Erosion. The Modified Universal Soil Loss Equation (MUSLE) as presented in NUREG/CR4620 (Nelson et al., 1986) was used to evaluate the potential for soil loss due to sheet flows across the gravel/topsoil surface layer of the cover.

The MUSLE is defined as: $A = R * K * LS * VM$

Where:

A = soil loss, in tons per acre per year,
R = rainfall factor,
K = soil erodibility factor,
LS = topographic factor, and
VM = dimensionless erosion factor relating to vegetative and mechanical factors

The rainfall factor, R, is 30, as given in NUREG/CR-4620 for the eastern third of Utah. The soil erodibility factor, K, was estimated to be 0.28 for the topsoil and 0.16 for the gravel and topsoil mixture, based on the nomograph (Fig. 5.1) in NUREG/CR-4620.

The topographic factor, LS, is calculated based on the following equation:

$$LS = \frac{650 + 450s + 65s^2}{10{,}000 + s^2} * \left(\frac{L}{72.6}\right)^m$$

Where:

s = slope steepness, in percent (%),
L = slope length in feet,
m = slope steepness dependent exponent

The topographic factor was calculated using a slope of 0.82 percent and a slope length of 1,300 feet. From the Table 5.2 in NUREG/CR-4620, the slope steepness exponent, m, is 0.2 for slopes less than or equal to 1.0 percent.

The erosion factor, VM, used was 0.4, from Table 5.3 of NUREG/CR-4620, to represent seedlings of 0 to 60 days, to mimic light vegetation on the cover. Table G.5 summarizes the MUSLE results for the proposed topsoil and the proposed topsoil mixed with 25 percent gravel, by weight.

Table G.6. Results of MUSLE

Soil Cover	Proposed Topsoil	Proposed Topsoil with 25% Gravel
Rainfall factor, R	30	30
Silt and very fine sand (%)	43.6	32.7
Sand (%)	39.2	29.4
Organic matter (%)	1.5	1.5
Soil structure	Fine granular	Medium or coarse granular
Relative permeability	Moderate	Moderate to rapid
Erodibility factor, K	0.28	0.12
Topographic Factor, LS	0.16	0.19
Erosion factor, VM – low density seedings	0.4	0.4
Soil loss (tons/acre/year)	0.54	0.27
Soil loss (inches/1,000 years)	3.0	1.4

The soil loss equation shows the potential for erosion will be reduced by almost one half, by using 25 percent gravel in the topsoil mixture. The topsoil loss of 1.5 to 3.0 inches over the life of the cover (1,000 years) is less than the minimum design thickness of 6 inches.

G.7 ROCK SIZING FOR APRON

Additional erosion protection will be provided for runoff from the south side slopes of the reclaimed surfaces of Cells 4A and 4B, the east side of Cell 4A, and the north side of Cell 1 with a rock apron. The perimeter apron will: (1) serve as an impact basin and provide for energy dissipation of runoff, (2) provide erosion protection, and (3) transition flow from side slopes to natural ground. The median rock size required in the perimeter apron was calculated using the equations derived by Abt et al. (1998) as outlined in NUREG 1623 (Johnson, 2002) as follows:

$$D_{50\ energy\ dissipation} = 10.46S^{0.43}q^{0.56}$$

Flow Characteristics. The peak unit discharge values from Table G.1 were used to represent flow conditions down the embankment side slopes south of Cells 4A and 4B. Concentration factors of 3 were used to account for channelization of flow.

Rock Characteristics. A specific gravity of 2.65 was assumed for the riprap. Both rounded and angular rock was used in the apron design.

Based on the above equation, the rock apron (Apron A) along the toe of the non-accumulating slopes covered with rounded riprap (west and east side slopes of Cells 2 and 3) should be constructed using rounded rock with a median rock diameter of 3.4 inches. The width of the apron should be a minimum of 15 times the median rock size (4.25 ft) and the apron thickness should be a minimum of three times the median rock size (10.2 inches). Rock Apron B should be placed on the toes of the south slope of Cells 4A and 4B and along the east of Cell 4A. Apron B should have a median angular rock size of 10.6 inches, with a minimum width of 13.2 feet and a minimum thickness of 2.7 feet. Rock Apron C should be placed on the toes of the remaining slope (Cell 1 disposal area side slope). Apron C should have a median rock size of 9.0 inches, a minimum width of 11.3 feet, and a minimum thickness of 2.3 feet.

Filter Requirements. NUREG-1623 (Johnson, 2002), as detailed in section G.6, was used to determine if a bedding layer was required for the rock aprons. The results are presented in Table G.7 below.

Table G.7. Results of Filter Requirements for Rock Aprons

Location	Apron A: Non-Accumulating Slopes (Rounded)	Apron B: Cell 4A and 4B slopes(Angular)	Apron C: Cell 1 disposal area side slope (Angular)
Minimum D_{50} (inches)	3.4	10.6	9.0
Maximum D_{10} (inches)	1.0	3.3	2.8
Slope (%)	1	1	1
Interstitial Velocity (ft/s)	0.13	0.24	0.22
Filter Requirement	No	No	No

Based on the results in Table G.7, it is not required to place a bedding layer between the soil and rock protection for the rock aprons.

G.8 DISCHARGE CHANNEL AND SEDIMENTATION BASIN

The PMP event described in Section G.3 was used to determine the peak discharge to the channel to be located at the west end of the sedimentation basin. The peak discharge calculations were made using the Rational Method and the time of concentration was calculated for the longest flow path (see Figure G.1) across the mill site and sedimentation basin using the procedures described in section G.4. A runoff coefficient of 1.0 was used to represent PMP conditions (DOE, 1989). These characteristics represent high runoff quantities and peak flow velocities.

The PMP peak discharge calculated across the mill site and sedimentation basin is presented in Table G.8. This discharge represents the peak flow into the channel. Further details of the calculations can be found in Attachment G.1

Table G.8. Peak Discharge Flow to the Discharge Channel

Location	Slope Length (feet)	Time of Concentration (min)	Rainfall Intensity (in/hr)	Runoff Coefficient	Peak Discharge (cfs)
Mill site and sedimentation basin	4,600	26.3	16.4	1.0	2,440

The peak discharge value in Table G.8 above, was used to evaluate the peak flow velocities through the discharge channel excavated into bedrock. The channel dimensions are shown on Drawing REC-3 and include a 150-foot bottom width and 3:1 (H:V) side slopes. The Manning's n-value was estimated and adjusted based on the anticipated type of bedrock and the presumed roughness, along the channel, after excavation. Table G.9 includes peak flow velocities for Manning's n-values of 0.02 and 0.03.

Table G.9. Peak Discharge Channel Flow Velocities

Location	Channel Bottom Width (feet)	Channel Side Slopes (H:V)	Manning Coefficient, n	Flow Depth (ft)	Cross Sectional Area of Flow (ft^2)	Hydraulic Radius (ft)	Peak Velocity (fps)
Discharge channel	150	3:1	0.02	1.67	259	1.61	9.4
Discharge channel	150	3:1	0.03	2.12	332	2.03	7.3

Based on the available bedrock information near the channel location, the rock is expected to consist of a fine to medium-grained sandstone with varying degrees of cementation and weathering, or a claystone (Dames and Moore, 1978). The shear wave velocities from seismic refraction surveys indicate the bedrock will range from rippable to hard rock, requiring blasting (D'Appolonia, 1979). Because of this variability, an initial Manning's n-value of 0.015 was selected, for a channel in rock and then modifications of 0.005 and 0.015 were added for increasing irregularities in the final excavated rock surface. (USBR, 1987). Maximum suggested permissible peak channel velocities are 10 feet per second for channels excavated in "poor rock" (USACE, 1994).

G.9 REFERENCES

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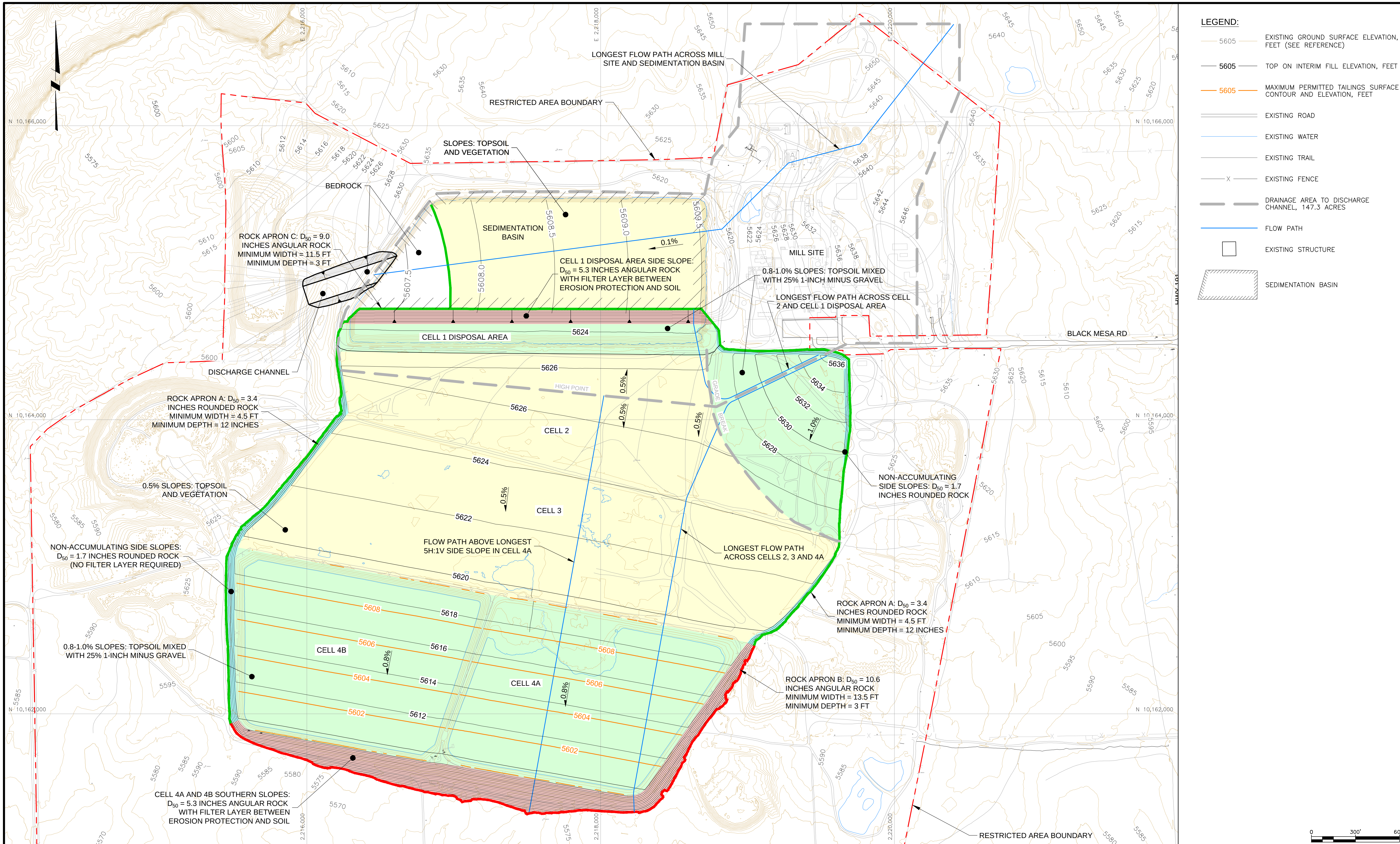

Energy Fuels Resources (USA) Inc.

PROJECT
WHITE MESA MILL TAILINGS RECLAMATION

TITLE
RECLAMATION COVER EROSION PROTECTION

MWH

SHEET
FIGURE G.1

FILE NAME
WMM EROS PRO

DATE
APR 2016

ATTACHMENT G.1

PMP CALCULATIONS
DENISON (2012)
DENISON (2009)

Client:	**Denison Mines**	**Job No.:**	**1009740**
Project:	**White Mesa Reclamation Plan**	**Date:**	**5/10/2012**
Detail:	**Updated Probable Maximum Precipitation (PMP) Calculation**	**Computed By:**	**MMD**

References:

Denison Mines (USA) Corporation (Denison), 2009. Re: Cell 4B Lining System Design Report, Response to DRC Request for Additional Information – Round 3 Interrogatory, Cell 4B Design – Exhibit C: Probable Maximum Precipitation (PMP) Event Calculation, Letter to Dane Finerfrock, September 11.

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Approach:

Update previous calculations (Denison, 2009) to incorporate Jensen (1995) and Jensen (2003) references as recommended by DRC (2012) Jensen (2003) is applicable for 72-hour durations for areas up to 5,000 square miles. Incorporation of this reference does not modify the previous calculations for one-hour or six-hour duration PMP values for the site.

Calculations:

Site Information

Parameter	Value	Units	Comments
Drainage Area	0.4	mi^2	Denison (2009) for Cells 2 through 4B
Latitude	N 37°31'		Denison (2009)
Longitude	W 109°30'		Denison (2009)
Minimum Elevation	5600	ft	Denison (2009)

Updated Local-Storm PMP Estimates

Parameter	Value	Units	Comments
One-hour point precipitation PMP value	8.6	in	Jensen (1995) references Figure 4.7 in Hansen (1984).
Elevation Reduction	97	%	Jensen (1995) recomments same elevation reduction as used in Hansen (1984).
One-Hour PMP (adjusted for elevation)	8.3	in	This is the same value presented in Denison (2009)
6-hr to 1-hr Depth Percentage	115	%	Table 15 in Jensen (1995)
Six-Hour PMP	9.6	in	One-hour PMP multiplied by 6-hr to 1-hr depth percentage
Areal Reduction	100	%	Table 15 in Jensen (1995) for 1 sq. mi. area

RESULTS

One-Hour Duration PMP	**8.3**	**in**
Six-Hour Duration PMP	**9.6**	**in**

Updated Local-Storm PMP Incremental Values

Duration (hr)	Percentage of 1-hr PMP	Depth (in)	Incremental Depth (in)
0.25	50	4.2	4.2
0.5	74	5.5	1.3
0.75	90	7.5	2.0
1	100	8.3	0.8
2	110	9.1	0.8
3	112	9.3	0.2
4	113.5	9.4	0.1
5	114.5	9.5	0.1
6	115	9.6	0.1

Six-Hour Duration PMP	
Hourly Increments	Depth (in)
1st	0.1
2nd	0.2
3rd	8.3
4th	0.8
5th	0.1
6th	0.1

One-Hour Duration PMP	
15-Min. Increments	Depth (in)
1st	4.2
2nd	2.0
3rd	1.3
4th	0.8

EXHIBIT C

PROBABLE MAXIMUM PRECIPITATION (PMP) EVENT CALCULATION PACKAGE

Geosyntec consultants

COMPUTATION COVER SHEET

Client: **DMC**	Project: **White Mesa Mill – Cell 4B**	Project/ Proposal No.: Task No.	**SC0349**

Title of Computations **PROBABLE MAXIMUM PRECIPITATION (PMP) EVENT COMPUTATION**

Computations by:	Signature	[signature]	9/4/09 Date
	Printed Name	Meghan Lithgow	
	Title	Senior Staff Engineer	
Assumptions and Procedures Checked by: (peer reviewer)	Signature	[signature]	9/9/09 Date
	Printed Name	Rebecca Flynn, PE	
	Title	Engineer	
Computations Checked by:	Signature	[signature]	9/9/09 Date
	Printed Name	Meghan Lithgow	
	Title	Senior Staff Engineer	
Computations backchecked by: (originator)	Signature	[signature]	9/9/09 Date
	Printed Name	Meghan Lithgow	
	Title	Senior Staff Engineer	
Approved by: (pm or designate)	Signature	[signature]	9/10/09 Date
	Printed Name	Gregory T. Corcoran, PE	
	Title	Principal	

Approval notes:

Revisions (number and initial all revisions)

No.	Sheet	Date	By	Checked by	Approval

Written by:	**M. Lithgow**	Date:	**09/04/09**	Reviewed by:	**G. Corcoran**	Date:	**9/10/09**
Client:	**DMC**	Project:	**White Mesa Mill-Cell 4B**	Project/ Proposal No.:	**SC0349**	Task No.:	**02**

PROBABLE MAXIMUM PRECIPITATION (PMP) EVENT COMPUTATION WHITE MESA MILL – CELL 4B BLANDING, UTAH

OBJECTIVE

The purpose of this calculation is to evaluate the local-storm Probable Maximum Precipitation (PMP) event for the White Mesa Mill Facility site located in Blanding, Utah. This calculation demonstrates that the probable maximum precipitation (PMP) event that the site will experience is 10 inches (0.83 ft) in 6 hours.

PMP COMPUTATION PROCEDURE

The Probable Maximum Precipitation (PMP) for the site was evaluated using "Hydrometeorological Report No. 49: Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages" (Hansen, et. al., 1984). The use of this method is cited in a hydrology report that was prepared as part of an agreement between UMETCO and the Nuclear Regulatory Commission (NRC) during the permitting of Cell 4A (UMETCO, 1990).

PROBABLE MAXIMUM PRECIPITATION EVENT CALCULATIONS

Step 1: Calculate the Average 1-hr 1-mi^2 PMP for drainage using Figure 4.5

The average 1-hr 1-mi^2 PMP is 8.6-in (Attachment A, 1/7)

Step 2a: Reduce the 1-hr 1-mi^2 PMP event for elevation

If the lowest elevation within the drainage is above 5,000 feet (ft) above Mean Seal Level (MSL), decrease the PMP value from Step 1 by 5% for each 1,000 ft or proportionate fraction thereof above 5,000 ft to obtain the elevation adjusted drainage average 1-hr 1-mi^2 PMP.

The elevation of Cell 4B is 5,598 ft above MSL, which is conservatively the lowest elevation for the completed cells 2 through 4B; therefore, it is required to interpolate

Written by:	M. Lithgow	Date:	09/04/09	Reviewed by:	G. Corcoran	Date:	9/10/09
Client:	DMC	Project:	White Mesa Mill-Cell 4B	Project/ Proposal No.:	SC0349	Task No.:	02

between 95% and 100% using the following equation:

$$\frac{5\,\%}{1{,}000\ ft} = \frac{x\,\%}{598\ ft}$$; x = 3% reduction

100 % - 3 % = 97 %

Therefore, reduce the value obtained in Step 1 by 97%.

Step 2b: Multiply the number calculated in Step 1 by the number calculated in Step 2a.

8.6 inches x 0.97 = 8.3 inches

Step 3: Determine the average 6/1-hr ratio for drainage using Figure 4.7

The average 6/1-hr ratio for drainage is approximately 1.2. (Attachment A, 2/7)

Step 4: Calculate the durational variation for 6/1-hr ratio of Step 3 using Table 4.4

The durational value is determined using Table 4.4 is as follows: (Attachment A, 3/7)

Duration (hr)									
¼	½	¾	1	2	3	4	5	6	
74	89	95	100	110	115	118	119	120	%

Step 5: Multiply step 2b by Step 4 to calculate the 1-mi^2 PMP for indicated durations

For example, for the ¼ hour duration: 8.3 x 0.74 = 6.1

The following numbers are calculated as follows:

Duration (hr)									
¼	½	¾	1	2	3	4	5	6	
6.1	7.4	7.9	8.3	9.1	9.5	9.8	9.9	10.0	in.

Step 6: Determine the areal reduction using Figure 4.9 for the site:

Written by:	M. Lithgow	Date:	09/04/09	Reviewed by:	G. Corcoran	Date:	9/10/09
Client:	DMC	Project:	White Mesa Mill-Cell 4B	Project/ Proposal No.:	SC0349	Task No.:	02

First, determine the total watershed contributing to Cell 4B, including Cell 4B. The watershed areas of the upstream Cells 2, 3, and 4A are 87 acres (ac), 83 ac, and 40 ac, respectively and the proposed Cell 4B is 42 ac. Areas outside of these cells do not drain to Cell 4B and are therefore not part of the watershed area.

Total acreage is 87 ac + 83 ac + 42 ac + 42 ac = 254 acres.
Next, convert this number into square miles:

$$254\ acre\ x\ \frac{43{,}560\ ft^2}{1\ acre}\ x\ \frac{(1mi)^2}{(5{,}280\ ft)^2} = 0.40\ mi^2$$

Using Figure 4.9, the depth ratio of ≤1 mi^2 is 100 percent for each of the durations (Attachment A, 4/7).

Step 7: Multiply the duration values in Step 5 by the areal reduction in Step 6 to calculate the areal reduced PMP.

This step is neglected because the depth ratio is 100 percent; therefore, the values obtained in Step 5 are not reduced.

Step 8: Calculate the incremental PMP using successive subtraction of the values in Step 7 for the hourly durations (1 hr through 6 hr) and 15-minute incremental durations (1/4 hr through 1 hr).

The incremental PMP is calculated in two separate steps; the incremental PMP is calculated on the first line for the hourly increments (hours 1 through 6) and then calculated on the second line for the 15-minute increments during the first hour of the storm. To determine the incremental PMP, the following formula is used:

$$PMP_{t\ to\ t+1} = PMP_{t+1} - PMP_t$$, where t = time

In this example, the PMP between the first interval and second interval is determined by subtracting the PMP for interval 1 from the PMP for the second interval, as calculated in Step 5. The following equation illustrates the calculation of the incremental PMP between hours 0 and 1:

Written by:	M. Lithgow	Date:	09/04/09	Reviewed by:	G. Corcoran	Date:	9/10/09
Client:	DMC	Project:	White Mesa Mill-Cell 4B	Project/ Proposal No.:	SC0349	Task No.:	02

$$PMP_1 - PMP_0 = 8.3 \text{ in} - 0 \text{ in.} = 8.3 \text{ in.}$$

The next equation illustrates the calculation of the incremental PMP between hours 1 and 2:

$$PMP_2 - PMP_1 = 9.1 \text{ in} - 8.3 \text{ in.} = 0.8 \text{ in.}$$

This calculation is continued until the following table is completed as shown for each PMP interval.

Duration (hr)									
¼	½	¾	1	2	3	4	5	6	
			8.3	0.8	0.4	0.2	0.1	0.1	in.
6.1	1.2	0.5	0.4						in.

Step 9: Order the incremental PMP in a sequence dictated by hourly and 15-minute increments using Table 4.7 (Attachment 5/7) and Table 4.8 (Attachment 6/7), respectively.

The incremental PMP calculated in Step 8 must now be arranged in a specific order to model the runoff generated by the storm event. This order is dictated by Table 4.7 for the hourly PMP intervals and Table 4.8 for the 15-minute PMP intervals.

The final arrangement of the numbers determined in Step 8 is as follows:

Hourly increments:	0.1	0.4	8.3	0.8	0.2	0.1	in.
15-minute increments:	6.1	1.2	0.5	0.4			in.

The storm's 6 hour PMP runoff event is calculated by summing the incremental PMP for each hour of the storm.

0.1 in. + 0.4 in. + 8.3 in. + 0.8 in. + 0.2 in. + 0.1 in. = 9.9 inches **(10 inches).**

This step is repeated to calculate the runoff generated during the first hour of the storm.

6.1 in. + 1.3 in. + 0.5 in. + 0.4 in. = 8.3 inches

Written by:	**M. Lithgow**	Date:	**09/04/09**	Reviewed by:	**G. Corcoran**	Date:	**9/10/09**
Client:	**DMC**	Project:	**White Mesa Mill-Cell 4B**	Project/ Proposal No.:	**SC0349**	Task No.:	**02**

Because 9.9 > 8.3, the runoff generated from the 6 hour storm (9.9 inches) is used.

CONCLUSIONS AND RECOMMENDATIONS

Our calculations are summarized in a worksheet modeled after Table 6.3A in the Hydrometerological Report No. 49 and is provided as Attachment A, 7/7. Our analysis determined the Probable Maximum Precipitation (PMP) event generates 10 inches (0.83 ft) over 6 hours.

REFERENCES

UMETCO Minerals Corporation, 1990, “White Mesa Mill Drainage Report for Submittal to NRC.”

Attachment A

Hansen, E. Marshall, Schwartz, Francis K., Riedel, John T., 1984. “Hydrometeorological Report No. 49: Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages,” Hydrometeorological Branch Office of Hydrology National Weather Service, U.S. Department of Commerce, National Oceanic and Atmosphere Administration, U.S. Department of Army Corps of Engineers, Silver Springs, Md.

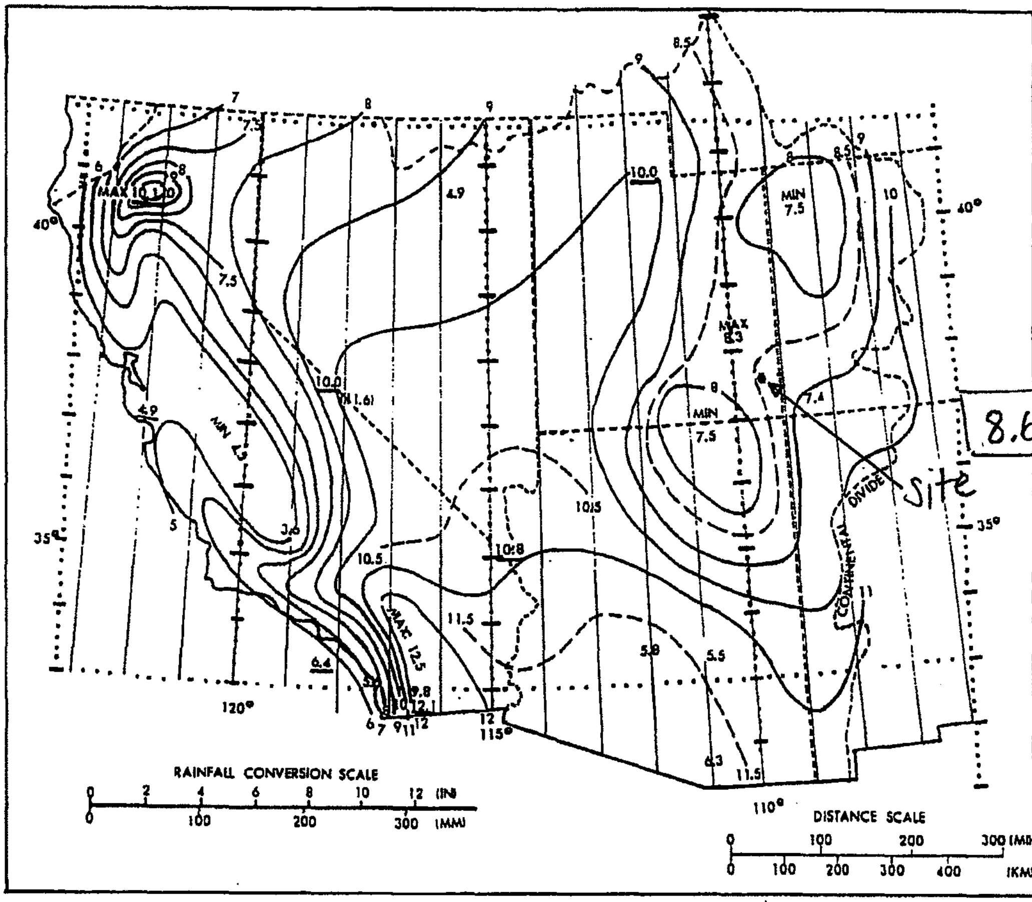


Figure 4.5--Local-storm PMP for 1 mi^2 (2.6 km^2) 1 hr. Directly applicable for locations between sea level and 5000 ft (1524 m). Elevation adjustment must be applied for locations above 5000 ft.

events. In contrast to figure 4.4, figure 4.5 maintains a maximum between these two locations. There is no known meteorological basis for a different solution. The analysis suggests that in the northern portion of the region maximum PMP occurs between the Sierra Nevada on the west and the Wasatch range on the east.

A discrete maximum (> 10 inches, 254 mm) occurs at the north end of the Sacramento Valley in northern California because the northward-flowing moist air is increasingly channeled and forced upslope. Support for this PMP center comes from the Newton, Kennett, and Red Bluff storms (fig. 4.1). Although the analysis in this region appears to be an extension of the broad maximum through the center of the Southwestern Region, it does not indicate the direction of moist inflow. The pattern has evolved primarily as a result of attempts to tie plotted maxima into a reasonable picture while considering inflow directions, terrain effects, and moisture potential.

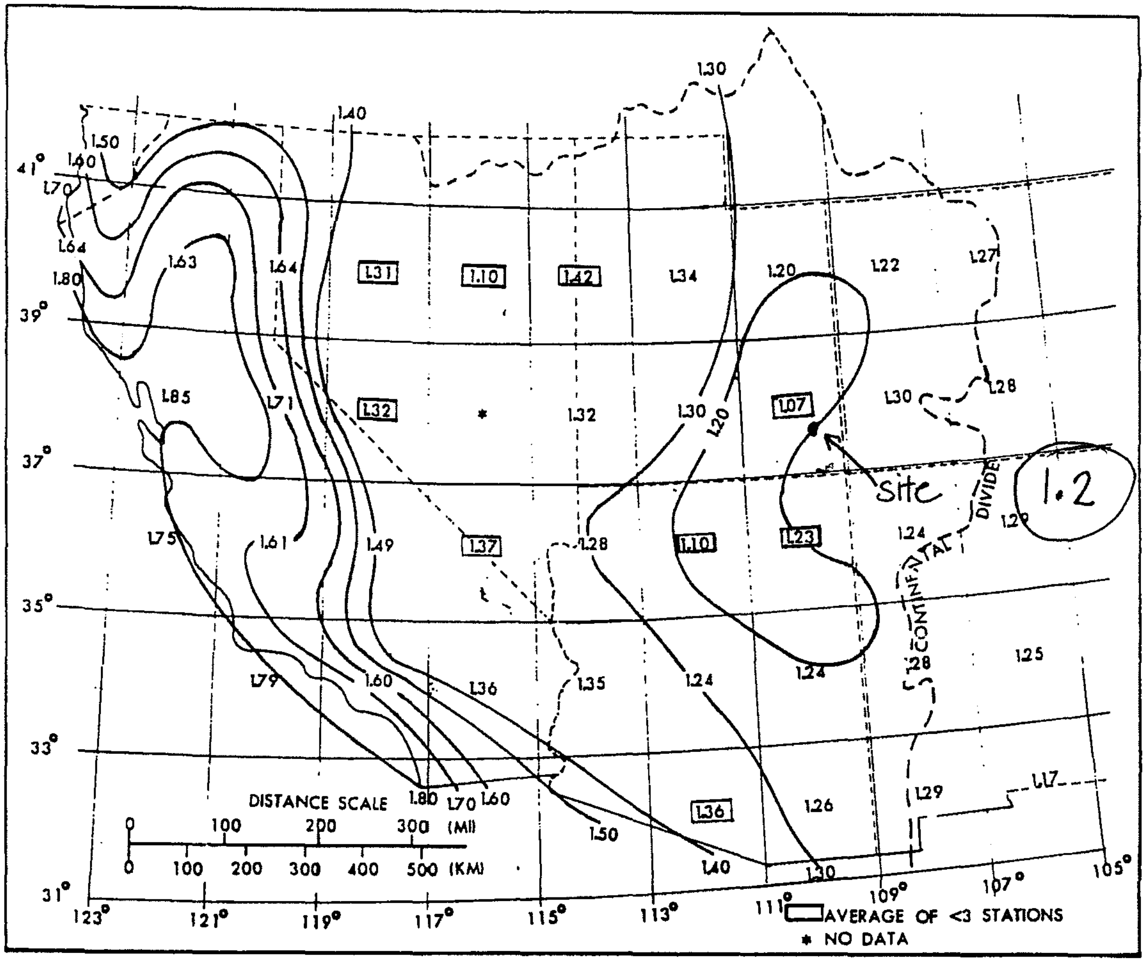


Figure 4.7.--Analysis of 6/1-hr ratios of averaged maximum station data (plotted at midpoints of a 2° latitude-longitude grid).

establish the basic depth-duration curve, then structure a variable set of depth-duration curves to cover the range of 6/1-hr ratios that are needed.

Three sets of data were considered for obtaining a base relation (see table 4.3 for depth-duration data).

a. An average of depth-duration relations from each of 17 greatest 3-hr rains from summer storms (1940-49) in Utah (U. S. Weather Bureau 1951b) and in unpublished tabulations for Nevada and Arizona (1940-63). The 3-hr amounts ranged from 1 to 3 inches (25 to 76 mm) in these events.

b. An average depth-duration relation from 14 of the most extreme short-duration storms listed in Storm Rainfall (U. S. Army, Corps of Engineers 1945-). These storms come from Eastern and Central States and have 3-hr amounts of 5 to 22 inches (127 to 559 mm).

Attachment A, 2/7

ratios than storms with high 3/1-hr ratios. The geographical distribution of 15-min to 1-hr ratios also were inversely correlated with magnitudes of the 6/1-hr ratios of figure 4.7. For example, Los Angeles and San Diego (high 6/1-hr ratios) have low 15-min to 1-hr ratios (approximately 0.60) whereas the 15-min to 1-hr ratios in Arizona and Utah (low 6/1-hr ratios) were generally higher (approximately 0.75).

Depth-duration relations for durations less than 1 hour were then smoothed to provide a family of curves consistent with the relations determined for 1 to 6 hours, as shown in figure 4.3. Adjustment was necessary to some of the curves to provide smoother relations through the common point at 1 hour.

We believe we were justified in reducing the number of the curves shown in figure 4.3 for durations less than 1 hour, letting one curve apply to a range of 6/1-hr ratios. The corresponding curves have been indicated by letter designators, A-D, on figure 4.3. As an example, for any 6-hr amount between 115% and 135% of 1-hr, 1-mi^2 (2.6-km^2) PMP, the associated values for durations less than 1 hour are obtained from the curve designated as "B".

Table 4.4 lists durational variations in percent of 1-hr PMP for selected 6/1-hr rain ratios. These values were interpolated from figure 4.3.

To determine 6-hr PMP for a basin, use figure 4.3 (or table 4.4) and the geographical distribution of 6/1-hr ratios given in figure 4.7.

Table 4.4.--Durational variation of 1-mi^2 (2.6-km^2) local-storm PMP in percent of 1-hr PMP (see figure 4.3)

6/1-hr ratio	Duration (hr) 1/4	1/2	3/4	1	2	3	4	5	6
1.1	86	93	97	100	107	109	110	110	110
✩ 1.2	74	89	95	100	110	115	118	119	120
1.3	74	89	95	100	114	121	125	128	130
1.4	63	83	93	100	118	126	132	137	140
1.5	63	83	93	100	121	132	140	145	150
1.6	43	70	87	100	124	138	147	154	160
1.8	43	70	87	100	130	149	161	171	180
2.0	43	70	87	100	137	161	175	188	200

4.5 Depth-Area Relation

We have thus far developed local-storm PMP for an area of 1 mi^2 (2.6 km^2). To apply PMP to a basin, we need to determine how 1-mi^2 (2.6-km^2) PMP should decrease with increasing area. We have adopted depth-area relations based on rainfalls in the Southwest and from consideration of a model thunderstorm.

Attachment A, 3/7

Attachment A, 4/7

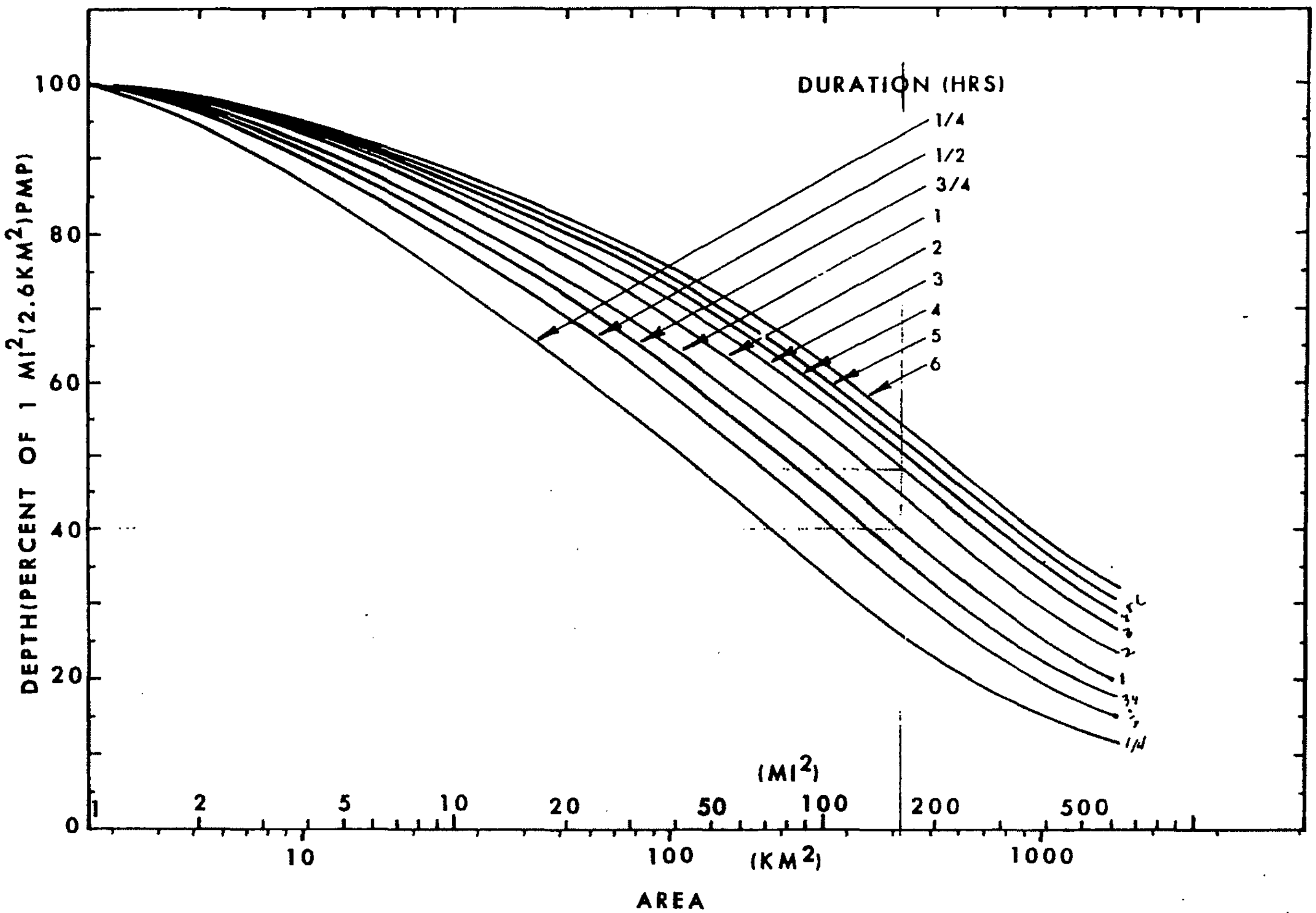


Figure 4.9.--Adopted depth-area relations for local-storm PMP.

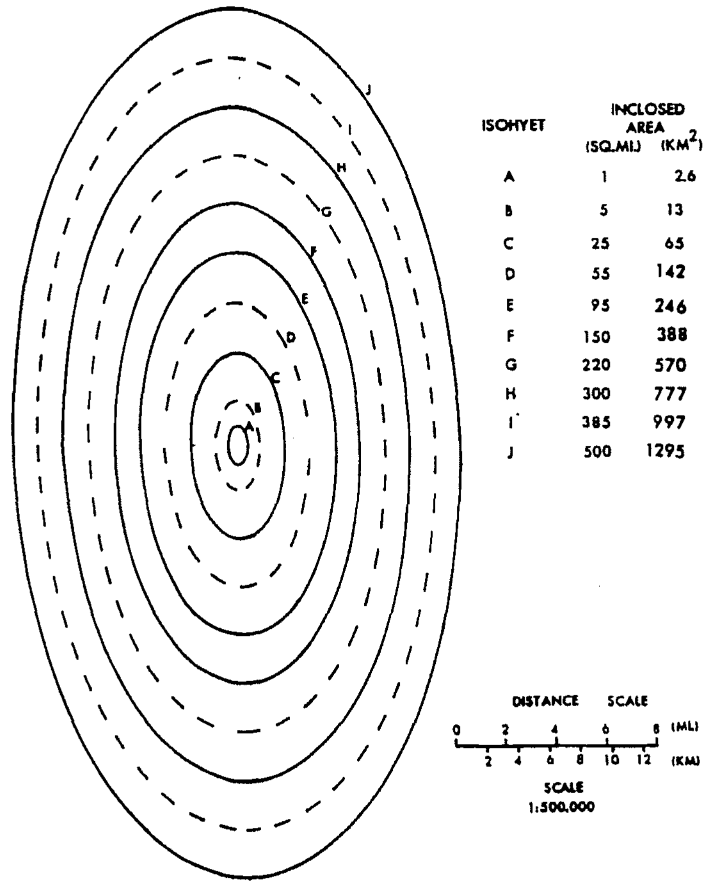


Figure 4.10.--Idealized local-storm isohyetal pattern.

storm period. The sequence of hourly incremental PMP for the Southwest 6-hr thunderstorm in accord with this study is presented in column 2 of table 4.7. A small variation from this sequence is given in Engineering Manual 1110-2-1411 (U. S. Army, Corps of Engineers 1965). The latter, listed in column 3 of table 4.7, places greater incremental amounts somewhat more toward the end of the 6-hr storm period. In application, the choice of either of these distributions is left to the user since one may prove to be more critical in a specific case than the other.

Table 4.7.--Time sequence for hourly incremental PMP in 6-hr storm

Increment		★ HMR No. 5[1]	EM1110-2-1411[2]
		Sequence Position	
Largest hourly amount	8.3	Third	Fourth
★ 2nd largest	0.8	Fourth	Third
3rd largest	0.5	Second	Fifth
4th largest	0.2	Fifth	Second
5th largest	0.2	First	Last
least	0.1	Last	First

[1]U. S. Weather Bureau 1947.
[2]U. S. Corps of Engineers 1952.

Attachment A, 5/7

Also of importance is the sequence of the four 15-min incremental PMP values. We recommend a time distribution, table 4.8, giving the greatest intensity in the first 15-min interval (U.S. Weather Bureau 1947). This is based on data from a broad geographical region. Additional support for this time distribution is found in the reports of specific storms by Keppell (1963) and Osborn and Renard (1969).

Table 4.8.--Time sequence for 15-min incremental PMP within 1 hr.

Increment	Sequence Position
Largest 15-min amount	First
2nd largest	Second
3rd largest	Third
least	Last

4.8 Seasonal Distribution

The time of the year when local-storm PMP is most likely is of interest. Guidance was obtained from analysis of the distribution of maximum 1-hr thunderstorm events through the warm season at the recording stations in Utah, Arizona, and in southern California (south of 37°N and east of the Sierra Nevada ridgeline). The period of record used was for 1940-72 with an average record length for the stations considered of 27 years. The month with the one greatest thunderstorm rainfall for the period of record at each station was noted. The totals of these events for each month, by States, are shown in table 4.9.

Table 4.9.--Seasonal distribution of thunderstorm rainfalls.

(The maximum event at each of 108 stations, period of record 1940-72.)

	Month						
	M	J	J	A	S	O	No. of Cases
Utah	1	5	9	14	5		34
Arizona		4	16	19	4		43
S. Calif.*		14	10	7			31
No. of cases/mo.	1	23	35	40	9	0	

*South of 37°N and east of Sierra Nevada ridgeline.

Attachment A, 6/7

Table 6.3A -- Local-storm PMP computation, Colorado River, Great Basin and California drainages. For drainage average depth PMP.

Drainage: White Mesa Mill Facility, Cells 2 - 4B		Area	0.39	mi^2
Latitude: N 37° 31'	Longitude: W 109° 30'	Min. Elevation	5598	ft

Step	Description										
1	Average 1-hr 1-mi^2 (2.6-km^2) PMP for drainage [fig. 4.5]	8.6	in.								
2a.	Reduction for Elevation. [No adjustment for elevations up to 5,000 feet: 5% decrease per 1,000 feet above 5,000 feet.	0.97	%								
b.	Multiply step 1 by step 2a.	8.3	in.								
3.	Average 6/1-hr ratio for drainage [fig 4.7]	1.2									

		Duration (hr)									
		1/4	1/2	3/4	1	2	3	4	5	6	
4	Durational variation for 6/1-hr ratio of step 3 [table 4.4]	74	89	95	100	110	115	118	119	120	%
5	1-mi^2 (2.6 km^2) PMP for indicated durations [step 2b x step 4]	6.1	7.4	7.9	8.3	9.1	9.5	9.8	9.9	10.0	
6	Areal reduction [fig. 4.9]	100	100	100	100	100	100	100	100	100	%
7	Areal reduced PMP [steps 5 x 6]	6.1	7.4	7.9	8.3	9.1	9.5	9.8	9.9	10.0	in.
8	Incremental PMP [successive subtraction in step 7]				8.3	0.8	0.4	0.2	0.1	0.1	in.
		6.1	1.2	0.5	0.4	} 15-min. increments					
9	Time sequence of incremental PMP to: Hourly increments [table 4.7]				0.1	0.4	8.3	0.8	0.2	0.1	in.
						Total depth of 6 hour storm				**9.9**	**in.**
	Four largest 15-min increments [table 4.8]				6.1	1.2	0.5	0.4	in		
					Total depth of 1st hour of storm					**8.3**	**in.**

ATTACHMENT G.2

SUPPORTING CALCULATIONS

Client: Energy Fuels Resources (USA) Inc.
Project: White Mesa Reclamation Plan
Detail: Erosion Protection

Job No.: 1009740
Date: 5/31/2011
Computed By: RTS

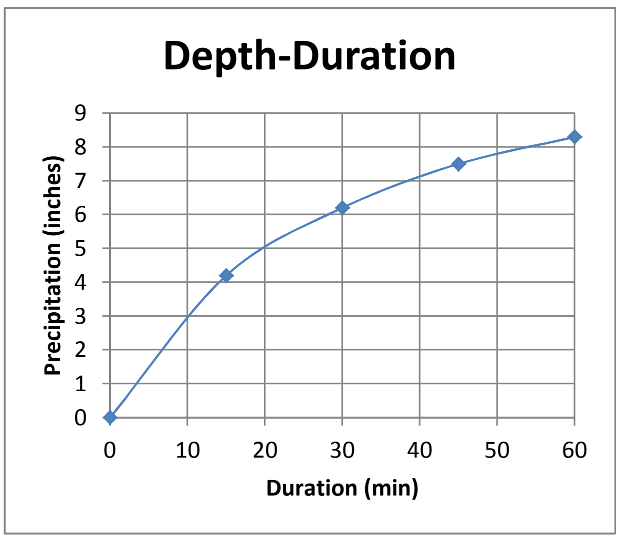
PMP Event

PMP calculation from "Re: Cell 4B Lining System Design Report, Response to DRC Request fo Additional Information - Round 3 Interrogatory, Cell 4B design", September 11,2009.

Procedure: Hydrometeorological Report No. 49: Probable Maximum Precipitation Estimates, Colorado river and Great Basin Drainages (Hansen et al., 1984), corrected for elevation and area.

Table 1. Estimated Precipitation Depths For Local-Storm PMP, White Mesa Mill, Utah Site

Hourly Increments	**First Hour**	**Second Hour**	**Third Hour**				**Fourth Hour**	**Fifth Hour**	**Sixth Hour**
PMP Depths (inches)	0.1	0.2	8.3				0.8	0.1	0.1
Third-Hour Component Depths (inches)			4.2	2.0	1.3	0.8			



Client:	**Energy Fuels Resources (USA) Inc.**	**Job No.:**	**1009740**
Project:	**White Mesa Reclamation Plan**	**Date:**	**8/22/2015**
Detail:	**Erosion Protection**	**Computed By:**	**TMS/MMD**

Time of Concentration

1-hour PMP (in) 8.3

Flow Path 1: flow path across longest 5H:1V side slope in Cell 4A

Description	Slope (feet/feet)	Slope Length (feet)	Time of Concentration (minutes) Kirpich	SCS	Brant and Oberman	Average	% of 1-hour PMP	PD_{PMP} (in)	Intensity (in/hr)
Cell 2 at 0.5%	0.005	570	7.9	8.0	11.8	9.2	61.3	5.08	33.0
Cell 3 top	0.005	870	18.9	19.0	25.4	21.1	82.3	6.83	19.4
Cell 4A top	0.008	1200	30.7	30.7	38.4	33.3	91.2	7.57	13.7
Cell 4A side slope	0.2	230	31.7	31.7	41.0	34.8	92.0	7.6	13.2

Note: Flow accumulates as it flows from Cell 2 to Cell 4A. Design flow path is longest path across maximum 5H:1V side slope

Flow Path 2: longest flow path across cells across cells 2, 3, 4A and 4B

Description	Slope (feet/feet)	Slope Length (feet)	Time of Concentration (minutes) Kirpich	SCS	Brant and Oberman	Average	% of 1-hour PMP	PD_{PMP} (in)	Intensity (in/hr)
Cell 2 at 1%	0.01	900	8.6	8.7	10.9	9.4	61.8	5.13	32.7
Cell 2 at 0.5%	0.005	550	16.4	16.4	22.6	18.5	79.3	6.58	21.4
Cell 3 top	0.005	830	27.0	27.0	36.0	30.0	89.4	7.42	14.8
Cell 4A top	0.008	1200	38.7	38.8	49.0	42.2	95.0	7.88	11.2
Cell 4A side slope	0.2	100	39.2	39.3	50.9	43.2	95.3	7.9	11.0

Note: Flow accumulates as it flows from Cell 2 to Cell 4A. Design flow path is longest path across Cell 2, 3, and 4A, and not the longest flow path across each individual cell

Cell 2 and Side slopes that only drain area of slope

Description	Slope (feet/feet)	Slope Length (feet)	Time of Concentration (minutes) Kirpich	SCS	Brant and Oberman	Average	% of 1-hour PMP	PD_{PMP} (in)	Intensity (in/hr)
Cell 2 Top 1% Slope	0.01	830	8.1	8.1	10.6	9.0	60.4	5.0	33.6
Cell 2 Northern .5% Slope	0.005	250	12.3	12.3	19.6	14.8	73.8	6.1	24.9
Cell 1 Disposal 1% Slope	0.01	230	15.4	15.4	26.6	19.1	80.1	6.6	20.9
Cell 1 Northern Side Slope	0.2	90	15.8	15.8	28.4	20.0	81.1	6.7	20.2
Non-Accumulating Side Slopes	0.2	50	0.3	0.3	1.5	2.5	27.5	2.3	54.8

Note: These are the slopes on the sides of Cells 4A, 4B, 3, and 2

Flow Path 3: Flow Path Across Cell 1

Description	Slope (feet/feet)	Slope Length (feet)	Time of Concentration (minutes) Kirpich	SCS	Brant and Oberman	Average	% of 1-hour PMP	PD_{PMP} (in)	Intensity (in/hr)
Cell 1 at .1%	0.001	2232	42.2	42.3	31.9	38.8	93.7	7.8	12.0

Source: Brant and Oberman(1975) as presented in UMTRA TAD (1989)
Formula: tc=C(L/Si^2)^(1/3).
Source:Kirpich (1940) as presented in NUREG 4620
Formula: tc=0.00013*L^0.77/S^0.385 with L in feet, tc in hours
Source: SCS as presented in NUREG 4620
Formula: tc=(11.9L^3/H)^0.385 with L in miles, H in feet, t in hours
% of one-hour PMP=RD/(0.0089*RD+0.0686) for tc<15 min based on Table 4.1 of TAD
Cell geometry based on Figure G.1

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Project:	**White Mesa Reclamation Plan**	**Date:**	**8/22/2015**
Detail:	**Erosion Protection**	**Computed By:**	**TMS/MMD**

Unit discharge of PMP

Flow Path 1: flow path across longest 5H:1V side slope in Cell 4A

Description	Total Drainage Length (ft)	C	Tc (min)	Intensity (in/hr)	unit discharge (cfs/ft)
Cell 2 at 0.5%	570	1	9.2	33.0	0.43
Cell 3 top	1440	1	21.1	19.4	0.64
Cell 4A top	2640	1	33.3	13.7	0.83
Cell 4A side slope	2870	1	34.8	13.2	0.87

Note: Flow accumulates as it flows from Cell 2 to Cell 4A

Flow Path 2: longest flow path across cells with 0.8% top slope across cells 4A and 4B

Description	Total Drainage Length (ft)	C	Tc (min)	Intensity (in/hr)	unit discharge (cfs/ft)
Cell 2 at 1%	900	1	9.4	32.7	0.68
Cell 2 at 0.5%	1450	1	18.5	21.4	0.71
Cell 3 top	2280	1	30.0	14.8	0.78
Cell 4A top	3480	1	42.2	11.2	0.90
Cell 4A side slope	3580	1	42.2	11.2	0.92

Note: Flow accumulates as it flows from Cell 2 to Cell 4A

Side Slope Flow Paths

Description	Total Drainage Length (ft)	C	Tc (min)	Intensity (in/hr)	unit discharge
Cell 2 Northern 1% Slope	830	1	9.0	33.6	0.64
Cell 2 Northern .5% Slope	1080	1	14.8	24.9	0.62
Cell 1 Disposal 1% Slope	1310	1	19.1	20.9	0.63
Cell 1 Disposal Side Slope	1400	1	20.0	20.2	0.65
Non-Accumulating Side Slopes	50	1	2.5	54.8	0.06
Cell 1 at .1%	2232	1	38.8	12.0	0.62

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Project:	**White Mesa Reclamation Plan**	**Date:**	**8/22/2015**
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Temple Method for Vegetated Slopes - Top Soil

Reference: Temple, D.M., Robinson, K.M., Ahring, R.M., and Davis, A.G., 1987. Stability Design of Grass-Lined Open Channels, USDA Handbook 667.
And as presented in UMTRA TAD Section 4.3.3 and NUREG 1623, Appendix A

Area	Cell 2 at 0.5%	Cell 3 top	
PMP Design flow (cfs/ft)	0.71	0.78	
Concentration Factor, F	3	3	
PMP Design flow (cfs/ft), q	**2.14**	**2.33**	
Slope, S (ft/ft)	0.005	0.005	
average dry density (pcf)	100	100	(estimated from laboratory testing)
average specific gravity	2.61	2.61	(estimated from laboratory testing)
void ratio, e	0.629	0.629	
unit weight water (pcf)	62.4	62.4	

Topsoil Description	topsoil	topsoil	
Plasticity Index, PI	<10	<10	(from laboratory testing)
base allowable tractive shear stress (psf) τab=	na	na	
void ratio correction factor, Ce=	na	na	
allowable tractive shear stress (psf), τa=	0.020	0.020	
Long-term, PMP precip			
Repr. stem length (ft) h(ave)			
good veg	2	2	pg 36 and 39 of Temple et al. (1987)
poor veg	1	1	
Repr. stem density (stems/sq ft), M(ave)			
good veg	200	200	Temple Table 3.1, grass mixture
poor veg	67	67	
Retardance curve index, Ci			
good veg	7.62	7.62	
poor veg	5.03	5.03	
Cover factor, Cf			
good veg	0.75	0.75	Temple Table 3.1, grass mixture
poor veg	0.375	0.375	assume min 30% coverage
allowable vegetated shear strength (psf), τva			
good veg	5.71	5.71	
poor veg	3.78	3.78	
Mannings n for soil roughness, ns=	0.0156	0.0156	
Mannings n for vegetal conditions, nr			
good veg	0.0916	0.0872	
poor veg	0.0503	0.0487	
Mannings n for vegetated slopes, nv			
good veg	0.0916	0.0872	
poor veg	0.0503	0.0487	
assumed depth of flow, d (ft)			
good veg	1.452	1.485	
poor veg	1.013	1.047	
calculated q (cfs/ft), with veg			
good veg	2.14	2.33	
poor veg	2.14	2.33	
qcalc - qdesign			
good veg	**0.00**	**0.00**	
poor veg	**0.00**	**0.00**	
Iterate with d until q calc equals q design			
velocity (ft/s), v			
good veg	1.47	1.57	
poor veg	2.11	2.23	
effective shear stress (psf), τe			
good veg	0.0033	0.0037	
poor veg	0.0190	0.0210	
effective veg shear stress (psf) τve			
good veg	0.4497	0.4597	
poor veg	0.2970	0.3056	
shear stress ratio, vegetated slope			
good veg	**12.7**	**12.4**	
poor veg	**12.7**	**12.4**	
shear stress ratio, soil on vegetated slope			
good veg	**6.1**	**5.4**	
poor veg	**1.1**	**1.0**	

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Detail:	**Erosion Protection**	**Computed By:**	**TMS/MMD**

Temple Method for Vegetated Slopes - Top Soil Ammended with 25% Gravel

Reference: Temple, D.M., Robinson, K.M., Ahring, R.M., and Davis, A.G., 1987. Stability Design of Grass-Lined Open Channels, USDA Handbook 667.
And as presented in UMTRA TAD Section 4.3.3 and NUREG 1623, Appendix A

Area	Cell 1 at 1%	Cell 2 at 1%	Cell 4A top	
PMP Design flow (cfs/ft)	0.63	0.68	0.87	
Concentration Factor, F	3	3	3	
PMP Design flow (cfs/ft), q	**1.88**	**2.03**	**2.60**	
Slope, S (ft/ft)	0.01	0.01	0.008	
average dry density (pcf)	106	106	106	(estimated from laboratory testing)
average specific gravity	2.62	2.62	2.62	(estimated from laboratory testing)
void ratio, e	0.542	0.542	0.542	
unit weight water (pcf)	61.4	62.4	62.4	

Topsoil Description	Topsoil with 25% 1"-minus gravel	Topsoil with 25% 1"-minus gravel	Topsoil with 25% 1"-minus gravel	
d75 (inches)	0.2	0.2	0.2	from preliminary gradation specs
base allowable tractive shear stress (psf) τab=	na	na	na	
void ratio correction factor, Ce=	na	na	na	
allowable tractive shear stress (psf), τa=	0.080	0.080	0.080	
Long-term, PMP precip				
Repr. stem length (ft) h(ave)				
good veg	2	2	2	pg 36 and 39 of Temple et al. (1987)
poor veg	1	1	1	
Repr. stem density (stems/sq ft), M(ave)				
good veg	200	200	200	Temple Table 3.1, grass mixture
poor veg	67	67	67	
Retardance curve index, Ci				
good veg	7.62	7.62	7.62	
poor veg	5.03	5.03	5.03	
Cover factor, Cf				
good veg	0.75	0.75	0.75	Temple Table 3.1, grass mixture
poor veg	0.375	0.375	0.375	assume min 30% coverage
allowable vegetated shear strength (psf), τva				
good veg	5.71	5.71	5.71	
poor veg	3.78	3.78	3.78	
Mannings n for soil roughness, ns=	0.0196	0.0196	0.0196	
Mannings n for vegetal conditions, nr				
good veg	0.0986	0.0944	0.0821	
poor veg	0.0528	0.0513	0.0468	
Mannings n for vegetated slopes, nv				
good veg	0.0993	0.0952	0.0829	
poor veg	0.0541	0.0526	0.0482	
assumed depth of flow, d (ft)				
good veg	1.148	1.169	1.338	
poor veg	0.797	0.819	0.966	
calculated q (cfs/ft), with veg				
good veg	1.88	2.03	2.60	
poor veg	1.88	2.03	2.60	
qcalc - qdesign				
good veg	**0.00**	**0.00**	**0.00**	
poor veg	**0.00**	**0.00**	**0.00**	
Iterate with d until q calc equals q design				
velocity (ft/s), v				
good veg	1.64	1.73	1.95	
poor veg	2.36	2.47	2.69	
effective shear stress (psf), τe				
good veg	0.0068	0.0077	0.0093	
poor veg	0.0401	0.0442	0.0497	
effective veg shear stress (psf) τve				
good veg	0.6978	0.7219	0.6587	
poor veg	0.4494	0.4672	0.4328	
shear stress ratio, vegetated slope				
good veg	**8.2**	**7.9**	**8.7**	
poor veg	**8.4**	**8.1**	**8.7**	
shear stress ratio, soil on vegetated slope				
good veg	**11.7**	**10.4**	**8.6**	
poor veg	**2.0**	**1.8**	**1.6**	

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Abt and Johnson method (Abt and Johnson, 1991) applicable for slopes of 50% or less.

Angular-Shaped rock sizing equation: $D_{50} = 5.23S^{0.43} q_{design}^{0.56}$ $q_{design} = 1.35 q_f$

For rounded rock, increase size by 40%.

Area	Cell 4A Flow Path 2 Southern Side Slope - Angular	Non-Accumulating Side Slopes - Rounded	Cell 2 Northern Side Slope - Angular
Side Slope (ft/ft)	0.2	0.2	0.2
angle α (rad)	0.197	0.197	0.197
PMP unit flow (cfs/ft)	0.87	0.06	0.65
Concentration Factor	3	3	3
Coef. Of Movement	1.35	1.35	1.35
design flow (cfs/ft)	3.51	0.25	2.63
Coef. Of Uniformity	NA	NA	NA
design flow over rock (cfs/ft)	3.51	0.25	2.63
D50 (inches)	5.29	1.70	4.49

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Project:	White Mesa Reclamation Plan	Date:	8/22/2015
Detail:	Erosion Protection	Computed By:	TMS/MMD

Preliminary Gradations

This spreadsheet calculates preliminary gradations of riprap based on D50
Source: NUREG 4620
Source: USDA, National Engineering Handbook, Part 633, Chapter 26, Gradation Design of Sand and Gravel Filters, October 1994.

Area Description	Cell 4A side slope	Comment
Minimum D50 (in)	4.49	Assuming Angular Rock, Safety Factor Method for Top Slope, Abt and Johnson (1991) method for side slopes
Rock thickness (in)	8.99	Based on constructability: 1.5 to 2*D50. May consider 12" as minimum thickness for rock
Maximum D50 (in)	5.99	Based on constructability: Thickness/1.5
Maximum D50 (in)	22.47	Prevent gap-grading: minimum D50*5
Maximum D50 (in)	5.99	Smaller of two above criteria
Maximum D100 (in)	8.99	Based on constructability: 1*Thickness
Maximum D100 (in)	29.96	Based on internal stability?: 5*maximum D50
Maximum D100 (in)	8.99	Smaller of two above criteria
Minimum D100 (in)	6.74	1.5*minimum D50
Minimum D15 (in)	0.56	Based on internal stability: Maximum D100/16
Maximum D15 (in)	2.81	Prevent gap-grading: Minimum D15*5
Minimum D60 (in)	6.29	Prevent gap-grading: D60/D10<=6
Maximum D60 (in)	8.39	Prevent gap-grading: D60/D10<=6
Minimum D10 (in)	1.05	Prevent gap-grading: D60/D10<=6
Maximum D10 (in)	1.40	Prevent gap-grading: D60/D10<=6

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Interstitial Velocities

Source: NUREG 1623, Section D
Abt, SR, JF Ruff, RJ Wittler (1991). Estimating Flow Through Riprap, Journal of Hydraulic Engineering, Vol. 117, No. 5, May.

Description	Non-Accumulating Side Slopes - Rounded	Cell 1 Disposal Area Side Slope - Angular	Cell 4A Flow Path 2 Southern Side Slope - Angular	
Minimum D50 (inches)	1.70	4.49	5.29	from Safety Factor Method, or Abt/Johnson Method, assuming rounded rock
Minimum D10 (inches)	0.40	1.05	1.23	from preliminary gradation specs
Maximum D10 (inches)	0.53	1.40	1.65	from preliminary gradation specs
Slope (ft/ft)	0.2	0.20	0.20	from preliminary design
Min Velocity (ft/s)	0.37	0.60	0.65	calculated from Abt et al. (1991) based on Min D10
Max Velocity (ft/s)	0.43	0.69	0.75	calculated from Abt et al. (1991) based on Max D10
Underlying filter required?	No	Recommended	Recommended	Per NUREG 1623, Appendix D, section 2.1.1

Client: Energy Fuels Resources (USA) Inc.
Project: White Mesa Reclamation Plan
Detail: Erosion Protection

Job No.: 1009740
Date: 7/9/2012
Computed By: TMS

USDA Filter Gradation Calulations - 2010 Material Testing

Step 1: Plot Gradation Curve of Base Soil

Stockpile ID	**E4 (Field ID 2)**		**E5 (Field ID 3)**		**E6 (Field ID 4)**		**E7 (Field ID 5)**		**E8 (Field ID 6)**		**W9 (Field ID 7)**		**W7 (Field ID 8)**		**W1 (Field ID 12)**		**W2 (Field ID 13)**	
Description	Sandy Clay Random Fill		Sandy Clay Random Fill		Clay Random Fill		Sandy Clay Random Fill		Sandy Clay Random Fill		Sandy Clay Random Fill		Sandy Clay Random Fill		Sandy Clay Random Fill		Sandy Clay Random Fill	
Sieve Sizes	Diameter (mm)	% Finer	Diameter (mm)	% Finer	Diameter (mm)	% Finer	Diameter (mm)	% Finer	Diameter (mm)	% Finer	Diameter (mm)	% Finer	Diameter (mm)	% Finer	Diameter (mm)	% Finer	Diameter (mm)	% Finer
1 1/2"	38.1	100	38.1	100	38.1	100	38.1	100	38.1	100	38.1	100	38.1	100	38.1	100	38.1	100
1"	25.4	100	25.4	100	25.4	100	25.4	100	25.4	100	25.4	100	25.4	100	25.4	100	25.4	100
3/4"	19.1	100	19.1	100	19.1	100	19.1	100	19.1	100	19.1	100	19.1	100	19.1	100	19.1	100
3/8"	9.8	100	9.8	100	9.8	100	9.8	100	9.8	100	9.8	100	9.8	100	9.8	100	9.8	100
Nº 4	4.75	99.9	4.75	100	4.75	99.9	4.75	100	4.75	100	4.75	100	4.75	100	4.75	100	4.75	99.8
Nº 10	2	99.8	2	99.9	2	99.9	2	100	2	100	2	100	2	99.3	2	100	2	99.7
Nº 20	0.85	98.9	0.85	99.2	0.85	99.2	0.85	100	0.85	99	0.85	99.3	0.85	98.8	0.85	99.5	0.85	97.4
Nº 40	0.425	97.7	0.425	97.9	0.425	96.9	0.425	99.7	0.425	97.4	0.425	98.3	0.425	98.1	0.425	98.8	0.425	94.7
Nº 60	0.25	95.1	0.25	93.1	0.25	92.6	0.25	98.8	0.25	91.9	0.25	96.1	0.25	94.4	0.25	97.8	0.25	88.2
Nº 100	0.15	90.8	0.15	80.9	0.15	88.8	0.15	96.7	0.15	74.7	0.15	92.3	0.15	79.4	0.15	95.2	0.15	76.6
Nº 200	0.075	58.8	0.075	64.5	0.075	82.2	0.075	69.8	0.075	53	0.075	62.6	0.075	56.2	0.075	59.4	0.075	58.3

D15 estimated as 0.025

All Steps below are from USDA Ch. 26 Example 26-2A

Step 4. Base Soil Category		2		2		2		2		2		2		2		2		2
D85	0.14		0.18		0.11		0.12		0.21		0.13		0.19		0.13		0.22	
Step 5. Filtering Criteria (Max D15) (mm)		0.70		0.70		0.70		0.70		0.70		0.70		0.70		0.70		0.70
Step 6. Min D15		0.08		0.07		0.05		0.06		0.08		0.07		0.08		0.08		0.08
Step 7. Ratio		9.15		10.03		12.79		10.86		8.24		9.74		8.74		9.24		9.07
Control Point 1 (D15max)		0.38		0.35		0.27		0.32		0.42		0.36		0.40		0.38		0.39
Control Point 2 (D15min)		0.08		0.07		0.05		0.06		0.08		0.07		0.08		0.08		0.08
Step 8. MaxD10		0.32		0.29		0.23		0.27		0.35		0.30		0.33		0.32		0.32
CP3 Max D60		1.91		1.74		1.37		1.61		2.12		1.80		2.00		1.89		1.93
CP4 Min D60		0.38		0.35		0.27		0.32		0.42		0.36		0.40		0.38		0.39
Step 9. CP5 D5min		0.08		0.08		0.08		0.08		0.08		0.08		0.08		0.08		0.08
CP6 D100 max		75.00		75.00		75.00		75.00		75.00		75.00		75.00		75.00		75.00
Step 10. CP7 D10		0.06		0.06		0.05		0.05		0.07		0.06		0.07		0.06		0.06
CP8 D90		20.00		20.00		20.00		20.00		20.00		20.00		20.00		20.00		20.00
For Plotting:	4.75	100.00																

Step 11. Connecting Control Points

	CP	**E4 (Field ID 2)**		**E5 (Field ID 3)**		**E6 (Field ID 4)**		**E7 (Field ID 5)**		**E8 (Field ID 6)**		**W9 (Field ID 7)**		**W7 (Field ID 8)**		**W1 (Field ID 12)**		**W2 (Field ID 13)**	
		D(mm)	% Finer	D(mm)	% Finer	D(mm)	% Finer	D(mm)	% Finer	D(mm)	% Finer	D(mm)	% Finer	D(mm)	% Finer	D(mm)	% Finer	D(mm)	% Finer
Fine Design Band (Upper)	4	0.382653	60	0.348837	60	0.273722628	60	0.32234957	60	0.424528	60	0.359425	60	0.400356	60	0.378787879	60	0.385935	60
	2	0.076531	15	0.069767	15	0.054744526	15	0.064469914	15	0.084906	15	0.071885	15	0.080071	15	0.075757576	15	0.077187	15
	5	0.075	5	0.075	5	0.075	5	0.075	5	0.075	5	0.075	5	0.075	5	0.075	5	0.075	5
Course Design	6	75	100	75	100	75	100	75	100	75	100	75	100	75	100	75	100	75	100
	3	1.913265	60	1.744186	60	1.368613139	60	1.611747851	60	2.122642	60	1.797125	60	2.001779	60	1.893939394	60	1.929674	60
	1	0.382653	15	0.348837	15	0.273722628	15	0.32234957	15	0.424528	15	0.359425	15	0.400356	15	0.378787879	15	0.385935	15
	7	0.063776	10	0.05814	10	0.045620438	10	0.053724928	10	0.070755	10	0.059904	10	0.066726	10	0.063131313	10	0.064322	10

Step 12. Determine Gradation from plot

Shaded boxes means these values were changed to meet the requirements from the references listed below.
References cited and listed in Appendix G

D50 base	0.06	0.06	0.05	0.05	0.07	0.06	0.07	0.06	0.06
D50 Fine Filter	0.31	0.29	0.23	0.27	0.35	0.30	0.33	0.31	0.32
D50 Course Filter	1.57	1.43	1.13	1.33	1.75	1.48	1.65	1.56	1.59

Nelson eqn 4.35	2.81	1.90	2.56	2.75	2.02	2.73	2.14	2.94	1.74
Cedergren eqn 5.3	24.67	24.67	24.67	24.67	24.67	24.67	24.67	24.67	24.67
Nelson eqn 4.36	2.81	1.90	2.56	2.75	2.02	2.73	2.14	2.94	1.74

Client: Energy Fuels Resources (USA) Inc
Project: White Mesa Reclamation Plan
Detail: Erosion Protection

Job No.: 1009740
Date: 7/9/2012
Computed By: TMS

USDA Filter Gradation Calulations - 2012 Material Testing

Step 1: Plot Gradation Curve of Base Soil

Field ID	E3-A		E5-B		E8-B		W2-A		W2-B		W5-A		W5-B		W8-A		W8-B		W9-B	
Description	Sandy Clay Random Fill		Sandy Clay Random Fill		Clay Random Fill		Sandy Clay Random Fill		Sandy Clay Random Fill		Sandy Clay Random Fill		Sandy Clay Random Fill		Sandy Clay Random Fill		Sandy Clay Random Fill		Sandy Clay Random Fill	
Sieve Sizes	Diameter (mm)	% Finer	Diameter (mm)	% Finer	Diameter (mm)	% Finer	Diameter (mm)	% Finer	Diameter (mm)	% Finer	Diameter (mm)	% Finer	Diameter (mm)	% Finer	Diameter (mm)	% Finer	Diameter (mm)	% Finer	Diameter (mm)	% Finer
2"	50.8	100	50.8	100	50.8	100	50.8	100	50.8	100	50.8	100	50.8	100	50.8	100	50.8	100	50.8	100
1"	25.4	100	25.4	100	25.4	81.93	25.4	93.18	25.4	100	25.4	100	25.4	82.21	25.4	85.17	25.4	75.41	25.4	100
3/4"	19.1	100	19.1	100	19.1	76.8	19.1	90.46	19.1	100	19.1	100	19.1	81.53	19.1	79.85	19.1	75.41	19.1	98.84
3/8"	9.8	100	9.8	99.31	9.8	66.01	9.8	79.02	9.8	100	9.8	99.64	9.8	75.03	9.8	71.12	9.8	69.81	9.8	97.64
Nº 4	4.75	99.56	4.75	98.46	4.75	60.03	4.75	69.56	4.75	99.89	4.75	99.08	4.75	70.97	4.75	65.34	4.75	68.41	4.75	94.13
Nº 10	2	97.56	2	97.21	2	56.18	2	59.53	2	99.72	2	97	2	66.88	2	59.49	2	66.04	2	89.65
Nº 20	0.85	95.84	0.85	96.11	0.85	54.66	0.85	53.25	0.85	99.46	0.85	95.03	0.85	64.04	0.85	55.59	0.85	63.76	0.85	86.42
Nº 40	0.425	94.66	0.425	95.19	0.425	52.56	0.425	49.39	0.425	98.73	0.425	93.04	0.425	59.3	0.425	48.97	0.425	58.56	0.425	84.16
Nº 60	0.25	92.35	0.25	93.34	0.25	47.28	0.25	43.49	0.25	96.47	0.25	88.27	0.25	45.76	0.25	33.93	0.25	47.26	0.25	80.58
Nº 100	0.15	86.48	0.15	89.93	0.15	39.4	0.15	34.43	0.15	94.12	0.15	83.32	0.15	38.09	0.15	20.12	0.15	39.94	0.15	75.53
Nº 200	0.075	76.74	0.075	82.68	0.075	28.78	0.075	25.11	0.075	61.5	0.075	50.38	0.075	26.77	0.075	13.78	0.075	28.17	0.075	50.1

Note: Areas with fiels ID's E1-A and W4-B were topsoil samples and thus were not included in this analysis

All Steps below are from USDA Ch. 26 Example 26-2A

Step 4. Base Soil Category		2		2		3		3		2		2		3		4		3		2
D85	0.14		0.10		29.72		14.66		0.13		0.18		29.38		25.20		35.31		0.58	
Step 5. Filtering Criteria (Max D15) (mm)		0.70		0.70		53.73		35.21		0.70		0.70		62.53		100.79		67.20		0.70
Step 6. Min D15		0.10		0.10		0.16		0.18		0.10		0.10		0.17		0.27		0.16		0.10
Step 7. Ratio		7.00		7.00		343.64		196.48		7.00		7.00		371.98		368.62		420.65		7.00
Control Point 1 (D15max)		0.50		0.49		0.78		0.90		0.50		0.50		0.84		1.37		0.80		0.50
Control Point 2 (D15min)		0.10		0.10		0.16		0.18		0.10		0.10		0.17		0.27		0.16		0.10
Step 8. MaxD10		0.42		0.41		0.65		0.75		0.42		0.42		0.70		1.14		0.67		0.42
CP3 Max D60		2.50		2.45		3.91		4.48		2.50		2.50		4.20		6.84		3.99		2.50
CP4 Min D60		0.50		0.49		0.78		0.90		0.50		0.50		0.84		1.37		0.80		0.50
Step 9. CP5 D5min		0.08		0.08		0.08		0.08		0.08		0.08		0.08		0.08		0.08		0.08
CP6 D100 max		75.00		75.00		75.00		75.00		75.00		75.00		75.00		75.00		75.00		75.00
Step 10. CP7 min D10		0.08		0.08		0.13		0.15		0.08		0.08		0.14		0.23		0.13		0.08
CP8 D90		20		20		20		20		20		20		20		20		20		20
For Plotting:	4.75	100																		

Step 11. Connecting Control Points

	CP	E3-A		E5-B		E8-B		W2-A		W2-B		W5-A		W5-B		W8-A		W8-B		W9-B	
		D(mm)	% Finer	D(mm)	% Finer	D(mm)	% Finer	D(mm)	% Finer	D(mm)	% Finer	D(mm)	% Finer	D(mm)	% Finer	D(mm)	% Finer	D(mm)	% Finer	D(mm)	% Finer
Fine Design Band (Upper)	4	0.5	60	0.49	60	0.782	60	0.896	60	0.5	60	0.5	60	0.840	60	1.367	60	0.799	60	0.5	60
	2	0.1	15	0.1	15	0.156	15	0.179	15	0.1	15	0.1	15	0.168	15	0.273	15	0.160	15	0.1	15
	5	0.075	5	0.075	5	0.075	5	0.075	5	0.075	5	0.075	5	0.075	5	0.075	5	0.075	5	0.075	5
Course Design Band (Lower)	6	75	100	75	100	75	100	75	100	75	100	75	100	75	100	75	100	75	100	75	100
	3	1.4	60	1.3	60	3.909	60	4.480	60	1.8	60	2.2	60	4.202	60	6.836	60	3.994	60	2.2	60
	1	0.5	15	0.49	15	0.782	15	0.896	15	0.5	15	0.5	15	0.840	15	1.367	15	0.799	15	0.5	15
	7	0.083	10	0.083	10	0.130	10	0.149	10	0.083	10	0.083	10	0.140	10	0.228	10	0.133	10	0.083	10

Step 12. Determine Gradation from plot

Shaded boxes means these values were changed to meet the requirements from the references listed below
References cited and listed in Appendix G

D50 base	0.05	0.05	0.34	0.49	0.06	0.07	0.30	0.49	0.29	0.07
D50 Fine Filter	0.41	0.40	0.64	0.74	0.41	0.41	0.69	1.12	0.66	0.41
D50 Course Filter	1.20	1.12	3.21	3.68	1.51	1.82	3.46	5.62	3.28	1.82

Nelson eqn 4.35	3.61	4.95	0.03	0.06	3.88	2.72	0.03	0.05	0.02	0.86
Cedergren eqn 5.3	24.56	24.69	9.45	7.48	24.78	24.48	11.34	11.44	11.23	24.34
Nelson eqn 4.36	3.61	4.95	0.03	0.06	3.88	2.72	0.03	0.05	0.02	0.86

Client:	**Energy Fuels Resources (USA) Inc.**	**Job No.:**	**1009740**
Project:	**White Mesa Reclamation Plan**	**Date:**	**8/22/2015**
Detail:	**Erosion Protection**	**Computed By:**	**TMS/MMD**

Apron Protection

Source: Abt, SR, Johnson, TL, Thornton, CI, and Trabant, SC, Riprap Sizing at Toe of Embankment Slopes, Journal of Hydraulic Engineering, Vol. 124, No. 7, July 1998.

Equation: D50=10.46*S^0.43*qd^0.56

	Apron C: Cell 2 Northern Side Slope	Apron B: Cell 4A Southern Side Slope	Apron A: Non-Accumulating Slopes	West
unit discharge (cfs/ft)	0.65	0.87	0.06	0.06
Cr	1	1	1	1
Cf	3	3	3	3
Cm	1.35	1.35	1.35	1.35
design discharge (cfs/ft)	2.63	3.51	0.25	0.25
Slope (ft/ft)	0.2	0.2	0.2	0.2
D50 **Angular** (in)	9.0	10.6	2.4	2.4
D50 **Rounded** (in)	12.6	14.8	3.4	3.4

Client:	**Energy Fuels Resources (USA) Inc.**	**Job No.:**	**1009740**
Project:	**White Mesa Reclamation Plan**	**Date:**	**8/22/2015**
Detail:	**Erosion Protection**	**Computed By:**	**TMS/MMD**

Interstitial Velocities - Apron

Source: NUREG 1623, Section D
Abt, SR, JF Ruff, RJ Wittler (1991). Estimating Flow Through Riprap, Journal of Hydraulic Engineering, Vol. 117, No. 5, May.

Description	Non-Accumulating Side Slopes - Rounded	Cell 1 Disposal Area Side Slope - Angular	Cell 4A Flow Path 2 Southern Side Slope - Angular	
Minimum D50 (inches)	3.18	8.99	10.58	from Safety Factor Method, or Abt/Johnson Method, assuming rounded rock
Minimum D10 (inches)	0.74	2.10	2.47	from preliminary gradation specs
Maximum D10 (inches)	0.99	2.80	3.29	from preliminary gradation specs
Slope (ft/ft)	0.01	0.01	0.01	from preliminary design
Min Velocity (ft/s)	0.11	0.19	0.21	calculated from Abt et al. (1991) based on Min D10
Max Velocity (ft/s)	0.13	0.22	0.24	calculated from Abt et al. (1991) based on Max D10
Underlying filter required?	No	No	No	Per NUREG 1623, Appendix D, section 2.1.1

Client:	**Energy Fuels Resources (USA) Inc.**	**Job No.:**	**1009740**
Project:	**White Mesa Reclaimation**	**Date:**	**8/22/2015**
Detail:	**Erosion Protection**	**Computed By:**	**TMS/MMD**

Modified Universal Soil Loss Equation (MUSLE)

Source : Clyde et al. (1978) as presented in NUREG 4620, section 5.1.2
A=R*K*LS*VM

	Topsoil	Rock Mulch	
Inputs for K factor			
Percent silt and very fine sand	43.6	32.7	from laboratory testing
Percent sand (0.10-2.0 mm)	39.2	29.4	from laboratory testing
Percent organic matter	1.5	1.5	
Soil structure Number	2	3	
Permeability	3	2	
Inputs for LS factor			
Slope length (ft)	1440	1200	from Figure G.1
slope steepness (%)	0.5	0.8	
m exponent	0.2	0.2	Table 5.2 of NUREG 4620

		Topsoil	Rock Mulch	
R	Rainfall Factor	30	30	From Table 5.1 of NUREG 4620 for eastern third of Utah
K	Soil Erodibility factor	0.28	0.12	From nomograph Fig. 5.1 of NUREG 4620
LS	Topographic factor	0.16	0.18	
VM	Dimensionless erosion control factor	0.4	0.4	From Table 5.3 of NUREG 4620 for seedings, 0-60 days
A	Soil Loss (tons/acre/year)	0.54	0.27	
A	Soil density (pcf)	100	106	from laboratory testing
A	Soil Loss (inches/1000 years)	3.0	1.4	

Client:	**Energy Fuels Resources (USA) Inc.**	**Job No.:**	1009740
Project:	**White Mesa Mill**	**Date:**	8/14/2012
Detail:	**Discharge Channel**	**Computed By:**	JMC

Peak Discharge of PMP precipitation

Description	Total Drainage Area (acres)	C	Tc (min)	Intensity (in/hr)	Q (cfs)
Sed-Channel	**148.40**	1	26.3	16.4	2440.1

Client:	**Energy Fuels Resources (USA) Inc.**	**Job No.:**	**1009740**
Project:	**White Mesa Mill**	**Date:**	**8/14/2012**
Detail:	**Discharge Channel**	**Computed By:**	**JMC**

Time of Concentration

1-hour PMP (in) 8.3

Description	Slope (feet/feet)	Path Length (feet)	Time of Concentration (minutes)				% of 1-hour PMP	PD_{PMP} (in)	Intensity (in/hr)
			Kirpich	SCS	Brant and Oberman	Average			
Sed-Channel	**0.010**	**4600**	30.1	30.2	18.7	26.3	86.9	7.21	16.4

Source: Brant and Oberman(1975) as presented in UMTRA TAD (1989)
Formula: tc=C(L/Si^2)^(1/3).
Source:Kirpich (1940) as presented in NUREG 4620
Formula: tc=0.00013*L^0.77/S^0.385 with L in feet, tc in hours
Source: SCS as presented in NUREG 4620
Formula: tc=(11.9L^3/H)^0.385 with L in miles, H in feet, t in hours
% of one-hour PMP=RD/(0.0089*RD+0.0686) for tc<15 min based on Table 4.1 of TAD
Cell geometry and grading based on REC-1 Reclamation Plan Revisions, September, 2011

Client:	Energy Fuels Resources (USA) Inc.	**Job No.:**	1009740
Project:	White Mesa Mill	**Date:**	8/2/2012
Detail:	Discharge Channel	**Computed By:**	JMC

Peak Channel Velocity

Design flow: 2,440 cfs

Trapezoid or triangular channels			
slope (ft/ft)	0.009	ft/ft	
Channel Side Slope 1 (ft/ft)	0.33	ft/ft	
Channel Side Slope 2 (ft/ft)	0.33	ft/ft	
bottom width	150	ft	
Q	2,440	cfs	
n native soils	0.020		bedrock channel with minor irregularities
Area of flow (A)	258.52	ft^2	
Wetted Perimeter Slope 1 (P1)	5.32	ft	
Wetted Perimeter Slope 2 (P2)	5.32	ft	
Hydraulic Radius (R)	1.61	ft	
Top Width (T)	160.1	ft	
Maximum depth of flow (d)	1.67	ft	
Q calc	2440.0	cfs	**ok**
average velocity (v)	**9.4**	**fps**	**8-10 fps ok**
unit discharge	**15.74**	**cfs/ft**	take as total Q divided by average flow width

Client:	Energy Fuels Resources (USA) Inc.	**Job No.:**	1009740
Project:	White Mesa Mill	**Date:**	8/14/2012
Detail:	Discharge Channel	**Computed By:**	JMC

Peak Channel Velocity

Design flow: 2,440 cfs

Trapezoid or triangular channels				
slope (ft/ft)	0.009	ft/ft		
Channel Side Slope 1 (ft/ft)	0.33	ft/ft		
Channel Side Slope 2 (ft/ft)	0.33	ft/ft		
bottom width	150	ft		
Q	2,440	cfs		
n native soils	0.030		bedrock channel with moderate irregularities	
Area of flow (A)	332.10	ft^2		
Wetted Perimeter Slope 1 (P1)	6.77	ft		
Wetted Perimeter Slope 2 (P2)	6.77	ft		
Hydraulic Radius (R)	2.03	ft		
Top Width (T)	162.9	ft		
Maximum depth of flow (d)	2.12	ft		
Q calc	2440.0	cfs	**ok**	
average velocity (v)	**7.3**	**fps**	**less than 8-10 fps**	**ok**
unit discharge	**15.60**	**cfs/ft**	take as total Q divided by average flow width	

Client:	Energy Fuels Resources (USA) Inc.	**Job No.:**	1009740
Project:	White Mesa Mill	**Date:**	8/2/2012
Detail:	Discharge Channel	**Computed By:**	JMC

Manning's N-value Determination

From US Department of the Interior, Bureau of Reclamation. Design of Small Dams. p. 595. 1987.

Basic N-value for channels in Rock	0.015	
Modifications of N-value	0.005	Minor degree of irregularity
	0.010	Moderate degree of irregularity
	0.020	Severe irregualrity

Based on seismic refraction data, test numbers 1-3, shear wave velocities ranged from 3100 to 7400 feet/sec (see test results from Nielsons, 1978, Appendix A D'Appolonia, 1979). The bedrock in the area c excavation is anticpated to range from soft and rippable to hard rock requiring blasting. The excavated rock surface will likely exhibit minor ro moderate irregularity.

Assume an N-value ranging from 0.020 0.030

From US Army Corps of Engineers. Hydraulic Design of Flood Control Channels, EM 1110-2-1601. p.2-16. June 1994.
From Table 2-5, Suggested Maximum Permissible Mean Channel Velocities

Poor Rock (usually sedimentary)	10.0	fps
Soft Sandstone	8.0	fps
Soft Shale	3.5	fps
Good Rock (usually igneous or hard metamorphic)	20.0	fps

The bedrock within the channel excavation is anticipated to consist of fine to medium-grained sandstone of varying cementation and weathering, or claystone. (see borings by Dames and Moore, 1978) Based on the presumed rock type and the referenced table above, permissible mean channel velocities may range up to 8 to 10 fps.

APPENDIX H

TAILINGS DEWATERING

ATTACHMENT H.1

TAILINGS DEWATERING INFORMATION FOR CELLS 2 AND 3

SELECT INFORMATION FROM MWH (2010)

Denison Mines (USA) Corp.

Revised Infiltration and Contaminant Transport Modeling Report, White Mesa Mill Site, Blanding, Utah

March 2010

MWH

REVISED
INFILTRATION AND CONTAMINANT TRANSPORT MODELING REPORT
WHITE MESA MILL SITE
BLANDING, UTAH

DENISON MINES (USA) CORP.

March 2010

Prepared for:

Denison Mines (USA) Corp.
1050 17th Street, Suite 950
Denver, Colorado
80265

Prepared by:

MWH Americas, Inc.
10619 South Jordan Gateway, Suite 100
Salt Lake City, Utah
84095

APPENDIX J

TAILINGS CELL DEWATERING MODELING

APPENDIX J

TAILINGS CELL DEWATERING MODELING

This appendix describes the dewatering modeling performed with MODFLOW to estimate the time required to dewater the tailings in Cells 2 & 3 and estimate the residual saturated thickness of tailings. The model-predicted water levels (saturated thickness of tailings) are used in the Giroud-Bonaparte Equation to calculate potential flux rates through the liner into the underlying bedrock vadose zone, as described in Appendix L. A tailings cell dewatering model was not constructed for Cells 4A & 4B because analytical solutions presented by Geosyntec Consultants (2007) were deemed adequate given the uniform distribution of the drain system in those cells.

Tailings Cells 2 & 3 Slimes Drains

To dewater the tailings in Cells 2 & 3, slimes drain networks consisting of perforated PVC pipe are located across the base of the cells which drain to an extraction sump on the southern side of each cell. The drains cover an approximately 400-foot by 600-foot area in the southern part of the cells. The design for the slimes drains is the same for both cells (D'Appolonia Consulting Engineers, 1982). The drain pipes are situated in nine alignments spaced 50 feet apart running in an approximately east-west direction. Each drain is 600 feet long, extending 300 feet in each direction from the central collection pipe that drains to the sump. The drain pipes are covered by an envelope of sand over the drains, rather than a continuous layer across the bottom of the tailing cells ("burrito drains"). Water gravity drains to the sump, whence it is pumped to Cell 1.

METHODOLOGY

Model Code

The computer code MODFLOW was used in this modeling effort with the Department of Defense Groundwater Modeling System (GMS) pre- and post-processor. MODFLOW is a modular three-dimensional finite-difference flow model developed by the United States Geological Survey (McDonald and Harbaugh, 1988; Harbaugh et al., 2000) to calculate hydraulic-head distribution and determine flow within a simulated aquifer. This model was selected because it can adequately represent and simulate the hydrogeologic conditions necessary and it is well-documented, frequently used, and a versatile program that is widely accepted by the scientific and regulatory communities (Anderson and Woessner, 1992).

Model Domain, Layering, and Grid

The domain for the tailings cell model was approximately 3,500 by 1,200 feet, representing Cells 2 & 3 (see Figure J-1). The finite-difference grid consisted of a constant spacing of 10 feet. The model included two layers to represent the tailings and slimes drains. The bottom layer was 1 foot thick so that the drains could be simulated explicitly (hydraulic conductivity was variable to represent tailings between the drains). The top layer had a variable thickness that represented the tailings. The water level in the top layer was allowed to vary spatially and temporally. The bottom elevations were set based on information presented in the tailings cell construction report (D'Appolonia Consulting Engineers, 1982).

Boundary Conditions

Boundary conditions define hydraulic constraints at the boundaries of the model domain. There are three general types of boundary conditions:

1. Specified head or Dirichlet (e.g., constant head)

2. Specified flux or Neumann (e.g., constant flow, areal recharge, extraction wells, no flow)

3. Head-dependent flux or Cauchy (e.g., drains, evapotranspiration)

No-flow boundaries are a special case of the specified flux boundary in which the flow is set to zero.

For the tailings cell model, no-flow boundaries were assumed to surround the domain. A net flux rate from the cell was assumed across the entire domain. This assumed flux rate represents the combination of potential fluxes from the cell through the liner and potential infiltration into the cell through the cover. The net flux rate was calculated using the average infiltration rate through the cover predicted by the HYDRUS-1D tailings cover model and the potential flux rate through the bottom of Cells 2 & 3 (see Appendix L). The resulting average net flux rate for Cells 2 & 3 was 6.9×10^{-4} cm/day (2.27×10^{-5} ft/day). This assumed net flux rate was applied uniformly across the domain and was simulated with MODFLOW as a negative recharge rate.

The slimes drains were simulated with the Drain package in MODFLOW. Drains are head-dependent boundary conditions in which flow varies based on the difference in hydraulic head in the aquifer and the drain: as head in the aquifer declines (tailings in this case), so does the dewatering rate. Groundwater flow to this array is gravity driven and dependent on the head difference between the surrounding material and the perforated pipe. Operation of the slimes drain extraction pump is only necessary to extract the groundwater driven into this array to maintain a head difference. Essentially, this system acts as a field drain array. The MODFLOW Drain package was developed specifically to simulate this sort of gravity driven, head dependent drain system. A thorough quantitative explanation of the MODFLOW Drain package is presented in *A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model: U.S. Geological Survey Techniques of Water-Resources Investigations, book 6, chap. A1* (McDonald and Harbaugh, 1988).

Drain cells were set along nine alignments spaced 50 feet apart. Each drain was 600 feet long. Drains were set in the model as shown on Figure J-1.

Hydraulic Properties

The saturated hydraulic conductivity of the tailings assumed for White Mesa was based on measured values reported for the aquifer testing performed in uranium mill tailings at Cotter Corporation's Canon City Mill tailings impoundment (MFG, Inc., 2005). See Appendix I for details concerning the comparison of tailings grain size for the White Mesa Mill to those of the Canon City Mill. The average hydraulic conductivity of the tailings ranged from 2.1 ft/day (7.4 x 10^{-4} cm/sec) to 8.5 ft/day (3.0 x 10^{-3} cm/sec) with an average value of 4.8 ft/day (1.7 x 10^{-3} cm/sec). A hydraulic conductivity of 4.8 ft/day was assumed for the tailings (in both model layers). A hydraulic conductivity of 25 ft/day was assumed for the sand adjacent to the slimes drain in the bottom layer of the model. This was used only in layer 1 in the cells that represent drains. Hydraulic conductivity values representative of tailings were assumed across the remainder of the bottom layer.

Calibration

The calibration process involves iterating values for model parameters in sequential model simulations to produce estimated values that better match field-measured data. The initial-parameter values were adjusted through calibration until the model produced results that adequately simulated the known data. The tailings cell model was calibrated by varying the drain conductance term until the flow rates approximately matched the 2007 dewatering rates (average rate of 12.5 gpm) and average water levels of 20 feet above the liner.

RESULTS

The MODFLOW dewatering model predicts that the tailings would draindown nonlinearly through time reaching an average saturated thickness of 3.5 feet (1.07 m) after 10 years of dewatering (see Figure J-2). The model also predicts that dewatering rates would decline to approximately 2 gallons per minute (gpm) after 10 years of pumping. This reduction in pumping rates is caused by the reduction in saturated thickness of tailings. Dewatering rates are also controlled by the saturated hydraulic conductivity of the tailings. If the actual hydraulic conductivity of the tailings is higher than the value assumed in the model, dewatering rates could be higher and water levels could be lowered more rapidly. Conversely, if the actual hydraulic conductivity of the tailings is lower than the value assumed in the model, dewatering rates could be lower and water levels could require more time to dewater. Mass balance errors for the MODFLOW model were less than 1%.

A dewatering model was not constructed for Cells 4A & 4B because dewatering rates were estimated by Geosyntec Consultants (2007). Water levels in Cell 4A were estimated to decline to less than 1 foot after approximately six years of dewatering. Cells 4A & 4B is estimated to be dewatered significantly faster than Cells 2 & 3 due to the more extensive slimes drain network. The dewatering system in Cell 4B is assumed to be designed similarly to Cell 4A, thus dewatering rates were assumed to be similar.

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Figure J-1. MODFLOW tailings cell model domain, grid, and boundary conditions

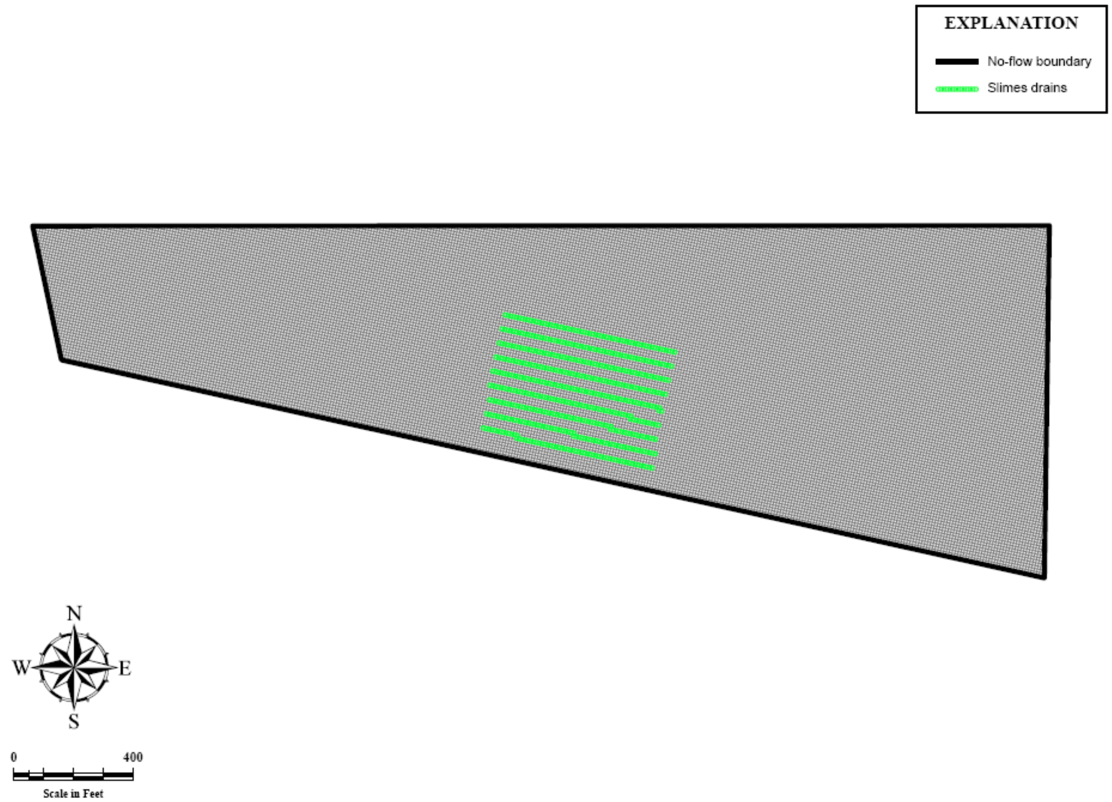
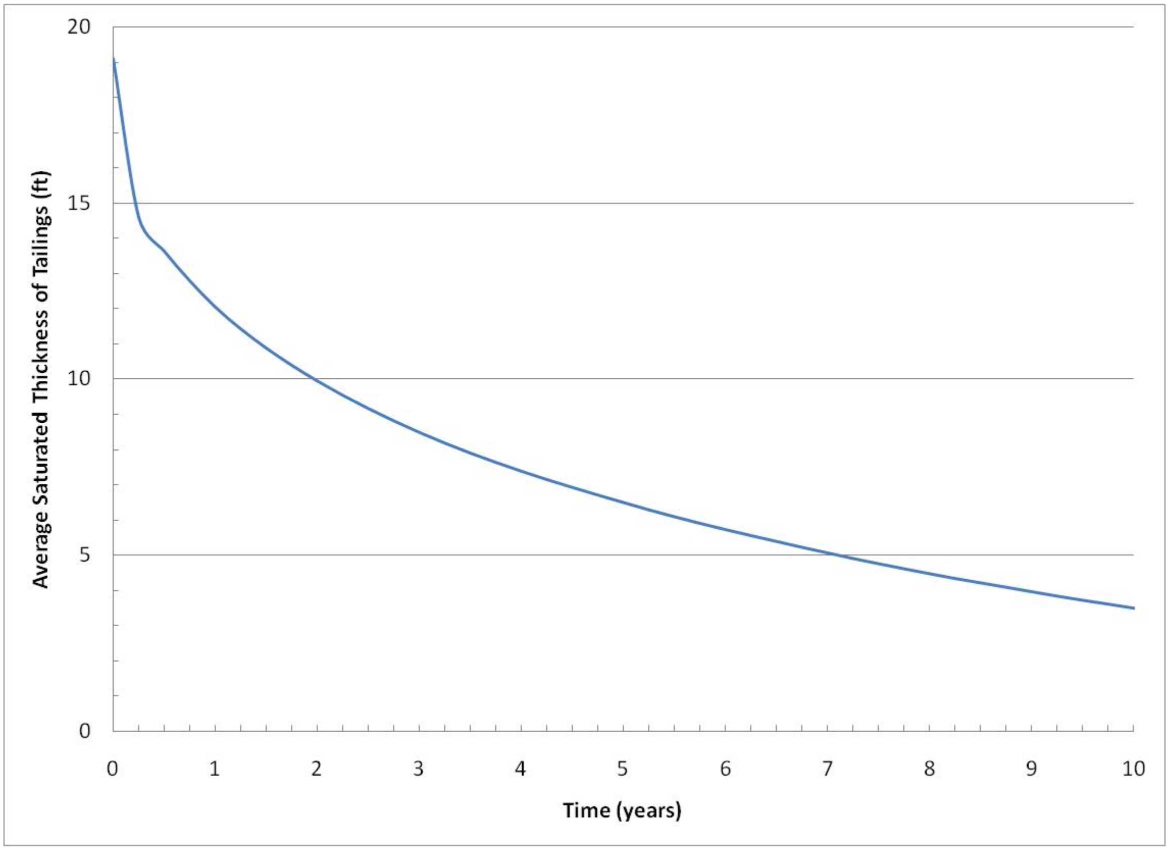


Figure J-2. Model-predicted average saturated thickness of tailings in Cells 2 & 3 with dewatering pumping.



ATTACHMENT H.2

TAILINGS DEWATERING INFORMATION FOR CELLS 4A AND 4B

SELECT INFORMATION FROM GEOSYNTEC (2008a, 2008b) AND DRC (2008)

Geosyntec consultants

COMPUTATION COVER SHEET

Client: **Denison Mines** Project: **White Mesa Mill** Project/ Proposal No.: **SC0349-01** Task No. **04**

Title of Computations **ANALYSIS OF SLIMES DRAIN**

Computations by:	Signature		
	Printed Name	Meghan Lithgow	Date
	Title	Staff Engineer	
Assumptions and Procedures Checked by: (peer reviewer)	Signature		
	Printed Name	Gregory T. Corcoran	Date
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Computations Checked by:	Signature		
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Computations backchecked by: (originator)	Signature		
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	Title	Staff Engineer	
Approved by: (pm or designate)	Signature		
	Printed Name	Gregory T. Corcoran	Date
	Title	Principal	

Approval notes: ______________________

Revisions (number and initial all revisions)

No.	Sheet	Date	By	Checked by	Approval

Written by:	**M. Lithgow**	Date:	**05/11/07**	Reviewed by:	**G. Corcoran**	Date:	**05/12/07**
Client: **Denison Mines**		Project:	**White Mesa Mill – Cell 4A**	Project/ Proposal No.:	**SC0349-01**	Task No.:	**04**

PURPOSE AND METHOD OF ANALYSIS

The purpose of this calculation package is to demonstrate that the proposed "slimes drain system" will dewater the tailings at the site within a reasonable time.

Fluid flow rate in porous media will be evaluated using Darcy's law.

ASSUMPTIONS

- This project involves the construction of a 42 acre double lined tailings cell (Cell 4A) that is approximately 42 feet deep at its deepest point and 26 feet deep at the shallowest point with an average depth of 34 feet. The liquids level in the cell will be kept a minimum of 3 feet below the top of the berm (free-board). Therefore, the maximum depth of liquid in the cell will be 39 feet at the start of dewatering.
- The cell will be filled with -28 mesh (US No. 30 sieve) tailings, largely consisting of fine sands and silts, with some clay. Results of grinding test sieve analyses, which are reported based on Tyler Mesh sieve sizes, are presented in Table 1. The grinding test data report is presented in Attachment A. Sieve to Tyler Mesh conversions are presented in Attachment B.
- The tailings will be placed within the cell in a slurry form under the surface of the free liquid contained within the cell. This placement methodology is anticipated to result in a low density (no compaction) soil structure. Therefore, saturated hydraulic conductivity and total porosity are anticipated to be higher than similar soils that are compacted.
- Based on the grinding report (Attachment A), tailings are comprised of approximately 6% medium sand, 49% fine sand, and 45% silt and clay size particles (Table 1).
- Based on the gradation of the tailings (Table 1) from the grinding report (Attachment A), the tailings would be classified as silty sand (SM) by the unified soil classification system (USCS). According to the Hydrologic Evaluation of Landfill Performance (HELP) Model Engineering Documentation (Attachment C), **low density** SM soils would exhibit saturated hydraulic conductivities of

between $1.7x10^{-3}$ cm/sec and $5.2x10^{-4}$ cm/sec and **low density** silt (ML) and sandy clay (SC) would exhibit saturated hydraulic conductivities of between $3.7x10^{-4}$ cm/sec and $1.2x10^{-4}$ cm/sec. The geomean of these two groups of soils, which are gradationally similar to the tailings, is $4.74x10^{-4}$ cm/sec (Table 2). According to Cedergren (Attachment D), under a normal stress of 2 tons per square foot (approximate normal stress on deeper tailings in the cell), medium sand, fine sand, silt, and silty clay would exhibit a saturated hydraulic conductivities of approximately $2x10^{-2}$ cm/sec, $1x10^{-2}$ cm/sec, $1x10^{-4}$ cm/sec $5x10^{-7}$ cm/sec, respectively. The geomean of these three soil types, where are gradationally similar to the tailings, is $3.31x10^{-4}$ cm/sec. The more conservative, lower hydraulic conductivity of $3.31x10^{-4}$ cm/sec, will be used in this analysis.

- Based on the gradation of the tailings from the grinding report, the tailings would be classified as silty sand (SM) by the unified soil classification system (USCS). According to the HELP Model Engineering Documentation (Attachment C), **low density** SM soils would exhibit drainable porosity of between 0.251 and 0.332 and **low density** silt (ML) and sandy clay (SC) would exhibit drainable porosity of between 0.154 and 0.231. The average of these two groups of soils, which are gradationally similar to the tailings, is 0.253 (Table 2). According to the HELP Model Engineering Documentation, medium sand, fine sand, silt, and silty clay would exhibit drainable porosity values of 0.35, 0.29, 0.14, and 0.11, respectively. The average of these three soil types, where are gradationally similar to the tailings, is 0.22. Since the average drainable porosity of 0.22 corresponds to the lower hydraulic conductivity (higher density, lower permeability, lower porosity) selected above, this value will be used in this analysis.

- The permeability of the tailings is isotropic.

- Darcy's law will be used to compute groundwater flow velocities.

- The proposed slimes drain system will consist of a series of strip drains (geotextile wrapped HDPE core, 1" thick, 12" wide, with a transmissivity of 29 (gal/min/ft), which connect to a perforated 4" diameter PVC header pipe that is bedded in drainage aggregate and wrapped in a woven geotextile. The PVC pipe will convey the liquid to the sump for removal.

- The slimes drain spacing will be 50' and will be continuous across the base of the cell (Figure 1).

CALCULATIONS

The flow geometry for the average depth of liquid within the cell is illustrated on Figure 2 and used to compute the emptying time for the proposed slimes drain system.

Calculate the flow into a unit length of strip drain for the various hydraulic gradient conditions.

At the start of cell dewatering, the maximum depth of liquid will vary between 23 feet at the shallow end and 39 feet at the deep end, with an average depth of approximately 31 feet. As the water level drops within the cell, the length of the longest flow path and the associated hydraulic gradient will continually change with time.

The total volume to be drained by a unit length of strip, Q, can be calculated using Darcy's law as follows:

$$Q = kiA$$

where:

k = hydraulic conductivity of tailings = $3.31\text{x}10^{-4}$ cm/sec = $6.51\text{x}10^{-4}$ ft/min

i = gradient along flowpath = $\frac{dh}{dl} = \frac{31}{39.8} = 0.78$ (see Figure 2)

A = area of strip drain where flow will pass =1.17 ft^2/ft (see Figure 3)

$$Q = (6.51\times10^{-4}\,\frac{ft}{\text{min}})(0.78)(1.17\;ft^2)$$

$$Q = 5.94x10^{-4}\,\frac{ft^3}{\text{min}}\text{ x 7.48 gal/ft}^3 = 4.44\text{x}10^{-3}\text{ gpm}$$

For each one foot incremental drop in fluid elevation within the cell, the total volume to be drained by a unit length of strip drain is as follows:

V = 1 ft unit length x 1ft depth x 50 ft width x .022 (drainable porosity) = 11 CF of free liquid

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Therefore, the time to drain the first one foot of liquid within the cell can be estimated as follows:

$t = V/Q = 11\ CF / 5.94x10^{-4}\ CF/min = 18{,}519\ minutes = 12.86\ days$

Tables 3, 4, and 5 depict the calculations for the maximum (39 feet), average (31 feet), and minimum (23 feet) cell liquid depth, respectively. The results of the maximum depth calculations indicate that the proposed slimes drain system will allow the tailings contained in Cell 4A to drain within approximately 5.5 years.

<u>Calculate the design flow rate of the strip drains.</u>

For this calculation we will assume that the strip drains have a flow rate of 29 gallon per minute per foot (Attachment E, GDE Multi-Flow, 2006), a width of 12" and that flow is occurring under a gradient of 0.01.

Design Flow rate of strip drains:

$$q = \Theta i$$

where:

q = flowrate per unit width

$$i = \frac{dh}{dl} = 0.01$$

Θ = transmissivity = 29 gpm/ft

To account for detrimental effects on the geonet such as chemical clogging, biological clogging, installation defects, and creep, partial factors of safety were used to reduce the strip drain transmissivity. Using recommended partial factor of safety values from Koerner (1999) (Attachment F, 2/4), the reduced transmissivity is calculated as follows:

$$\Theta_{allow} = \Theta_{ult}\left[\frac{1}{FS_{IN} \times FS_{CR} \times FS_{CC} \times FS_{BC}}\right]$$

where:

Θ_{allow} = allowable flow

$\Theta_{ultimate}$ = calculated value of flow

FS_{IN} = factor of safety for installation, 1.5 (CQA performed during installation)

FS_{CR} = factor of safety for creep, 2.0

FS_{CC} = factor of safety for chemical clogging, 2.0

FS_{BC} = factor of safety for biological clogging, 1.0 (low pH precludes biological activity)

The factors of safety are used to calculate the allowable transmissivity:

$$\Theta_{allow} = 29\,\frac{gpm}{ft}\left[\frac{1}{1.5 \times 2.0 \times 2.0 \times 1.0}\right] = 4.83\,\frac{gpm}{ft}$$

Using this transmissivity value, the average factor of safety for flow in the strip composite is estimated to be as follows:

$$FS = \frac{Q_D}{Q_R} = \frac{4.83\ gpm}{0.0044\ gpm} = 1{,}087 \quad \text{(Acceptable)}$$

The average allowable flow rate is much larger than the average maximum flow rate, even with the built-in partial factors of safety. Furthermore, as indicated on Tables 3, 4, and 5, the calculated flow rate within the strip drain decreases with time, which further increases the factor of safety.

Calculate the minimum required AOS and permittivity for filtration geotextile component of strip drain

The geotextile serves as a filter between the strip composite core and the tailings material. The geotextile minimizes fine particles of the tailings material from migrating into the strip composite, yet allows water to penetrate. Migration of fine particles would have the adverse effect of decreasing the transmissivity of the strip composite layer.

To be conservative in these calculations, the tailings material soil is assumed to consist of more than 20 percent clay.

The retention requirements for geotextiles can be evaluated using the chart entitled "Soil Retention Criteria for Steady-State Flow Conditions" developed by Luettich et al., (1991) (Attachment G, 1/3). This chart uses soil properties to evaluate the required apparent opening size (AOS or O_{95}) of the geotextile. Using the Soil Retention Chart, the AOS of the filter fabrics shall be:

$O_{95} < 0.21$ mm, which corresponds to sieve No. 70.

The permeability of the filter fabric must be evaluated to allow flow through the filter fabric. The following equation can be used to evaluate the minimum allowable geotextile permeability:

$k_g > i_s\, k_s$ (Luettich et al. (1991), Att. G, 2/3)

where: k_g = permeability of geotextile (cm/s)
i_s = hydraulic gradient (dimensionless)
k_s = permeability of the tailings material (cm/s)

Hydraulic Gradient, i_s: Attachment G, page 3/3 from Luettich et al. (1991) lists typical hydraulic gradients for various geotextile drainage applications. In this attachment, a hydraulic gradient of 10 for liquid impoundment applications is recommended.

Soil Permeability, k_s: A permeability of 3.31×10^{-4} cm/s was assumed for the tailings material, as previously defined.

Therefore,

$k_g >\ i_s\, k_s = (10)(3.31\times10^{-4}$ cm/s)
$k_g >\ 3.31 \times 10^{-}$ cm/s

Koerner (1999) suggests applying partial factors of safety to the ultimate flow capacity of the geotextile to account for clogging of the geotextile. Using recommendations

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given in Table 2.12 on p. 150 of Koerner (1999) (Attachment F, 1/4), the following partial safety values were applied:

soil clogging and blinding:	10 (5 – 10)
creep reduction of voids:	2.0 (1.5 – 2.0)
intrusion into voids:	1.2 (1.0 – 1.2)
chemical clogging:	1.5 (1.2 – 1.5)
biological clogging (low pH precludes biological activity):	1.0 (2 – 10)

Therefore,

$k_g > (3.31 \times 10^{-3})(10)(2)(1.2)(1.5)(1)$

$k_g > 0.12$ cm/s

The thickness of a typical nonwoven needled punched 4 oz/yd^2 (135 g/m^2) geotextile is approximately 40 mils (0.10 cm), see Attachment H. Dividing the permeability by the thickness of the geotextile results in a required minimum permittivity of 1.2 sec^{-1}. The geotextile used in this project has a permittivity of 2.0 sec^{-1}, which is greater than the required permittivity.

Check Pipe Flow Rate

Based on calculations from previous sections, the maximum daily flow rate to the sump is estimated to be 132 gpm (0.29 cfs) (Table 3). The capacity of the pipe is calculated based on Manning's equation for gravity flow as follows:

$$Q = \frac{1.486}{n} R_h^{2/3} S^{1/2} A = 0.35\ cfs$$

Where

n = 0.010 (Koerner (1999), Attachment E, 4/4)
S = Slope of liner (ft/ft) = 1.0 %
R_h = hydraulic radius, ft
Q = flow rate, cubic feet per second, cfs
A = flow area, sf

Assuming 4-inch pipe:

$A = \pi D^2/4$ = 12.6 sq. inches = 0.088 sf
R_h = Area ($\pi D^2/4$)/Wetted Perimeter (π D)

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= D/4 = 1 in = 0.083 ft

$$Q = \frac{1.486}{0.010} 0.083^{2/3} 0.01^{1/2} 0.088\ sf = 0.28\ cfs = 112\ gpm$$

Since 112 gpm is less than the maximum required 132 gpm, this calculation shows that the 4-inch diameter slimes drain pipe is the limiting factor for dewatering the tailings in the early phase of dewatering (high flow rates). However, it does not mean that the pipe will be unable to handle this flow, but rather the pipe will require additional time to drain. The additional time needed is computed in the following section.

Effect of Maximum Pipe Capacity on Drainage Time

The maximum capacity of the pipe is 112 gpm, as computed above. Assuming the cell's total lateral length of strip drain is 27,550 feet, the flow rate, per foot of strip drain is calculated to be:

$$\text{Flow Rate} = \frac{112\ gallon}{\text{min}} * \frac{60\ \text{min}}{1\ hr} * \frac{24\ hr}{1\ day} * \frac{1 ft^3}{7.48\ gallon} * \frac{1}{27{,}550\ feet} = 0.78 \frac{ft^3}{day}$$

The time needed to de-water first layer is:

$$Time = \frac{Volume}{Drain\ \ length\ \times flow\ rate} = \frac{(50x1x1x0.22)\ ft^3}{1\ ft \times 0.78\ \dfrac{ft^3}{day}} = 14.1\ days$$

The difference between the maximum daily flow rate drainage time and the maximum daily flow the pipe is able to deliver for the first foot is:

14.1 day – 11.93 day (first row of Table 3) = 2.17 days.

Therefore, the first layer will require an additional 2.17 days to drain. The calculation is repeated until the pipe's allowable flow capacity of 112 gpm is equal to the maximum flow rate from the cell (Table 3). The additional drainage time needed for each layer is added to the original drainage time of 5.5 years. The results of this analysis are shown in Table 3.

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The total additional drainage time occurs over the first 9 layers and adds 11 days (0.03 years) to the computed drainage time. Including the effects of the maximum pipe capacity, the cell will take an estimated 5.5 years to drain.

Effect of Precipitation on Drainage Time

To account for the effect of precipitation added to the tailings cell, the HELP Model was used to estimate the average annual leakage through a 3 foot thick (tailings above the liquid) layer of silty sand material (Attachment I). HELP Model default parameters were used along with a maximum 16 inch evaporative zone (conservative for dry climate) and weather data from Grand Junction, Colorado. The model was performed for a 10 year period and included precipitation events ranging from 5.83 to 10.36 inches per year.

The results of this analysis suggest that a maximum average annual percolation through the 3 foot soil layer above the liquid will be approximately 12 ft^3 per acre or 504 ft^3 (3,770 gal.) for the entire Cell 4A area.

The average flow rate during Cell 4A dewatering, as calculated from Table 3 is equal to 71 gpm (102,240 gallon/day).

The time required to drain the additional volume of precipitation in the tailing is computed using the following equation:

$$Time = \frac{Volume}{FlowRate} = \frac{3{,}770\ gal}{102{,}240\ \frac{gal}{day}} = 0.04\ days$$

The additional time that the pond will require to empty due to precipitation is insignificant.

Therefore, the estimated time to dewater Cell 4A will be 5.5 years (baseline) + 0.03 years (pipe limitations) + 0 years (precipitation) = 5.5 years.

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(Attachment G)

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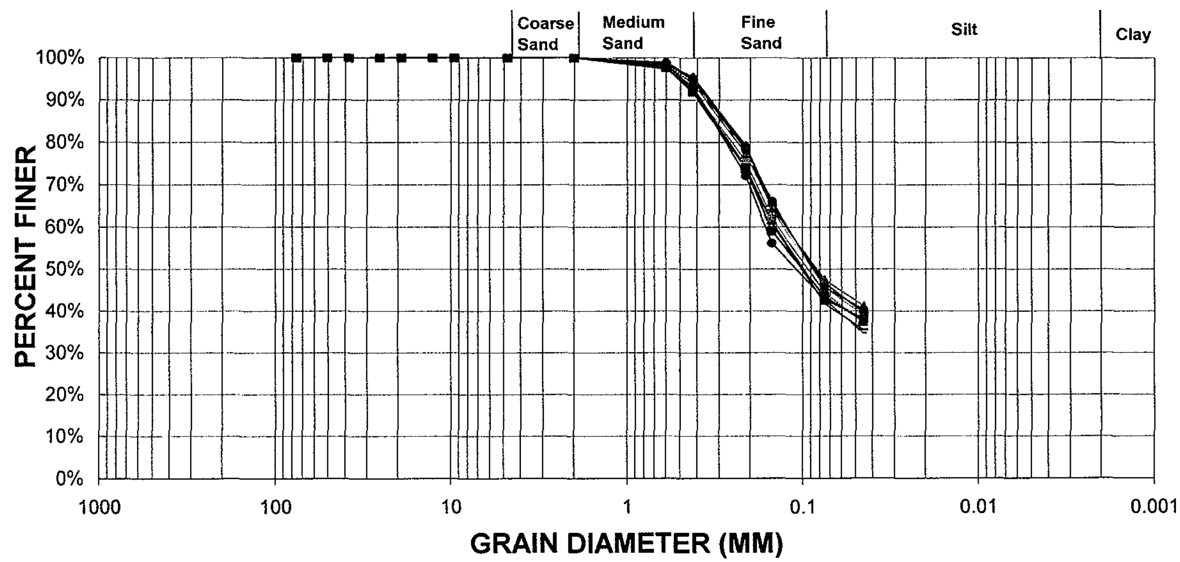
Table 1
DSM Screen Undersize Gradation

SIEVE ANALYSIS

		Grinding Test 1			Grinding Test 2A			Grinding Test 2B			Grinding Test 3A			Grinding Test 3B		
Sieve No.	Diameter (mm)	Wt. Retained (grams)	% Retained	% Finer	Wt. Retained (grams)	% Retained	% Finer	Wt. Retained (grams)	% Retained	% Finer	Wt. Retained (grams)	% Retained	% Finer	Wt. Retained (grams)	% Retained	% Finer
3 in.	76.2	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
2 in.	50.8	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
1 1/2 in.	38.1	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
1 in.	25.4	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
3/4 in.	19.1	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
1/2 in.	12.7	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
3/8 in.	9.530	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
No. 4	4.750	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
No. 10	2.000	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
No. 30	0.600	1.2	1.2%	98.8%	2.0	2.0%	98.0%	1.7	1.7%	98.3%	2.4	2.4%	97.6%	1.9	1.9%	98.1%
No. 40	0.425	4.6	4.6%	95.4%	7.3	7.3%	92.7%	6.0	6.0%	94.0%	8.1	8.1%	91.9%	6.9	6.9%	93.1%
No. 70	0.212	20.8	20.8%	79.2%	24.5	24.5%	75.5%	22.6	22.6%	77.4%	26.2	26.2%	73.8%	27.9	27.9%	72.1%
No. 100	0.150	34.8	34.8%	65.2%	38.1	38.1%	61.9%	35.5	35.5%	64.5%	41.0	41.0%	59.0%	43.9	43.9%	56.1%
No. 200	0.075	53.4	53.4%	46.6%	55.7	55.7%	44.3%	52.5	52.5%	47.5%	56.6	56.6%	43.4%	57.4	57.4%	42.6%
No. 325	0.045	60.5	60.5%	39.5%	62.7	62.7%	37.3%	58.8	58.8%	41.2%	62.5	62.5%	37.5%	61.9	61.9%	38.1%
Pan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

		Grinding Test 6A			Grinding Test 6B			Grinding Test 4A			Grinding Test 4B		
Sieve No.	Diameter (mm)	Wt. Retained (grams)	% Retained	% Finer	Wt. Retained (grams)	% Retained	% Finer	Wt. Retained (grams)	% Retained	% Finer	Wt. Retained (grams)	% Retained	% Finer
3 in.	76.2	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
2 in.	50.8	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
1 1/2 in.	38.1	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
1 in.	25.4	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
3/4 in.	19.1	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
1/2 in.	12.7	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
3/8 in.	9.530	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
No. 4	4.750	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
No. 10	2.000	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
No. 30	0.600	1.3	1.3%	98.7%	1.0	1.0%	99.0%	2.7	2.7%	97.3%	2.7	2.7%	97.3%
No. 40	0.425	5.2	5.2%	94.8%	4.7	4.7%	95.3%	7.6	7.6%	92.4%	7.3	7.3%	92.7%
No. 70	0.212	21.7	21.7%	78.3%	21.4	21.4%	78.6%	26.2	26.2%	73.8%	25.9	25.9%	74.1%
No. 100	0.150	34.1	34.1%	65.9%	35.9	35.9%	64.1%	38.7	38.7%	61.3%	39.2	39.2%	60.8%
No. 200	0.075	54.4	54.4%	45.6%	54.4	54.4%	45.6%	57.3	57.3%	42.7%	58.3	58.3%	41.7%
No. 325	0.045	59.7	59.7%	40.3%	61.1	61.1%	38.9%	65.4	65.4%	34.6%	64.6	64.6%	35.4%
Pan	-	-	-	-	-	-	-	-	-	-	-	-	-



Average

Med Sand	6.4%
Fine Sand	49.1%
Silt	44.4%

%FINER = 100 - Σ%RETAINED

5/12/2007

Table 2
Tailings Parameters

Soil	Permeability[1] (cm/sec)	Drainable Porosity[2] (vol./vol.)
med sand	2.00E-02	0.35
fine sand	1.00E-02	0.29
silt	1.00E-04	0.14
silty clay	6.00E-07	0.11
average	7.53E-03	0.22
geomean	3.31E-04	0.20

Soil	Permeability[3] (cm/sec)	Drainable Porosity[3] (vol./vol.)
SM (LS)	1.70E-03	0.332
SM (LFS)	1.00E-03	0.326
SM (SL)	7.20E-04	0.263
SM (FSL)	5.20E-04	0.251
ML (L)	3.70E-04	0.231
ML (SiL)	1.90E-04	0.217
SC (SCL)	1.20E-04	0.154
average	6.60E-04	0.253
geomean	4.74E-04	0.246

Notes:

(1) Source - "Seepage, Drainage, and Flow Nets", Cedergren, H. R., 1989.

(2) Source - The Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 3, EPA, 1994 - Figure 2 - Soil texture vs. Moisture Retention.

(3) Source - The Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 3, EPA, 1994 - Table 1 - Low Density Soil Characteristics.

TABLE 3
White Mesa Mill
Cell 4A Slimes Drain
Maximum Liquid Depth

Permeability (cm/sec)	Permeability (ft/min)	Drainage Path Length (ft.)	Thickness (VF)	Q (cfm/ft)	Volume of Liquid (CF/ft)	Time to Dewater (min/VF/ft)	Time to Dewater (days/VF/ft)	Total Flow Rate (gpm)	Volume Removed (gal)	Pipe Limitation (days)
3.31E-04	6.51E-04	46.3	39	6.40E-04	11	17,185	11.93	131.92	2,266,966	2.17
3.31E-04	6.51E-04	45.8	38	6.31E-04	11	17,446	12.12	129.94	2,266,966	1.98
3.31E-04	6.51E-04	45.4	37	6.19E-04	11	17,761	12.33	127.63	2,266,966	1.77
3.31E-04	6.51E-04	45.0	36	6.08E-04	11	18,094	12.57	125.29	2,266,966	1.53
3.31E-04	6.51E-04	44.6	35	5.96E-04	11	18,446	12.81	122.90	2,266,966	1.29
3.31E-04	6.51E-04	44.2	34	5.85E-04	11	18,818	13.07	120.47	2,266,966	1.03
3.31E-04	6.51E-04	43.8	33	5.73E-04	11	19,213	13.34	117.99	2,266,966	0.76
3.31E-04	6.51E-04	43.5	32	5.59E-04	11	19,677	13.66	115.21	2,266,966	0.44
3.31E-04	6.51E-04	43.2	31	5.45E-04	11	20,172	14.01	112.38	2,266,966	0.09
3.31E-04	6.51E-04	43.0	30	5.30E-04	11	20,748	14.41	109.26	2,266,966	
3.31E-04	6.51E-04	42.8	29	5.15E-04	11	21,363	14.84	106.11	2,266,966	
3.31E-04	6.51E-04	42.6	28	4.99E-04	11	22,023	15.29	102.94	2,266,966	
3.31E-04	6.51E-04	42.4	27	4.84E-04	11	22,731	15.79	99.73	2,266,966	
3.31E-04	6.51E-04	42.3	26	4.67E-04	11	23,550	16.35	96.26	2,266,966	
3.31E-04	6.51E-04	42.2	25	4.50E-04	11	24,434	16.97	92.78	2,266,966	
3.31E-04	6.51E-04	42.1	24	4.33E-04	11	25,392	17.63	89.28	2,266,966	
3.31E-04	6.51E-04	42.1	23	4.15E-04	11	26,496	18.40	85.56	2,266,966	
3.31E-04	6.51E-04	42.1	22	3.97E-04	11	27,700	19.24	81.84	2,266,966	
3.31E-04	6.51E-04	42.1	21	3.79E-04	11	29,019	20.15	78.12	2,266,966	
3.31E-04	6.51E-04	42.2	20	3.60E-04	11	30,543	21.21	74.22	2,266,966	
3.31E-04	6.51E-04	42.3	19	3.41E-04	11	32,226	22.38	70.34	2,266,966	
3.31E-04	6.51E-04	42.5	18	3.22E-04	11	34,178	23.73	66.33	2,266,966	
3.31E-04	6.51E-04	42.6	17	3.03E-04	11	36,273	25.19	62.50	2,266,966	
3.31E-04	6.51E-04	42.8	16	2.84E-04	11	38,721	26.89	58.55	2,266,966	
3.31E-04	6.51E-04	43.1	15	2.64E-04	11	41,592	28.88	54.50	2,266,966	
3.31E-04	6.51E-04	43.3	14	2.46E-04	11	44,770	31.09	50.64	2,266,966	
3.31E-04	6.51E-04	43.6	13	2.27E-04	11	48,548	33.71	46.70	2,266,966	
3.31E-04	6.51E-04	44.0	12	2.07E-04	11	53,076	36.86	42.71	2,266,966	
3.31E-04	6.51E-04	44.3	11	1.89E-04	11	58,296	40.48	38.89	2,266,966	
3.31E-04	6.51E-04	44.7	10	1.70E-04	11	64,704	44.93	35.04	2,266,966	
3.31E-04	6.51E-04	45.1	9	1.52E-04	11	72,537	50.37	31.25	2,266,966	
3.31E-04	6.51E-04	45.6	8	1.33E-04	11	82,509	57.30	27.48	2,266,966	
3.31E-04	6.51E-04	46.0	7	1.16E-04	11	95,123	66.06	23.83	2,266,966	
3.31E-04	6.51E-04	46.5	6	9.81E-05	11	112,183	77.90	20.21	2,266,966	
3.31E-04	6.51E-04	47.1	5	8.07E-05	11	136,357	94.69	16.63	2,266,966	
3.31E-04	6.51E-04	47.6	4	6.39E-05	11	172,255	119.62	13.16	2,266,966	
3.31E-04	6.51E-04	48.2	3	4.73E-05	11	232,569	161.51	9.75	2,266,966	
3.31E-04	6.51E-04	48.8	2	3.11E-05	11	353,196	245.27	6.42	2,266,966	
3.31E-04	6.51E-04	49.4	1	1.54E-05	11	715,076	496.58	3.17	2,266,966	
						days	**1,989.58**		**88,411,655**	**11.06**
						years	**5.45**			

Average Soil Porosity	0.22	
Geomean Soil Permeability	3.31E-04	cm/sec
Distance Between Drains	50	ft
Thickness of Unit	1	ft
Maximum Depth	39	ft
Length of Strip Drain	27,550	ft

TABLE 4
White Mesa Mill
Cell 4A Slimes Drain
Average Liquid Depth

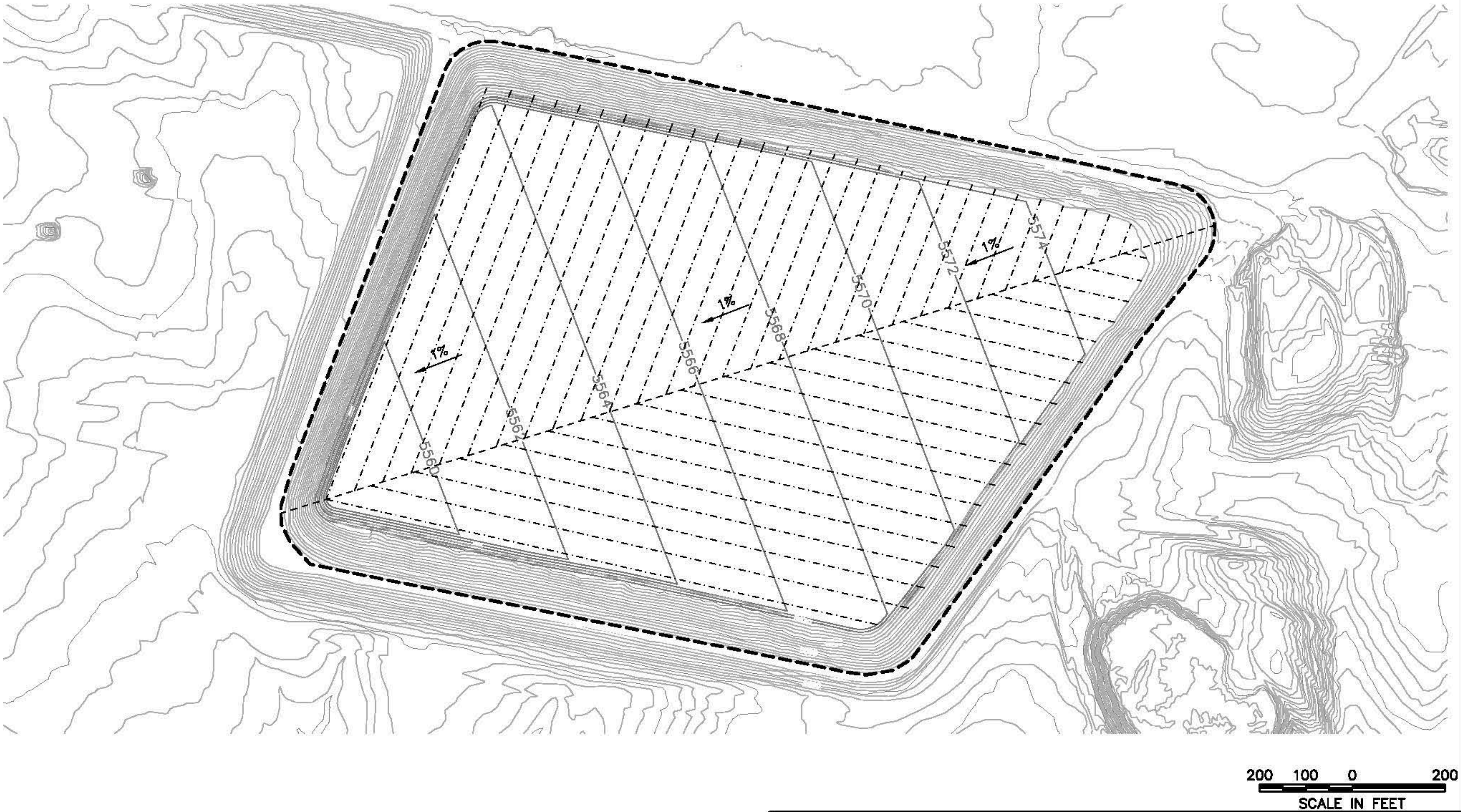
Permeability (cm/sec)	Permeability (ft/min)	Drainage Path Length (ft.)	Thickness (VF)	Q (cfm/ft)	Volume of Liquid (CF/ft)	Time to Dewater (min/VF/ft)	Time to Dewater (days/VF/ft)	Total Flow Rate (gpm)	Volume Removed (gal)
3.31E-04	6.51E-04	39.8	31	5.92E-04	11	18,584	12.91	121.98	2,266,966
3.31E-04	6.51E-04	39.6	30	5.76E-04	11	19,107	13.27	118.64	2,266,966
3.31E-04	6.51E-04	39.4	29	5.59E-04	11	19,666	13.66	115.27	2,266,966
3.31E-04	6.51E-04	39.2	28	5.43E-04	11	20,265	14.07	111.86	2,266,966
3.31E-04	6.51E-04	39.1	27	5.25E-04	11	20,962	14.56	108.14	2,266,966
3.31E-04	6.51E-04	39.0	26	5.07E-04	11	21,713	15.08	104.41	2,266,966
3.31E-04	6.51E-04	38.9	25	4.88E-04	11	22,523	15.64	100.65	2,266,966
3.31E-04	6.51E-04	38.9	24	4.69E-04	11	23,462	16.29	96.62	2,266,966
3.31E-04	6.51E-04	39.0	23	4.48E-04	11	24,545	17.05	92.36	2,266,966
3.31E-04	6.51E-04	39.0	22	4.29E-04	11	25,661	17.82	88.34	2,266,966
3.31E-04	6.51E-04	39.2	21	4.07E-04	11	27,020	18.76	83.90	2,266,966
3.31E-04	6.51E-04	39.3	20	3.87E-04	11	28,444	19.75	79.70	2,266,966
3.31E-04	6.51E-04	39.5	19	3.66E-04	11	30,093	20.90	75.33	2,266,966
3.31E-04	6.51E-04	39.8	18	3.44E-04	11	32,006	22.23	70.83	2,266,966
3.31E-04	6.51E-04	40.1	17	3.22E-04	11	34,145	23.71	66.39	2,266,966
3.31E-04	6.51E-04	40.4	16	3.01E-04	11	36,550	25.38	62.02	2,266,966
3.31E-04	6.51E-04	40.8	15	2.79E-04	11	39,373	27.34	57.58	2,266,966
3.31E-04	6.51E-04	41.2	14	2.58E-04	11	42,599	29.58	53.22	2,266,966
3.31E-04	6.51E-04	41.6	13	2.37E-04	11	46,321	32.17	48.94	2,266,966
3.31E-04	6.51E-04	42.1	12	2.17E-04	11	50,784	35.27	44.64	2,266,966
3.31E-04	6.51E-04	42.6	11	1.96E-04	11	56,059	38.93	40.44	2,266,966
3.31E-04	6.51E-04	43.1	10	1.76E-04	11	62,388	43.33	36.34	2,266,966
3.31E-04	6.51E-04	43.7	9	1.57E-04	11	70,285	48.81	32.25	2,266,966
3.31E-04	6.51E-04	44.3	8	1.37E-04	11	80,157	55.66	28.28	2,266,966
3.31E-04	6.51E-04	44.9	7	1.18E-04	11	92,848	64.48	24.42	2,266,966
3.31E-04	6.51E-04	45.6	6	1.00E-04	11	110,012	76.40	20.61	2,266,966
3.31E-04	6.51E-04	46.2	5	8.22E-05	11	133,751	92.88	16.95	2,266,966
3.31E-04	6.51E-04	46.9	4	6.48E-05	11	169,722	117.86	13.36	2,266,966
3.31E-04	6.51E-04	47.7	3	4.78E-05	11	230,156	159.83	9.85	2,266,966
3.31E-04	6.51E-04	48.4	2	3.14E-05	11	350,301	243.26	6.47	2,266,966
3.31E-04	6.51E-04	49.2	1	1.54E-05	11	712,181	494.57	3.18	2,266,966
						days	**1,841.45**		**70,275,931**
						years	**5.05**		

Average Soil Porosity	0.22	
Geomean Soil Permeability	3.31E-04	cm/sec
Distance Between Drains	50	ft
Thickness of Unit	1	ft
Maximum Depth	31	ft
Length of Strip Drain	27,550	ft

TABLE 5
White Mesa Mill
Cell 4A Slimes Drain
Minimum Liquid Depth

Permeability (cm/sec)	Permeability (ft/min)	Drainage Path Length (ft.)	Thickness (VF)	Q (cfm/ft)	Volume of Liquid (CF/ft)	Time to Dewater (min/VF/ft)	Time to Dewater (days/VF/ft)	Total Flow Rate (gpm)	Volume Removed (gal)
3.31E-04	6.51E-04	34.0	23	5.14E-04	11	21,398	14.86	105.94	2,266,966
3.31E-04	6.51E-04	34.1	22	4.90E-04	11	22,437	15.58	101.04	2,266,966
3.31E-04	6.51E-04	34.3	21	4.65E-04	11	23,643	16.42	95.88	2,266,966
3.31E-04	6.51E-04	34.6	20	4.39E-04	11	25,042	17.39	90.53	2,266,966
3.31E-04	6.51E-04	35.0	19	4.13E-04	11	26,665	18.52	85.02	2,266,966
3.31E-04	6.51E-04	35.4	18	3.86E-04	11	28,468	19.77	79.63	2,266,966
3.31E-04	6.51E-04	35.8	17	3.61E-04	11	30,483	21.17	74.37	2,266,966
3.31E-04	6.51E-04	36.3	16	3.35E-04	11	32,841	22.81	69.03	2,266,966
3.31E-04	6.51E-04	36.9	15	3.09E-04	11	35,609	24.73	63.66	2,266,966
3.31E-04	6.51E-04	37.5	14	2.84E-04	11	38,773	26.93	58.47	2,266,966
3.31E-04	6.51E-04	38.2	13	2.59E-04	11	42,535	29.54	53.30	2,266,966
3.31E-04	6.51E-04	38.9	12	2.34E-04	11	46,924	32.59	48.31	2,266,966
3.31E-04	6.51E-04	39.6	11	2.11E-04	11	52,111	36.19	43.50	2,266,966
3.31E-04	6.51E-04	40.4	10	1.88E-04	11	58,480	40.61	38.76	2,266,966
3.31E-04	6.51E-04	41.2	9	1.66E-04	11	66,264	46.02	34.21	2,266,966
3.31E-04	6.51E-04	42.1	8	1.44E-04	11	76,176	52.90	29.76	2,266,966
3.31E-04	6.51E-04	43.0	7	1.24E-04	11	88,919	61.75	25.49	2,266,966
3.31E-04	6.51E-04	43.9	6	1.04E-04	11	105,910	73.55	21.40	2,266,966
3.31E-04	6.51E-04	44.8	5	8.48E-05	11	129,698	90.07	17.48	2,266,966
3.31E-04	6.51E-04	45.8	4	6.64E-05	11	165,741	115.10	13.68	2,266,966
3.31E-04	6.51E-04	46.8	3	4.87E-05	11	225,814	156.81	10.04	2,266,966
3.31E-04	6.51E-04	47.9	2	3.17E-05	11	346,682	240.75	6.54	2,266,966
3.31E-04	6.51E-04	48.9	1	1.55E-05	11	707,839	491.55	3.20	2,266,966
						days	**1,665.59**		**52,140,207**
						years	**4.56**		

Average Soil Porosity	0.22	
Geomean Soil Permeability	3.31E-04	cm/sec
Distance Between Drains	50	ft
Thickness of Unit	1	ft
Maximum Depth	23	ft
Length of Strip Drain	27,550	ft



GEOSYNTEC CONSULTANTS

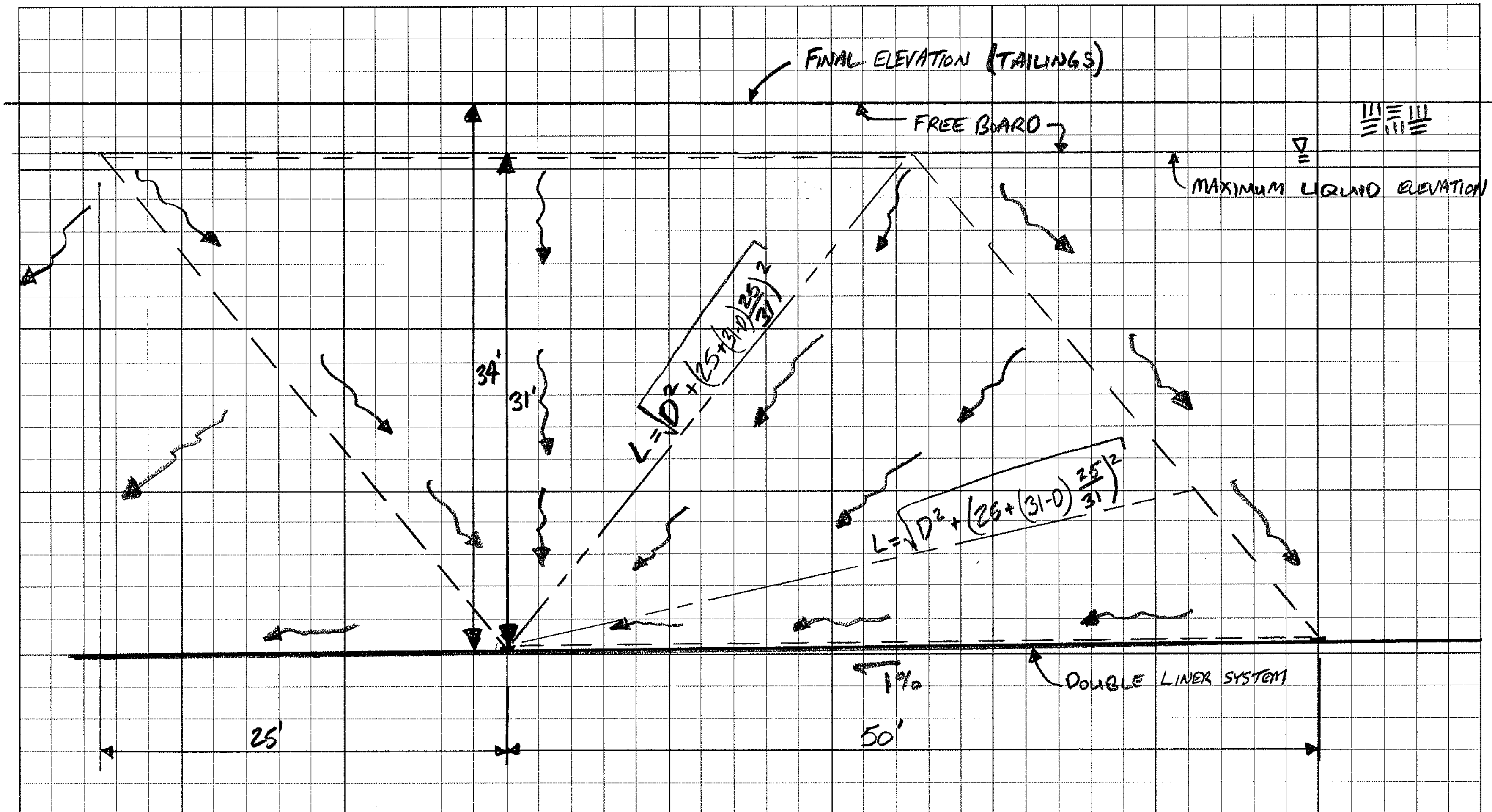
SLIMES DRAIN LAYOUT CELL 4A BLANDING, UTAH	FIGURE NO.	1
	PROJECT NO.	SC0349
	DATE:	MARCH 2007

P:\PRJ\SDCadd\CADD\SC0349\FIGURES\SC0349-01-04\SC0349_Figure 1_Slimes Drain Layout.dwg 7/10/2006 5:25 PM John Hall

Geosyntec consultants

Written by: G. Corcoran Date: 10 / 5 / 07 (DD MM YY) Reviewed by: ______ Date: __/__/__ (DD MM YY)

Client: Dawson Mines Project: Cell 4A. Project/Proposal No. SC0349 Task No. 01/04



AVERAGE DEPTH - FLOW GEOMETRY

EXAMPLES

① D = 31' $L = \sqrt{31^2 + \left(25 + (31-31)\left(\frac{25}{31}\right)\right)^2} = 39.8'$

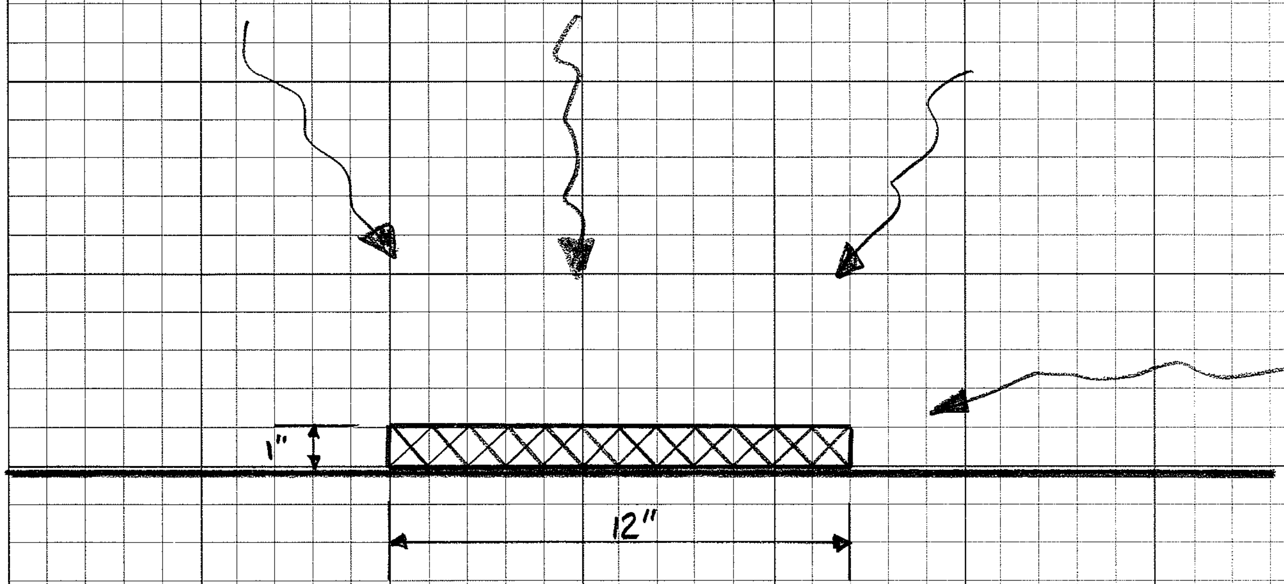
② D = 10' $L = \sqrt{10^2 + \left(25 + (31-10)\left(\frac{25}{31}\right)\right)^2} = 43.1'$

FIGURE 2

Geosyntec consultants

Written by: G. CORCORAN Date: 10 / 5 / 07 (DD MM YY) Reviewed by: ____ Date: __/__/__ (DD MM YY)

Client: DENISON MINES Project: CELL 4A Project/Proposal No. SC0349 Task No. 01/04



FLOW AREA - STRIP COMPOSITE

$$A = \frac{14''}{12''/ft} = 1.17\ ft^2/ft.$$

FIGURE 3

EXHIBIT 1

SAMPLE DESCRIPTION AND PREPARATION

CSMRI Sample 1

Sponsor's Designation of Sample: Run-of-mine.

Date Received at Institute: June 5, 1978.

Sample Weight: 100,520 lb.

Sample Container: Two truckloads.

Sample Description: Mine ore -- estimate 5% +10-in. material. Largest boulder -- 48 in. x 24 in. x 14 in. Only two or three rocks were greater than 36 in.

Method of Preparation: All +10-in. material broken to -10 in. by sledgehammer and jackhammer. The sample was screened at 6 in. and 1-1/2 in. with the +6 in. fraction, put in barrels, and the -1/2 in. fraction piled. The -6 in. +1-1/2 in. material was screened at 4 in. and 1-1/2 in. with the -6 in. +4 in. and -4 in. +1-1/2 in. fractions barreled. The additional -1-1/2 in. fraction was piled with the previous -1-1/2 in. fraction. A screen size analysis of the entire quantity of mill feed material is presented in Exhibit 3. A summary screen size analysis of the ore is as follows:

Screen Product in.		Weight %
Head (calculated)		100.00
-10	+6	2.92
-6	+4	9.48
-4	+1-1/2	15.30
-1-1/2		72.30

EXHIBIT 1

CSMRI Sample 2

Sponsor's Designation of Sample:	Crushed ore.
Date Received at Institute:	June 5, 1978.
Sample Weight:	47,380 lb.
Sample Container:	One truckload.
Sample Description:	Ore previously crushed to -3 in., maximum particles approximately 2-1/2 in.
Method of Preparation:	The ore was used as received.

EXHIBIT 2

GRINDING TESTS

Grinding Test 1, Autogenous

Date:	June 13, 1978
Feed Rate, stph:	2
Ore:	Run-of-mine
DSM Screen, in. width:	12
DSM Screen Opening, mm:	1.27
Measured Mill Power Tare (empty mill), kw:	2.06
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Meter Reading watt-hr	Mill-Bearing Oil Temp. °F	Ore Feed Rate (as received)(1) -1-1/2 in. lb/hr	-4 in. +1-1/2 in. lb/hr	-6 in. +4 in. lb/hr	-10 in. +6 in. lb/hr	Mill Discharge Solids %	Mill Discharge Solids lb/hr	Sweco Screen Oversize Solids %	Sweco Screen Oversize Solids lb/hr	DSM Screen Overflow Solids %	DSM Screen Overflow Solids lb/hr	DSM Screen Underflow Solids %	DSM Screen Underflow Solids lb/hr	Mill Water Meter %	Mill Water Rate lb/hr	Mill Load Volume %	Remarks
0910	0	--	--	104	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Start mill.
0915	5	12.2	12,964	--	3,150	612	380	116	63	8,335	--	--	--	--	--	--(2)	90	2,858	--	--
1005	55	8.7	--	--	2,880	612	380	116	62	--	90	506	60	3,348	57	2,616(2)	90	2,858	--	--
1030	80	6.8	--	105	2,835	612	380	116	69	--	90	304	70	3,591	58	710(2)	90	2,858	--	--
1100	110	6.5	12,977	106	2,993	612	380	116	66	--	--	--	69	4,223	58	679(2)	80	2,540	--	--
1135	145	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Mill down, elevator plugged.
1142	145	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Start mill.
1150	153	6.2	--	109	2,993	612	380	116	69	12,420	90	1,114	70	5,544	56	2,583	--	--	--	--
1230	193	6.0	12,988	111	2,903	612	380	116	64	10,829	90	405	69	6,955	60	4,388	75	2,382	--	--
1300	223	6.2	--	112	3,319	612	380	116	65	11,232	90	365	70	6,048	60	3,861	81	2,572	--	--
1345	238	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Pump plugged. DSM feed.
1400	253	6.4	--	112	3,128	612	380	116	65	11,700	90	122	69	3,229	60	3,996	80	2,540	--	Sample
1415	268	6.3	13,004	112	2,970	612	380	116	65	9,945	90	547	71	3,515	59	2,907	79	2,509	15	Sample.
Average					3,019	612	380	116	65	10,744	90	480	69	4,557	59	3,547	83	2,640		

(1) Moisture: -1-1/2 in., 2.8%; -4 in. +1-1/2 in., 1.0%; -6 in. +4 in., 0.8%; -10 in. +6 in., 0.7%. Average dry ore feed rate: -1-1/2 in., 2,934.5 lb/hr; -4 in. +1-1/2 in., 605.9 lb/hr; -6 in. +4 in., 376.8 lb/hr; -10 in. +6 in., 115.0 lb/hr; total, 4,032.2 lb/hr, 2.016 dry stph. Mill volume end of test: 15%.

(2) Excluded from average.

Feed Rate, stph dry:	2.016
Ball Charge:	None
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Instantaneous Gross Power (meter reading) kwhr	Instantaneous Corrected Power (from input-output curve) kwhr	Power Consumption Gross kwhr/st	Power Consumption Net kwhr/st	Circulating Load Weight % of Feed(1)	Mill Discharge Solids %	Remarks
0910	0	--	--	--	--	--	--	--	--
0915	5	12.2	4.25	2.64	1.31	1.01	--	63	--
1005	55	8.7	5.96	4.25	2.11	1.81	--	62	--
1030	80	6.8	7.62	5.80	2.88	2.58	--	69	--
1100	110	6.5	7.97	6.10	3.03	2.73	--	66	--
1135	145	--	--	--	--	--	--	--	Unplug bucket elevator.
1150	153	6.2	8.36	6.47	3.21	2.91(2)	162.0	69	--
1230	193	6.0	8.64	6.73	3.34	3.04(2)	183.0	64	--
1300	223	6.2	8.36	6.47	3.21	2.91(2)	145.0	65	--
1345	238	--	--	--	--	--	--	--	Unplug DSM feed pump.
1400(3)	253	6.4	8.10	6.23	2.09	2.79(2)	79.0	65	--
1415(3)	268	6.3	8.23	6.35	3.15	2.85(2)	100.0	65	--
Average						2.90	133.8		

(1) Calculated: Sum of Sweco oversize and DSM oversize as percentage of dry mill feed.

(2) Average for power (last five readings): 2.90 kwhr/st.

(3) Sample run.

EXHIBIT 2

Grinding Test 1 -- continued

Procedure: Sample was wet screened on a 325M screen, products dried, and the +325M material dry screened using a Ro-Tap for 30 min.

Test Product	Screen Size Analysis DSM Screen Undersize
Sample Time:	1415
Sample Weight, g:	4,630.5
Screen Product (Tyler) Mesh	**Weight %**
Head (calculated)	100.0
+28	1.2
-28 +35	3.4
-35 +65	16.2
-65 +100	14.0
-100 +200	18.6
-200 +325	7.1
-325	39.5

US SIEVE

GTC 5/10/07

No. 30
No. 40
No. 70
No. 100
No. 200
No. 325

EXHIBIT 2

Grinding Test 2

Date:	June 14, 1978
Feed Rate, stph:	2.0
Ore:	Run-of-mine
Ball Charge:	Total: 301.8 lb; 2% mill volume
-1-1/2 in. +1 in. Balls, lb:	114.5
-2 in. +1-1/2 in. Balls, lb:	151.3
3 in. Balls, lb:	36.0
DSM Screen, in. width:	12
DSM Screen Openings, mm:	1.27
Measured Mill Power Tare (empty mill), kw:	2.06
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Meter Reading watt-hr	Mill-Bearing Oil Temp. °F	Ore Feed Rate (as received)(1) -1-1/2 in. lb/hr	-4 in. +1-1/2 in. lb/hr	-6 in. +4 in. lb/hr	-10 in. +6 in. lb/hr	Mill Discharge Solids %	Mill Discharge Solids lb/hr	Sweco Screen Oversize Solids %	Sweco Screen Oversize Solids lb/hr	DSM Screen Overflow Solids %	DSM Screen Overflow Solids lb/hr	DSM Screen Underflow Solids %	DSM Screen Underflow Solids lb/hr	Mill Water Meter %	Mill Water Rate lb/hr	Mill Load Volume %	Remarks
1040	0	8.7	13,004	102	--	612	380	116	--	--	--	--	--	--	--	--	95	3,017	-	Start mill.
1110	30	5.2	--	104	--	612	380	116	--	--	--	--	--	--	--	--	83	2,636	-	--
1130	50	5.3	--	106	3,060	612	380	116	62	8,147	50	248	74	1,565	54	2,989(2)	84	2,668	-	--
1200	80	5.0	--	108	2,846	612	380	116	63	6,577	67	653	71	1,150	--	--	82	2,604	-	--
1230	110	4.8	13,023	111	3,105	612	380	116	64	8,467	64	605	73	1,281	--	--	82	2,604	-	--
1300	140	4.8	--	112	3,139	612	380	116	63	6,917	62	391	73	2,102	57	3,694	81	2,572	-	--
1330	170	4.8	--	113	3,263	612	380	116	66	8,494	63	595	69	3,571	56	3,881	81	2,572	-	--
1400	200	4.9	--	113	2,981	612	380	116	66	9,029	64	624	71	2,939	58	3,680	81	2,572	-	--
1415	215	5.0	--	113	2,869	612	380	116	66	10,098	64	547	70	3,119	58	3,811	79	2,509	-	Sample.
1430	230	5.0	13,044	113	2,993	612	380	116	65	8,483	64	557	71	3,259	57	3,565	79	2,509	9	Sample. End of test.
Average					3,032	612	380	116	65	8,277	62	528	72	2,373	57	3,726	83	2,626		

(1) Moisture: -1-1/2 in., 2.8%; -4 in. +1-1/2 in., 1.0%; -6 in. +4 in., 0.8%; -10 in. +6 in., 0.7%. Average dry ore feed rate: -1-1/2 in., 2,947.0 lb/hr; -4 in. +1-1/2 in., 605.9 lb/hr; -6 in. +4 in., 376.8 lb/hr; -10 in. +6 in., 115.0 lb/hr; total: 4,044.7 lb/hr, 2.022 dry stph. Mill volume end of test: 9%.

(2) Excluded from average.

Feed Rate, stph dry:	2.022
Ball Charge:	301.8 lb, 2% mill volume
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Instantaneous Gross Power (meter reading) kwhr	Instantaneous Corrected Power (from input-output curve) kwhr	Power Consumption Gross kwh/st	Power Consumption Net kwh/st	Circulating Load Weight % of Feed(1)	Mill Discharge Solids %
1040	0	8.7	5.96	4.22	2.09	1.79	--	--
1110	30	5.2	9.97	7.93	3.92	3.63	--	--
1130	50	5.3	9.78	7.78	3.85	3.55	--	62
1200	80	5.0	10.36	8.25	4.08	3.78	--	63
1230	110	4.8	10.80	8.63	4.27	3.97	--	64
1300	140	4.8	10.80	8.63	4.27	3.97	59.0(4)	63
1330	170	4.8	10.80	8.63	4.27	3.97	95.0	66
1400	200	4.9	10.58	8.44	4.17	3.88	87.0	66
1415(3)	215	5.0	10.36	8.25	4.08	3.78(2)	92.0	66
1430(3)	230	5.0	10.36	8.25	4.08	3.78(2)	93.0	65
Average						3.78	91.8	

(1) Calculated: Sum of Sweco oversize and DSM oversize as a percentage of dry mill feed.
(2) Average for power (last two readings): 3.78 kwhr/st.
(3) Sample run.
(4) Omitted from average.

EXHIBIT 2

Grinding Test 2 -- continued

Procedure: Samples were wet screened on a 325M screen, products dried, and the +325M material dry screened using a Ro-Tap for 30 min.

Screen Size Analysis

Test Product	Mill Discharge		Sweco Screen Oversize		DSM Screen Oversize		DSM Screen Undersize		Circulating Load
Sample Time	1415	1430	1415	1430	1415	1430	1415	1430	
Sample Weight, g:	1,058.8	1,206.6	669.3	979.0	915.6	1,106.8	888.1	932.3	
Screen Product (Tyler) Mesh	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %
Head (calculated)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
+28	23.8	21.6	65.5	71.8	40.4	37.6	2.0	1.7	43.4
-28 +35	6.8	6.4	2.5	1.6	8.4	9.9	5.3	4.3	8.1
-35 +65	13.5	13.3	4.2	3.6	8.8	12.0	17.2	16.6	9.4
-65 +100	9.4	10.2	3.2	3.0	4.7	7.6	13.6	12.9	5.7
-100 +200	11.9	13.4	5.0	5.0	7.3	10.3	17.6	17.0	8.3
-200 +325	4.2	5.9	3.0	2.1	1.6	4.7	7.0	6.3	3.1
-325	30.4	29.2	16.6	12.9	28.8	17.9	37.3	41.2	22.0

EXHIBIT 2

Grinding Test 3

Date:	June 15, 1978
Feed Rate, stph:	3.0
Ore:	Run-of-mine
Ball Charge:	Total: 301.8 lb, 2% mill volume
-1-1/2 in. +1 in. Balls, lb:	114.5
-2 in. +1-1/2 in. Balls, lb:	151.3
3 in. Balls, lb:	36.0
DSM Screen, in. width:	12
DSM Screen Openings, mm:	1.27
Measured Mill Power Tare (empty mill), kw:	2.06
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Meter Reading watt-hr	Mill-Bearing Oil Temp. °F	Ore Feed Rate (as received)(1) -1-1/2 in. lb/hr	Ore Feed Rate -4 in. +1-1/2 in. lb/hr	Ore Feed Rate -6 in. +4 in. lb/hr	Ore Feed Rate -10 in. +6 in. lb/hr	Mill Discharge Solids %	Mill Discharge Solids lb/hr	Sweco Screen Oversize Solids %	Sweco Screen Oversize Solids lb/hr	DSM Screen Overflow Solids %	DSM Screen Overflow Solids lb/hr	DSM Screen Underflow Solids %	DSM Screen Underflow Solids lb/hr	Mill Water Meter %(2)	Mill Water Rate lb/hr	Mill Load Volume %	Remarks
1050	0	5.0	13,045	93	--	918	570	174	--	--	--	--	--	--	--	--	--	--	--	Start mill.
1135	45	4.5	--	--	--	918	570	174	--	--	--	--	--	--	--	--	--	--	--	--
1200	70	4.4	--	99	4,350	918	570	174	65	13,631	68	857	70	6,237	58	5,090	105	3,350	--	--
1207	77	--	--	--	--	918	570	174	--	--	--	--	--	--	--	--	--	--	--	Shutdown, rock jammed in feeder.
1230	77	--	--	--	--	918	570	174	--	--	--	--	--	--	--	--	--	--	--	Start mill.
1300	107	4.9	--	109	3,435	918	570	174	65	10,530	63	808	73	3,679	55	4,430	106	3,366	--	--
1330	137	4.8	--	108	4,815	918	570	174	66	11,642	64	878	72	5,508	61	5,408	104	3,303	--	--
1400	167	4.9	--	110	4,275	918	570	174	67	11,095	58	639	73	5,059	61	5,545	104	3,303	--	--
1430	197	4.7	--	111	4,590	918	570	174	67	11,156	65	761	72	5,573	61	4,804	103	3,271	--	Sample.
1445	212	4.8	13,085	112	5,040	918	570	174	67	15,135	67	1,010	71	6,646	62	5,692	104	3,303	--	Sample.
1500	242	--	--	--	--	918	570	174	--	--	--	--	--	--	--	--	--	--	25	Shut down.
Average					4,417	918	570	174	66	12,198	64	826	72	5,450	60	5,162	104	3,316		

(1) Moisture: -1-1/2 in., 2.8%; -4 in. +1-1/2 in., 1.0%; -6 in. +4 in., 0.8%, -10 in. +6 in., 0.7%. Average dry ore feed rate: -1-1/2 in., 4,293.8 lb/hr, -4 in. +1-1/2 in., 908.8 lb/hr; -6 in. +4 in., 565.4 lb/hr; -10 in. +6 in., 172.8 lb/hr; total, 5,940.8 lb/hr, 2.970 dry stph. Mill volume end of test: 25%.
(2) Auxilliary water line used -- measured twice, averaged, and added as percentage of regular water meter.

Feed Rate, stph dry:	2.970 stph dry
Ball Charge:	301.8 lb, 2% of mill volume
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Instantaneous Gross Power (meter reading) kwhr	Instantaneous Corrected Power (from input-output curve) kwhr	Power Consumption Gross kwhr/st	Power Consumption Net kwhr/st	Circulating Load Weight % of Feed(1)	Mill Discharge Solids %	Remarks
1050	0	5.0	10.36	8.26	2.78	2.58	--	--	--
1135	45	4.5	11.52	9.24	3.11	2.91	--	--	--
1200	70	4.4	11.78	9.45	3.18	2.98	118.0(4)	65	--
1207	77	--	--	--	--	--	--	--	Rock jammed in feeder.
1230	77	--	--	--	--	--	--	--	--
1300	107	4.9	10.58	8.43	2.84	2.64	88.0	65	--
1330	137	4.8	10.80	8.62	2.90	2.70(2)	99.0	66	--
1400	167	4.9	10.58	8.43	2.84	2.64(2)	96.0	67	--
1430(3)	197	4.7	11.03	8.82	2.97	2.77(2)	101.0	67	--
1445(3)	212	4.8	10.80	8.62	2.90	2.70(2)	114.0	67	--
1500	242								
Average						2.70	99.6		

(1) Calculated: Sum of Sweco oversize and DSM oversize as a percentage of dry mill feed.
(2) Average for power (last four readings): 2.70 kwhr/st.
(3) Sample run.
(4) Omitted from average.

EXHIBIT 2

Grinding Test 3

Procedure: Samples were wet screened on a 325M screen, products dried, and the +325M material dry screened using a Ro-Tap for 30 min.

	Screen Size Analysis								
Test Product	Mill Discharge		Sweco Screen Oversize		DSM Screen Oversize		DSM Screen Undersize		Circulating Load
Sample Time	1430	1445	1430	1445	1430	1445	1430	1445	--
Sample Weight, g:	1,174.9	1,310.3	1,365.7	1,223.1	1,183.4	1,245.5	850.1	962.4	--
Screen Product (Tyler) Mesh	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %
Head (calculated)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
+28	27.8	25.1	65.0	67.5	47.4	33.3	2.4	1.9	43.7
-28 +35	6.5	7.1	1.8	2.0	9.1	7.9	5.7	5.0	7.6
-35 +65	12.8	14.6	3.7	4.0	12.4	13.2	18.1	21.0	11.7
-65 +100	9.2	9.0	3.1	3.4	6.5	8.5	14.8	16.0	7.0
-100 +200	11.4	13.5	5.4	5.5	8.9	9.9	15.6	13.5	8.9
-200 +325	4.8	3.4	3.4	3.3	1.6	3.3	5.9	4.5	2.5
-325	27.5	27.3	17.6	14.3	14.1	23.9	37.5	38.1	18.6

EXHIBIT 2

Grinding Test 4

Date:	June 16, 1978
Feed Rate, stph:	2.5
Ore:	Crushed
Ball Charge:	Total: 301.8 lb, 2% mill volume
-1-1/2 in. +1 in. Balls, lb:	114.5
-2 in. +1-1/2 in. Balls, lb:	151.3
3 in. Balls, lb:	36.0
DSM Screen, in. width:	12
DSM Screen Openings, mm:	1.27
Measured Mill Power Tare (empty mill), kw:	2.06
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Meter Reading watt-hr	Mill-Bearing Oil Temp. °F	Ore Feed Rate (as received)(1) -3 in. lb/hr	Mill Discharge Solids %	Mill Discharge Solids lb/hr	Sweco Screen Oversize Solids %	Sweco Screen Oversize Solids lb/hr	DSM Screen Overflow Solids %	DSM Screen Overflow Solids lb/hr	DSM Screen Underflow Solids %	DSM Screen Underflow Solids lb/hr	Mill Water Meter %(1)	Mill Water Rate lb/hr	Mill Load Volume %	Remarks
1010	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9	Start mill.
1030	20	6.6	13,094	96	--	--	--	--	--	--	--	--	--	90	2,858	--	--
1100	50	6.3	--	97	5,130	63	7,598	67	362	74	1,931	61	5,243	87	2,763	--	--
1130	80	5.9	--	99	5,350	62	8,091	64	418	72	2,398	60	4,482	82	2,604	--	--
1200	110	5.9	--	99	4,995	65	12,519	66	535	70	3,717	61	3,953	80	2,540	--	--
1215	125	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Feed off (feed belt jammed).
1218	125	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Start mill.
1230	137	6.0	--	100	4,770	62	5,692	62	288	71	2,077	58	3,628	80	2,540	--	--
1300	167	6.0	--	100	5,423	65	6,786	62	326	71	1,885	60	4,428	80	2,540	--	--
1320	187	--	--	--	--	--	--	--	--	--	--	60	4,316(3)	--	--	--	--
1330	197	5.8	--	102	4,826	65	6,728	65	449	69	2,298	59	4,806	79	2,509	--	--
1400	227	5.7	--	104	4,635	64	6,797	62	260	72	1,134	60	4,617	79	2,509	--	Sample.
1415	242	5.7	13,128	104	6,793	63	6,010	64	230	70	819	59	4,328	79	2,509	15	Sample.
1500	257	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Average					5,240	64	7,528	64	359	71	2,032	60	4,422	82	2,597	--	

(1) Moisture: -3 in., 4.3%. Average dry ore feed rate: -3 in., 5,015 lb/hr, 2.508 dry stph. Mill volume end of test: 15%.
(2) Auxilliary water line used -- measured twice, averaged, and added as percentage of regular water meter.
(3) 55-gal drum timed sample.

Feed Rate, stph:	2.508
Ball Charge:	301.8 lb, 2% of mill volume
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Instantaneous Gross Power (meter reading) kwhr	Instantaneous Corrected Power (from input-output curve) kwhr	Power Consumption Gross kwhr/st	Power Consumption Net kwhr/st	Circulating Load Weight % of Feed(1)	Mill Discharge Solids %	Remarks
1010	0	--	--	--	--	--	--	--	--
1030	20	6.6	7.85	6.00	2.39	2.15	--	--	--
1100	50	6.3	8.23	6.35	2.53	2.29	--	63	--
1130	80	5.9	8.78	6.87	2.74	2.50	50.0(4)	62	--
1200	110	5.9	8.78	6.87	2.74	2.50	81.0(4)	65	--
1215	125	--	--	--	--	--	--	--	Feed belt jammed.
1230	137	6.0	8.64	6.73	2.68	2.44	48.0	62	--
1300	167	6.0	8.64	6.73	2.68	2.44	39.0	65	--
1320	187	--	--	--	--	--	--	--	--
1330	197	5.8	8.93	7.00	2.79	2.55(2)	54.0	65	--
1400(3)	227	5.7	9.09	7.13	2.84	2.60(2)	29.0	64	--
1415(3)	242	5.7	9.09	7.13	2.84	2.60(2)	14.0	63	--
Average						2.58	36.8		

(1) Calculated: Sum of Sweco oversize and DSM oversize as a percentage of dry mill feed.
(2) Average for power (last three readings): 2.58 kwhr/st.
(3) Sample run.
(4) Omitted from average.

EXHIBIT 2

Grinding Test 4 -- continued

Procedure: Samples were wet screened on a 325M screen, products dried, and the +325M material dry screened using a Ro-Tap for 30 min.

	Screen Size Analysis								
Test Product	Mill Discharge		Sweco Screen Oversize		DSM Screen Oversize		DSM Screen Undersize		Circulating Load
Sample Time	1140	1415	1400	1415	1400	1415	1400	1415	--
Sample Weight, g:	1,139.4	886.7	715.4	726.2	1,152.9	1,020.0	763.8	769.4	--
Screen Product (Tyler) Mesh	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %
Head (calculated)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
+28	15.3	13.1	86.5	91.8	39.1	43.1	2.7	2.7	55.5
-28 +35	5.8	5.2	0.3	0.3	8.9	7.6	4.9	4.6	5.9
-35 +65	17.8	17.9	0.9	0.5	14.9	12.7	18.6	18.6	9.9
-65 +100	11.1	11.8	0.7	0.3	6.8	6.3	12.5	13.3	4.7
-100 +200	15.8	16.7	1.6	0.7	8.8	8.9	18.6	19.1	6.6
-200 +325	7.7	6.4	0.9	0.4	3.3	4.1	8.1	6.3	2.8
-325	26.5	28.9	9.1	6.0	18.2	17.3	34.6	35.4	14.6

EXHIBIT 2

Grinding Test 5

Date:	June 19, 1978
Feed Rate, stph:	2.0
Ore:	Crushed
Ball Charge:	Total 301.8 lb, 2% mill volume
-1-1/2 in. Balls, lb:	114.5
-2 in. +1-1/2 in. Balls, lb:	151.3
3 in. Balls, lb:	36.0
DSM Screen, in. width:	12
DSM Screen Openings, mm:	1.27
Measured Mill Power Tare (empty mill), kw:	2.06
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Meter Reading watt-hr	Mill-Bearing Oil Temp. °F	Ore Feed Rate (as received)(1) -3 in. lb/hr	Mill Discharge Solids %	Mill Discharge Solids lb/hr	Sweco Screen Oversize Solids %	Sweco Screen Oversize Solids lb/hr	DSM Screen Overflow Solids %	DSM Screen Overflow Solids lb/hr	DSM Screen Underflow Solids %	DSM Screen Underflow Solids lb/hr	Mill Water Meter %	Mill Water Rate lb/hr	Mill Load Volume %	Remarks
0840	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7	Start mill.
0910	30	6.7	13,136	90	3,623	--	--	--	--	--	--	--	--	75	2,382	--	--
0930	50	6.3	--	91	3,960	67	8,744	48	356	67	3,558	60	2,970	71	2,255	--	--
1000	80	6.2	--	92	3,803	66	6,663	45	324	70	2,079	60	4,077	68	2,159	--	--
1030	110	6.5	--	91	--	56	3,578	15	68	70	347	59	3,452	66	2,096	--	Shut down -- out of feed.
1035	115	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1040	115	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Start mill.
1100	135	6.5	--	94	4,230	66	4,990	38	182	75	346	62	4,241	68	2,159	--	--
1130	165	6.6	--	96	4,298	66	5,049	42	239	72	729	62	4,101	69	2,191	--	--
1155	190	--	--	--	--	--	--	--	--	--	--	--	--	--	--	13	--
1200	195	6.7	--	97	4,320	63	3,856	37	200	75	405	61	3,870	69	2,191	--	--
1230	225	6.7	--	100	3,533	62	3,894	27	101	73	394	58	3,445	64	2,032	--	--
1300	255	6.6	--	103	4,016	66	4,693	29	111	70	851	61	3,870	68	2,159	--	--
1330	285	6.3	--	104	4,005	68	9,058	34	173	68	3,672	64	3,744	61	1,937	--	--
1345	300	6.5	--	104	3,645	63	4,139	32	134	71	250	59	3,452	68	2,159	--	Sample.
1400	315	6.1	--	104	4,005	64	4,781	34	143	72	238	57	3,104	69	2,191	--	Sample.
1430	345	6.1	--	105	4,140	63	4,820	33	193	69	598	59	3,505	69	2,191	--	--
1445	360	6.0	--	106	3,713	62	4,018	38	182	71	423	56	2,696	69	2,191	--	Sample.
1500	375	5.7	13,184	107	4,028	63	4,139	36	151	70	1,323	56	2,696	69	2,191	--	Sample.
1510	380	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15	Shut down.
1513	388	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Collecting mill discharge sample.
1522	397	--	--	--	3,690	--	--	--	--	--	--	--	--	--	--	--	Second barrel.
1529	404	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Third barrel.
1536	411	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Hopper went empty.
1537	412	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15	Shut down mill.
Average	--	--	--	--	3,934	64	5,173	35	183	71	1,087	59	3,516	68	2,165	--	--

(1) Moisture: -3 in., 2.0%. Average dry ore feed rate: -3 in., 3,855 lb/hr, 1.928 dry stph. Mill volume end of test: 15%.

EXHIBIT 2

Grinding Test 5 -- continued

Feed Rate, stph (dry): 1.928
Ball Charge: 301.8 lb, 2% of mill charge
Corrected Mill Power Tare (empty mill), kw: 0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Instantaneous Gross Power (meter reading) kwhr	Instantaneous Corrected Power (from input-output curve) kwhr	Power Consumption Gross kwhr/st	Power Consumption Net kwhr/st	Circulating Load Weight % of Feed(1)	Mill Discharge Solids %	Remarks
0840	0	--	--	--	--	--	--	--	--
0910	30	6.7	7.73	5.89	3.05	2.74	--	--	--
0930	50	6.3	8.23	6.35	3.29	2.98	--	67	--
1000	80	6.2	8.36	6.47	3.36	3.04	--	66	--
1030	110	6.5	7.97	6.10	3.16	2.85	--	56	--
1035	115	--	--	--	--	--	--	--	Ran out of ore.
1100	135	6.5	7.97	6.10	3.16	2.85	12.0(4)	66	--
1130	165	6.6	7.85	6.00	3.11	2.80	23.0(4)	66	--
1155	190	--	--	--	--	--	--	--	Check mill volume.
1200	195	6.7	7.73	5.89	3.05	2.74	14.0	63	--
1230	225	6.7	7.73	5.89	3.05	2.74	14.0	62	--
1300	255	6.6	7.85	6.00	3.11	2.80	24.0	66	--
1330	285	6.3	8.23	6.35	3.29	2.98	96.0(4)	68	--
1345(3)	300	6.5	7.97	6.10	3.16	2.85	11.0	63	--
1400(3)	315	6.1	8.50	6.60	3.42	3.11(2)	10.0	64	--
1430	345	6.1	8.50	6.60	3.42	3.11(2)	19.0	63	--
1445(3)	360	6.0	8.64	6.73	3.49	3.18(2)	16.0	62	--
1500(3)	375	5.7	9.09	7.13	3.70	3.37	37.0	63	--
1510	385	--	--	--	--	--	--	--	Check mill load level.
1513	388	--	--	--	--	--	--	--	Start filling No. 1 mill discharge sample barrel.
1522	397	--	--	--	--	--	--	--	Start filling No. 2 mill discharge sample barrel.
1529	404	--	--	--	--	--	--	--	Start filling No. 3 mill discharge sample barrel.
1536	411	--	--	--	--	--	--	--	End filling No. 3 mill discharge sample barrel.
1537	412	--	--	--	--	--	--	--	End of test.
Average						3.13	18.0		

(1) Calculated: Sum of Sweco oversize and DSM oversize as a percentage of dry mill feed.
(2) Average for power (three readings, omitted reading at 1,500 from average): 3.13 kwhr/st.
(3) Sample run.
(4) Omitted from average.

Procedure: Samples were wet screened on a 325M screen, products dried, and the +325M material dry screened using a Ro-Tap for 30 min.

Screen Size Analysis

Test Product	Mill Discharge				Sweco Screen Oversize				DSM Screen Oversize				DSM Screen Underflow				Circulating Load
Sample Time	1345	1400	1445	1500	1345	1400	1445	1500	1345	1400	1445	1500	1345	1400	1445	1500	--
Sample Weight, g:	1,058.6	1,062.1	911.3	859.1	442.5	300.3	282.2	381.8	1,065.9	713.5	478.8	920.6	817.4	757.0	743.7	787.8	--
Screen Product (Tyler) Mesh	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %
Head (calculated)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
+28	12.0	11.5	10.2	10.8	78.4	82.9	81.4	87.5	67.0	54.5	51.9	32.0	1.8	2.0	1.9	1.6	58.1
-28 +35	3.7	3.7	2.7	2.9	1.5	0.8	1.0	0.4	5.0	4.6	4.5	3.9	3.1	3.1	2.8	2.3	3.7
-35 +65	15.3	16.3	12.9	13.4	4.1	1.9	3.0	1.1	6.2	7.4	6.9	10.9	16.8	16.3	15.8	14.2	6.7
-65 +100	12.3	13.4	12.8	12.7	2.4	1.2	1.9	0.8	3.4	5.2	5.2	9.1	14.7	14.6	14.2	14.5	4.8
-100 +200	19.1	18.5	21.3	20.6	4.1	2.7	3.7	1.6	5.3	8.2	9.3	14.2	20.5	20.5	21.7	21.8	8.0
-200 +325	8.0	6.6	9.0	8.6	1.1	1.0	1.1	1.2	1.6	2.8	4.0	5.3	8.1	8.4	7.4	7.4	2.9
-325	29.6	30.0	31.1	31.0	8.4	9.5	7.9	7.4	11.5	17.3	18.2	24.6	35.0	35.1	36.2	38.2	15.8

EXHIBIT 2

Grinding Test 6

Date:	June 20, 1978
Feed Rate, stph:	2.5
Ore:	Run-of-mine
Ball Charge:	Total: 301.8 lb, 2% mill volume
-1-1/2 in. +1 in. Balls, lb:	114.5
-2 in. +1-1/2 in. Balls, lb:	151.3
3 in. Balls, lb:	36.0
DSM Screen, in. width:	12
DSM Screen Openings, mm:	1.27
Measured Mill Power Tare (empty mill), kw:	2.06
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Meter Reading watt-hr	Mill-Bearing Oil Temp. °F	Ore Feed Rate (as received)(1) -1-1/2 in. lb/hr	-4 in. +1-1/2 in. lb/hr	-6 in. +4 in. lb/hr	-10 in. -6 in. lb/hr	Mill Discharge Solids %	Mill Discharge Solids lb/hr	Sweco Screen Oversize Solids %	Sweco Screen Oversize Solids lb/hr	DSM Screen Overflow Solids %	DSM Screen Overflow Solids lb/hr	DSM Screen Underflow Solids %	DSM Screen Underflow Solids lb/hr	Mill Water Meter %	Mill Water Rate lb/hr	Mill Load Volume %	Remarks
0820	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--(Grind out)--		Start mill.
0925	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Start feed.
0930	5	6.8	13,195	82	--	768	474	219	--	--	--	--	--	--	--	--	80	2,540	--	--
1000	35	5.9	--	80	--	768	474	219	66	11,286	60	662	71	4,090	61	5,737	85	2,699	--	--
1030	65	5.3	--	82	3,713	768	474	219	66	9,742	54	535	68	4,896	61	3,486	84	2,668	--	--
1100	95	5.2	--	83	3,825	768	474	219	67	10,492	60	608	68	4,651	61	4,255	85	2,699	--	--
1135	130	5.2	--	84	3,510	768	474	219	66	7,960	59	597	68	3,733	61	4,255	84	2,668	25	--
1200	155	5.2	--	87	3,758	768	474	219	68	10,588	57	487	68	4,651	60	3,699	85	2,699	--	--
1230	185	5.1	--	88	3,420	768	474	219	68	10,037	55	545	69	3,974	60	4,104	89	2,826	--	--
1245	200	5.1	--	88	3,420	768	474	219	67	9,950	52	714	68	4,223	59	4,275	89	2,826	--	Sample.
1300	215	5.0	--	89	3,600	768	474	219	67	11,759	62	781	68	6,487	62	3,627	85	2,699	--	Sample.
1330	245	5.0	12,236	92	--	768	474	219	67	8,924	60	1,337	68	4,039	60	3,780	88	2,795	--	--
1337	252	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	27	Shut down.
Average					3,607	768	474	219	67	10,082	58	696	68	4,527	61	4,135	85	2,712		

(1) Moisture: -1-1/2 in., 2.3%; -4 in. +1-1/2 in., 1.0%; -6 in. +4 in., 0.8%; -10 in. +6 in., 0.7%. Average dry ore feed rate: -1-1/2 in., 3,524 lb/hr; -4 in. +1-1/2 in., 760.3 lb/hr; -6 in. +4 in., 470.2 lb/hr; -10 in. +6 in., 217.5 lb/hr; Total: 4,972 lb/hr; 2.486 dry stph. Mill volume end of test: 27%.

Feed Rate, stph (dry):	2.486
Ball Charge:	301.8 lb, 2% of mill volume
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Instantaneous Gross Power (meter reading) kwhr	Instantaneous Corrected Power (from input-output curve) kwhr	Power Consumption Gross kwhr/st	Power Consumption Net kwhr/st	Circulating Load Weight % of Feed(1)	Mill Discharge Solids %	Remarks
0820	--	--	--	--	--	--	--	--	Grind out.
0925	--	--	--	--	--	--	--	--	Start feed.
0930	5	6.8	7.62	5.80	2.33	2.09	--	--	--
1000	35	5.9	8.78	6.87	2.76	2.52	--	66	--
1030	65	5.3	9.78	7.78	3.13	2.92	105.0	66	--
1100	95	5.2	9.97	7.92	3.18	2.94	99.0	67	--
1135	130	5.2	9.97	7.92	3.18	2.94	87.0	66	--
1200	155	5.2	9.97	7.92	3.18	2.94	98.0	68	--
1230	185	5.1	10.16	8.09	3.25	3.01	93.0	68	--
1245(3)	200	5.1	10.16	8.09	3.25	3.01	101.0	67	--
1300(3)	215	5.0	10.36	8.26	3.32	3.08(2)	144.0	67	--
1330	245	4.0	10.36	8.26	3.32	3.08(2)	--	67	--
1337	252	--	--	--	--				End of test.
Average						3.08	103.9		

(1) Calculated: Sum of Sweco oversize and DSM oversize as a percentage of dry mill feed.
(2) Average for power (two readings): 3.08 kwhr/st.
(3) Sample run.

COLORADO SCHOOL OF MINES RESEARCH INSTITUTE

EXHIBIT 2

Grinding Test 6 -- continued

Procedure: Samples were wet screened on a 325M screen, products dried, and the +325M material dry screened using a Ro-Tap for 30 min.

Total Product	Screen Size Analysis								
	Mill Discharge		Sweco Screen Oversize		DSM Screen Oversize		DSM Screen Undersize		Circulating Load
Sample Time	1245	1300	1245	1300	1245	1300	1245	1300	
Sample Weight, g:	1,258.8	1,237.7	673.8	642.6	1,361.9	1,079.3	832.1	918.1	--
Screen Product (Tyler) Mesh	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %
Head (calculated)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
+28	21.0	18.4	64.8	70.7	32.9	23.1	1.3	1.0	32.9
-28 +35	6.4	6.5	1.9	1.2	9.4	8.5	3.9	3.7	8.1
-35 +65	13.9	15.1	3.8	2.7	12.8	14.3	16.5	16.7	12.2
-65 +100	10.5	11.4	3.2	2.2	8.8	8.6	12.4	14.5	8.0
-100 +200	13.3	14.2	5.4	5.0	11.8	14.2	20.3	18.5	12.0
-200 +325	5.5	5.6	3.1	2.2	4.8	3.7	5.3	6.7	4.1
-325	29.4	28.8	17.8	16.0	19.5	27.6	40.3	38.9	22.7

Sediment Description and Classification Background

U.S. Standard Sieves

Note that the same size mesh can be a differing sieve number depending on the Sieve manufacturer (Tyler vs. ASTM)

Mesh Size (microns)	**TYLER**	**ASTM-E11**	**BS-410**	**DIN-4188**
µm	Mesh	No.	Mesh	mm
5	2500		2500	0.005
10	1250		1250	0.010
15	800		800	0.015
20	625		625	0.020
22				0.022
25	500		500	0.025
28				0.028
32				0.032
36				0.036
38	400	400	400	
40				0.040
45	325	325	350	0.045
50				0.050
53	270	270	300	
56				0.056
63	250	230	240	0.063
71				0.071
75	200	200	200	
80				0.080
90	170	170	170	0.090
100				0.100
106	150	140	150	
112				0.112
125	115	120	120	0.125
140				0.140
150	100	100	100	

ATTACHMENT B, 1/10

160				0.160
180	80	80	85	0.180
200				0.200
212	65	70	72	
250	60	60	60	0.250
280				0.280
300	48	50	52	
315				0.315
355	42	45	44	0.355
400				0.400
425	35	40	36	
450				0.450
500	32	35	30	0.500
560				0.560
600	28	30	25	
630				0.630
710	24	25	22	0.710
800				0.800
850	20	20	18	
900				0.900
1000	16	18	16	1.0
1120				1.12
1180	14	16	14	
1250				1.25
1400	12	14	12	1.4
1600				1.6
1700	10	12	10	
1800				1.8
2000	9	10	8	2.0
2240				2.24
2360	8	8	7	
2500				2.5
2800	7	7	6	2.8
3150				3.15
3350	6	6	5	
3550				3.55
4000	5	5	4	4.0
4500				4.5

4750	4	4	3.5	
5000				5.0

Sediment Classification based on Grain Size:

Unified Soil Classification System (USCS)

Sediment Name	**Diameter (mm)**	**Sieve No.**
Cobble	greater than 75 mm	
Gravel	4.75 to 75 mm	4
Sand	0.075 to 4.75 mm	200
Fines (silt and clay)	less than 0.075 mm	

USCS Division of Sands

Sediment Name	Diameter Range (mm)	Passes through Sieve No.	Retained on Sieve No.
Coarse Sand	2.0 - 4.8	4	10
Medium Sand	0.43 - 2.0	10	40
Fine Sand	0.075 - 0.43	40	200

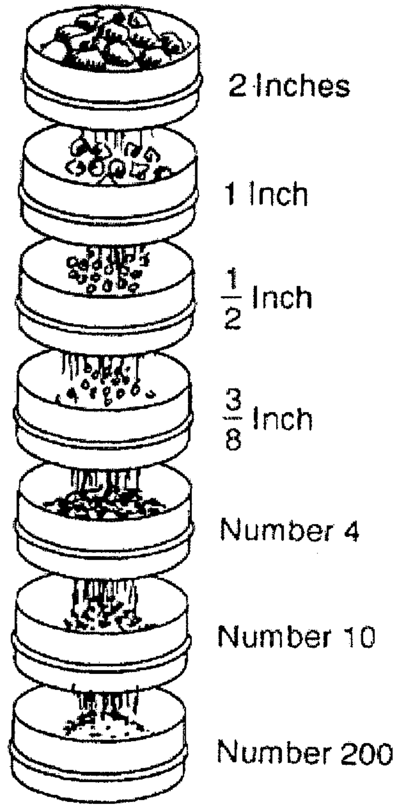


Figure 4-3. Dry sieve analysis.

USCS Classification System

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	DESCRIPTIONS
COARSE GRAINED SOILS More Than Half Retained on 200 Sieve	GRAVELS More Than Half Coarse Fraction Retained on No. 4 Sieve	Clean Gravels (Little or no Fines)	GW	Well Graded Gravels, Gravel - Sand Mixtures, Little or no Fines
			GP	Poorly Graded Gravels, Gravel - Sand Mixtures, Little or no Fines
		Gravels With Fines (Appreciable Fines)	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	SANDS More Than Half Coarse Fraction Passes a No. 4 Sieve	Clean Sands (Little or no Fines)	SW	Well Graded Sands, Gravelly Sands, Little or no Fines
			SP	Poorly Graded Sands, Gravelly Sands, Little or no Fines
		Sands With Fines (Appreciable Fines)	SM	Silty Sands, Sand - Silt Mixtures
			SC	Clayey Sands, Sand - Clay Mixtures
FINE GRAINED SOILS More Than Half Passes 200 Sieve	SILTS and CLAYS Liquid Limit Less Than 50		ML	Inorganic Silts & Very Fine Sands, Silty or Clayey Fine Sands, Clayey Silts
			CL	Inorganic Clays of Low to Medium Plasticity, Lean Clays
			OL	Organic Silts & Organic Silty Clays of Low Plasticity
	SILTS and CLAYS Liquid Limit Greater Than 50		MH	Inorganic Silts, Fine Sand or Silty Soils, Elastic Silts
			CH	Inorganic Clays of High Plasticity, Fat Clays
			OH	Organic Clays of Medium to High Plasticity, Organic Silts
Highly Organic Soils			PT	Peat and Other Highly Organic Soils

Visual logging of sediments entails estimating percentages of gravels, sands and fines (silt and clays). Practice and the use of the Geotechnical Gage will increase your confidence and ability in visually logging sediments.

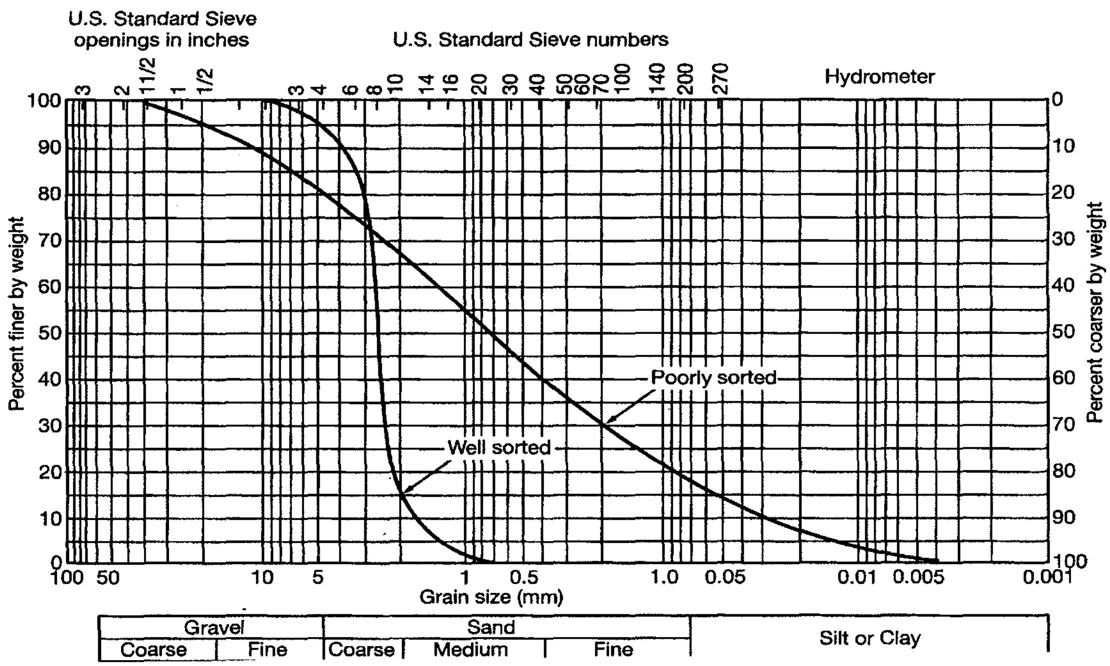
Read: Visual Exam Test

Read: <u>Field Identification Guidelines</u>

Ultimately, sediment samples may undergo grain size analysis through sieves. Graphing the cumulative weight percent retained/passing by sieve no. or grain size will result in the sediment grain-size distribution curve. The grain-size distribution curve is used to quantitatively classify the sediment type (your visual identification is a qualitative classification).

Read: <u>Grain Size Distribution Measurement</u>

Grain Size Distribution Curve



The grain-size distribution curve is used with the USCS classification chart to classify the sediment type. Other measures used to describe the sediment are the sorting or gradation of the sediment. As can be seen in the above chart, a well-sorted sediment has a small range of sediment grain sizes while a poorly sorted sediment has a large range of sediment grain sizes. In the USCS classification scheme, the gradation of the sediment is used instead of the sorting. A well-graded sediment has a large range of grain sizes while a poorly or uniformly graded sediment has a small range of grain sizes.

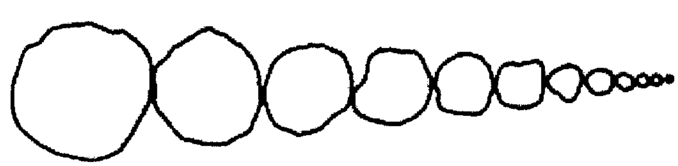


Figure 4-6. Well-graded soil.

POORLY SORTED SEDIMENT = WELL GRADED SEDIMENT

Figure 4-7. Uniformly graded soil.

WELL-SORTED SEDIMENT = POORLY OR UNIFORMLY GRADED SEDIMENT

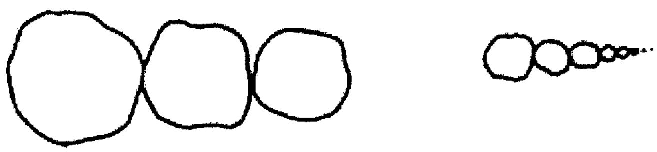


Figure 4-8. Gap-graded soil.

After sieve analysis, the data are tabulated showing the weight of sediment retained on each sieve. The cumulative weight retained is calculated starting from the largest sieve size and adding subsequent sediment weights from the smaller size sieves (see table below). The percent retained is calculated from the weight retained and the total weight of the sample. [Don't get confused by the graph - it is individual percent retained in Column 16 and cumulative percent passing in Column 17]. The cumulative percent passing in Column 17 of the table below is calculated by sequentially subtracting percent retained from 100 %. In table below, cumulative percent passing 1/4 inch sieve = 100 - 16 = 84; cumulative percent passing #4 sieve = 84-5.2 = 78.8; etc.

SIEVE ANALYSIS DATA

1. DATE STARTED: 22 FEB 91
2. PROJECT: BRAVO AIRFIELD
3. EXCAVATION: 1+00
4. DATE COMPLETED: 28 FEB 91
5. SAMPLE DESCRIPTION: LIGHT BROWN SANDY SOIL
6. SAMPLE NUMBER: 1A
7. PREWASHED (x one): XX YES / NO
8. ORIGINAL SAMPLE WEIGHT: 2459
9. + #200 SAMPLE WEIGHT: 2359
10. − #200 SAMPLE WEIGHT: 100

11. SIEVE SIZE	12. WEIGHT OF SIEVE	13. WEIGHT OF SIEVE + SAMPLE	14. WEIGHT RETAINED	15. CUMULATIVE WEIGHT RETAINED	16. PERCENT RETAINED	17. PERCENT PASSING
1½	202					
1	231					
½	210	210	0	0	0	100.0
¼	230	624	394	394	16.0	84.0
#4	205	332	127	521	5.2	78.8
#8	225	691	466	987	19.0	59.8
#20	215	612	397	1384	16.2	43.6
#60	235	581	346	1730	14.1	29.5
#100	250	612	362	2092	14.7	14.8
#200	260	515	255	2347	10.4	4.4

Item	Value
18. TOTAL WEIGHT RETAINED IN SIEVES (Sum Column 14)	2347
20. WEIGHT SIEVED THROUGH #200 (Weight in pan) 270-260	10
21. WASHING LOSS (8 - (9 + 10)) 2459-(2359+100)	0
22. TOTAL WEIGHT PASSING #200 (20 + 10) 10+100	110
23. TOTAL WEIGHT OF FRACTIONS (18 + 22)	2457

19. ERROR (8 - 23): 2459-2457 = 2

24. REMARKS

USCS SP
PERCENT - G 21.2
PERCENT - S 74.4
PERCENT - F 4.4

25. ERROR (Percent)

$\frac{\text{ERROR (19)}}{\text{ORIGINAL WT (8)}} \times 100 =$

$\frac{2}{2459} \times 100 = .08$

26. TECHNICIAN: Joe Blob PVZ
27. COMPUTED BY (Signature): Joe Blob PVZ
28. CHECKED BY (Signature): Fred Jones SSG

DD Form 1206, DEC 86 Previous editions are obsolete

Figure 4-4. Data sheet, example of dry sieve analysis.

The cumulative percent passing is plotted on the grain-size distribution graph. The percentage passing the No. 4 and 200 sieves is used to classify the sediments as gravels (G), sands (S) or fines (must use plasiticity index to differentiate between silts and clays).

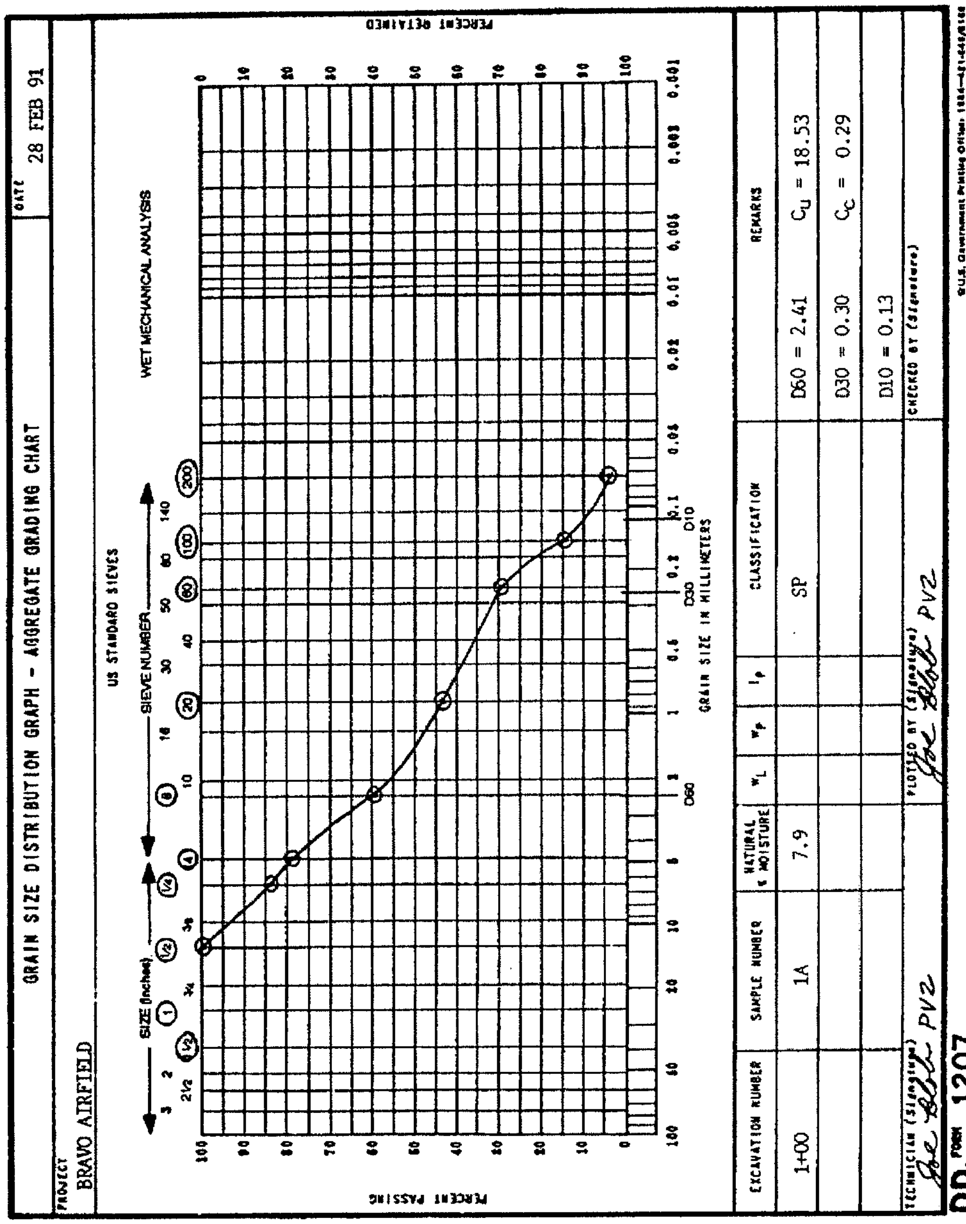


Figure 4-5. Grain-size distribution curve from sieve analysis.

The grain-size distribution graph is used to read off the grain size at which 10% of the sample passed (D_{10}), 30% of the sample passed (D_{30}) and 60% of the sample passed (D_{60}). These numbers are used to calculate several coefficients:

Hazen's effective size, D_{10}, which will be used to estimate permeability

Uniformity Coefficient, $C_u = D_{60}/D_{10}$

In the above graph,

$D_{60} = 2.4$ mm and $D_{10} = 0.13$ mm

then $C_u = 2.4/0.13 = 18.5$

The uniformity coefficient is used to judge gradation.

Coefficient of Curvature, C_c

$$C_c = \frac{(D_{30})^2}{(D_{60} \times D_{10})}$$

In the above graph,

$D_{30} = 0.3$ mm

and $C_c = \frac{(0.3)^2}{(2.4)(0.13)} = .29$

In the graph below, well-graded soils (GW and SW) are long curves spanning a wide range of sizes with a constant or gently varying slope. Uniformly graded soils (SP) are steeply sloping curves spanning a narrow range of sizes. For a gap-graded soil (GP), the curve flattens out in the area of the grain-size deficiency or gap.

The USCS criteria for well-graded gravels (GW) and sands (SW) are:

1. Less than 5% finer than No. 200 sieve
2. Uniformity coefficient greater than 4
3. Coefficient of curvature between 1 and 3

If Criterion 1 is met, but not Criteria 2 and 3, the gravels are gap-graded or uniform gravels (GP) or sands (SP)

If you are interested in more information: Gradation and Bearing Capacity

United States
Environmental Protection
Agency

Office of Research and
Development
Washington DC 20460

EPA/600/R-94/168b
September 1994

EPA

The Hydrologic Evaluation of Landfill Performance (HELP) Model

Engineering Documentation for Version 3

Attachment C, 1/3

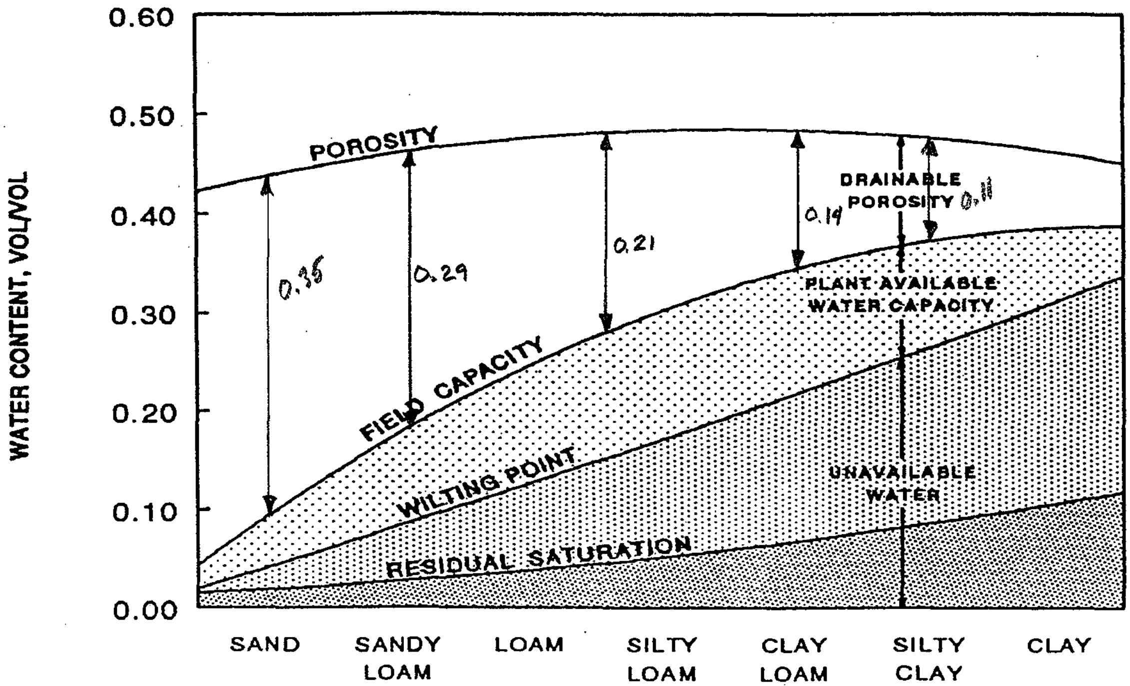


Figure 2. Relation Among Moisture Retention Parameters and Soil Texture Class

are not specified, the program assumes values near the steady-state values (allowing no long-term change in moisture storage) and runs a year of simulation to initialize the moisture contents closer to steady state. The soil water contents at the end of this year are substituted as the initial values for the simulation period. The program then runs the complete simulation, starting again from the beginning of the first year of data. The results of the volumetric water content initialization period are not reported in the output.

3.3.2 Unsaturated Hydraulic Conductivity

Darcy's constant of proportionality governing flow through porous media is known quantitatively as hydraulic conductivity or coefficient of permeability and qualitatively as permeability. Hydraulic conductivity is a function of media properties, such as particle size, void ratio, composition, fabric, degree of saturation, and the kinematic viscosity of the fluid moving through the media. The HELP program uses the saturated and unsaturated hydraulic conductivities of soil and waste layers to compute vertical drainage, lateral drainage and soil liner percolation. The vapor diffusivity for geomembranes is specified as a saturated hydraulic conductivity to compute leakage through geomembranes by vapor diffusion.

Attachment C, 2/3

TABLE 1. DEFAULT LOW DENSITY SOIL CHARACTERISTICS

Soil Texture Class			A Total Porosity vol/vol	B Field Capacity vol/vol	Wilting Point vol/vol	Saturated Hydraulic Conductivity cm/sec	A-B Drainable Porosity vol/vol
HELP	USDA	USCS					
1	CoS	SP	0.417	0.045	0.018	$1.0x10^{-2}$	
2	S	SW	0.437	0.062	0.024	$5.8x10^{-3}$	
3	FS	SW	0.457	0.083	0.033	$3.1x10^{-3}$	
4	LS	SM	0.437	0.105	0.047	$1.7x10^{-3}$	0.332
5	LFS	SM	0.457	0.131	0.058	$1.0x10^{-3}$	0.326
6	SL	SM	0.453	0.190	0.085	$7.2x10^{-4}$	0.263
7	FSL	SM	0.473	0.222	0.104	$5.2x10^{-4}$	0.251
8	L	ML	0.463	0.232	0.116	$3.7x10^{-4}$	0.231
9	SiL	ML	0.501	0.284	0.135	$1.9x10^{-4}$	0.217
10	SCL	SC	0.398	0.244	0.136	$1.2x10^{-4}$	0.154
11	CL	CL	0.464	0.310	0.187	$6.4x10^{-5}$	
12	SiCL	CL	0.471	0.342	0.210	$4.2x10^{-5}$	
13	SC	SC	0.430	0.321	0.221	$3.3x10^{-5}$	
14	SiC	CH	0.479	0.371	0.251	$2.5x10^{-5}$	
15	C	CH	0.475	0.378	0.251	$2.5x10^{-5}$	
21	G	GP	0.397	0.032	0.013	$3.0x10^{-1}$	

a = constant representing the effects of various fluid constants and gravity, 21 cm^3/sec

ϕ = total porosity, vol/vol

θ_r = residual volumetric water content, vol/vol

ψ_b = bubbling pressure, cm

λ = pore-size distribution index, dimensionless

A more detailed explanation of Equation 11 can be found in Appendix A of the HELP program Version 3 User's Guide and the cited references.

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ered that when well-graded mixtures of sand and gravel contained as little as 5% of fines (sizes smaller than a No. 200 sieve) high compactive efforts reduced the effective porosities nearly to zero and the permeabilities to less than 0.01% of those at moderate densities. These tests explain one of the reasons that blends of sand and gravel often used for drains are virtually useless as drainage aggregates if they contain more than insignificant amounts of fines.

In the preceding paragraphs variations in the permeability of remolded materials caused by variable compaction were discussed. Any factor that densifies soils reduces permeability. Studies of the rate of consolidation of clay and peat foundations are sometimes made by using initial coefficients of permeability of compressible formations. While the consolidation process is going on in foundations their permeabilities are becoming less. Generally, decreases in the permeabilities of clay foundations are rather moderate, but they can be large in highly compressible organic silts and clays and in peats. Modified calculation methods utilizing the changing permeability are needed in the analysis of highly compressible foundations. Some typical variations in permeability caused by consolidation are given in Fig. 2.10, a plot of consolidation pressure versus permeability.

$\sigma_n \simeq 31' \times 130$ pcf.
$\simeq 4000$ psf
$\simeq 2$ Tsf

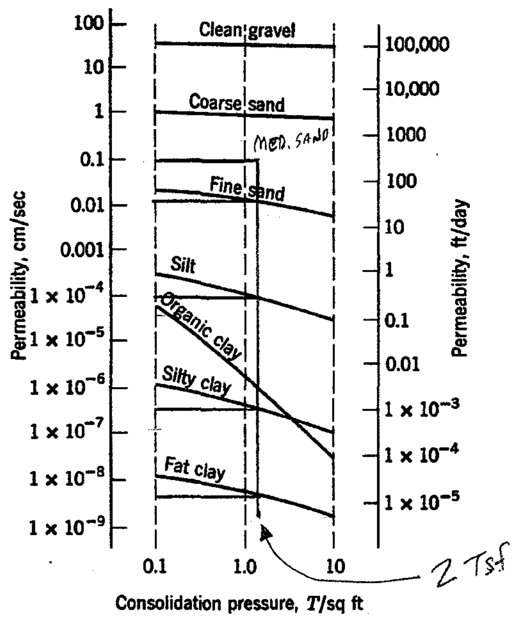

FIG. 2.10 Permeability versus consolidation pressure.

"Seepage, Drainage, and Flow Nets"
3rd Edition, Cedergren, H.R. 1989

Attachment D

1/2

$$k = \frac{Q}{iAt} \qquad (2.2)$$

Darcy's *discharge velocity* multiplied by the entire cross-sectional area, including voids e and solids 1, gives the seepage quantity Q under a given hydraulic gradient $i = \Delta h/\Delta l$ or h/L. It is an imaginary velocity that does not exist anywhere. The average *seepage velocity* v_s of a mass of water progressing through the pore spaces of a soil is equal to the discharge velocity ($v_d = ki$) multiplied by $(1 + e)/e$ or the discharge velocity divided by the effective porosity n_e; hence permeability is related to seepage velocity by the expression

$$k = \frac{v_s n_e}{i} \qquad (2.3)$$

For any seepage condition in the laboratory or in the field in which the *seepage quantity,* the area perpendicular to the direction of flow, and the hydraulic gradient are known the coefficient of permeability can be calculated. Likewise, for any situation where the *seepage velocity* is known at a point at which the hydraulic gradient and soil porosity also are known, permeability can be calculated.

Experimentally determined coefficients of permeability can be combined with prescribed hydraulic gradients and discharge areas in solving practical problems involving seepage quantities and velocities. When a coefficient of permeability has been properly determined, it furnishes a very important factor in the analysis of seepage and in the design of drainage features for engineering works.

The coefficient of permeability as used in this book and in soil mechanics in general should be distinguished from the physicists' coefficient of permeability K, which is a more general term than the engineers' coefficient and has units of centimeters squared rather than a velocity; it varies with the porosity of the soil but is independent of the viscosity and density of the fluid. The transmissibility factor T represents the capability of an aquifer to discharge water and is the product of permeability k and aquifer thickness t.

The engineers' coefficient, which is used in practical problems of seepage through masses of earth and other porous media, applies only to the flow of water and is a simplification introduced purely from the standpoint of convenience. It has units of a velocity and is expressed in centimeters per second, feet per minute, feet per day, or feet per year, depending on the habits and personal preferences of individuals using the coefficient. In standard soil mechanics terminology k is expressed in centimeters per second.

Although coefficient of permeability is often considered to be a constant for a given soil or rock, it can vary widely for a given material, depending on a number of factors. Its absolute values depend, first of all, on the properties of water, of which viscosity is the most important. For individual materials

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Cedergren, "Seepage, Drainage, and Flow Nets", 3rd Ed. 1989

GDE Control Products, Inc.

Multi-FLO

Technical Properties

Multi-Flow
Product Information
Applications
Fittings
Accessories
Technical
Backfill
Installation
Drainage Guide
FAQ's

Drainage Core

Property	Test Method	Value
Thickness, inches	ASTM D-1777	1.0
Flow Rate, gpm/ft*	ASTM D-4716	29 *
~~Compressive Strength~~	~~ASTM D-1621~~	~~6000~~

Geotextile Filter

Property	Test Method	Value
Weight, oz/sq yd2	ASTM D-3776	4.0
Tensile Strength, lb.	ASTM D-4632	100
Elongation, %	ASTM D-4632	50
Puncture, lb.	ASTM D-4833	50
Mullen Burst, psi	ASTM D-3786	200
Trapezoidal Tear, lb.	ASTM D-4533	42
Coeffecient of Perm,cm/sec	ASTM D-4491	0.1
Flow Rate, gpm/ft2	ASTM D-4491	100
Permittivity, 1/sec	ASTM D-4491	1.8
A.O.S Max US Std Sieve	ASTM D 4751	70
UV Stability, 500 hrs., %	ASTM D-4355	70
Seam Strength, lb./ft	ASTM D-4595	100
Fungus	ASTM G-21	No Growth

* Horizontal Installation , gradient = 0.01, compressive force = 10 psi for 1(

All values given represent minimum average roll values

GDE Control Products, Inc. Laguna Hills, CA. 949-305-7117

GDE, Multi-Flow
<http: www.gdccontrol.com/Multi-Flow5.html> Attachment E 1/1

TABLE 2.12 RECOMMENDED REDUCTION FACTOR VALUES FOR USE IN EQ. (2.25a)

	Range of Reduction Factors				
Application	Soil Clogging and Blinding*	Creep Reduction of Voids	Intrusion into Voids	Chemical Clogging†	Biological Clogging
Retaining wall filters	2.0 to 4.0	1.5 to 2.0	1.0 to 1.2	1.0 to 1.2	1.0 to 1.3
Underdrain filters	5.0 to 10	1.0 to 1.5	1.0 to 1.2	1.2 to 1.5	2.0 to 4.0
Erosion-control filters	2.0 to 10	1.0 to 1.5	1.0 to 1.2	1.0 to 1.2	2.0 to 4.0
* Landfill filters	5.0 to 10	1.5 to 2.0	1.0 to 1.2	1.2 to 1.5	5 to 10‡
Gravity drainage	2.0 to 4.0	2.0 to 3.0	1.0 to 1.2	~~1.2 to 1.5~~	1.2 to 1.5
Pressure drainage	2.0 to 3.0	2.0 to 3.0	1.0 to 1.2	1.1 to 1.3	1.1 to 1.3

*If stone riprap or concrete blocks cover the surface of the geotextile, use either the upper values or include an additional reduction factor.

†Values can be higher particularly for high alkalinity groundwater.

‡Values can be higher for turbidity and/or for microorganism contents greater than 5000 mg/l.

$$q_{\text{allow}} = q_{\text{ult}}\left(\frac{1}{\Pi \text{RF}}\right) \tag{2.25b}$$

where

q_{allow} = allowable flow rate,
q_{ult} = ultimate flow rate,
RF_{SCB} = reduction factor for soil clogging and blinding,
RF_{CR} = reduction factor for creep reduction of void space,
RF_{IN} = reduction factor for adjacent materials intruding into geotextile's void space,
RF_{CC} = reduction factor for chemical clogging,
RF_{BC} = reduction factor for biological clogging, and
ΠRF = value of cumulative reduction factors.

As with Eqs. (2.24) for strength reduction, this flow-reduction equation could also have included additional site-specific terms, such as blocking of a portion of the geotextile's surface by riprap or concrete blocks.

2.5 DESIGNING FOR SEPARATION

Application areas for geotextiles used for the separation function were given in Section 1.3.3. There are many specific applications, and it could be said, in a general sense, that geotextiles always serve a separation function. If they do not also serve this function, any other function, including the primary one, will not be served properly. This should not give the impression that the geotextile function of separation always plays a secondary role. Many situations call for separation only, and in such cases the geotextiles serve a significant and worthwhile function.

ATTACHMENT F 1/4

4.1.6 Allowable Flow Rate

As described previously, the very essence of the design-by-function concept is the establishment of an adequate factor of safety. For geonets, where flow rate is the primary function, this takes the following form.

$$\text{FS} = \frac{q_{\text{allow}}}{q_{\text{reqd}}} \tag{4.3}$$

where

FS = factor of safety (to handle unknown loading conditions or uncertainties in the design method, etc.),
q_{allow} = allowable flow rate as obtained from laboratory testing, and
q_{reqd} = required flow rate as obtained from design of the actual system.

Alternatively, we could work from transmissivity to obtain the equivalent relationship.

$$\text{FS} = \frac{\theta_{\text{allow}}}{\theta_{\text{reqd}}} \tag{4.4}$$

where θ is the transmissivity, under definitions as above. As discussed previously, however, it is preferable to design with flow rate rather than with transmissivity because of nonlaminar flow conditions in geonets.

Concerning the allowable flow rate or transmissivity value, which comes from hydraulic testing of the type described in Section 4.1.3, we must assess the realism of the test setup in contrast to the actual field system. If the test setup does not model site-specific conditions adequately, then adjustments to the laboratory value must be made. This is usually the case. Thus the laboratory-generated value is an ultimate value that must be reduced before use in design; that is,

$$q_{\text{allow}} < q_{\text{ult}}$$

One way of doing this is to ascribe reduction factors on each of the items not adequately assessed in the laboratory test. For example,

$$q_{\text{allow}} = q_{\text{ult}}\left[\frac{1}{\text{RF}_{IN} \times \text{RF}_{CR} \times \text{RF}_{CC} \times \text{RF}_{BC}}\right] \tag{4.5}$$

or if all of the reduction factors are considered together.

$$q_{\text{allow}} = q_{\text{ult}}\left[\frac{1}{\Pi \text{RF}}\right] \tag{4.6}$$

where

q_{ult} = flow rate determined using ASTM D4716 or ISO/DIS 12958 for short-term tests between solid platens using water as the transported liquid under laboratory test temperatures,

ATTACHMENT F

q_{allow} = allowable flow rate to be used in Eq. (4.3) for final design purposes,
RF_{IN} = reduction factor for elastic deformation, or intrusion, of the adjacent geosynthetics into the geonet's core space,
RF_{CR} = reduction factor for creep deformation of the geonet and/or adjacent geosynthetics into the geonet's core space,
RF_{CC} = reduction factor for chemical clogging and/or precipitation of chemicals in the geonet's core space,
RF_{BC} = reduction factor for biological clogging in the geonet's core space, and
ΠRF = product of all reduction factors for the site-specific conditions.

Some guidelines for the various reduction factors to be used in different situations are given in Table 4.2. Please note that some of these values are based on relatively sparse information. Other reduction factors, such as installation damage, temperature effects, and liquid turbidity, could also be included. If needed, they can be included on a site-specific basis. On the other hand, if the actual laboratory test procedure has included the particular item, it would appear in the above formulation as a value of unity. Examples 4.2 and 4.3 illustrate the use of geonets and serve to point out that high reduction factors are warranted in critical situations.

Example 4.2

What is the allowable geonet flow rate to be used in the design of a capillary break beneath a roadway to prevent frost heave? Assume that laboratory testing was done at the proper design load and hydraulic gradient and that this testing yielded a short-term between-rigid-plates value of 2.5×10^{-4} m²/s.

Solution: Since better information is not known, average values from Table 4.2 are used in Eq. (4.5).

TABLE 4.2 RECOMMENDED PRELIMINARY REDUCTION FACTOR VALUES FOR EQ. (4.5) FOR DETERMINING ALLOWABLE FLOW RATE OR TRANSMISSIVITY OF GEONETS

Application Area	RF_{IN}	RF_{CR}*	RF_{CC}	RF_{BC}
Sport fields	1.0 to 1.2	1.0 to 1.5	1.0 to 1.2	1.1 to 1.3
Capillary breaks	1.1 to 1.3	1.0 to 1.2	1.1 to 1.5	1.1 to 1.3
Roof and plaza decks	1.2 to 1.4	1.0 to 1.2	1.0 to 1.2	1.1 to 1.3
Retaining walls, seeping rock, and soil slopes	1.3 to 1.5	1.2 to 1.4	1.1 to 1.5	1.0 to 1.5
Drainage blankets	1.3 to 1.5	1.2 to 1.4	1.0 to 1.2	1.0 to 1.2
Surface water drains for landfill covers	1.3 to 1.5	1.1 to 1.4	1.0 to 1.2	1.2 to 1.5
Secondary leachate collection (landfills)	1.5 to 2.0	1.4 to 2.0	1.5 to 2.0	1.5 to 2.0
Primary leachate collection (landfills)	1.5 to 2.0	1.4 to 2.0	1.5 to 2.0	1.5 to 2.0

*These values are sensitive to the density of the resin used in the geonet's manufacture. The higher the density, the lower the reduction factor. Creep of the covering geotextile(s) is a product-specific issue.

ATTACHMENT F, 3/4

The above formula can be readily converted to flow rate, Q, by multiplying the velocity by the cross-sectional area A of the pipe.

For pipelines that are either flowing full or flowing partially full, the *Manning equation* is generally used.

$$V = \frac{1}{n} R_H^{0.66} S^{0.5} \tag{7.10}$$

where

V = velocity of flow (m/s),
R_H = hydraulic radius (m),
S = slope or gradient of pipeline (m/m), and
n = coefficient of roughness (see Table 7.7) (dimensionless).

Note that plastic pipe of the type discussed in this chapter, with a *smooth interior,* has a Manning coefficient from 0.009 to 0.010. Plastic pipe with a *profiled or corrugated interior* has a Manning coefficient ranging from 0.018 to 0.025.

Eqs. (7.9) and (7.10) are generally used in the form of charts or nomographs to determine pipe sizes, flow velocity or discharge flow rates (see Figures 7.6 and 7.7). For each chart we include an example from Hwang [7], illustrated on the respective nomographs by heavy lines. Note that both nomographs are for pipes flowing full.

Example 7.1

A 100 m long pipe with D = 200 mm and C = 120 carries a discharge of 30 l/s. Determine the head loss in the pipe. (See the Hazen-Williams chart in Figure 7.6.)

Solution: Applying the conditions given to the solution chart in Figure 7.6, the energy gradient is obtained.

$$S = 0.0058 \text{ m/m}$$

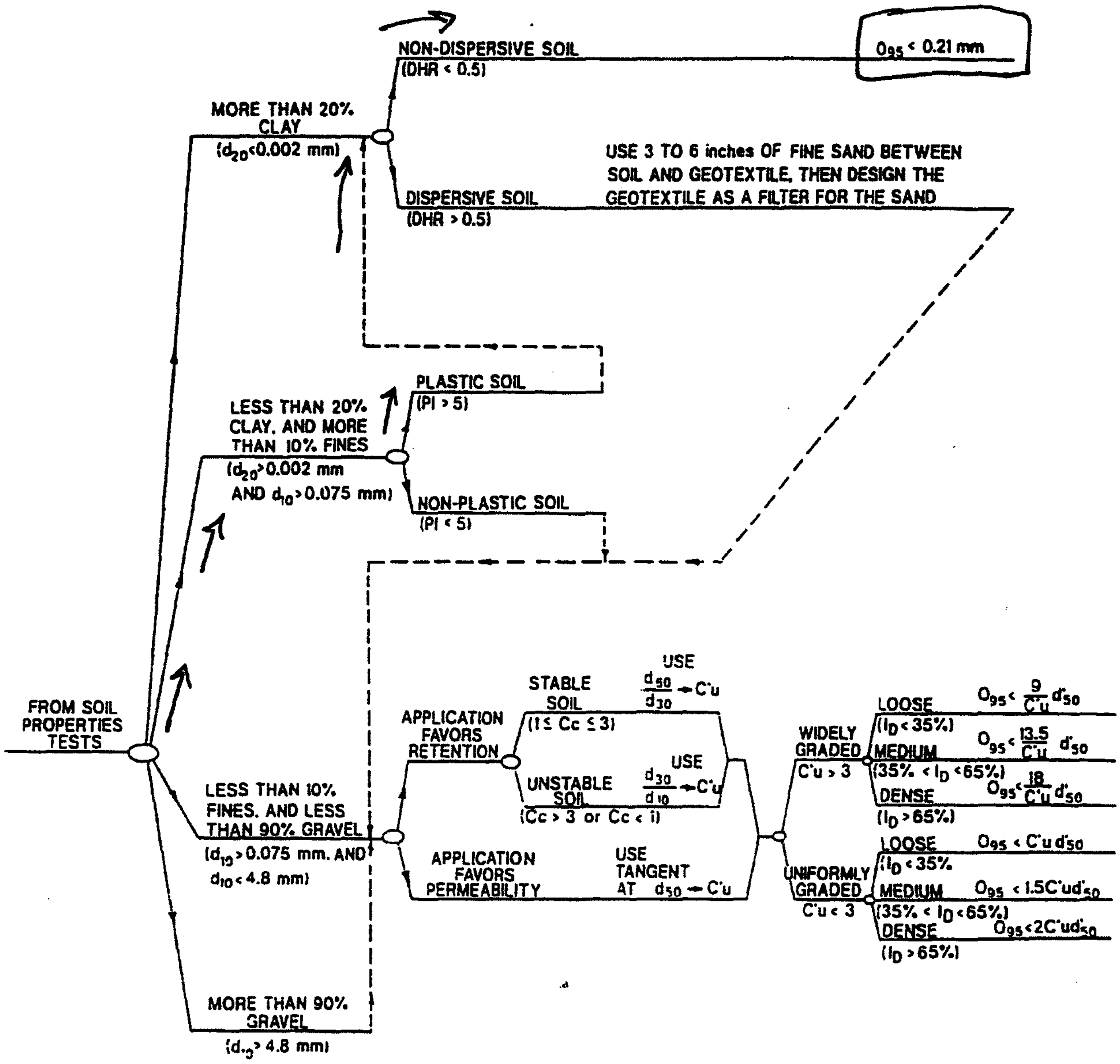
TABLE 7.7 VALUES OF MANNING ROUGHNESS COEFFICIENT, N, FOR REPRESENTATIVE SURFACES

Type of Pipe Surface	Representative n value
Lucite, glass, or plastic*	0.010
Wood or finished concrete	[illegible]
Unfinished concrete, well-laid brickwork, concrete or cast iron pipe	[illegible]
Riveted or spiral steel pipe	[illegible]
Smooth, uniform earth channel	[illegible]
Corrugated flumes, typical canals, river free from large stones and heavy weeds	[illegible]
Canals and rivers with many stones and weeds	[illegible]

*The table does not distinguish between different types of plastic, or between smooth wall [illegible] pipes with perforations.

Source: After Fox and McDonald [9].

CHART 1
SOIL RETENTION CRITERIA
FOR STEADY-STATE FLOW CONDITIONS



NOTES:

d_x is the particle size of which x percent is smaller

$C'u = \sqrt{\frac{d'_{100}}{d'_0}}$ where: d'_{100} and d'_0 are the extremities of a straight line drawn through the particle-size distribution, as directed above; and d'_{50} is the midpoint of this line.

$Cc = \frac{(d_{30})^2}{d_{60} \times d_{10}}$

I_D is the relative denisty of the soil

PI is the plasticity index of the soil

DHR is the double-hydrometer ratio of the soil

Portions of this flow chart modified from Giroud (1988)

Source: Luettich, S.M., Giroud, J.P., and Bachus, R.C. (1991). "Geotextile Filter Design Manual". Report prepared for Nicolon Corporation, Norcross, Georgia.

Attachment G 1/3

4.2 Define the Hydraulic Gradient for the Application (i_s)

The hydraulic gradient will vary depending on the application of the filter. Anticipated hydraulic gradients for various applications may be estimated using Figure 3.

4.3 Determine the Minimum Allowable Geotextile Permeability (k_g)

After determining the soil hydraulic conductivity and the hydraulic gradient, the following equation can be used to determine the minimum allowable geotextile permeability [Giroud, 1988]:

$$k_g > i_s \, k_s$$

The hydraulic conductivity (permeability) of the geotextile can be calculated from the permittivity test method ASTM D 4491; this value can often be obtained from the manufacturer's literature as well. The geotextile permeability is defined as the product of the permittivity, ψ, and the geotextile thickness, t_g:

$$k_g > \varphi \, t_g$$

STEP 5. DETERMINE ANTI-CLOGGING REQUIREMENTS

To minimize the risk of clogging, the following criteria should be met:

- Use the largest opening size (O_{95}) that satisfies the retention criteria.
- For nonwoven geotextiles, use the largest porosity available, but not less than 30 percent.
- For woven geotextiles, use the largest percent open area available, but not less than 4 percent.

Source: Luettich, S.M., Giroud, J.P., and Bachus, R.C. (1991). "Geotextile Filter Design Manual". Report prepared for Nicolon Corporation, Norcross, Georgia.

Attachment G 2/3

Table 4-5

Typical Hydraulic Gradients[a]

DRAINAGE APPLICATION	TYPICAL HYDRAULIC GRADIENT
Standard Dewatering Trench	1.0
Vertical Wall Drain	1.5
Pavement Edge Drain	1[b]
Landfill LCDRS	1.5
Landfill LCRS	1.5
Landfill SWCRS	1.5
Inland Channel Protection	1[b]
Shoreline Protection	10[b]
Dams	10[b]
Liquid Impoundments	10[b]

NOTES: [a] Table developed after Giroud [1988].

[b] Critical applications may require designing with higher gradients than those given.

Attachment G

3/3

AMOCO WASTE RELATED GEOTEXTILES

MINIMUM PHYSICAL PROPERTIES
(Minimum Average Roll Values)

Property	Test Method	Units	4504	4506	4508	4510	4512	4516
Unit Weight	ASTM D-3776	Oz./yd.^{2}	4.0 *	6.0	8.0	10.0	12.0	16.0
Grab Tensile	ASTM D-4632	lbs.	95	150	200	235	275	350
Grab Elongation	ASTM D-4632	%	50	50	50	50	50	50
Mullen Burst	ASTM D-3787	psi	225	350	450	550	650	750
Puncture	ASTM D-4833	lbs.	55	90	130	165	185	220
Trapezoid Tear	ASTM D-4533	lbs.	35	65	80	95	115	130
Apperent Opening Size	ASTM D-4751	US Sieve Number	70	70	100	100	100	100
Permittivity	ASTM D-4491	gal/min/ft^2 sec^{-1}	100 2.0	90 1.7	80 1.5	70 1.1	60 0.9	50 0.7
Permeability	ASTM D-4491	cm/sec	.2	.2	.2	.2	.2	.2
Thickness	ASTM D-1777	mils	40 *	65	90	110	130	175
U.V. Resistance	ASTM D-4355[1]	%[2]	70	70	70	70	70	70

1. Fabric conditioned per ASTM D-4355 2. Percent of minimum grab tensile after conditioning.

TYPICAL PHYSICAL PROPERTIES

Property	Test Method	Units	4504	4506	4508	4510	4512	4516
Grab Tensile	ASTM D-4632	lbs.	130/115	225/200	275/270	315/310	410/370	510/470
Grab Elongation	ASTM D-4632	%	75	65	65	65	65	65
Mullen Burst	ASTM D-3786	psi	285	410	575	650	825	920
Puncture	ASTM D-4833	lbs.	75	120	170	190	210	270
Trapezoid Tear	ASTM D-4533	lbs.	60/50	100/80	140/120	160/140	185/155	220/180
Apparent Opening Size	ASTM D-4751	US Sieve Number	70/120	70/140	100/200	100+	100+	100+
Permittivity	ASTM D-4491	gal/min/ft^2 sec^{-1}	150 3.1	110 2.0	100 1.8	80 1.5	70 1.3	60 1.0
Permeability	ASTM D-4491	cm/sec	.35	.31	.27	.26	.25	.23
Thickness	ASTM D-1777	mils	50	75	115	130	150	195

PACKAGING

Dimensions		4504	4506	4508	4510	4512	4516
Roll Width	ft.	15	15	15	15	15	15
Roll Length	ft.	1200	900	600	600	450	300
Gross Weight	lbs.	500	550	500	600	550	500
Area	sq. yds.	2000	1500	1000	1000	750	500

The information contained herein is furnished without charge or obligation and the recipi... conditions of use and handling may vary and are beyond our control we make no represent... accuracy or reliability of said information or the performance of any product. Any specif... provided as information only and in no way modify, amend, enlarge or create any warra... permission or as a recommendation to infringe any patent.

Amoco Fabrics and Fibers Company 900 Circle 75 Parkway, Suite 300 Atlanta, Georgi...

Amoco Fabrics & Fibers Company, 1991. "Amoco Waste Related Geotextiles" H 1/1

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□
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**            HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                 **
**              HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                  **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                  USAE WATERWAYS EXPERIMENT STATION                       **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HLP3\IUC\IUC30.D4
TEMPERATURE DATA FILE:       C:\HLP3\IUC\IUC30.D7
SOLAR RADIATION DATA FILE:   C:\HLP3\IUC\IUC30.D13
EVAPOTRANSPIRATION DATA:     C:\HLP3\IUC\IUC30.D11
SOIL AND DESIGN DATA FILE:   C:\HLP3\IUC\SOIL-8.D10
OUTPUT DATA FILE:            C:\HLP3\IUC\3ft-sm2.OUT


TIME:  11:34     DATE:   5/ 4/2007


******************************************************************************

     TITLE:  IUC 40 feet, 10 year slime drain simulation

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   0
           THICKNESS                  =     36.00   INCHES
           POROSITY                   =      0.4730 VOL/VOL
           FIELD CAPACITY             =      0.2220 VOL/VOL
           WILTING POINT              =      0.1040 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2000 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =   0.520000001000E-03 CM/SEC


                                  LAYER  2
                                  --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
```


ATTACHMENT I, 1/9

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4730	VOL/VOL
FIELD CAPACITY	=	0.2220	VOL/VOL
WILTING POINT	=	0.1040	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2220	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.520000001000E-03	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	75.0	FEET

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 1.% AND A SLOPE LENGTH OF 75. FEET.

SCS RUNOFF CURVE NUMBER	=	88.80	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	16.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.762	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	7.568	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.664	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	8.532	INCHES
TOTAL INITIAL WATER	=	8.532	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM GRAND JUNCTION COLORADO

STATION LATITUDE	=	39.07	DEGREES
MAXIMUM LEAF AREA INDEX	=	1.00	
START OF GROWING SEASON (JULIAN DATE)	=	109	
END OF GROWING SEASON (JULIAN DATE)	=	293	
EVAPORATIVE ZONE DEPTH	=	16.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.10	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	60.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	36.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	36.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	57.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR GRAND JUNCTION COLORADO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC

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0.64	0.54	0.75	0.71	0.76	0.44
0.47	0.91	0.70	0.87	0.63	0.58

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR GRAND JUNCTION COLORADO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
25.50	33.50	41.90	51.70	62.10	72.30
78.90	75.90	67.10	54.90	39.60	28.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR GRAND JUNCTION COLORADO
AND STATION LATITUDE = 39.07 DEGREES

****

ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.42	26934.602	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	6.873	24947.395	92.62
PERC./LEAKAGE THROUGH LAYER 2	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	0.547	1987.206	7.38
SOIL WATER AT START OF YEAR	8.532	30971.395	
SOIL WATER AT END OF YEAR	9.080	32958.598	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.002	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.91	35973.301	100.00

RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	11.228	40758.055	113.30
PERC./LEAKAGE THROUGH LAYER 2	0.012633	45.857	0.13
CHANGE IN WATER STORAGE	-1.331	-4830.604	-13.43
SOIL WATER AT START OF YEAR	9.080	32958.598	
SOIL WATER AT END OF YEAR	7.619	27656.164	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.130	471.831	1.31
ANNUAL WATER BUDGET BALANCE	0.0000	-0.008	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.74	31726.203	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	8.431	30605.041	96.47
PERC./LEAKAGE THROUGH LAYER 2	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	0.309	1121.151	3.53
SOIL WATER AT START OF YEAR	7.619	27656.164	
SOIL WATER AT END OF YEAR	8.058	29249.146	
SNOW WATER AT START OF YEAR	0.130	471.831	1.49
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.010	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.57	31109.109	100.00
RUNOFF	0.000	0.000	0.00

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EVAPOTRANSPIRATION	8.223	29850.770	95.96
PERC./LEAKAGE THROUGH LAYER 2	0.003014	10.940	0.04
CHANGE IN WATER STORAGE	0.344	1247.404	4.01
SOIL WATER AT START OF YEAR	8.058	29249.146	
SOIL WATER AT END OF YEAR	8.401	30496.551	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.004	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.36	37606.805	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	10.137	36797.102	97.85
PERC./LEAKAGE THROUGH LAYER 2	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	0.223	809.710	2.15
SOIL WATER AT START OF YEAR	8.401	30496.551	
SOIL WATER AT END OF YEAR	8.624	31306.262	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.007	0.00

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.78	28241.400	100.00
RUNOFF	0.000	0.000	0.00

5h

EVAPOTRANSPIRATION	8.167	29645.734	104.97
PERC./LEAKAGE THROUGH LAYER 2	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	-0.387	-1404.339	-4.97
SOIL WATER AT START OF YEAR	8.624	31306.262	
SOIL WATER AT END OF YEAR	8.237	29901.922	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.005	0.00

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.20	29766.002	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	7.154	25970.750	87.25
PERC./LEAKAGE THROUGH LAYER 2	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	1.046	3795.249	12.75
SOIL WATER AT START OF YEAR	8.237	29901.922	
SOIL WATER AT END OF YEAR	9.023	32752.676	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.260	944.495	3.17
ANNUAL WATER BUDGET BALANCE	0.0000	0.004	0.00

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.46	27079.803	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	8.640	31362.828	115.82

PERC./LEAKAGE THROUGH LAYER 2	0.017125	62.163	0.23
CHANGE IN WATER STORAGE	-1.197	-4345.196	-16.05
SOIL WATER AT START OF YEAR	9.023	32752.676	
SOIL WATER AT END OF YEAR	7.452	27050.932	
SNOW WATER AT START OF YEAR	0.260	944.495	3.49
SNOW WATER AT END OF YEAR	0.634	2301.042	8.50
ANNUAL WATER BUDGET BALANCE	0.0000	0.009	0.00

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	5.83	21162.902	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	6.171	22400.824	105.85
PERC./LEAKAGE THROUGH LAYER 2	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	-0.341	-1237.930	-5.85
SOIL WATER AT START OF YEAR	7.452	27050.932	
SOIL WATER AT END OF YEAR	7.582	27522.836	
SNOW WATER AT START OF YEAR	0.634	2301.042	10.87
SNOW WATER AT END OF YEAR	0.163	591.209	2.79
ANNUAL WATER BUDGET BALANCE	0.0000	0.008	0.00

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.35	26680.502	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	6.669	24209.432	90.74

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PERC./LEAKAGE THROUGH LAYER 2	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	0.681	2471.069	9.26
SOIL WATER AT START OF YEAR	7.582	27522.836	
SOIL WATER AT END OF YEAR	8.309	30162.926	
SNOW WATER AT START OF YEAR	0.163	591.209	2.22
SNOW WATER AT END OF YEAR	0.116	422.187	1.58
ANNUAL WATER BUDGET BALANCE	0.0000	0.001	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.44	0.44	0.65	0.81	0.75	0.52
	0.39	1.08	0.58	1.00	0.94	0.54
STD. DEVIATIONS	0.23	0.30	0.31	0.44	0.53	0.63
	0.30	0.48	0.44	0.63	0.52	0.31
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.440	0.536	0.624	0.720	0.941	1.161
	0.512	0.979	0.483	0.735	0.587	0.451
STD. DEVIATIONS	0.214	0.265	0.279	0.353	0.546	0.558
	0.398	0.510	0.397	0.632	0.250	0.226
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0000	0.0000	0.0001	0.0010	0.0009	0.0008
	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0004	0.0024	0.0020	0.0017
	0.0000	0.0000	0.0000	0.0000	0.0014	0.0000

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8/9

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET	PERCENT
PRECIPITATION	8.16	(1.320)	29628.1	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	8.169	(1.5803)	29654.79	100.090
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.00328	(0.00628)	11.896	0.04015
CHANGE IN WATER STORAGE	-0.011	(0.7880)	-38.63	-0.130

*

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	0.86	3121.800
RUNOFF	0.000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.002888	10.48416
SNOW WATER	0.72	2615.3926

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2313

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1040

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	6.9773	0.1938
2	1.3320	0.2220
SNOW WATER	0.116	

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9/h

From: <GCorcoran@Geosyntec.com>
To: <DRUPP@utah.gov>, <hroberts@denisonmines.com>, <Ssnyder@denisonmines.com...
CC: <JCox@Geosyntec.com>, <LMORTON@utah.gov>
Date: 7/2/08 5:42 PM
Subject: RE: DUSA Cell 4A Construction: Two Items noted.
Attachments: Slimes Drain Drainage.070208.pdf

Dave,
I have revised the calculations presented in the Analysis of Slimes Drain included in the Cell 4A Interrogatories. The original calculation was based on an area for flow to pass into the strip composite of 14 inches per foot of length (12 inches across the top and two sides at 1 inch each). This calculation, using the maximum liquid depth resulted in a drainage time of approximately 5.5 years.
The sand bag coverage issue likely only impacts a discreet amount of the sides of the strip composite (probably much less than 10%). However, taking a conservative approach, I assumed that all two inches of the sides of the entire strip composite is not available for flow. Incorporating the 12 inches per foot of length flow area into the maximum liquid level model calculation results in a drainage time of approximately 6.4 years (see attached), an increase of approximately 0.9 years. Given that the relationship is linear, one can interpolate between 5.5 and 6.4 years to estimate the impact of the percentage of strip composite sides that are not covered by sand bags. If this value is 10%, one can estimate that the drainage time would be approximately 5.6 years (0.9 years x 10% + 5.5 years).
We believe that this minor change meets the design intent.
Please let us know if you have additional comments, and confirm that this addresses your concerns.
Regards,
Greg

From: Dave Rupp [mailto:DRUPP@utah.gov]
Sent: Wednesday, July 02, 2008 1:54 PM
To: hroberts@denisonmines.com; Ssnyder@denisonmines.com; Greg Corcoran
Cc: Jim Cox; Jephory McMichen; Loren Morton
Subject: RE: DUSA Cell 4A Construction: Two Items noted.

Greg,
Thanks for your response. As I view section C-5 of the drawings, the sandbags drape over the both edges of the strip-drain, and preclude access to the edge and top of the strip-drain by the tailings. This will be a criterion we will use in inspecting for conformance to the existing plans.
The first photograph DRC sent on 6-25-08 regarding this problem shows six openings through the sandbags to the strip-drain surfaces. It appears that if the existing bags are only centered with respect to the strip-drain, the coverage will not achieve conformance to the drawing section C-5.
The design intent was to fully protect the strip-drain from clogging. Therefore, DUSA needs to make the necessary adjustments to conform to the drawings, or submit an alternative design proposal to accomplish the design intent. - -

David A. Rupp, P.E.
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>>> <GCorcoran@Geosyntec.com> 7/1/2008 1:50 PM >>>
Dave,
Over the past few days, the contractor has repositioned sand bags over the slimes drain to address this issue, and bring the installation into compliance with the design drawings and specifications. We believe this fully addresses your earlier concerns.
Please let us know if you have additional comments, and confirm that this addresses your concerns.
Regards,
Greg

From: Dave Rupp [mailto:DRUPP@utah.gov]
Sent: Tuesday, July 01, 2008 6:41 AM
To: hroberts@denisonmines.com; Ssnyder@denisonmines.com; Greg Corcoran
Cc: Jim Cox; Jephory McMichen; Loren Morton
Subject: RE: DUSA Cell 4A Construction: Two Items noted.

Greg,
I am fine with your explanation of the waves in the geomembrane and strip-drain.

However, regarding the overfilled sandbags creating incomplete coverage over the strip-drains, DUSA needs to either:
1). Provide revised calculations showing the new time required for completion of the drainage of the tailings through the slimes drain, at the time of cell closure. This is critical, given the existing configuration which departs from the approved design, in which

portions of the strip-drain would now be compromised by invasion of the strip-drains by slimes material, and the corresponding reduction of flow into the collection pipe, or
2). Provide proposed design or field construction adjustments to prevent this problem, with corresponding calculations as necessary to demonstrate the effectiveness of the adjustments.

We cannot agree with your claim that when the cell is loaded the sandbags will settle and the problem may resolve itself, because there will be no practical means available to verify this claim. Without such verification DUSA has an obligation to prevent the problem now.

Please be advised that the As-built Report cannot be approved without prior resolution of this construction problem. - -

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>>> <GCorcoran@Geosyntec.com> 6/25/2008 1:30 PM >>>
Dave,
The waves in the geomembrane are a result of expanding geomembrane (thermal expansion due to increasing daytime temperatures) and the "plastic memory" in the underlying geonet. The plastic memory results from the manufacturing process, which uses an extrusion process consisting of extruding molten plastic through counter-rotating, round dies. As the plastic geonet is formed, it exits the die as a round column. As the plastic net cools in the column, the plastic develops a slight "memory" of this shape. After the column is cut and laid flat to form the geonet rolls, the geonet "remembers" that it was once a column or tube shape and when laid flat exhibits some minor curling of the edges. This is not detrimental to the geonet, but just creates minor curling of the edges that are easily laid flat with a small normal load on the surface.
The waves will lay down once the sand bags are put in place between the header pipe and the lateral. The filling of the cell with liquids will provide a relatively uniform liner system temperature, thereby reducing the thermal expansion due to elevated daytime air temperature. The material in the cell, whether liquid or solid, will also provide ballast that will get the waves to lay down, especially the underlying geonet with its "plastic memory". Remember that the slimes drain system will not be operated until the cell is filled with tailings.
The section on the drawings does show that the sand bag drapes over the strip composite. However, some of the sandbags were overfilled and leave a small gap at the sides of the strip composite. We do not believe that this causes any problems with the intent of the slimes drain design. Furthermore, we believe that the sand bags will settle in a bit more once the liquid loading is in the cell. The sand bags were designed to provide a sand layer that would act as a filtration layer in addition to the filter geotextile on the strip composite. The bags themselves were only required as a means to get the sand on top of the strip composite. In addition, the sand in the sand bags will convey liquid to the header pipe as the bags are placed in a continuous line.
Please let us know if you have additional comments, and confirm that this addresses your concerns.
Regards,
Greg

From: Dave Rupp [mailto:DRUPP@utah.gov]
Sent: Wednesday, June 25, 2008 8:08 AM
To: hroberts@denisonmines.com; Ssnyder@denisonmines.com
Cc: Greg Corcoran; Jephory McMichen; Loren Morton
Subject: DUSA Cell 4A Construction: Two Items noted.

Harold/Steve:
On a site visit last Friday, I had two items of concern I wanted to point out for your resolution.
The main one is the covering by the sand bags on the strip drains. Incomplete covering of the drains is seen now, and does not conform to the drawings, which show the bags completely covering the drains. On site I spoke with Messrs. D.Turk of DUSA and J.McMichen of GeoSyntec regarding this.
The other item is the inconsistent grade of the last few feet of some of the strip-drains near their connection to the herring backbone interceptor piping. The is grade waving, which if left would impede the flow from the strip-drain into the piping.
These items are illustrated in the attached photos. These items will need to be resolved prior to DRC final acceptance. Please contact me if you have questions. - -
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TABLE 3
White Mesa Mill
Cell 4A Slimes Drain
Maximum Liquid Depth

Permeability (cm/sec)	Permeability (ft/min)	Drainage Path Length (ft.)	Thickness (VF)	Q (cfm/ft)	Volume of Liquid (CF/ft)	Time to Dewater (min/VF/ft)	Time to Dewater (days/VF/ft)	Total Flow Rate (gpm)	Volume Removed (gal)	Pipe Limitation (days)
3.31E-04	6.51E-04	46.3	39	5.49E-04	11	20,049	13.92	113.07	2,266,966	0.18
3.31E-04	6.51E-04	45.8	38	5.40E-04	11	20,354	14.13	111.38	2,266,966	
3.31E-04	6.51E-04	45.4	37	5.31E-04	11	20,722	14.39	109.40	2,266,966	
3.31E-04	6.51E-04	45.0	36	5.21E-04	11	21,110	14.66	107.39	2,266,966	
3.31E-04	6.51E-04	44.6	35	5.11E-04	11	21,520	14.94	105.34	2,266,966	
3.31E-04	6.51E-04	44.2	34	5.01E-04	11	21,954	15.25	103.26	2,266,966	
3.31E-04	6.51E-04	43.8	33	4.91E-04	11	22,415	15.57	101.14	2,266,966	
3.31E-04	6.51E-04	43.5	32	4.79E-04	11	22,957	15.94	98.75	2,266,966	
3.31E-04	6.51E-04	43.2	31	4.67E-04	11	23,534	16.34	96.33	2,266,966	
3.31E-04	6.51E-04	43.0	30	4.54E-04	11	24,206	16.81	93.65	2,266,966	
3.31E-04	6.51E-04	42.8	29	4.41E-04	11	24,924	17.31	90.96	2,266,966	
3.31E-04	6.51E-04	42.6	28	4.28E-04	11	25,694	17.84	88.23	2,266,966	
3.31E-04	6.51E-04	42.4	27	4.15E-04	11	26,520	18.42	85.48	2,266,966	
3.31E-04	6.51E-04	42.3	26	4.00E-04	11	27,475	19.08	82.51	2,266,966	
3.31E-04	6.51E-04	42.2	25	3.86E-04	11	28,507	19.80	79.52	2,266,966	
3.31E-04	6.51E-04	42.1	24	3.71E-04	11	29,624	20.57	76.52	2,266,966	
3.31E-04	6.51E-04	42.1	23	3.56E-04	11	30,912	21.47	73.34	2,266,966	
3.31E-04	6.51E-04	42.1	22	3.40E-04	11	32,317	22.44	70.15	2,266,966	
3.31E-04	6.51E-04	42.1	21	3.25E-04	11	33,856	23.51	66.96	2,266,966	
3.31E-04	6.51E-04	42.2	20	3.09E-04	11	35,633	24.75	63.62	2,266,966	
3.31E-04	6.51E-04	42.3	19	2.93E-04	11	37,598	26.11	60.30	2,266,966	
3.31E-04	6.51E-04	42.5	18	2.76E-04	11	39,874	27.69	56.85	2,266,966	
3.31E-04	6.51E-04	42.6	17	2.60E-04	11	42,319	29.39	53.57	2,266,966	
3.31E-04	6.51E-04	42.8	16	2.43E-04	11	45,175	31.37	50.18	2,266,966	
3.31E-04	6.51E-04	43.1	15	2.27E-04	11	48,524	33.70	46.72	2,266,966	
3.31E-04	6.51E-04	43.3	14	2.11E-04	11	52,231	36.27	43.40	2,266,966	
3.31E-04	6.51E-04	43.6	13	1.94E-04	11	56,639	39.33	40.02	2,266,966	
3.31E-04	6.51E-04	44.0	12	1.78E-04	11	61,922	43.00	36.61	2,266,966	
3.31E-04	6.51E-04	44.3	11	1.62E-04	11	68,012	47.23	33.33	2,266,966	
3.31E-04	6.51E-04	44.7	10	1.46E-04	11	75,488	52.42	30.03	2,266,966	
3.31E-04	6.51E-04	45.1	9	1.30E-04	11	84,626	58.77	26.79	2,266,966	
3.31E-04	6.51E-04	45.6	8	1.14E-04	11	96,260	66.85	23.55	2,266,966	
3.31E-04	6.51E-04	46.0	7	9.91E-05	11	110,977	77.07	20.43	2,266,966	
3.31E-04	6.51E-04	46.5	6	8.40E-05	11	130,880	90.89	17.32	2,266,966	
3.31E-04	6.51E-04	47.1	5	6.91E-05	11	159,083	110.47	14.25	2,266,966	
3.31E-04	6.51E-04	47.6	4	5.47E-05	11	200,964	139.56	11.28	2,266,966	
3.31E-04	6.51E-04	48.2	3	4.05E-05	11	271,330	188.42	8.36	2,266,966	
3.31E-04	6.51E-04	48.8	2	2.67E-05	11	412,062	286.15	5.50	2,266,966	
3.31E-04	6.51E-04	49.4	1	1.32E-05	11	834,256	579.34	2.72	2,266,966	
						days	**2,321.18**		**88,411,655**	**0.18**
						years	**6.36**			

Average Soil Porosity	0.22	
Geomean Soil Permeability	3.31E-04	cm/sec
Distance Between Drains	50	ft
Thickness of Unit	1	ft
Maximum Depth	39	ft
Length of Strip Drain	27,550	ft

Geosyntec
consultants

COMPUTATION COVER SHEET

Client:	Denison Mines	Project:	White Mesa Mill – Cell 4B	Project/ Proposal No.:	SC0349-01
				Task No.	04

Title of Computations: **ANALYSIS OF SLIMES DRAIN**

Computations by:	Signature	[signature]	Date: 11/30/07
	Printed Name	Rebecca Flynn	
	Title	Senior Staff Engineer	
Assumptions and Procedures Checked by: (peer reviewer)	Signature	[signature]	Date: 12/3/07
	Printed Name	Gregory T. Corcoran	
	Title	Principal	
Computations Checked by:	Signature	[signature]	Date: 12/3/07
	Printed Name	Gregory T. Corcoran	
	Title	Principal	
Computations backchecked by: (originator)	Signature	[signature]	Date: 11/30/07
	Printed Name	Rebecca Flynn	
	Title	Senior Staff Engineer	
Approved by: (pm or designate)	Signature	[signature]	Date: 12/3/07
	Printed Name	Gregory T. Corcoran	
	Title	Principal	

Approval notes:

Revisions (number and initial all revisions)

No.	Sheet	Date	By	Checked by	Approval

Written by:	R. Flynn	Date:	08/30/07	Reviewed by:	G. Corcoran	Date:	
Client:	Denison Mines	Project:	White Mesa Mill – Cell 4B	Project/ Proposal No.:	SC0349-01	Task No.:	04

PURPOSE AND METHOD OF ANALYSIS

The purpose of this calculation package is to demonstrate that the proposed "slimes drain system" will dewater the tailings at the site within a reasonable time.

Fluid flow rate in porous media will be evaluated using Darcy's law.

ASSUMPTIONS

- This project involves the construction of a 42 acre double lined tailings cell (Cell 4B) that is approximately 42 feet deep at its deepest point and 31 feet deep at the shallowest point with an average depth of 35 feet. The liquids level in the cell will be kept a minimum of 3 feet below the top of the berm (free-board). Therefore, the maximum depth of liquid in the cell will be 39 feet at the start of dewatering.
- The cell will be filled with -28 mesh (US No. 30 sieve) tailings, largely consisting of fine sands and silts, with some clay. Results of grinding test sieve analyses, which are reported based on Tyler Mesh sieve sizes, are presented in Table 1. The grinding test data report is presented in Attachment A. Sieve to Tyler Mesh conversions are presented in Attachment B.
- The tailings will be placed within the cell in a slurry form under the surface of the free liquid contained within the cell. This placement methodology is anticipated to result in a low density (no compaction) soil structure. Therefore, saturated hydraulic conductivity and total porosity are anticipated to be higher than similar soils that are compacted.
- Based on the grinding report (Attachment A), tailings are comprised of approximately 6% medium sand, 49% fine sand, and 45% silt and clay size particles (Table 1).
- Based on the gradation of the tailings (Table 1) from the grinding report (Attachment A), the tailings would be classified as silty sand (SM) by the unified soil classification system (USCS). According to the Hydrologic Evaluation of Landfill Performance (HELP) Model Engineering Documentation (Attachment C), **low density** SM soils would exhibit saturated hydraulic

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Client:	Denison Mines	Project:	White Mesa Mill – Cell 4B	Project/ Proposal No.:	SC0349-01	Task No.:	04

conductivities of between $1.7x10^{-3}$ cm/sec and $5.2x10^{-4}$ cm/sec and **low density** silt (ML) and sandy clay (SC) would exhibit saturated hydraulic conductivities of between $3.7x10^{-4}$ cm/sec and $1.2x10^{-4}$ cm/sec. The geomean of these two groups of soils, which are gradationally similar to the tailings, is $4.74x10^{-4}$ cm/sec (Table 2). According to Cedergren (Attachment D), under a normal stress of 2 tons per square foot (approximate normal stress on deeper tailings in the cell), medium sand, fine sand, silt, and silty clay would exhibit a saturated hydraulic conductivities of approximately $2x10^{-2}$ cm/sec, $1x10^{-2}$ cm/sec, $1x10^{-4}$ cm/sec $5x10^{-7}$ cm/sec, respectively. The geomean of these three soil types, where are gradationally similar to the tailings, is $3.31x10^{-4}$ cm/sec. The more conservative, lower hydraulic conductivity of $3.31x10^{-4}$ cm/sec, will be used in this analysis.

- Based on the gradation of the tailings from the grinding report, the tailings would be classified as silty sand (SM) by the unified soil classification system (USCS). According to the HELP Model Engineering Documentation (Attachment C), **low density** SM soils would exhibit drainable porosity of between 0.251 and 0.332 and **low density** silt (ML) and sandy clay (SC) would exhibit drainable porosity of between 0.154 and 0.231. The average of these two groups of soils, which are gradationally similar to the tailings, is 0.253 (Table 2). According to the HELP Model Engineering Documentation, medium sand, fine sand, silt, and silty clay would exhibit drainable porosity values of 0.35, 0.29, 0.14, and 0.11, respectively. The average of these three soil types, where are gradationally similar to the tailings, is 0.22. Since the average drainable porosity of 0.22 corresponds to the lower hydraulic conductivity (higher density, lower permeability, lower porosity) selected above, this value will be used in this analysis.
- The permeability of the tailings is isotropic.
- Darcy's law will be used to compute groundwater flow velocities.
- The proposed slimes drain system will consist of a series of strip drains (geotextile wrapped HDPE core, 1" thick, 12" wide, with a transmissivity of 29 (gal/min/ft), which connect to a perforated 4" diameter PVC header pipe that

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is bedded in drainage aggregate and wrapped in a woven geotextile. The PVC pipe will convey the liquid to the sump for removal.

- The slimes drain spacing will be 50' and will be continuous across the base of the cell (Figure 1).

CALCULATIONS

The flow geometry for the average depth of liquid within the cell is illustrated on Figure 2 and used to compute the emptying time for the proposed slimes drain system.

Calculate the flow into a unit length of strip drain for the various hydraulic gradient conditions.

At the start of cell dewatering, the maximum depth of liquid will vary between 31 feet at the shallow end and 39 feet at the deep end, with an average depth of approximately 35 feet. As the water level drops within the cell, the length of the longest flow path and the associated hydraulic gradient will continually change with time.

The total volume to be drained by a unit length of strip, Q, can be calculated using Darcy's law as follows:

$$Q = kiA$$

where:

k = hydraulic conductivity of tailings = 3.31×10^{-4} cm/sec = 6.51×10^{-4} ft/min

i = gradient along flowpath = $\frac{dh}{dl} = \frac{35}{40.6} = 0.86$ (see Figure 2)

A = area of strip drain where flow will pass = 1.17 ft^2/ft (see Figure 3)

$$Q = (6.51 \times 10^{-4} \frac{ft}{\min})(0.86)(1.17\ ft^2)$$

$$Q = 6.55x10^{-4} \frac{ft^3}{\min} \times 7.48 \frac{gal}{ft^3} = 4.9x10^{-3} \frac{gal}{\min}$$

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For each one foot incremental drop in fluid elevation within the cell, the total volume to be drained by a unit length of strip drain is as follows:

V = 1 ft unit length x 1ft depth x 50 ft width x 0.022 (drainable porosity) = 11 ft^3 of free liquid

Therefore, the time to drain the first one foot of liquid within the cell can be estimated as follows:

$t = V/Q = 11\ ft^3 / 6.55\times10^{-4}\ ft^3/min = 16{,}793$ minutes = 11.66 days

Tables 3, 4, and 5 depict the calculations for the maximum (39 feet), average (35 feet), and minimum (31 feet) cell liquid depth, respectively. The results of the maximum depth calculations indicate that the proposed slimes drain system will allow the tailings contained in Cell 4B to drain within approximately 5.45 years.

Calculate the design flow rate of the strip drains.

For this calculation we will assume that the strip drains have a flow rate of 29 gallon per minute per foot (Attachment E, GDE Multi-Flow, 2006), a width of 12" and that flow is occurring under a gradient of 0.01.

Design Flow rate of strip drains:

$$q = \Theta i$$

where:

q = flowrate per unit width

$$i = \frac{dh}{dl} = 0.01$$

Θ = transmissivity = 29 gpm/ft

To account for detrimental effects on the geonet such as chemical clogging, biological clogging, installation defects, and creep, partial factors of safety were used to reduce the strip drain transmissivity. Using recommended partial factor of safety values from Koerner (1999) (Attachment F, 2/4), the reduced transmissivity is calculated as follows:

Written by:	R. Flynn	Date:	08/30/07	Reviewed by:	G. Corcoran	Date:	12/3/07
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$$\Theta_{allow} = \Theta_{ult}\left[\frac{1}{FS_{IN} \times FS_{CR} \times FS_{CC} \times FS_{BC}}\right]$$

where:

Θ_{allow} = allowable flow

$\Theta_{ultimate}$ = calculated value of flow

FS_{IN} = factor of safety for installation, 1.5 (CQA performed during installation)

FS_{CR} = factor of safety for creep, 2.0

FS_{CC} = factor of safety for chemical clogging, 2.0

FS_{BC} = factor of safety for biological clogging, 1.0 (low pH precludes biological activity)

The factors of safety are used to calculate the allowable transmissivity:

$$\Theta_{allow} = 29\frac{gpm}{ft}\left[\frac{1}{1.5 \times 2.0 \times 2.0 \times 1.0}\right] = 4.83\frac{gpm}{ft}$$

Using this transmissivity value, the average factor of safety for flow in the strip composite is estimated to be as follows:

$$FS = \frac{Q_D}{Q_R} = \frac{4.83\ gpm}{0.0049\ gpm} = 986 \quad \text{(Acceptable)}$$

The average allowable flow rate is much larger than the average maximum flow rate, even with the built-in partial factors of safety. Furthermore, as indicated on Tables 3, 4, and 5, the calculated flow rate within the strip drain decreases with time, which further increases the factor of safety.

Written by:	R. Flynn	Date:	08/30/07	Reviewed by:	G. Corcoran	Date:	12/3/07
Client:	Denison Mines	Project:	White Mesa Mill – Cell 4B	Project/ Proposal No.:	SC0349-01	Task No.:	04

Calculate the minimum required AOS and permittivity for filtration geotextile component of strip drain

The geotextile serves as a filter between the strip composite core and the tailings material. The geotextile minimizes fine particles of the tailings material from migrating into the strip composite, yet allows water to penetrate. Migration of fine particles would have the adverse effect of decreasing the transmissivity of the strip composite layer.

To be conservative in these calculations, the tailings material soil is assumed to consist of more than 20 percent clay.

The retention requirements for geotextiles can be evaluated using the chart entitled "Soil Retention Criteria for Steady-State Flow Conditions" developed by Luettich et al., (1991) (Attachment G, 1/3). This chart uses soil properties to evaluate the required apparent opening size (AOS or O_{95}) of the geotextile. Using the Soil Retention Chart, the AOS of the filter fabrics shall be:

$O_{95} < 0.21$ mm, which corresponds to sieve No. 70.

The permeability of the filter fabric must be evaluated to allow flow through the filter fabric. The following equation can be used to evaluate the minimum allowable geotextile permeability:

$k_g > i_s k_s$ (Luettich et al. (1991), Att. G, 2/3)

where: k_g = permeability of geotextile (cm/s)
i_s = hydraulic gradient (dimensionless)
k_s = permeability of the tailings material (cm/s)

Hydraulic Gradient, i: Attachment G, page 3/3 from Luettich et al. (1991) lists typical hydraulic gradients for various geotextile drainage applications. In this attachment, a hydraulic gradient of 10 for liquid impoundment applications is recommended.

Soil Permeability, k_s: A permeability of 3.31×10^{-4} cm/s was assumed for the tailings material, as previously defined.

Written by:	R. Flynn	Date:	08/30/07	Reviewed by:	G. Corcoran	Date:	12/3/07
Client:	Denison Mines	Project:	White Mesa Mill – Cell 4B	Project/ Proposal No.:	SC0349-01	Task No.:	04

Therefore,

$k_g >$ $i_s k_s = (10)(3.31 \times 10^{-4}$ cm/s)
$k_g >$ 3.31×10^{-3} cm/s

Koerner (1999) suggests applying partial factors of safety to the ultimate flow capacity of the geotextile to account for clogging of the geotextile. Using recommendations given in Table 2.12 on p. 150 of Koerner (1999) (Attachment F, 1/4), the following partial safety values were applied:

soil clogging and blinding:	10 (5 – 10)
creep reduction of voids:	2.0 (1.5 – 2.0)
intrusion into voids:	1.2 (1.0 – 1.2)
chemical clogging:	1.5 (1.2 – 1.5)
biological clogging (low pH precludes biological activity):	1.0 (2 – 10)

Therefore,

$k_g >$ $(3.31 \times 10^{-3})(10)(2)(1.2)(1.5)(1)$
$k_g >$ 0.12 cm/s

The thickness of a typical nonwoven needled punched 4 oz/yd^2 (135 g/m^2) geotextile is approximately 40 mils (0.10 cm), see Attachment H. Dividing the permeability by the thickness of the geotextile results in a required minimum permittivity of 1.2 sec^{-1}. The geotextile used in this project has a permittivity of 2.0 sec^{-1}, which is greater than the required permittivity.

Check Pipe Flow Rate

Based on calculations from previous sections, the maximum daily flow rate to the sump is estimated to be 144 gpm (0.32 cfs) (Table 3). The capacity of the pipe is calculated based on Manning's equation for gravity flow as follows:

$$Q = \frac{1.486}{n} R_h^{2/3} S^{1/2} A$$

Where

n = 0.010 (Koerner (1999), Attachment F, 4/4)
S = Slope of liner (ft/ft) = 1.0 %

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R_h = hydraulic radius, ft
Q = flow rate, cubic feet per second, ft^3/s
A = flow area, ft^2

Assuming 4-inch pipe:
$A = \pi D^2/4$ = 12.6 sq. inches = 0.088 ft^2
R_h = Area ($\pi D^2/4$)/Wetted Perimeter (π D)
= D/4 = 1 in = 0.083 ft

$$Q = \frac{1.486}{0.010} 0.083^{2/3} 0.01^{1/2} 0.088 \text{ ft}^2 = 0.25 \frac{\text{ft}^3}{s} = 112\ gpm$$

Since 112 gpm is less than the maximum required 144 gpm, this calculation shows that the 4-inch diameter slimes drain pipe is the limiting factor for dewatering the tailings in the early phase of dewatering (high flow rates). However, it does not mean that the pipe will be unable to handle this flow, but rather the pipe will require additional time to drain. The additional time needed is computed in the following section.

Effect of Maximum Pipe Capacity on Drainage Time

The maximum capacity of the pipe is 112 gpm, as computed above. Assuming the cell's total lateral length of strip drain is 27,550 feet, the flow rate, per foot of strip drain is calculated to be:

$$\text{Flow Rate} = \frac{112\ gallon}{\text{min}} * \frac{60\ \text{min}}{1\ hr} * \frac{24\ hr}{1\ day} * \frac{1 ft^3}{7.48\ gallon} * \frac{1}{29{,}977\ feet} = 0.72 \frac{ft^3}{day}$$

The time needed to de-water first layer is:

$$Time = \frac{Volume}{Drain\ \ length\ \times flow\ rate} = \frac{(50\ x\ 1\ x\ 1\ x\ 0.22)\ ft^3}{1\ ft \times 0.72 \frac{ft^3}{day}} = 15.27\ days$$

The difference between the maximum daily flow rate drainage time and the maximum daily flow the pipe is able to deliver for the first foot is:

15.27 day – 11.93 day (first row of Table 3) = 3.34 days.

Written by:	R. Flynn	Date:	08/30/07	Reviewed by:	G. Corcoran	Date:	12/3/07
Client:	Denison Mines	Project:	White Mesa Mill – Cell 4B	Project/ Proposal No.:	SC0349-01	Task No.:	04

Therefore, the first layer will require an additional 3.34 days to drain. The calculation is repeated until the pipe's allowable flow capacity of 112 gpm is equal to the maximum flow rate from the cell (Table 3). The additional drainage time needed for each layer is added to the original drainage time of 5.45 years. The results of this analysis are shown in Table 3.

The total additional drainage time occurs over the first 12 layers and adds 23 days (0.06 years) to the computed drainage time. Including the effects of the maximum pipe capacity, the cell will take an estimated 5.51 years to drain.

Effect of Precipitation on Drainage Time

To account for the effect of precipitation added to the tailings cell, the HELP Model was used to estimate the average annual leakage through a 3 foot thick (tailings above the liquid) layer of silty sand material (Attachment I). HELP Model default parameters were used along with a maximum 16 inch evaporative zone (conservative for dry climate) and weather data from Grand Junction, Colorado. The model was performed for a 10 year period and included precipitation events ranging from 5.83 to 10.36 inches per year.

The results of this analysis suggest that a maximum average annual percolation through the 3 foot soil layer above the liquid will be approximately 12 ft^3 per acre or 504 ft^3 (3,770 gal.) for the entire Cell 4B area of 42 acres.

The average flow rate during Cell 4B dewatering, as calculated from Table 3 is equal to 78 gpm (112,320 gallon/day).

The time required to drain the additional volume of precipitation in the tailing is computed using the following equation:

$$Time = \frac{Volume}{FlowRate} = \frac{3{,}770\ gal}{112{,}320 \frac{gal}{day}} = 0.03\ days$$

The additional time that the pond will require to empty due to precipitation is insignificant.

Written by:	R. Flynn	Date:	08/30/07	Reviewed by:	G. Corcoran	Date:	12/3/07
Client:	Denison Mines	Project:	White Mesa Mill – Cell 4B	Project/ Proposal No.:	SC0349-01	Task No.:	04

Therefore, the estimated time to dewater Cell 4B will be 5.45 years (baseline) + 0.06 years (pipe limitations) + 0.03 years (precipitation) = 5.54 years.

REFERENCES

Cedergren, H.R., "Seepage, Drainage, and Flow Nets," 3rd Ed., John Wiley & Sons, Inc., 1989
(Attachment D)

GDE Control Products, Inc. November 2006. Accessed 13 March 2007 <http://www.gdecontrol.com/Multi-Flow5.html>
(Attachment E)

Hydrologic Evaluation of Landfill Performance Model, Engineering Documentation for Version 3, EPA, 1994.
(Attachment C)

Koerner, R. M., "Designing With Geosynthetics," 4th Ed., Prentice Hall, 1999.
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Luettich, S.M., Giroud, J.P., and Bachus, R.C., (1991), "Geotextile Filter Design Manual, report prepared for Nicolon Corporation, Norcross, GA.
(Attachment G)

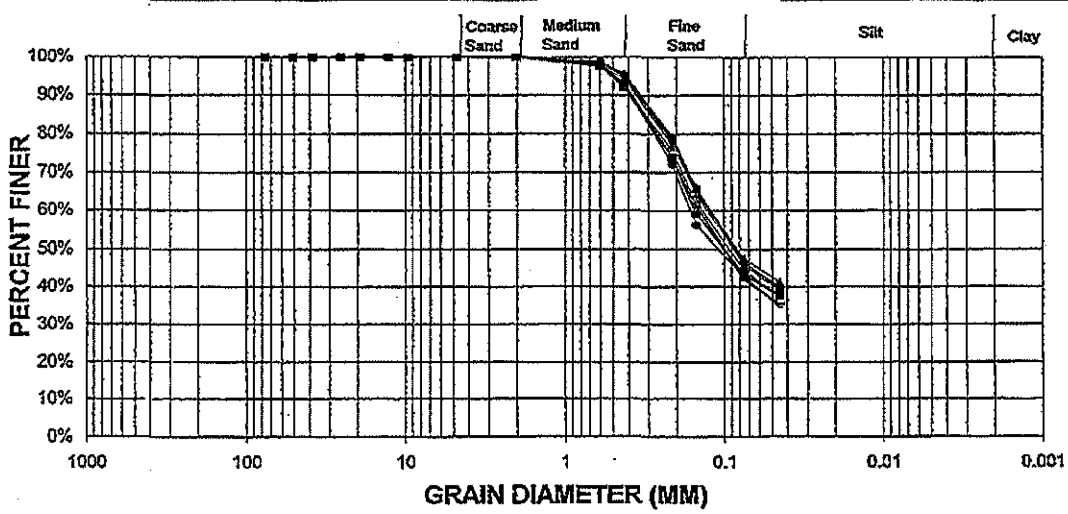
Amoco Fabrics and Fibers Company, (1991), "*Amoco Waste Related Geotextiles.*"
(Attachment H)

Table 1
DSM Screen Undersize Gradation

SIEVE ANALYSIS

		Grinding Test 1			Grinding Test 2A			Grinding Test 2B			Grinding Test 3A			Grinding Test 3B		
Sieve No.	Diameter (mm)	Wt. Retained (grams)	% Retained	% Finer	Wt. Retained (grams)	% Retained	% Finer	Wt. Retained (grams)	% Retained	% Finer	Wt. Retained (grams)	% Retained	% Finer	Wt. Retained (grams)	% Retained	% Finer
3 in.	76.2	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
2 in.	50.8	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
1 1/2 in.	38.1	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
1 in.	25.4	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
3/4 in.	19.1	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
1/2 in.	12.7	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
3/8 in.	9.530	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
No. 4	4.750	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
No. 10	2.000	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
No. 30	0.600	1.2	1.2%	98.8%	2.0	2.0%	98.0%	1.7	1.7%	98.3%	2.4	2.4%	97.6%	1.9	1.9%	98.1%
No. 40	0.425	4.6	4.6%	95.4%	7.3	7.3%	92.7%	6.0	6.0%	94.0%	8.1	8.1%	91.9%	6.9	6.9%	93.1%
No. 70	0.212	20.8	20.8%	79.2%	24.5	24.5%	75.5%	22.6	22.6%	77.4%	26.2	26.2%	73.8%	27.9	27.9%	72.1%
No. 100	0.150	34.8	34.8%	65.2%	38.1	38.1%	61.9%	35.5	35.5%	64.5%	41.0	41.0%	59.0%	43.9	43.9%	56.1%
No. 200	0.075	53.4	53.4%	46.6%	55.7	55.7%	44.3%	52.5	52.5%	47.5%	56.6	56.6%	43.4%	57.4	57.4%	42.6%
No. 325	0.045	60.5	60.5%	39.5%	62.7	62.7%	37.3%	58.8	58.8%	41.2%	62.5	62.5%	37.5%	61.9	61.9%	38.1%
Pan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

		Grinding Test 6A			Grinding Test 6B			Grinding Test 4A			Grinding Test 4B		
Sieve No.	Diameter (mm)	Wt. Retained (grams)	% Retained	% Finer	Wt. Retained (grams)	% Retained	% Finer	Wt. Retained (grams)	% Retained	% Finer	Wt. Retained (grams)	% Retained	% Finer
3 in.	76.2	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
2 in.	50.8	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
1 1/2 in.	38.1	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
1 in.	25.4	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
3/4 in.	19.1	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
1/2 in.	12.7	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
3/8 in.	9.530	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
No. 4	4.750	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
No. 10	2.000	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%	0.0	0.0%	100.0%
No. 30	0.600	1.3	1.3%	98.7%	1.0	1.0%	99.0%	2.7	2.7%	97.3%	2.7	2.7%	97.3%
No. 40	0.425	5.2	5.2%	94.8%	4.7	4.7%	95.3%	7.6	7.6%	92.4%	7.3	7.3%	92.7%
No. 70	0.212	21.7	21.7%	78.3%	21.4	21.4%	78.6%	26.2	26.2%	73.8%	25.9	25.9%	74.1%
No. 100	0.150	34.1	34.1%	65.9%	35.9	35.9%	64.1%	38.7	38.7%	61.3%	39.2	39.2%	60.8%
No. 200	0.075	54.4	54.4%	45.6%	54.4	54.4%	45.6%	57.3	57.3%	42.7%	58.3	58.3%	41.7%
No. 325	0.045	59.7	59.7%	40.3%	61.1	61.1%	38.9%	65.4	65.4%	34.6%	64.6	64.6%	35.4%
Pan	-	-	-	-	-	-	-	-	-	-	-	-	-



Average

Med Sand	6.4%
Fine Sand	49.1%
Silt	44.4%

%FINER = 100 - Σ%RETAINED

5/12/2007

Table 2
Tailings Parameters

Soil	Permeability[1] (cm/sec)	Drainable Porosity[2] (vol./vol.)
med sand	2.00E-02	0.35
fine sand	1.00E-02	0.29
silt	1.00E-04	0.14
silty clay	6.00E-07	0.11
average	7.53E-03	0.22
geomean	3.31E-04	0.20

Soil	Permeability[3] (cm/sec)	Drainable Porosity[3] (vol./vol.)
SM (LS)	1.70E-03	0.332
SM (LFS)	1.00E-03	0.326
SM (SL)	7.20E-04	0.263
SM (FSL)	5.20E-04	0.251
ML (L)	3.70E-04	0.231
ML (SiL)	1.90E-04	0.217
SC (SCL)	1.20E-04	0.154
average	6.60E-04	0.253
geomean	4.74E-04	0.246

Notes:

(1) Source - "Seepage, Drainage, and Flow Nets", Cedergren, H. R., 1989.

(2) Source - The Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 3, EPA, 1994 - Figure 2 - Soil texture vs. Moisture Retention.

(3) Source - The Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 3, EPA, 1994 - Table 1 - Low Density Soil Characteristics.

TABLE 3
White Mesa Mill
Cell 4B Slimes Drain
Maximum Liquid Depth

Permeability (cm/sec)	Permeability (ft/min)	Drainage Path Length (ft.)	Thickness (VF)	Q (cfm/ft)	Volume of Liquid (CF/ft)	Time to Dewater (min/VF/ft)	Time to Dewater (days/VF/ft)	Total Flow Rate (gpm)	Volume Removed (gal)	Pipe Limitation (days)
3.31E-04	6.51E-04	46.3	39	6.40E-04	11	17,185	11.93	143.54	2,466,685	3.34
3.31E-04	6.51E-04	45.8	38	6.31E-04	11	17,446	12.12	141.39	2,466,685	3.15
3.31E-04	6.51E-04	45.4	37	6.19E-04	11	17,761	12.33	138.88	2,466,685	2.94
3.31E-04	6.51E-04	45.0	36	6.08E-04	11	18,094	12.57	136.33	2,466,685	2.70
3.31E-04	6.51E-04	44.6	35	5.96E-04	11	18,446	12.81	133.73	2,466,685	2.46
3.31E-04	6.51E-04	44.2	34	5.85E-04	11	18,818	13.07	131.08	2,466,685	2.20
3.31E-04	6.51E-04	43.8	33	5.73E-04	11	19,213	13.34	128.39	2,466,685	1.93
3.31E-04	6.51E-04	43.5	32	5.59E-04	11	19,677	13.66	125.36	2,466,685	1.61
3.31E-04	6.51E-04	43.2	31	5.45E-04	11	20,172	14.01	122.28	2,466,685	1.26
3.31E-04	6.51E-04	43.0	30	5.30E-04	11	20,748	14.41	118.89	2,466,685	0.86
3.31E-04	6.51E-04	42.8	29	5.15E-04	11	21,363	14.84	115.46	2,466,685	0.43
3.31E-04	6.51E-04	42.6	28	4.99E-04	11	22,023	15.29	112.00	2,466,685	(0.02)
3.31E-04	6.51E-04	42.4	27	4.84E-04	11	22,731	15.79	108.51	2,466,685	
3.31E-04	6.51E-04	42.3	26	4.67E-04	11	23,550	16.35	104.74	2,466,685	
3.31E-04	6.51E-04	42.2	25	4.50E-04	11	24,434	16.97	100.95	2,466,685	
3.31E-04	6.51E-04	42.1	24	4.33E-04	11	25,392	17.63	97.14	2,466,685	
3.31E-04	6.51E-04	42.1	23	4.15E-04	11	26,496	18.40	93.10	2,466,685	
3.31E-04	6.51E-04	42.1	22	3.97E-04	11	27,700	19.24	89.05	2,466,685	
3.31E-04	6.51E-04	42.1	21	3.79E-04	11	29,019	20.15	85.00	2,466,685	
3.31E-04	6.51E-04	42.2	20	3.60E-04	11	30,543	21.21	80.76	2,466,685	
3.31E-04	6.51E-04	42.3	19	3.41E-04	11	32,226	22.38	76.54	2,466,685	
3.31E-04	6.51E-04	42.5	18	3.22E-04	11	34,178	23.73	72.17	2,466,685	
3.31E-04	6.51E-04	42.6	17	3.03E-04	11	36,273	25.19	68.00	2,466,685	
3.31E-04	6.51E-04	42.8	16	2.84E-04	11	38,721	26.89	63.70	2,466,685	
3.31E-04	6.51E-04	43.1	15	2.64E-04	11	41,592	28.88	59.31	2,466,685	
3.31E-04	6.51E-04	43.3	14	2.46E-04	11	44,770	31.09	55.10	2,466,685	
3.31E-04	6.51E-04	43.6	13	2.27E-04	11	48,548	33.71	50.81	2,466,685	
3.31E-04	6.51E-04	44.0	12	2.07E-04	11	53,076	36.86	46.47	2,466,685	
3.31E-04	6.51E-04	44.3	11	1.89E-04	11	58,296	40.48	42.31	2,466,685	
3.31E-04	6.51E-04	44.7	10	1.70E-04	11	64,704	44.93	38.12	2,466,685	
3.31E-04	6.51E-04	45.1	9	1.52E-04	11	72,537	50.37	34.01	2,466,685	
3.31E-04	6.51E-04	45.6	8	1.33E-04	11	82,509	57.30	29.90	2,466,685	
3.31E-04	6.51E-04	46.0	7	1.16E-04	11	95,123	66.06	25.93	2,466,685	
3.31E-04	6.51E-04	46.5	6	9.81E-05	11	112,183	77.90	21.99	2,466,685	
3.31E-04	6.51E-04	47.1	5	8.07E-05	11	136,357	94.69	18.09	2,466,685	
3.31E-04	6.51E-04	47.6	4	6.39E-05	11	172,255	119.62	14.32	2,466,685	
3.31E-04	6.51E-04	48.2	3	4.73E-05	11	232,569	161.51	10.61	2,466,685	
3.31E-04	6.51E-04	48.8	2	3.11E-05	11	353,196	245.27	6.98	2,466,685	
3.31E-04	6.51E-04	49.4	1	1.54E-05	11	715,076	496.58	3.45	2,466,685	
						days	1,989.58		96,200,703	22.86
						years	5.45			

Average Soil Porosity	0.22	
Geomean Soil Permeability	3.31E-04	cm/sec
Distance Between Drains	50	ft
Thickness of Unit	1	ft
Maximum Depth	39	ft
Length of Strip Drain	29,977	ft

TABLE 4
White Mesa Mill
Cell 4B Slimes Drain
Average Liquid Depth

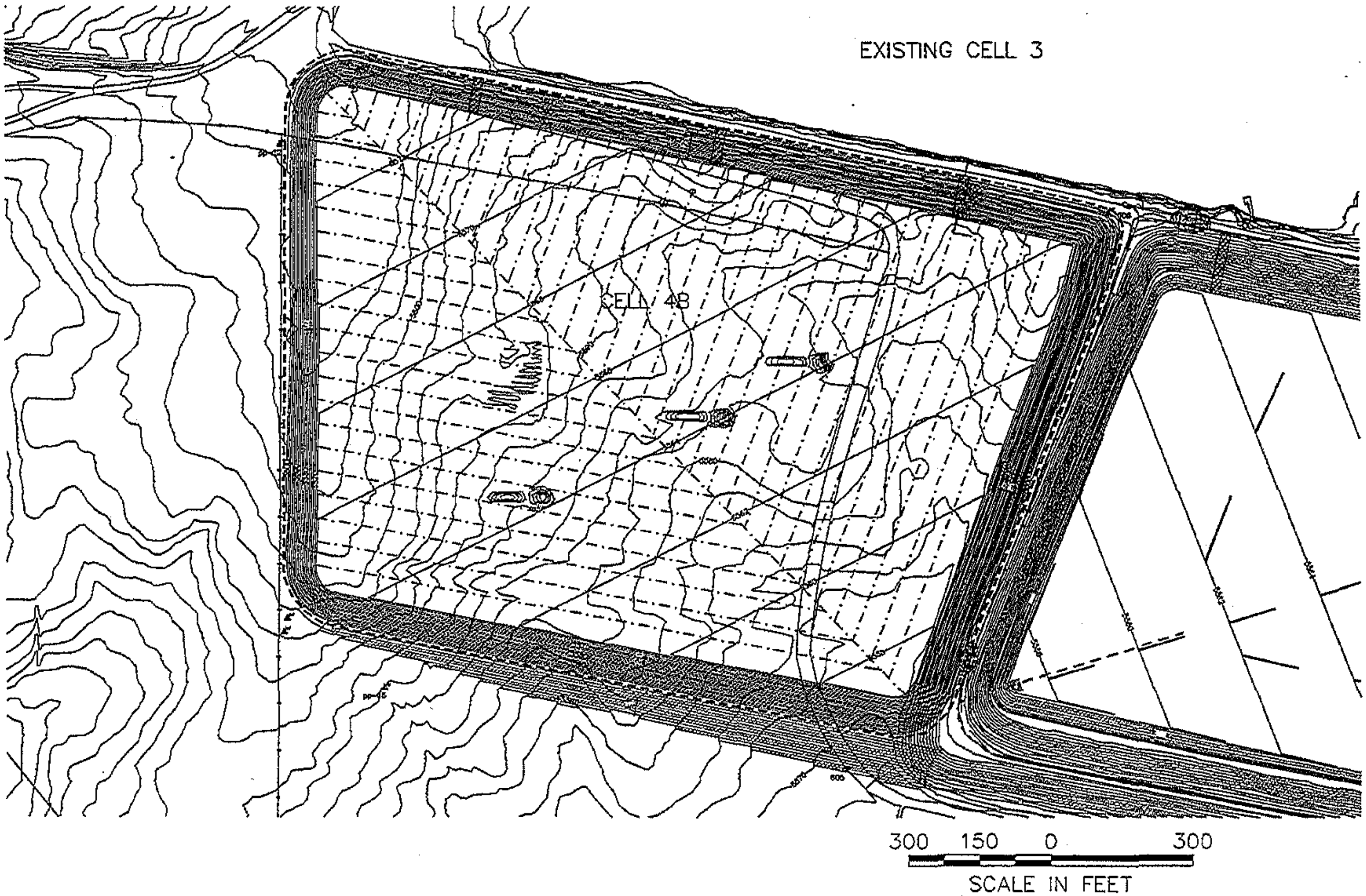
Permeability (cm/sec)	Permeability (ft/min)	Drainage Path Length (ft.)	Thickness (VF)	Q (cfm/ft)	Volume of Liquid (CF/ft)	Time to Dewater (min/VF/ft)	Time to Dewater (days/VF/ft)	Total Flow Rate (gpm)	Volume Removed (gal)
3.31E-04	6.51E-04	43.0	35	6.19E-04	11	17,784	12.35	138.70	2,466,685
3.31E-04	6.51E-04	42.6	34	6.07E-04	11	18,137	12.59	136.01	2,466,685
3.31E-04	6.51E-04	42.3	33	5.93E-04	11	18,555	12.89	132.94	2,466,685
3.31E-04	6.51E-04	42.0	32	5.79E-04	11	18,999	13.19	129.83	2,466,685
3.31E-04	6.51E-04	41.7	31	5.65E-04	11	19,472	13.52	126.68	2,466,685
3.31E-04	6.51E-04	41.4	30	5.51E-04	11	19,976	13.87	123.48	2,466,685
3.31E-04	6.51E-04	41.2	29	5.35E-04	11	20,565	14.28	119.95	2,466,685
3.31E-04	6.51E-04	41.0	28	5.19E-04	11	21,196	14.72	116.38	2,466,685
3.31E-04	6.51E-04	40.9	27	5.02E-04	11	21,927	15.23	112.49	2,466,685
3.31E-04	6.51E-04	40.8	26	4.84E-04	11	22,715	15.77	108.59	2,466,685
3.31E-04	6.51E-04	40.7	25	4.67E-04	11	23,566	16.37	104.67	2,466,685
3.31E-04	6.51E-04	40.7	24	4.48E-04	11	24,548	17.05	100.49	2,466,685
3.31E-04	6.51E-04	40.7	23	4.29E-04	11	25,615	17.79	96.30	2,466,685
3.31E-04	6.51E-04	40.7	22	4.11E-04	11	26,779	18.60	92.11	2,466,685
3.31E-04	6.51E-04	40.8	21	3.91E-04	11	28,123	19.53	87.71	2,466,685
3.31E-04	6.51E-04	40.9	20	3.72E-04	11	29,602	20.56	83.33	2,466,685
3.31E-04	6.51E-04	41.1	19	3.51E-04	11	31,312	21.74	78.78	2,466,685
3.31E-04	6.51E-04	41.3	18	3.31E-04	11	33,213	23.06	74.27	2,466,685
3.31E-04	6.51E-04	41.5	17	3.11E-04	11	35,337	24.54	69.81	2,466,685
3.31E-04	6.51E-04	41.8	16	2.91E-04	11	37,817	26.26	65.23	2,466,685
3.31E-04	6.51E-04	42.1	15	2.71E-04	11	40,627	28.21	60.72	2,466,685
3.31E-04	6.51E-04	42.4	14	2.51E-04	11	43,839	30.44	56.27	2,466,685
3.31E-04	6.51E-04	42.7	13	2.31E-04	11	47,546	33.02	51.88	2,466,685
3.31E-04	6.51E-04	43.1	12	2.12E-04	11	51,990	36.10	47.45	2,466,685
3.31E-04	6.51E-04	43.6	11	1.92E-04	11	57,375	39.84	42.99	2,466,685
3.31E-04	6.51E-04	44.0	10	1.73E-04	11	63,691	44.23	38.73	2,466,685
3.31E-04	6.51E-04	44.5	9	1.54E-04	11	71,572	49.70	34.46	2,466,685
3.31E-04	6.51E-04	45.0	8	1.35E-04	11	81,423	56.54	30.29	2,466,685
3.31E-04	6.51E-04	45.5	7	1.17E-04	11	94,089	65.34	26.22	2,466,685
3.31E-04	6.51E-04	46.1	6	9.89E-05	11	111,218	77.23	22.18	2,466,685
3.31E-04	6.51E-04	46.7	5	8.14E-05	11	135,199	93.89	18.24	2,466,685
						days	898.47		76,467,226
						years	2.46		

Average Soil Porosity	0.22	
Geomean Soil Permeability	3.31E-04	cm/sec
Distance Between Drains	50	ft
Thickness of Unit	1	ft
Average Depth	35	ft
Length of Strip Drain	29,977	ft

TABLE 5
White Mesa Mill
Cell 4B Slimes Drain
Minimum Liquid Depth

Permeability (cm/sec)	Permeability (ft/min)	Drainage Path Length (ft.)	Thickness (VF)	Q (cfm/ft)	Volume of Liquid (CF/ft)	Time to Dewater (min/VF/ft)	Time to Dewater (days/VF/ft)	Total Flow Rate (gpm)	Volume Removed (gal)
3.31E-04	6.51E-04	39.8	31	5.92E-04	11	18,584	12.91	132.73	2,466,685
3.31E-04	6.51E-04	39.6	30	5.76E-04	11	19,107	13.27	129.10	2,466,685
3.31E-04	6.51E-04	39.4	29	5.59E-04	11	19,666	13.66	125.43	2,466,685
3.31E-04	6.51E-04	39.2	28	5.43E-04	11	20,265	14.07	121.72	2,466,685
3.31E-04	6.51E-04	39.1	27	5.25E-04	11	20,962	14.56	117.67	2,466,685
3.31E-04	6.51E-04	39.0	26	5.07E-04	11	21,713	15.08	113.60	2,466,685
3.31E-04	6.51E-04	38.9	25	4.88E-04	11	22,523	15.64	109.52	2,466,685
3.31E-04	6.51E-04	38.9	24	4.69E-04	11	23,462	16.29	105.14	2,466,685
3.31E-04	6.51E-04	39.0	23	4.48E-04	11	24,545	17.05	100.50	2,466,685
3.31E-04	6.51E-04	39.0	22	4.29E-04	11	25,661	17.82	96.13	2,466,685
3.31E-04	6.51E-04	39.2	21	4.07E-04	11	27,020	18.76	91.29	2,466,685
3.31E-04	6.51E-04	39.3	20	3.87E-04	11	28,444	19.75	86.72	2,466,685
3.31E-04	6.51E-04	39.5	19	3.66E-04	11	30,093	20.90	81.97	2,466,685
3.31E-04	6.51E-04	39.8	18	3.44E-04	11	32,006	22.23	77.07	2,466,685
3.31E-04	6.51E-04	40.1	17	3.22E-04	11	34,145	23.71	72.24	2,466,685
3.31E-04	6.51E-04	40.4	16	3.01E-04	11	36,550	25.38	67.49	2,466,685
3.31E-04	6.51E-04	40.8	15	2.79E-04	11	39,373	27.34	62.65	2,466,685
3.31E-04	6.51E-04	41.2	14	2.58E-04	11	42,599	29.58	57.91	2,466,685
3.31E-04	6.51E-04	41.6	13	2.37E-04	11	46,321	32.17	53.25	2,466,685
3.31E-04	6.51E-04	42.1	12	2.17E-04	11	50,784	35.27	48.57	2,466,685
3.31E-04	6.51E-04	42.6	11	1.96E-04	11	56,059	38.93	44.00	2,466,685
3.31E-04	6.51E-04	43.1	10	1.76E-04	11	62,388	43.33	39.54	2,466,685
3.31E-04	6.51E-04	43.7	9	1.57E-04	11	70,285	48.81	35.10	2,466,685
						days	536.50		56,733,748
						years	1.47		

Average Soil Porosity	0.22	
Geomean Soil Permeability	3.31E-04	cm/sec
Distance Between Drains	50	ft
Thickness of Unit	1	ft
Maximum Depth	31	ft
Length of Strip Drain	29,977	ft



SLIMES DRAIN LAYOUT
CELL 4B
BLANDING, UTAH

Geosyntec consultants	DATE: SEPTEMBER 2007	FIGURE 1
	PROJECT NO. SC0349	

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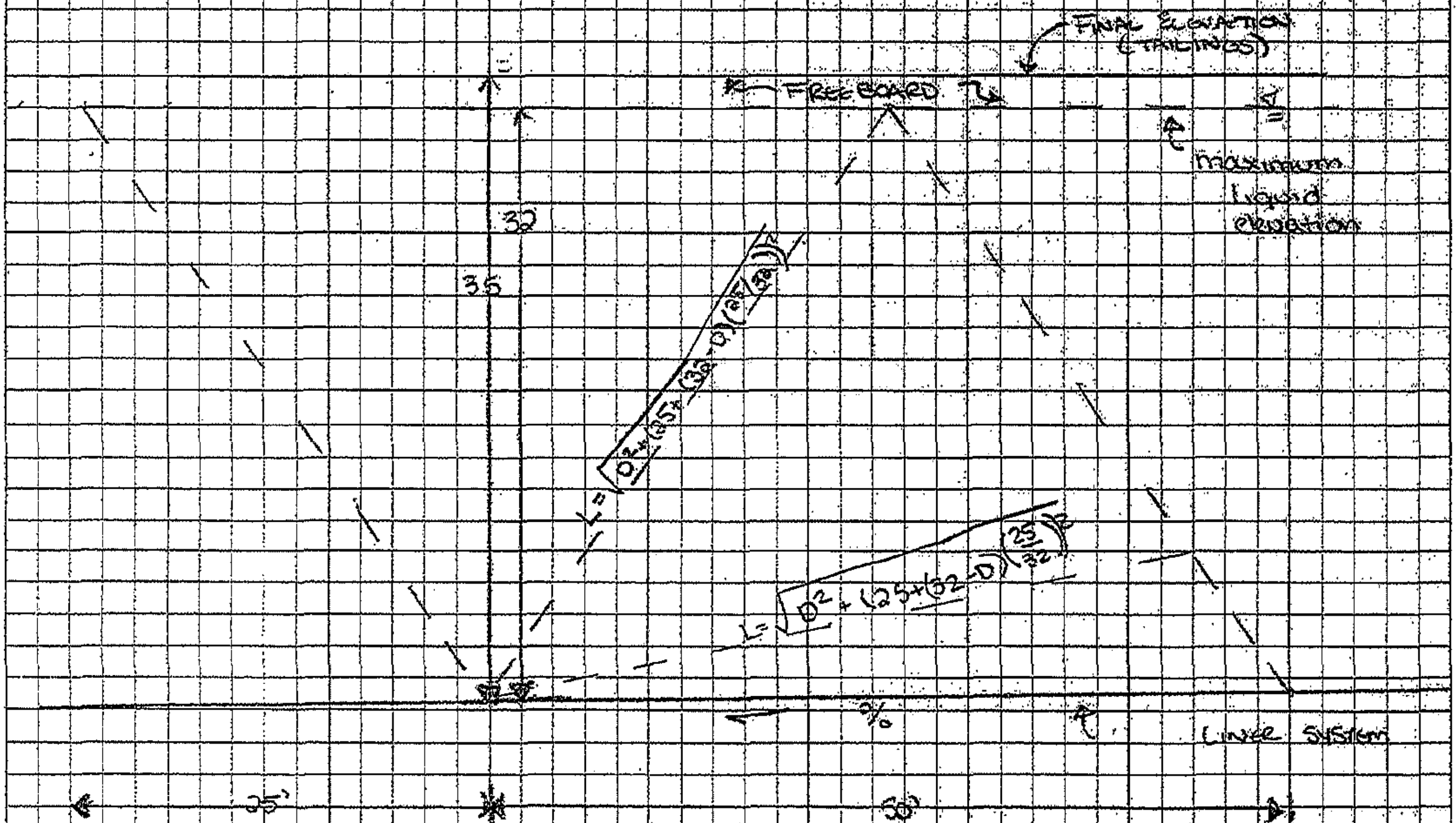
Geosyntec consultants

Written by: ______ Date: __/__/__ (DD MM YY) Reviewed by: ______ Date: __/__/__ (DD MM YY) Page ___ of ___

Client: ______ Project: ______ Project/Proposal No.: ______ Task No.: ______



AVERAGE DEPTH FLOW GEOMETRY

EXAMPLES:

$D = 32'$ $L = \sqrt{32^2 + (25 + (32-32)(25/32))^2} = 40.6$

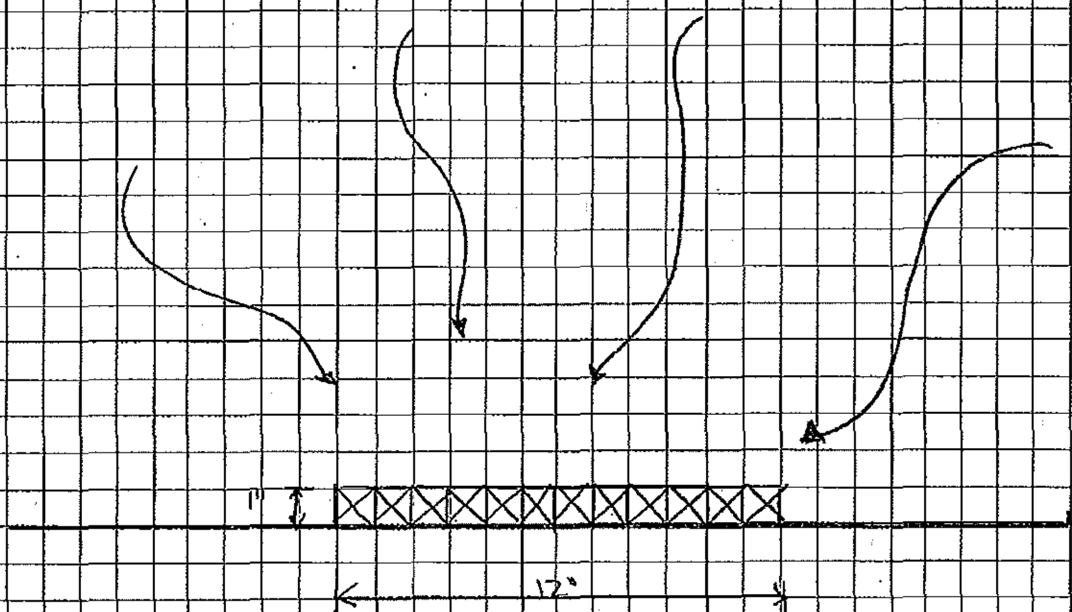
FIGURE 2

$D = 10'$ $L = \sqrt{10^2 + (25 + (32-10)(25/32))^2} = 43.4'$

Geosyntec consultants

Written by: RF Date: 30/08/07 (DD MM YY) Reviewed by: ________ Date: __/__/__ (DD MM YY)

Client: DMC Project: WMM-CC1148 Project/Proposal No. SC0349 Task No. ________



FLOW AREA - STRIP COMPOSITE

$$A = \frac{14"}{12"/1} = 1.17\ ft^2/ft$$

FIGURE 3

EXHIBIT 1

SAMPLE DESCRIPTION AND PREPARATION

CSMRI Sample 1

Sponsor's Designation of Sample:	Run-of-mine.
Date Received at Institute:	June 5, 1978.
Sample Weight:	100,520 lb.
Sample Container:	Two truckloads.
Sample Description:	Mine ore -- estimate 5% +10-in. material. Largest boulder -- 48 in. x 24 in. x 14 in. Only two or three rocks were greater than 36 in.
Method of Preparation:	All +10-in. material broken to -10 in. by sledgehammer and jackhammer. The sample was screened at 6 in. and 1-1/2 in. with the +6 in. fraction, put in barrels, and the -1/2 in. fraction piled. The -6 in. +1-1/2 in. material was screened at 4 in. and 1-1/2 in. with the -6 in. +4 in. and -4 in. +1-1/2 in. fractions barreled. The additional -1-1/2 in. fraction was piled with the previous -1-1/2 in. fraction. A screen size analysis of the entire quantity of mill feed material is presented in Exhibit 3. A summary screen size analysis of the ore is as follows:

Screen Product in.		Weight %
Head (calculated)		100.00
-10	+6	2.92
-6	+4	9.48
-4	+1-1/2	15.30
-1-1/2		72.30

EXHIBIT 1

CSMRI Sample 2

Sponsor's Designation of Sample:	Crushed ore.
Date Received at Institute:	June 5, 1978.
Sample Weight:	47,380 lb.
Sample Container:	One truckload.
Sample Description:	Ore previously crushed to -3 in., maximum particles approximately 2-1/2 in.
Method of Preparation:	The ore was used as received.

EXHIBIT 2

GRINDING TESTS

Grinding Test I, Autogenous

Date:	June 13, 1978
Feed Rate, stph:	2
Ore:	Run-of-mine
DSM Screen, in. width:	12
DSM Screen Opening, mm:	1.27
Measured Mill Power Tare (empty mill), kw:	2.06
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Motor Reading watt-hr	Mill-Bearing Oil Temp. °F	Ore Feed Rate (as received)(1) -1-1/2 in. lb/hr	-4 in. +1-1/2 in. lb/hr	-6 in. +4 in. lb/hr	-10 in. +6 in. lb/hr	Mill Discharge Solids %	Mill Discharge Solids lb/hr	Sweco Screen Oversize Solids %	Sweco Screen Oversize Solids lb/hr	DSM Screen Overflow Solids %	DSM Screen Overflow Solids lb/hr	DSM Screen Underflow Solids %	DSM Screen Underflow Solids lb/hr	Mill Water Meter %	Mill Water Rate lb/hr	Mill Load Volume %	Remarks
0910	0	--	--	104	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Start mill.
0915	5	12.2	12,964	--	3,150	612	380	116	63	8,335	--	--	--	--	--	--	90	2,858	--	--
1005	55	8.7	--	--	2,880	612	380	116	62	--	90	506	60	3,348	57	2,616(2)	90	2,858	--	--
1030	80	6.8	--	105	2,835	612	380	116	69	--	90	304	70	3,591	58	710(2)	90	2,858	--	--
1100	110	6.5	12,977	106	2,993	612	380	116	66	--	--	--	69	4,223	58	679(2)	80	2,540	--	--
1135	145	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Mill down, elevator plugged.
1142	145	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Start mill.
1150	153	6.2	--	109	2,993	612	380	116	69	12,420	90	1,114	70	5,544	56	2,583	--	--	--	--
1230	193	6.0	12,988	111	2,903	612	380	116	64	10,829	90	405	69	6,955	60	4,388	75	2,382	--	--
1300	223	6.2	--	112	3,319	612	380	116	65	11,232	90	365	70	6,048	60	3,861	81	2,572	--	--
1345	238	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Pump plugged. DSM feed.
1400	253	6.4	--	112	3,128	612	380	116	65	11,700	90	122	69	3,229	60	3,996	80	2,540	--	Sample
1415	268	6.3	13,004	112	2,970	612	380	116	65	9,945	90	547	71	3,515	59	2,907	79	2,509	15	Sample.
Average					3,019	612	380	116	65	10,744	90	480	69	4,557	59	3,547	83	2,640		

(1) Moisture: -1-1/2 in., 2.8%; -4 in. +1-1/2 in., 1.0%; -6 in. +4 in., 0.8%; -10 in. +6 in., 0.7%. Average dry ore feed rate: -1-1/2 in., 2,934.5 lb/hr; -4 in. +1-1/2 in., 605.9 lb/hr; -6 in. +4 in., 376.8 lb/hr; -10 in. +6 in., 115.0 lb/hr; total, 4,032.2 lb/hr, 2.016 dry stph. Mill volume end of test: 15%.
(2) Excluded from average.

Feed Rate, stph dry:	2.016
Ball Charge:	None
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Instantaneous Gross Power (meter reading) kwhr	Instantaneous Corrected Power (from input-output curve) kwhr	Power Consumption Gross kwhr/st	Power Consumption Net kwhr/st	Circulating Load Weight % of Feed(1)	Mill Discharge Solids %	Remarks
0910	0	--	--	--	--	--	--	--	--
0915	5	12.2	4.25	2.64	1.31	1.01	--	63	--
1005	55	8.7	5.96	4.25	2.11	1.81	--	62	--
1030	80	6.8	7.62	5.80	2.88	2.58	--	69	--
1100	110	6.5	7.97	6.10	3.03	2.73	--	66	--
1135	145	--	--	--	--	--	--	--	Unplug bucket elevator.
1150	153	6.2	8.36	6.47	3.21	2.91(2)	162.0	69	--
1230	193	6.0	8.64	6.73	3.34	3.06(2)	183.0	64	--
1300	223	6.2	8.36	6.47	3.21	2.93(2)	145.0	65	--
1345	238	--	--	--	--	--	--	--	Unplug DSM feed pump.
1400(3)	253	6.4	8.10	6.23	3.09	2.79(2)	79.0	65	--
1415(3)	268	6.3	8.23	6.35	3.15	2.85(2)	100.0	65	--
Average						2.90	133.8		

(1) Calculated: Sum of Sweco oversize and DSM oversize as percentage of dry mill feed.
(2) Average for power (last five readings): 2.90 kwhr/st.
(3) Sample run.

EXHIBIT 2

Grinding Test 1 -- continued

Procedure: Sample was wet screened on a 325M screen, products dried, and the +325M material dry screened using a Ro-Tap for 30 min.

Test Product	Screen Size Analysis DSM Screen Undersize
Sample Time:	1415
Sample Weight, g:	4,630.5
Screen Product (Tyler) Mesh	**Weight %**
Head (calculated)	100.0
+28	1.2
-28 +35	3.4
-35 +65	16.2
-65 +100	14.0
-100 +200	18.6
-200 +325	7.1
-325	39.5

US SIEVE

GTC 5/10/07

No. 30
No. 40
No. 70
No. 100
No. 200
No. 325

EXHIBIT 2

Grinding Test 2

Date:	June 14, 1978
Feed Rate, stph:	2.0
Ore:	Run-of-mine
Ball Charge:	Total: 301.8 lb; 2% mill volume
-1-1/2 in. +1 in. Balls, lb:	114.5
-2 in. +1-1/2 in. Balls, lb:	151.3
3 in. Balls, lb:	36.0
DSM Screen, in. width:	12
DSM Screen Openings, mm:	1.27
Measured Mill Power Tare (empty mill), kw:	2.06
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Motor Reading watt-hr	Mill-Bearing Oil Temp. °F	Ore Feed Rate (as received)(1) -1-1/2 in. lb/hr	Ore Feed Rate -4 in. +1-1/2 in. lb/hr	Ore Feed Rate -6 in. +4 in. lb/hr	Ore Feed Rate -10 in. +6 in. lb/hr	Mill Discharge Solids %	Mill Discharge Solids lb/hr	Sweco Screen Oversize Solids %	Sweco Screen Oversize Solids lb/hr	DSM Screen Overflow Solids %	DSM Screen Overflow Solids lb/hr	DSM Screen Underflow Solids %	DSM Screen Underflow Solids lb/hr	Mill Water Meter %	Mill Water Rate lb/hr	Mill Load Volume %	Remarks
1040	0	8.7	13,004	102	--	612	380	116	--	--	--	--	--	--	--	--	95	3,017	-	Start mill.
1110	30	5.2	--	104	--	612	380	116	--	--	--	--	--	--	--	--	83	2,636	-	--
1130	50	5.3	--	106	3,060	612	380	116	62	8,147	50	248	74	1,565	54	2,989(2)	84	2,668	-	--
1200	80	5.0	--	108	2,846	612	380	116	63	6,577	67	653	71	1,150	--	--	82	2,604	-	--
1230	110	4.8	13,023	111	3,105	612	380	116	64	8,467	64	605	73	1,281	--	--	82	2,604	-	--
1300	140	4.8	--	112	3,139	612	380	116	63	6,917	62	391	73	2,102	57	3,694	81	2,572	-	--
1330	170	4.8	--	113	3,263	612	380	116	66	8,494	63	595	69	3,571	56	3,881	81	2,572	-	--
1400	200	4.9	--	113	2,981	612	380	116	66	9,029	64	624	71	2,939	58	3,680	81	2,572	-	--
1415	215	5.0	--	113	2,869	612	380	116	66	10,098	64	547	70	3,119	58	3,811	79	2,509	-	Sample.
1430	230	5.0	13,044	113	2,993	612	380	116	65	8,483	64	557	71	3,259	57	3,565	79	2,509	9	Sample. End of test.
Average					3,032	612	380	116	65	8,277	62	528	72	2,373	57	3,726	83	2,626		

(1) Moisture: -1-1/2 in., 2.8%; -4 in. +1-1/2 in., 1.0%; -6 in. +4 in., 0.8%; -10 in. +6 in., 0.7%. Average dry ore feed rate: -1-1/2 in., 2,947.0 lb/hr; -4 in. +1-1/2 in., 605.9 lb/hr; -6 in. +4 in., 376.8 lb/hr; -10 in. +6 in., 115.0 lb/hr; total: 4,044.7 lb/hr, 2.022 dry stph. Mill volume end of test: 9%.

(2) Excluded from average.

Feed Rate, stph dry:	2.022
Ball Charge:	301.8 lb, 2% mill volume
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Instantaneous Gross Power (meter reading) kwhr	Instantaneous Corrected Power (from input-output curve) kwhr	Power Consumption Gross kwh/st	Power Consumption Net kwh/st	Circulating Load Weight % of Feed(1)	Mill Discharge Solids %
1040	0	8.7	5.96	4.22	2.09	1.79	--	--
1110	30	5.2	9.97	7.93	3.92	3.63	--	--
1130	50	5.3	9.78	7.78	3.85	3.55	--	62
1200	80	5.0	10.36	8.25	4.08	3.78	--	63
1230	110	4.8	10.80	8.63	4.27	3.97	--	64
1300	140	4.8	10.80	8.63	4.27	3.97	59.0(4)	63
1330	170	4.8	10.80	8.63	4.27	3.97	95.0	66
1400	200	4.9	10.58	8.44	4.17	3.88	87.0	66
1415(3)	215	5.0	10.36	8.25	4.08	3.78(2)	92.0	66
1430(3)	230	5.0	10.36	8.25	4.08	3.78(2)	93.0	65
Average						3.78	91.8	

(1) Calculated: Sum of Sweco oversize and DSM oversize as a percentage of dry mill feed.

(2) Average for power (last two readings): 3.78 kwhr/st.

(3) Sample run.

(4) Omitted from average.

EXHIBIT 2

Grinding Test 2 -- continued

Procedure: Samples were wet screened on a 325M screen, products dried, and the +325M material dry screened using a Ro-Tap for 30 min.

Test Product	Screen Size Analysis: Mill Discharge		Sweco Screen Oversize		DSM Screen Oversize		DSM Screen Undersize		Circulating Load
Sample Time	1415	1430	1415	1430	1415	1430	1415	1430	
Sample Weight, g:	1,058.8	1,206.6	669.3	979.0	915.6	1,106.8	888.1	932.3	
Screen Product (Tyler) Mesh	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %
Head (calculated)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
+28	23.8	21.6	65.5	71.8	40.4	37.6	2.0	1.7	43.4
-28 +35	6.8	6.4	2.5	1.6	8.4	9.9	5.3	4.3	8.1
-35 +65	13.5	13.3	4.2	3.6	8.8	12.0	17.2	16.6	9.4
-65 +100	9.4	10.2	3.2	3.0	4.7	7.6	13.6	12.9	5.7
-100 +200	11.9	13.4	5.0	5.0	7.3	10.3	17.6	17.0	8.3
-200 +325	4.2	5.9	3.0	2.1	1.6	4.7	7.0	6.3	3.1
-325	30.4	29.2	16.6	12.9	28.8	17.9	37.3	41.2	22.0

EXHIBIT 2

Grinding Test 3

Date:	June 15, 1978
Feed Rate, stph:	3.0
Ore:	Run-of-mine
Ball Charge:	Total: 301.8 lb, 2% mill volume
-1-1/2 in. +1 in. Balls, lb:	114.5
-2 in. +1-1/2 in. Balls, lb:	151.3
3 in. Balls, lb:	36.0
DSM Screen, in. width:	12
DSM Screen Openings, mm:	1.27
Measured Mill Power Tare (empty mill), kw:	2.06
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Meter Reading watt-hr	Mill-Bearing Oil Temp. °F	Ore Feed Rate (as received)(1) -1-1/2 in. lb/hr	-4 in. +1-1/2 in. lb/hr	-6 in. +4 in. lb/hr	-10 in. +6 in. lb/hr	Mill Discharge Solids %	Mill Discharge Solids lb/hr	Sweco Screen Oversize Solids %	Sweco Screen Oversize Solids lb/hr	DSM Screen Overflow Solids %	DSM Screen Overflow Solids lb/hr	DSM Screen Underflow Solids %	DSM Screen Underflow Solids lb/hr	Mill Water Meter %(2)	Mill Water Rate lb/hr	Mill Load Volume %	Remarks
1050	0	5.0	13,045	93	—	918	570	174	--	--	--	--	--	--	--	--	--	--	--	Start mill.
1135	45	4.5	--	--	—	918	570	174	--	--	--	--	--	--	--	--	--	--	--	--
1200	70	4.4	--	99	4,350	918	570	174	65	13,631	68	857	70	6,237	58	5,090	105	3,350	--	--
1207	77	--	--	--	—	918	570	174	--	--	--	--	--	--	--	--	--	--	--	Shutdown, rock jammed in feeder.
1230	77	--	--	--	—	918	570	174	--	--	--	--	--	--	--	--	--	--	--	Start mill.
1300	107	4.9	--	109	3,435	918	570	174	65	10,530	63	808	73	3,679	55	4,430	106	3,366	--	--
1330	137	4.8	--	108	4,815	918	570	174	66	11,642	64	878	72	5,508	61	5,408	104	3,303	--	--
1400	167	4.9	--	110	4,275	918	570	174	67	11,095	58	639	73	5,059	61	5,565	104	3,303	--	--
1430	197	4.7	--	111	4,590	918	570	174	67	11,156	65	761	72	5,573	61	4,804	103	3,271	--	Sample.
1445	212	4.8	13,085	112	5,040	918	570	174	67	15,135	67	1,010	71	6,646	62	5,692	104	3,303	--	Sample.
1500	242	--	--	--	—	918	570	174	--	--	--	--	--	--	--	--	--	--	25	Shut down.
Average					4,417	918	570	174	66	12,198	64	826	72	5,450	60	5,162	104	3,316		

(1) Moisture: -1-1/2 in., 2.8%; -4 in. +1-1/2 in., 1.0%; -6 in. +4 in., 0.8%, -10 in. +6 in., 0.7%. Average dry ore feed rate: -1-1/2 in., 4,293.8 lb/hr, -4 in. +1-1/2 in., 908.8 lb/hr; -6 in. +4 in., 565.4 lb/hr; -10 in. +6 in., 172.8 lb/hr; total, 5,940.8 lb/hr, 2.970 dry stph. Mill volume end of test: 25%.
(2) Auxiliary water line used -- measured twice, averaged, and added as percentage of regular water meter.

Feed Rate, stph dry:	2.970 stph dry
Ball Charge:	301.8 lb, 2% of mill volume
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Instantaneous Gross Power (meter reading) kwhr	Instantaneous Corrected Power (from input-output curve) kwhr	Power Consumption Gross kwhr/st	Power Consumption Net kwhr/st	Circulating Load Weight % of Feed(1)	Mill Discharge Solids %	Remarks
1050	0	5.0	10.36	8.26	2.78	2.58	--	--	--
1135	45	4.5	11.52	9.24	3.11	2.91	--	--	--
1200	70	4.4	11.78	9.45	3.18	2.98	118.0(4)	65	--
1207	77	--	--	--	--	--	--	--	Rock jammed in feeder.
1230	77	--	--	--	--	--	--	--	--
1300	107	4.9	10.58	8.43	2.84	2.64(2)	88.0	65	--
1330	137	4.8	10.80	8.62	2.90	2.70(2)	99.0	66	--
1400	167	4.9	10.58	8.43	2.84	2.64(2)	96.0	67	--
1430(3)	197	4.7	11.03	8.82	2.97	2.77(2)	101.0	67	--
1445(3)	212	4.8	10.80	8.62	2.90	2.70(2)	114.0	67	--
1500	242								
Average						2.70	99.6		

(1) Calculated: Sum of Sweco oversize and DSM oversize as a percentage of dry mill feed.
(2) Average for power (last four readings): 2.70 kwhr/st.
(3) Sample run.
(4) Omitted from average.

EXHIBIT 2

Grinding Test 3

Procedure: Samples were wet screened on a 325M screen, products dried, and the +325M material dry screened using a Ro-Tap for 30 min.

Test Product	Screen Size Analysis: Mill Discharge		Sweco Screen Oversize		DSM Screen Oversize		DSM Screen Undersize		Circulating Load
Sample Time	1430	1445	1430	1445	1430	1445	1430	1445	--
Sample Weight, g:	1,174.9	1,310.3	1,365.7	1,223.1	1,183.4	1,245.5	850.1	962.4	--
Screen Product (Tyler) Mesh	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %
Head (calculated)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
+28	27.8	25.1	65.0	67.5	47.4	33.3	2.4	1.9	43.7
-28 +35	6.5	7.1	1.8	2.0	9.1	7.9	5.7	5.0	7.6
-35 +65	12.8	14.6	3.7	4.0	12.4	13.2	18.1	21.0	11.7
-65 +100	9.2	9.0	3.1	3.4	6.5	8.5	14.8	16.0	7.0
-100 +200	11.4	13.5	5.4	5.5	8.9	9.9	15.6	13.5	8.9
-200 +325	4.8	3.4	3.4	3.3	1.6	3.3	5.9	4.5	2.5
-325	27.5	27.3	17.6	14.3	14.1	23.9	37.5	38.1	18.6

EXHIBIT 2

Grinding Test 4

Date:	June 16, 1978
Feed Rate, stph:	2.5
Ore:	Crushed
Ball Charge:	Total: 301.8 lb, 2% mill volume
-1-1/2 in. +1 in. Balls, lb:	114.5
-2 in. +1-1/2 in. Balls, lb:	151.3
3 in. Balls, lb:	36.0
DSM Screen, in. width:	12
DSM Screen Openings, mm:	1.27
Measured Mill Power Tare (empty mill), kw:	2.06
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Motor Reading watt-hr	Mill-Bearing Oil Temp. °F	Ore Feed Rate (as received)(1) -3 in. lb/hr	Mill Discharge Solids %	Mill Discharge Solids lb/hr	Sweco Screen Oversize Solids %	Sweco Screen Oversize Solids lb/hr	DSM Screen Overflow Solids %	DSM Screen Overflow Solids lb/hr	DSM Screen Underflow Solids %	DSM Screen Underflow Solids lb/hr	Mill Water Meter %(1)	Mill Water Rate lb/hr	Mill Load Volume %	Remarks
1010	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9	Start mill.
1030	20	6.6	13,094	96	--	--	--	--	--	--	--	--	--	98	2,858	--	--
1100	50	6.3	--	97	5,130	63	7,598	67	362	74	1,931	61	5,243	87	2,763	--	--
1130	80	5.9	--	99	5,350	62	8,091	64	418	72	2,398	60	4,482	82	2,604	--	--
1200	110	5.9	--	99	4,995	65	12,539	66	535	70	3,717	61	3,953	80	2,540	--	--
1215	125	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Feed off (feed belt jammed).
1218	125	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Start mill.
1230	137	6.0	--	100	4,770	62	5,692	62	288	71	2,077	58	3,628	80	2,540	--	--
1300	167	6.0	--	100	5,423	65	6,786	62	326	71	1,885	60	4,428	80	2,540	--	--
1320	187	--	--	--	--	--	--	--	--	--	--	60	4,316(3)	--	--	--	--
1330	197	5.8	--	102	4,826	65	6,728	69	449	69	2,298	59	4,806	79	2,509	--	--
1400	227	5.7	--	104	4,635	64	6,797	62	260	72	1,134	60	4,617	79	2,509	--	Sample.
1415	242	5.7	13,128	104	6,793	63	6,010	64	230	70	819	59	4,328	79	2,509	15	Sample.
1500	257	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
Average					5,240	64	7,528	64	359	71	2,032	60	4,422	82	2,597	--	

(1) Moisture: -3 in., 4.3%. Average dry ore feed rate: -3 in., 5,015 lb/hr, 2.508 dry stph. Mill volume end of test: 15%.
(2) Auxiliary water line used -- measured twice, averaged, and added as percentage of regular water meter.
(3) 55-gal drum timed sample.

Feed Rate, stph:	2.508
Ball Charge:	301.8 lb, 2% of mill volume
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Instantaneous Gross Power (motor reading) kwhr	Instantaneous Corrected Power (from input-output curve) kwhr	Power Consumption Gross kwhr/st	Power Consumption Net kwhr/st	Circulating Load Weight % of Feed(1)	Mill Discharge Solids %	Remarks
1010	0	--	--	--	--	--	--	--	--
1030	20	6.6	7.85	6.00	2.39	2.15	--	--	--
1100	50	6.3	8.23	6.35	2.53	2.29	--	63	--
1130	80	5.9	8.78	6.87	2.74	2.50	50.0(4)	62	--
1200	110	5.9	8.78	6.87	2.74	2.50	81.0(4)	65	--
1215	125	--	--	--	--	--	--	--	Feed belt jammed.
1230	137	6.0	8.64	6.73	2.68	2.44	48.0	62	--
1300	167	6.0	8.64	6.73	2.68	2.44	39.0	65	--
1320	187	--	--	--	--	--	--	--	--
1330	197	5.8	8.93	7.00	2.79	2.55(2)	54.0	65	--
1400(3)	227	5.7	9.09	7.13	2.84	2.60(2)	29.0	64	--
1415(3)	242	5.7	9.09	7.13	2.84	2.60(2)	14.0	63	--
Average						2.58	36.8		

(1) Calculated. Sum of Sweco oversize and DSM oversize as a percentage of dry mill feed.
(2) Average for power (last three readings): 2.58 kwhr/st.
(3) Sample run.
(4) Omitted from average.

EXHIBIT 2

Grinding Test 4 -- continued

Procedure: Samples were wet screened on a 325M screen, products dried, and the +325M material dry screened using a Ro-Tap for 30 min.

Test Product	Screen Size Analysis: Mill Discharge		Sweco Screen Oversize		DSM Screen Oversize		DSM Screen Undersize		Circulating Load
Sample Time	1140	1415	1400	1415	1400	1415	1400	1415	--
Sample Weight, g:	1,139.4	886.7	715.4	726.2	1,152.9	1,020.0	763.8	769.4	--
Screen Product (Tyler) Mesh	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %
Head (calculated)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
+28	15.3	13.1	86.5	91.8	39.1	43.1	2.7	2.7	55.5
-28 +35	5.8	5.2	0.3	0.3	8.9	7.6	4.9	4.6	5.9
-35 +65	17.8	17.9	0.9	0.5	14.9	12.7	18.6	18.6	9.9
-65 +100	11.1	11.8	0.7	0.3	6.8	6.3	12.5	13.3	4.7
-100 +200	15.8	16.7	1.6	0.7	8.8	8.9	18.6	19.1	6.6
-200 +325	7.7	6.4	0.9	0.4	3.3	4.1	8.1	6.3	2.8
-325	26.5	28.9	9.1	6.0	18.2	17.3	34.6	35.4	14.6

EXHIBIT 2

Grinding Test 5

Date:	June 19, 1978
Feed Rate, stph:	2.0
Ore:	Crushed
Ball Charge:	Total 301.8 lb, 2% mill volume
-1-1/2 in. Balls, lb:	114.5
-2 in. +1-1/2 in. Balls, lb:	151.3
3 in. Balls, lb:	36.0
DSM Screen, in. width:	12
DSM Screen Openings, mm:	1.27
Measured Mill Power Tare (empty mill), kw:	2.06
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Meter Reading watt-hr	Mill-Bearing Oil Temp. °F	Ore Feed Rate (as received)(1) -3 in. lb/hr	Mill Discharge Solids %	Mill Discharge Solids lb/hr	Sweco Screen Oversize Solids %	Sweco Screen Oversize Solids lb/hr	DSM Screen Overflow Solids %	DSM Screen Overflow Solids lb/hr	DSM Screen Underflow Solids %	DSM Screen Underflow Solids lb/hr	Mill Water Meter %	Mill Water Rate lb/hr	Mill Load Volume %	Remarks
0840	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7	Start mill.
0910	30	6.7	13,136	90	3,623	--	--	--	--	--	--	--	--	75	2,382	--	--
0930	50	6.3	--	91	3,960	67	8,744	48	356	67	3,558	60	2,970	71	2,255	--	--
1000	80	6.2	--	92	3,803	66	6,663	45	324	70	2,079	60	4,077	68	2,159	--	--
1030	110	6.5	--	91	--	56	3,578	15	68	70	347	59	3,452	66	2,096	--	Shut down -- out of feed.
1035	115	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1040	115	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Start mill.
1100	135	6.5	--	94	4,230	66	4,990	38	182	75	346	62	4,241	68	2,159	--	--
1130	165	6.6	--	96	4,298	66	5,049	42	239	72	729	62	4,101	69	2,191	--	--
1155	190	--	--	--	--	--	--	--	--	--	--	--	--	--	--	13	--
1200	195	6.7	--	97	4,320	63	3,856	37	200	75	405	61	3,870	69	2,191	--	--
1230	225	6.7	--	100	3,533	62	3,894	27	101	73	394	58	3,445	64	2,032	--	--
1300	255	6.6	--	103	4,016	66	4,693	29	111	70	851	61	3,870	68	2,159	--	--
1330	285	6.3	--	104	4,005	68	9,058	34	173	68	3,672	64	3,744	61	1,937	--	--
1345	300	6.5	--	104	3,645	63	4,139	32	134	71	250	59	3,452	68	2,159	--	Sample.
1400	315	6.1	--	104	4,005	64	4,781	34	143	72	238	57	3,104	69	2,191	--	Sample.
1430	345	6.1	--	105	4,140	63	4,820	33	193	69	598	59	3,505	69	2,191	--	--
1445	360	6.0	--	106	3,713	62	4,018	38	182	71	423	56	2,696	69	2,191	--	Sample.
1500	375	5.7	13,184	107	4,028	63	4,139	36	151	70	1,323	56	2,696	69	2,191	--	Sample.
1510	380	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15	Shut down.
1513	388	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Collecting mill discharge sample.
1522	397	--	--	--	3,690	--	--	--	--	--	--	--	--	--	--	--	Second barrel.
1529	404	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Third barrel.
1536	411	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Hopper went empty.
1537	412	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15	Shut down mill.
Average	--	--	--	--	3,934	64	5,173	35	183	71	1,087	59	3,516	68	2,165	--	--

(1) Moisture: -3 in., 2.0%. Average dry ore feed rate: -3 in., 3,855 lb/hr, 1.928 dry stph. Mill volume end of test: 15%.

EXHIBIT 2

Grinding Test 5 -- continued

Feed Rate, stph (dry): 1.928
Ball Charge: 301.8 lb, 2% of mill charge
Corrected Mill Power Tare (empty mill), kw: 0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Instantaneous Gross Power (meter reading) kwhr	Instantaneous Corrected Power (from input-output curve) kwhr	Power Consumption Gross kwhr/st	Power Consumption Net kwhr/st	Circulating Load Weight % of Feed(1)	Mill Discharge Solids %	Remarks
0840	0	--	--	--	--	--	--	--	--
0910	30	6.7	7.73	5.89	3.05	2.74	--	--	--
0930	50	6.3	8.23	6.35	3.29	2.98	--	67	--
1000	80	6.2	8.36	6.47	3.36	3.04	--	66	--
1030	110	6.5	7.97	6.10	3.16	2.85	--	56	--
1035	115	--	--	--	--	--	--	--	Ran out of ore.
1100	155	6.5	7.97	6.10	3.16	2.85	12.0(4)	66	--
1130	165	6.6	7.85	6.00	3.11	2.80	23.0(4)	66	--
1155	190	--	--	--	--	--	--	--	Check mill volume.
1200	195	6.7	7.73	5.89	3.05	2.74	14.0	63	--
1230	225	6.7	7.73	5.89	3.05	2.74	14.0	62	--
1300	255	6.6	7.85	6.00	3.11	2.80	24.0	66	--
1330	285	6.3	8.23	6.35	3.29	2.98	96.0(4)	68	--
1345(3)	300	6.5	7.97	6.10	3.16	2.85	11.0	63	--
1400(3)	315	6.1	8.50	6.60	3.42	3.11(2)	10.0	64	--
1430	345	6.1	8.50	6.60	3.42	3.11(2)	19.0	63	--
1445(3)	360	6.0	8.64	6.73	3.49	3.18(2)	16.0	62	--
1500(3)	375	5.7	9.09	7.13	3.70	3.37	37.0	63	--
1510	385	--	--	--	--	--	--	--	Check mill load level.
1513	388	--	--	--	--	--	--	--	Start filling No. 1 mill discharge sample barrel.
1522	397	--	--	--	--	--	--	--	Start filling No. 2 mill discharge sample barrel.
1529	404	--	--	--	--	--	--	--	Start filling No. 3 mill discharge sample barrel.
1536	411	--	--	--	--	--	--	--	End filling No. 3 mill discharge sample barrel.
1537	412	--	--	--	--	--	--	--	End of test.
Average						3.13	18.0		

(1) Calculated: Sum of Sweco oversize and DSM oversize as a percentage of dry mill feed.
(2) Average for power (three readings, omitted reading at 1,500 from average): 3.13 kwhr/st.
(3) Sample run.
(4) Omitted from average.

Procedure: Samples were wet screened on a 325M screen, products dried, and the +325M material dry screened using a Ro-Tap for 30 min.

Screen Size Analysis

Test Product	Mill Discharge				Sweco Screen Oversize				DSM Screen Oversize				DSM Screen Underflow				Circulating Load
Sample Time	1345	1400	1445	1500	1345	1400	1445	1500	1345	1400	1445	1500	1345	1400	1445	1500	--
Sample Weight, g:	1,058.6	1,062.1	911.3	859.1	442.5	300.3	282.2	381.8	1,065.9	713.5	478.8	920.6	817.4	757.0	743.7	787.8	--
Screen Product (Tyler) Mesh	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %
Head (calculated)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
+28	12.0	11.5	10.2	10.8	78.4	82.9	81.4	87.5	67.0	54.5	51.9	32.0	1.8	2.0	1.9	1.6	58.1
-28 +35	3.7	3.7	2.7	2.9	1.5	0.8	1.0	0.4	5.0	4.6	4.5	3.9	3.1	3.1	2.8	2.3	3.7
-35 +65	15.3	16.3	12.9	13.4	4.1	1.9	3.0	1.1	6.2	7.4	6.9	10.9	16.8	16.3	15.8	14.2	6.7
-65 +100	12.3	13.4	12.8	12.7	2.4	1.2	1.9	0.8	3.4	5.2	5.2	9.1	14.7	14.6	14.2	14.5	4.8
-100 +200	19.1	18.5	21.3	20.6	4.1	2.7	3.7	1.6	5.3	8.2	9.3	14.2	20.5	20.5	21.7	21.8	8.0
-200 +325	8.0	6.6	9.0	8.6	1.1	1.0	1.1	1.2	1.6	2.8	4.0	5.3	8.1	8.4	7.4	7.4	2.9
-325	29.6	30.0	31.1	31.0	8.4	9.5	7.9	7.4	11.5	17.3	18.2	24.6	35.0	35.1	36.2	38.2	15.8

EXHIBIT 2

Grinding Test 6

Date:	June 20, 1978
Feed Rate, stph:	2.5
Ore:	Run-of-mine
Ball Charge:	Total: 301.8 lb, 2% mill volume
-1-1/2 in. +1 in. Balls, lb:	114.5
-2 in. +1-1/2 in. Balls, lb:	151.3
3 in. Balls, lb:	36.0
DSM Screen, in. width:	12
DSM Screen Openings, mm:	1.27
Measured Mill Power Tare (empty mill), kw:	2.06
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Meter Reading watt-hr	Mill-Bearing Oil Temp. °F	Ore Feed Rate (as received)(1) -1-1/2 in. lb/hr	-4 in. +1-1/2 in. lb/hr	-6 in. +4 in. lb/hr	-10 in. -6 in. lb/hr	Mill Discharge Solids %	Mill Discharge Solids lb/hr	Sweco Screen Oversize Solids %	Sweco Screen Oversize Solids lb/hr	DSM Screen Overflow Solids %	DSM Screen Overflow Solids lb/hr	DSM Screen Underflow Solids %	DSM Screen Underflow Solids lb/hr	Mill Water Meter %	Mill Water Rate lb/hr	Mill Load Volume %	Remarks
0820	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--(Grind out)--		Start mill.
0925	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Start feed.
0930	5	6.8	13,195	82	--	768	474	219	--	--	--	--	--	--	--	--	80	2,540	--	--
1000	35	5.9	--	80	--	768	474	219	66	11,286	60	662	71	4,090	61	5,737	85	2,699	--	--
1030	65	5.3	--	82	3,713	768	474	219	66	9,742	54	535	68	4,896	61	3,486	84	2,668	--	--
1100	95	5.2	--	83	3,825	768	474	219	67	10,492	60	608	68	4,651	61	4,255	85	2,699	--	--
1135	130	5.2	--	84	3,510	768	474	219	66	7,960	59	597	68	3,733	61	4,255	84	2,668	25	--
1200	155	5.2	--	87	3,758	768	474	219	68	10,588	57	487	68	4,651	60	3,699	85	2,699	--	--
1230	185	5.1	--	88	3,420	768	476	219	68	10,037	55	545	69	3,974	60	4,104	89	2,826	--	--
1245	200	5.1	--	88	3,420	768	474	219	67	9,950	52	714	68	4,223	59	4,275	89	2,826	--	Sample.
1300	215	5.0	--	89	3,600	768	474	219	67	11,759	62	781	68	6,487	62	3,627	85	2,699	--	Sample.
1330	245	5.0	12,236	92	--	768	474	219	67	8,924	60	1,337	68	4,039	60	3,780	88	2,795	--	--
1337	252	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	27	Shut down.
Average					3,607	768	474	219	67	10,082	53	696	68	4,527	61	4,135	85	2,712		

(1) Moisture: -1-1/2 in., 2.3%; -4 in. +1-1/2 in., 1.0%; -6 in. +4 in., 0.8%; -10 in. +6 in., 0.7%. Average dry ore feed rate: -1-1/2 in., 3,524 lb/hr; -4 in. +1-1/2 in., 760.3 lb/hr; -6 in. +4 in., 470.2 lb/hr; -10 in. +6 in., 217.5 lb/hr; Total: 4,972 lb/hr; 2.486 dry stph. Mill volume end of test: 27%.

Feed Rate, stph (dry):	2.486
Ball Charge:	301.8 lb, 2% of mill volume
Corrected Mill Power Tare (empty mill), kw:	0.6

Clock Time	Running Time min	Disc Revolutions sec/rev	Instantaneous Gross Power (meter reading) kwhr	Instantaneous Corrected Power (from input-output curve) kwhr	Power Consumption Gross kwhr/st	Power Consumption Net kwhr/st	Circulating Load Weight % of Feed(1)	Mill Discharge Solids %	Remarks
0820	--	--	--	--	--	--	--	--	Grind out.
0925	--	--	--	--	--	--	--	--	Start feed.
0930	5	6.8	7.62	5.80	2.33	2.09	--	--	--
1000	35	5.9	8.78	6.87	2.76	2.52	--	66	--
1030	65	5.3	9.78	7.78	3.13	2.92	105.0	66	--
1100	95	5.2	9.97	7.92	3.18	2.94	99.0	67	--
1135	130	5.2	9.97	7.92	3.18	2.94	87.0	66	--
1200	155	5.2	9.97	7.92	3.18	2.94	98.0	68	--
1230	185	5.1	10.16	8.09	3.25	3.01	93.0	68	--
1245(3)	200	5.1	10.16	8.09	3.25	3.01	101.0	67	--
1300(3)	215	5.0	10.36	8.26	3.32	3.08(2)	144.0	67	--
1330	245	4.0	10.36	8.26	3.32	3.08(2)	--	67	--
1337	252	--	--	--	--				End of test.
Average						3.08	103.9		

(1) Calculated: Sum of Sweco oversize and DSM oversize as a percentage of dry mill feed.
(2) Average for power (two readings): 3.08 kwhr/st.
(3) Sample run.

EXHIBIT 2

Grinding Test 6 -- continued

Procedure: Samples were wet screened on a 325M screen, products dried, and the +325M material dry screened using a Ro-Tap for 30 min.

Total Product	Screen Size Analysis								
	Mill Discharge		Sweco Screen Oversize		DSM Screen Oversize		DSM Screen Undersize		Circulating Load
Sample Time	1245	1300	1245	1300	1245	1300	1245	1300	
Sample Weight, g:	1,258.8	1,237.7	673.8	642.6	1,361.9	1,079.3	832.1	918.1	--
Screen Product (Tyler) Mesh	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %
Head (calculated)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
+28	21.0	18.4	64.8	70.7	32.9	23.1	1.3	1.0	32.9
-28 +35	6.4	6.5	1.9	1.2	9.4	8.5	3.9	3.7	8.1
-35 +65	13.9	15.1	3.8	2.7	12.8	14.3	16.5	16.7	12.2
-65 +100	10.5	11.4	3.2	2.2	8.8	8.6	12.4	14.5	8.0
-100 +200	13.3	14.2	5.4	5.0	11.8	14.2	20.3	18.5	12.0
-200 +325	5.5	5.6	3.1	2.2	4.8	3.7	5.3	6.7	4.1
-325	29.4	28.8	17.8	16.0	19.5	27.6	40.3	38.9	22.7

Sediment Description and Classification Background

U.S. Standard Sieves

Note that the same size mesh can be a differing sieve number depending on the Sieve manufacturer (Tyler vs. ASTM)

Mesh Size (microns)	TYLER	ASTM-E11	BS-410	DIN-4188
µm	Mesh	No.	Mesh	mm
5	2500		2500	0.005
10	1250		1250	0.010
15	800		800	0.015
20	625		625	0.020
22				0.022
25	500		500	0.025
28				0.028
32				0.032
36				0.036
38	400	400	400	
40				0.040
45	325	325	350	0.045
50				0.050
53	270	270	300	
56				0.056
63	250	230	240	0.063
71				0.071
75	200	200	200	
80				0.080
90	170	170	170	0.090
100				0.100
106	150	140	150	
112				0.112
125	115	120	120	0.125
140				0.140
150	100	100	100	

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160				0.160
180	80	80	85	0.180
200				0.200
212	65	70	72	
250	60	60	60	0.250
280				0.280
300	48	50	52	
315				0.315
355	42	45	44	0.355
400				0.400
425	35	40	36	
450				0.450
500	32	35	30	0.500
560				0.560
600	28	30	25	
630				0.630
710	24	25	22	0.710
800				0.800
850	20	20	18	
900				0.900
1000	16	18	16	1.0
1120				1.12
1180	14	16	14	
1250				1.25
1400	12	14	12	1.4
1600				1.6
1700	10	12	10	
1800				1.8
2000	9	10	8	2.0
2240				2.24
2360	8	8	7	
2500				2.5
2800	7	7	6	2.8
3150				3.15
3350	6	6	5	
3550				3.55
4000	5	5	4	4.0
4500				4.5

4750	4	4	3.5	
5000				5.0

Sediment Classification based on Grain Size:

Unified Soil Classification System (USCS)

Sediment Name	**Diameter (mm)**	**Sieve No.**
Cobble	greater than 75 mm	
Gravel	4.75 to 75 mm	4
Sand	0.075 to 4.75 mm	200
Fines (silt and clay)	less than 0.075 mm	

USCS Division of Sands

Sediment Name	Diameter Range (mm)	Passes through Sieve No.	Retained on Sieve No.
Coarse Sand	2.0 - 4.8	4	10
Medium Sand	0.43 - 2.0	10	40
Fine Sand	0.075 - 0.43	40	200

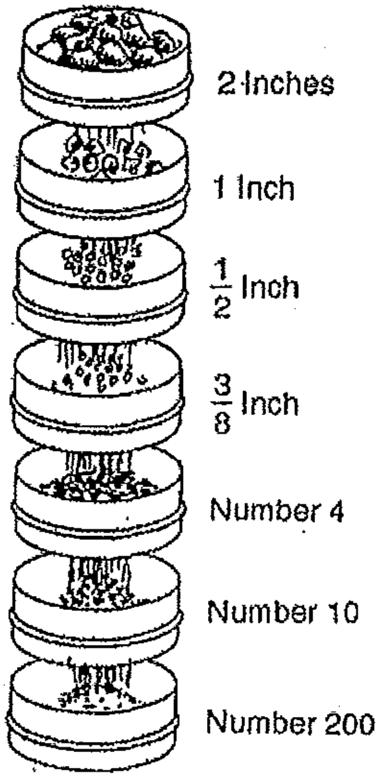


Figure 4-3. Dry sieve analysis.

USCS Classification System

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	DESCRIPTIONS
COARSE GRAINED SOILS More Than Half Retained on 200 Sieve	GRAVELS More Than Half Coarse Fraction Retained on No. 4 Sieve	Clean Gravels (Little or no Fines)	GW	Well Graded Gravels, Gravel - Sand Mixtures, Little or no Fines
			GP	Poorly Graded Gravels, Gravel - Sand Mixtures, Little or no Fines
		Gravels With Fines (Appreciable Fines)	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	SANDS More Than Half Coarse Fraction Passes a No. 4 Sieve	Clean Sands (Little or no Fines)	SW	Well Graded Sands, Gravelly Sands, Little or no Fines
			SP	Poorly Graded Sands, Gravelly Sands, Little or no Fines
		Sands With Fines (Appreciable Fines)	SM	Silty Sands, Sand - Silt Mixtures
			SC	Clayey Sands, Sand - Clay Mixtures
FINE GRAINED SOILS More Than Half Passes 200 Sieve	SILTS and CLAYS Liquid Limit Less Than 50		ML	Inorganic Silts & Very Fine Sands, Silty or Clayey Fine Sands, Clayey Silts
			CL	Inorganic Clays of Low to Medium Plasticity, Lean Clays
			OL	Organic Silts & Organic Silty Clays of Low Plasticity
	SILTS and CLAYS Liquid Limit Greater Than 50		MH	Inorganic Silts, Fine Sand or Silty Soils, Elastic Silts
			CH	Inorganic Clays of High Plasticity, Fat Clays
			OH	Organic Clays of Medium to High Plasticity, Organic Silts
Highly Organic Soils			PT	Peat and Other Highly Organic Soils

Visual logging of sediments entails estimating percentages of gravels, sands and fines (silt and clays). Practice and the use of the Geotechnical Gage will increase your confidence and ability in visually logging sediments.

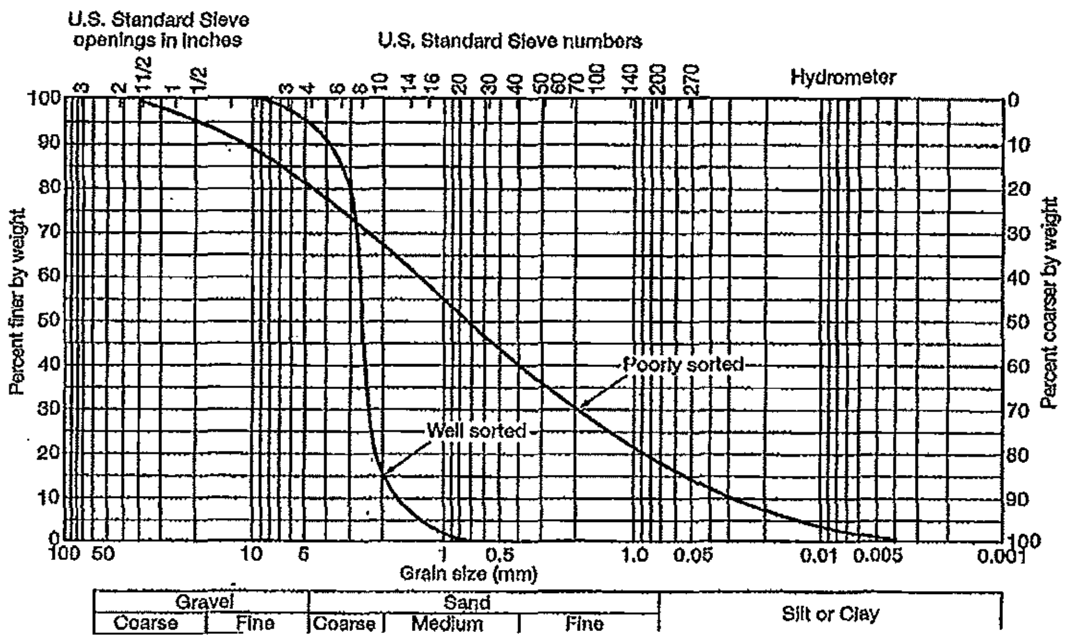
Read: Visual Exam Test

Read: Field Identification Guidelines

Ultimately, sediment samples may undergo grain size analysis through sieves. Graphing the cumulative weight percent retained/passing by sieve no. or grain size will result in the sediment grain-size distribution curve. The grain-size distribution curve is used to quantitatively classify the sediment type (your visual identification is a qualitative classification).

Read: Grain Size Distribution Measurement

Grain Size Distribution Curve



The grain-size distribution curve is used with the USCS classification chart to classify the sediment type. Other measures used to describe the sediment are the sorting or gradation of the sediment. As can be seen in the above chart, a well-sorted sediment has a small range of sediment grain sizes while a poorly sorted sediment has a large range of sediment grain sizes. In the USCS classification scheme, the gradation of the sediment is used instead of the sorting. A well-graded sediment has a large range of grain sizes while a poorly or uniformly graded sediment has a small range of grain sizes.

Figure 4-6. Well-graded soil.

POORLY SORTED SEDIMENT = WELL GRADED SEDIMENT

Figure 4-7. Uniformly graded soil.

WELL-SORTED SEDIMENT = POORLY OR UNIFORMLY GRADED SEDIMENT

Figure 4-8. Gap-graded soil.

After sieve analysis, the data are tabulated showing the weight of sediment retained on each sieve. The cumulative weight retained is calculated starting from the largest sieve size and adding subsequent sediment weights from the smaller size sieves (see table below). The percent retained is calculated from the weight retained and the total weight of the sample. [Don't get confused by the graph - it is individual percent retained in Column 16 and cumulative percent passing in Column 17]. The cumulative percent passing in Column 17 of the table below is calculated by sequentially subtracting percent retained from 100 %. In table below, cumulative percent passing 1/4 inch sieve = 100 - 16 = 84; cumulative percent passing #4 sieve = 84-5.2 = 78.8; etc.

SIEVE ANALYSIS DATA

1. DATE STARTED	22 FEB 91
2. PROJECT	BRAVO AIRFIELD
3. EXCAVATION	1+00
4. DATE COMPLETED	28 FEB 91
5. SAMPLE DESCRIPTION	LIGHT BROWN SANDY SOIL
6. SAMPLE NUMBER	1A
7. PREWASHED	XX YES / NO
8. ORIGINAL SAMPLE WEIGHT	2459
9. + #200 SAMPLE WEIGHT	2359
10. − #200 SAMPLE WEIGHT	100

11. SIEVE SIZE	12. WEIGHT OF SIEVE	13. WEIGHT OF SIEVE + SAMPLE	14. WEIGHT RETAINED	15. CUMULATIVE WEIGHT RETAINED	16. PERCENT RETAINED	17. PERCENT PASSING
1½	202					
1	231					
½	210	210	0	0	0	100.0
¼	230	624	394	394	16.0	84.0
#4	205	332	127	521	5.2	78.8
#8	225	691	466	987	19.0	59.8
#20	215	612	397	1384	16.2	43.6
#60	235	581	346	1730	14.1	29.5
#100	250	612	362	2092	14.7	14.8
#200	260	515	255	2347	10.4	4.4

18. TOTAL WEIGHT RETAINED IN SIEVES	2347	19. ERROR (8-23): 2459-2457 = 2
20. WEIGHT SIEVED THROUGH #200: 270-260	10	
21. WASHING LOSS (8-(9+10)): 2459-(2359+100)	0	
22. TOTAL WEIGHT PASSING #200 (20+10): 10+100	110	
23. TOTAL WEIGHT OF FRACTIONS (18+22)	2457	

24. REMARKS

USCS SP
PERCENT-G 21.2
PERCENT-S 74.4
PERCENT-F 4.4

25. ERROR (PERCENT)

$$\frac{\text{ERROR (19)}}{\text{ORIGINAL WT (8)}} \times 100 =$$

$$\frac{2}{2459} \times 100 = .08$$

26. TECHNICIAN	27. COMPUTED BY	28. CHECKED BY
Joe Blob PVZ	Joe Blob PVZ	Fred Jones SSG

DD Form 1206, DEC 86 — Previous editions are obsolete

Figure 4-4. Data sheet, example of dry sieve analysis.

The cumulative percent passing is plotted on the grain-size distribution graph. The percentage passing the No. 4 and 200 sieves is used to classify the sediments as gravels (G), sands (S) or fines (must use plasiticity index to differentiate between silts and clays).

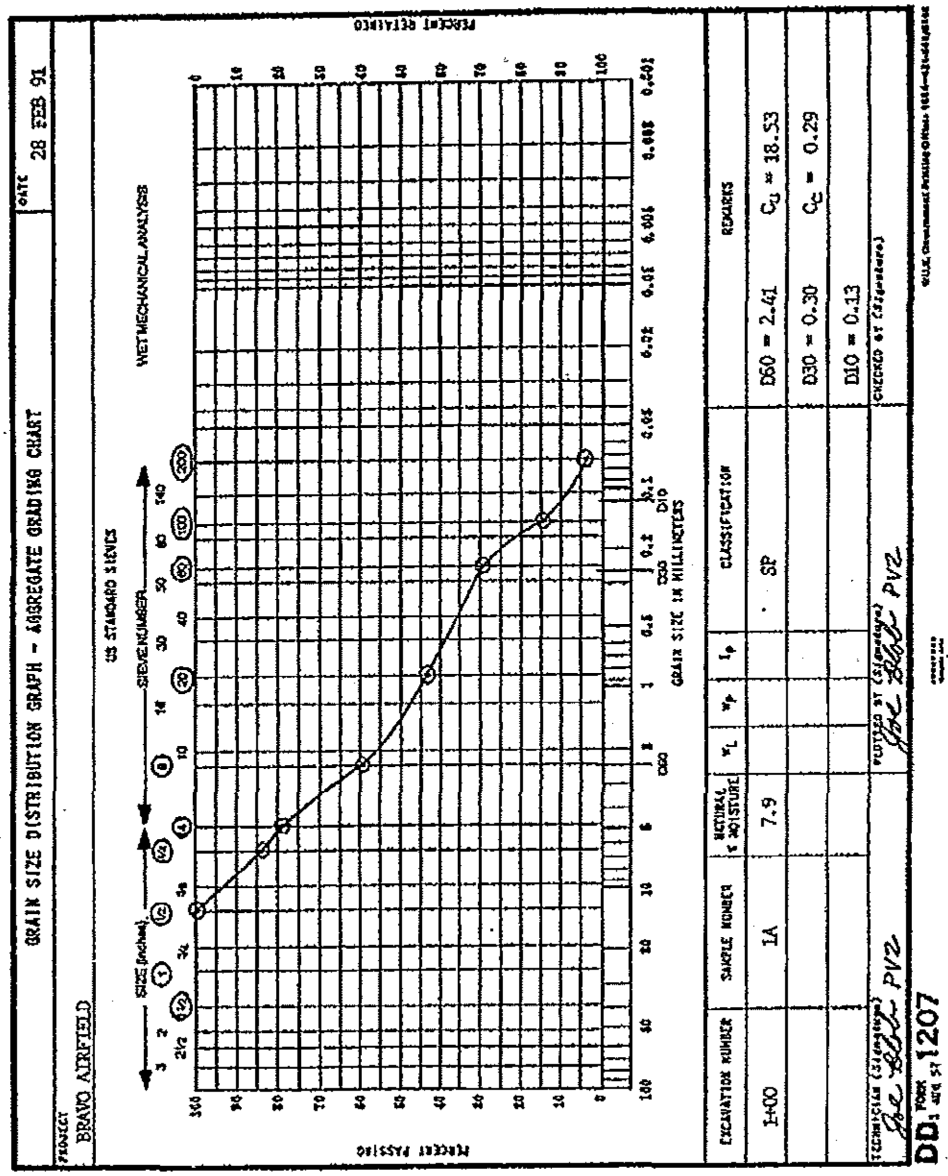


Figure 4-5. Grain-size distribution curve from sieve analysis.

The grain-size distribution graph is used to read off the grain size at which 10% of the sample passed (D_{10}), 30% of the sample passed (D_{30}) and 60% of the sample passed (D_{60}). These numbers are used to calculate several coefficients:

Hazen's effective size, D_{10}, which will be used to estimate permeability

Uniformity Coefficient, $C_u = D_{60}/D_{10}$

In the above graph,

$$D_{60} = 2.4 \text{ mm and } D_{10} = 0.13 \text{ mm}$$

$$\text{then} \quad C_u = {}^{2.4}/_{0.13} \approx 18.5$$

The uniformity coefficient is used to judge gradation.

Coefficient of Curvature, C_c

$$C_c = \frac{(D_{30})^2}{(D_{60} \times D_{10})}$$

In the above graph,

$$D_{30} = 0.3 \text{ mm}$$

$$\text{and } C_c = \frac{(0.3)^2}{(2.4)(0.13)} = .29$$

In the graph below, well-graded soils (GW and SW) are long curves spanning a wide range of sizes with a constant or gently varying slope. Uniformly graded soils (SP) are steeply sloping curves spanning a narrow range of sizes. For a gap-graded soil (GP), the curve flattens out in the area of the grain-size deficiency or gap.

The USCS criteria for well-graded gravels (GW) and sands (SW) are:

1. Less than 5% finer than No. 200 sieve
2. Uniformity coefficient greater than 4
3. Coefficient of curvature between 1 and 3

If Criterion 1 is met, but not Criteria 2 and 3, the gravels are gap-graded or uniform gravels (GP) or sands (SP)

If you are interested in more information: Gradation and Bearing Capacity

United States Environmental Protection Agency

Office of Research and Development Washington DC 20460

EPA/600/R-94/168b
September 1996

EPA

The Hydrologic Evaluation of Landfill Performance (HELP) Model

Engineering Documentation for Version 3

Attachment C, 1/3

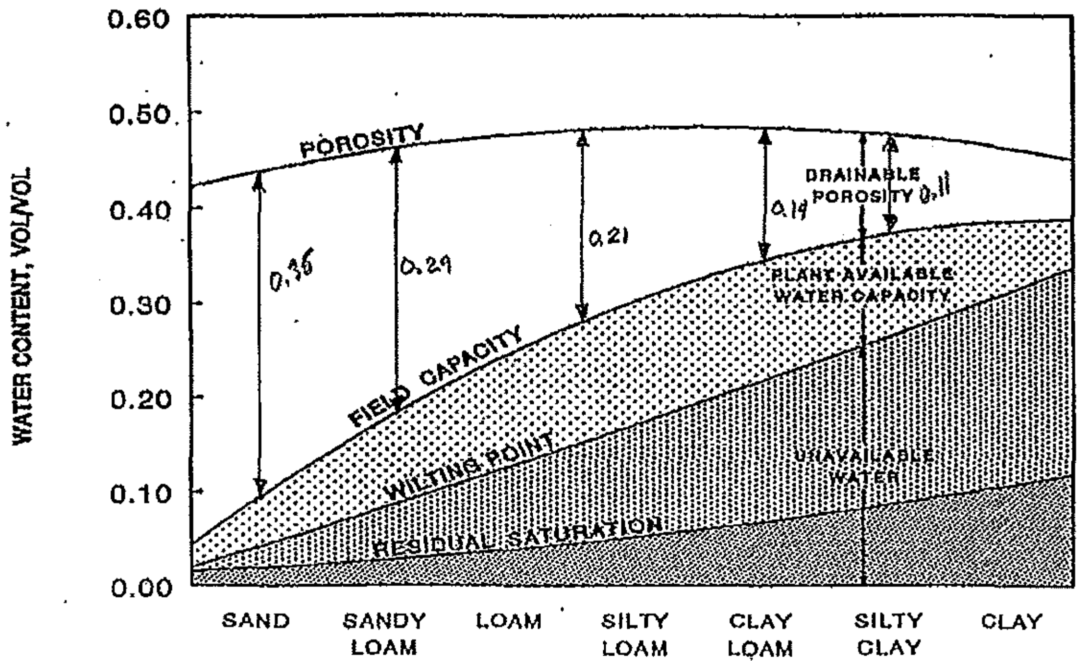


Figure 2. Relation Among Moisture Retention Parameters and Soil Texture Class

are not specified, the program assumes values near the steady-state values (allowing no long-term change in moisture storage) and runs a year of simulation to initialize the moisture contents closer to steady state. The soil water contents at the end of this year are substituted as the initial values for the simulation period. The program then runs the complete simulation, starting again from the beginning of the first year of data. The results of the volumetric water content initialization period are not reported in the output.

3.3.2 Unsaturated Hydraulic Conductivity

Darcy's constant of proportionality governing flow through porous media is known quantitatively as hydraulic conductivity or coefficient of permeability and qualitatively as permeability. Hydraulic conductivity is a function of media properties, such as particle size, void ratio, composition, fabric, degree of saturation, and the kinematic viscosity of the fluid moving through the media. The HELP program uses the saturated and unsaturated hydraulic conductivities of soil and waste layers to compute vertical drainage, lateral drainage and soil liner percolation. The vapor diffusivity for geomembranes is specified as a saturated hydraulic conductivity to compute leakage through geomembranes by vapor diffusion.

Attachment C, 2/3

TABLE 1. DEFAULT LOW DENSITY SOIL CHARACTERISTICS

Soil Texture Class			A Total Porosity vol/vol	B Field Capacity vol/vol	Wilting Point vol/vol	Saturated Hydraulic Conductivity cm/sec	A-B DRAINABLE POROSITY vol/vol
HELP	USDA	USCS					
1	CoS	SP	0.417	0.045	0.018	$1.0x10^{-2}$	
2	S	SW	0.437	0.062	0.024	$5.8x10^{-3}$	
3	FS	SW	0.457	0.083	0.033	$3.1x10^{-3}$	
4	LS	SM	0.437	0.105	0.047	$1.7x10^{-3}$	0.332
5	LFS	SM	0.457	0.131	0.058	$1.0x10^{-3}$	0.326
6	SL	SM	0.453	0.190	0.085	$7.2x10^{-4}$	0.263
7	FSL	SM	0.473	0.222	0.104	$5.2x10^{-4}$	0.251
8	L	ML	0.463	0.232	0.116	$3.7x10^{-4}$	0.231
9	SiL	ML	0.501	0.284	0.135	$1.9x10^{-4}$	0.217
10	SCL	SC	0.398	0.244	0.136	$1.2x10^{-4}$	0.154
11	CL	CL	0.464	0.310	0.187	$6.4x10^{-5}$	
12	SiCL	CL	0.471	0.342	0.210	$4.2x10^{-5}$	
13	SC	SC	0.430	0.321	0.221	$3.3x10^{-5}$	
14	SiC	CH	0.479	0.371	0.251	$2.5x10^{-5}$	
15	C	CH	0.475	0.378	0.251	$2.5x10^{-5}$	
21	G	GP	0.397	0.032	0.013	$3.0x10^{-1}$	

a = constant representing the effects of various fluid constants and gravity, 21 cm^3/sec

ϕ = total porosity, vol/vol

θ_r = residual volumetric water content, vol/vol

ψ_b = bubbling pressure, cm

λ = pore-size distribution index, dimensionless

A more detailed explanation of Equation 11 can be found in Appendix A of the HELP program Version 3 User's Guide and the cited references.

ATTACHMENT C, 3/3

ered that when well-graded mixtures of sand and gravel contained as little as 5% of fines (sizes smaller than a No. 200 sieve) high compactive efforts reduced the effective porosities nearly to zero and the permeabilities to less than 0.01% of those at moderate densities. These tests explain one of the reasons that blends of sand and gravel often used for drains are virtually useless as drainage aggregates if they contain more than insignificant amounts of fines.

In the preceding paragraphs variations in the permeability of remolded materials caused by variable compaction were discussed. Any factor that densifies soils reduces permeability. Studies of the rate of consolidation of clay and peat foundations are sometimes made by using initial coefficients of permeability of compressible formations. While the consolidation process is going on in foundations their permeabilities are becoming less. Generally, decreases in the permeabilities of clay foundations are rather moderate, but they can be large in highly compressible organic silts and clays and in peats. Modified calculation methods utilizing the changing permeability are needed in the analysis of highly compressible foundations. Some typical variations in permeability caused by consolidation are given in Fig. 2.10, a plot of consolidation pressure versus permeability.

$\sigma_n \approx 31' \times 130$ pcf.
≈ 4000 psf
≈ 2 Tsf

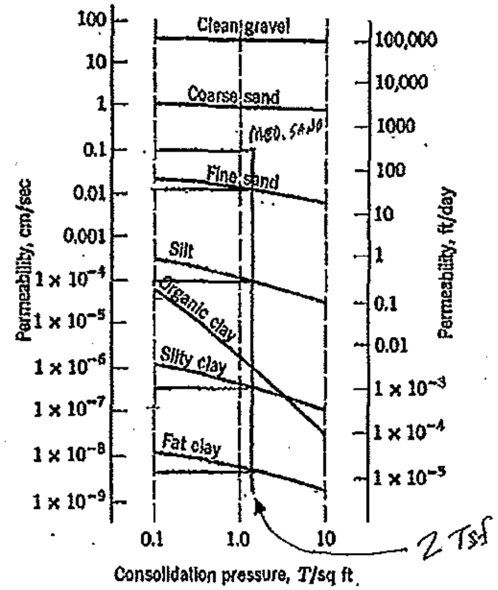


FIG. 2.10 Permeability versus consolidation pressure.

Attachment D

1/2

"Seepage, Drainage, and Flow Nets"
3rd Edition, Cedergren, H.R. 1989

$$k = \frac{Q}{iAt} \qquad (2.2)$$

Darcy's *discharge velocity* multiplied by the entire cross-sectional area, including voids e and solids 1, gives the seepage quantity Q under a given hydraulic gradient $i = \Delta h/\Delta l$ or h/L. It is an imaginary velocity that does not exist anywhere. The average *seepage velocity* v_s of a mass of water progressing through the pore spaces of a soil is equal to the discharge velocity ($v_d = ki$) multiplied by $(1 + e)/e$ or the discharge velocity divided by the effective porosity n_e; hence permeability is related to seepage velocity by the expression

$$k = \frac{v_s n_e}{i} \qquad (2.3)$$

For any seepage condition in the laboratory or in the field in which the *seepage quantity*, the area perpendicular to the direction of flow, and the hydraulic gradient are known the coefficient of permeability can be calculated. Likewise, for any situation where the *seepage velocity* is known at a point at which the hydraulic gradient and soil porosity also are known, permeability can be calculated.

Experimentally determined coefficients of permeability can be combined with prescribed hydraulic gradients and discharge areas in solving practical problems involving seepage quantities and velocities. When a coefficient of permeability has been properly determined, it furnishes a very important factor in the analysis of seepage and in the design of drainage features for engineering works.

The coefficient of permeability as used in this book and in soil mechanics in general should be distinguished from the physicists' coefficient of permeability K, which is a more general term than the engineers' coefficient and has units of centimeters squared rather than a velocity; it varies with the porosity of the soil but is independent of the viscosity and density of the fluid. The transmissibility factor T represents the capability of an aquifer to discharge water and is the product of permeability k and aquifer thickness t.

The engineers' coefficient, which is used in practical problems of seepage through masses of earth and other porous media, applies only to the flow of water and is a simplification introduced purely from the standpoint of convenience. It has units of a velocity and is expressed in centimeters per second, feet per minute, feet per day, or feet per year, depending on the habits and personal preferences of individuals using the coefficient. In standard soil mechanics terminology k is expressed in centimeters per second.

Although coefficient of permeability is often considered to be a constant for a given soil or rock, it can vary widely for a given material, depending on a number of factors. Its absolute values depend, first of all, on the properties of water, of which viscosity is the most important. For individual materials

Attachment D, 2/2

Cedergren, "Seepage, Drainage, and Flow Nets", 3rd Ed. 1989

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GDE Control Products, Inc.

Multi-FLO

Technical Properties

Drainage Core

Property	Test Method	Value
Thickness, inches	ASTM D-1777	1.0
Flow Rate, gpm/ft*	ASTM D-4716	29
~~Compressive Strength~~	~~ASTM D-1621~~	~~6000~~

*

Geotextile Filter

Property	Test Method	Value
Weight, oz/sq yd2	ASTM D-3776	4.0
Tensile Strength, lb.	ASTM D-4632	100
Elongation, %	ASTM D-4632	50
Puncture, lb.	ASTM D-4833	50
Mullen Burst, psi	ASTM D-3786	200
Trapezoidal Tear, lb.	ASTM D-4533	42
Coeffecient of Perm,cm/sec	ASTM D-4491	0.1
Flow Rate, gpm/ft2	ASTM D-4491	100
Permittivity, 1/sec	ASTM D-4491	1.8
A.O.S Max US Std Sieve	ASTM D 4751	70
UV Stability, 500 hrs., %	ASTM D-4355	70
Seam Strength, lb./ft	ASTM D-4595	100
Fungus	ASTM G-21	No Growth

* Horizontal Installation, gradient = 0.01, compressive force = 10 psi for 1(

All values given represent minimum average roll values

GDE Control Products, Inc. Laguna Hills, CA. 949-305-7117

GDE, Multi-Flow
<http: www.gdecontrol.com/Multi-Flow5.html> Attachment E 1/1

TABLE 2.12 RECOMMENDED REDUCTION FACTOR VALUES FOR USE IN EQ. (2.25a)

Application	Range of Reduction Factors				
	Soil Clogging and Blinding*	Creep Reduction of Voids	Intrusion into Voids	Chemical Clogging†	Biological Clogging
Retaining wall filters	2.0 to 4.0	1.5 to 2.0	1.0 to 1.2	1.0 to 1.2	1.0 to 1.3
Underdrain filters	5.0 to 10	1.0 to 1.5	1.0 to 1.2	1.2 to 1.5	2.0 to 4.0
Erosion-control filters	2.0 to 10	1.0 to 1.5	1.0 to 1.2	1.0 to 1.2	2.0 to 4.0
Landfill filters	5.0 to 10	1.5 to 2.0	1.0 to 1.2	1.2 to 1.5	5 to 10‡
Gravity drainage	2.0 to 4.0	2.0 to 3.0	1.0 to 1.2	1.2 to 1.5	1.2 to 1.5
Pressure drainage	2.0 to 3.0	2.0 to 3.0	1.0 to 1.2	1.1 to 1.3	1.1 to 1.3

*If stone riprap or concrete blocks cover the surface of the geotextile, use either the upper values or include an additional reduction factor.

†Values can be higher particularly for high alkalinity groundwater.

‡Values can be higher for turbidity and/or for microorganism contents greater than 5000 mg/l.

$$q_{allow} = q_{ult}\left(\frac{1}{\Pi RF}\right) \qquad (2.25b)$$

where

q_{allow} = allowable flow rate,
q_{ult} = ultimate flow rate,
RF_{SCB} = reduction factor for soil clogging and blinding,
RF_{CR} = reduction factor for creep reduction of void space,
RF_{IN} = reduction factor for adjacent materials intruding into geotextile's void space,
RF_{CC} = reduction factor for chemical clogging,
RF_{BC} = reduction factor for biological clogging, and
ΠRF = value of cumulative reduction factors.

As with Eqs. (2.24) for strength reduction, this flow-reduction equation could also have included additional site-specific terms, such as blocking of a portion of the geotextile's surface by riprap or concrete blocks.

2.5 DESIGNING FOR SEPARATION

Application areas for geotextiles used for the separation function were given in Section 1.3.3. There are many specific applications, and it could be said, in a general sense, that geotextiles always serve a separation function. If they do not also serve this function, any other function, including the primary one, will not be served properly. This should not give the impression that the geotextile function of separation always plays a secondary role. Many situations call for separation only, and in such cases the geotextiles serve a significant and worthwhile function.

ATTACHMENT F 1/4

4.1.6 Allowable Flow Rate

As described previously, the very essence of the design-by-function concept is the establishment of an adequate factor of safety. For geonets, where flow rate is the primary function, this takes the following form.

$$\text{FS} = \frac{q_{\text{allow}}}{q_{\text{reqd}}} \tag{4.3}$$

where

FS = factor of safety (to handle unknown loading conditions or uncertainties in the design method, etc.),
q_{allow} = allowable flow rate as obtained from laboratory testing, and
q_{reqd} = required flow rate as obtained from design of the actual system.

Alternatively, we could work from transmissivity to obtain the equivalent relationship.

$$\text{FS} = \frac{\theta_{\text{allow}}}{\theta_{\text{reqd}}} \tag{4.4}$$

where θ is the transmissivity, under definitions as above. As discussed previously, however, it is preferable to design with flow rate rather than with transmissivity because of nonlaminar flow conditions in geonets.

Concerning the allowable flow rate or transmissivity value, which comes from hydraulic testing of the type described in Section 4.1.3, we must assess the realism of the test setup in contrast to the actual field system. If the test setup does not model site-specific conditions adequately, then adjustments to the laboratory value must be made. This is usually the case. Thus the laboratory-generated value is an ultimate value that must be reduced before use in design; that is,

$$q_{\text{allow}} < q_{\text{ult}}$$

One way of doing this is to ascribe reduction factors on each of the items not adequately assessed in the laboratory test. For example,

$$q_{\text{allow}} = q_{\text{ult}}\left[\frac{1}{\text{RF}_{IN} \times \text{RF}_{CR} \times \text{RF}_{CC} \times \text{RF}_{BC}}\right] \tag{4.5}$$

or if all of the reduction factors are considered together.

$$q_{\text{allow}} = q_{\text{ult}}\left[\frac{1}{\Pi\text{RF}}\right] \tag{4.6}$$

where

q_{ult} = flow rate determined using ASTM D4716 or ISO/DIS 12958 for short-term tests between solid platens using water as the transported liquid under laboratory test temperatures,

ATTACHMENT

q_{allow} = allowable flow rate to be used in Eq. (4.3) for final design purposes,
RF_{IN} = reduction factor for elastic deformation, or intrusion, of the adjacent geosynthetics into the geonet's core space,
RF_{CR} = reduction factor for creep deformation of the geonet and/or adjacent geosynthetics into the geonet's core space,
RF_{CC} = reduction factor for chemical clogging and/or precipitation of chemicals in the geonet's core space,
RF_{BC} = reduction factor for biological clogging in the geonet's core space, and
ΠRF = product of all reduction factors for the site-specific conditions.

Some guidelines for the various reduction factors to be used in different situations are given in Table 4.2. Please note that some of these values are based on relatively sparse information. Other reduction factors, such as installation damage, temperature effects, and liquid turbidity, could also be included. If needed, they can be included on a site-specific basis. On the other hand, if the actual laboratory test procedure has included the particular item, it would appear in the above formulation as a value of unity. Examples 4.2 and 4.3 illustrate the use of geonets and serve to point out that high reduction factors are warranted in critical situations.

Example 4.2

What is the allowable geonet flow rate to be used in the design of a capillary break beneath a roadway to prevent frost heave? Assume that laboratory testing was done at the proper design load and hydraulic gradient and that this testing yielded a short-term between-rigid-plates value of 2.5×10^{-4} m²/s.

Solution: Since better information is not known, average values from Table 4.2 are used in Eq. (4.5).

TABLE 4.2 RECOMMENDED PRELIMINARY REDUCTION FACTOR VALUES FOR EQ. (4.5) FOR DETERMINING ALLOWABLE FLOW RATE OR TRANSMISSIVITY OF GEONETS

Application Area	RF_{IN}	RF_{CR}*	RF_{CC}	RF_{BC}
Sport fields	1.0 to 1.2	1.0 to 1.5	1.0 to 1.2	1.1 to 1.3
Capillary breaks	1.1 to 1.3	1.0 to 1.2	1.1 to 1.5	1.1 to 1.3
Roof and plaza decks	1.2 to 1.4	1.0 to 1.2	1.0 to 1.2	1.1 to 1.3
Retaining walls, seeping rock, and soil slopes	1.3 to 1.5	1.2 to 1.4	1.1 to 1.5	1.0 to 1.5
Drainage blankets	1.3 to 1.5	1.2 to 1.4	1.0 to 1.2	1.0 to 1.2
Surface water drains for landfill covers	1.3 to 1.5	1.1 to 1.4	1.0 to 1.2	1.2 to 1.5
Secondary leachate collection (landfills)	1.5 to 2.0	1.4 to 2.0	1.5 to 2.0	1.5 to 2.0
Primary leachate collection (landfills)	1.5 to 2.0	1.4 to 2.0	1.5 to 2.0	1.5 to 2.0

*These values are sensitive to the density of the resin used in the geonet's manufacture. The higher the density, the lower the reduction factor. Creep of the covering geotextile(s) is a product-specific issue.

ATTACHMENT F, 3/4

The above formula can be readily converted to flow rate, Q, by multiplying the velocity by the cross-sectional area A of the pipe.

For pipelines that are either flowing full or flowing partially full, the *Manning equation* is generally used.

$$V = \frac{1}{n} R_H^{0.66} S^{0.5} \tag{7.10}$$

where

V = velocity of flow (m/s),
R_H = hydraulic radius (m),
S = slope or gradient of pipeline (m/m), and
n = coefficient of roughness (see Table 7.7) (dimensionless).

Note that plastic pipe of the type discussed in this chapter, with a *smooth interior*, has a Manning coefficient from 0.009 to 0.010. Plastic pipe with a *profiled or corrugated interior* has a Manning coefficient ranging from 0.018 to 0.025.

Eqs. (7.9) and (7.10) are generally used in the form of charts or nomographs to determine pipe sizes, flow velocity or discharge flow rates (see Figures 7.6 and 7.7). For each chart we include an example from Hwang [7], illustrated on the respective nomographs by heavy lines. Note that both nomographs are for pipes flowing full.

Example 7.1

A 100 m long pipe with $D = 200$ mm and $C = 120$ carries a discharge of 30 l/s. Determine the head loss in the pipe. (See the Hazen-Williams chart in Figure 7.6.)

Solution: Applying the conditions given to the solution chart in Figure 7.6, the energy gradient is obtained.

$$S = 0.0058 \text{ m/m}$$

TABLE 7.7 VALUES OF MANNING ROUGHNESS COEFFICIENT, N, FOR REPRESENTATIVE [illegible] SURFACES

Type of Pipe Surface	Representative Values [illegible]
* Lucite, glass, or plastic*	[illegible]
Wood or finished concrete	[illegible]
Unfinished concrete, well-laid brickwork, concrete or cast iron pipe	[illegible]
Riveted or spiral steel pipe	[illegible]
Smooth, uniform earth channel	[illegible]
Corrugated flumes, typical canals, river free from large stones and heavy weeds	[illegible]
Canals and rivers with many stones and weeds	[illegible]

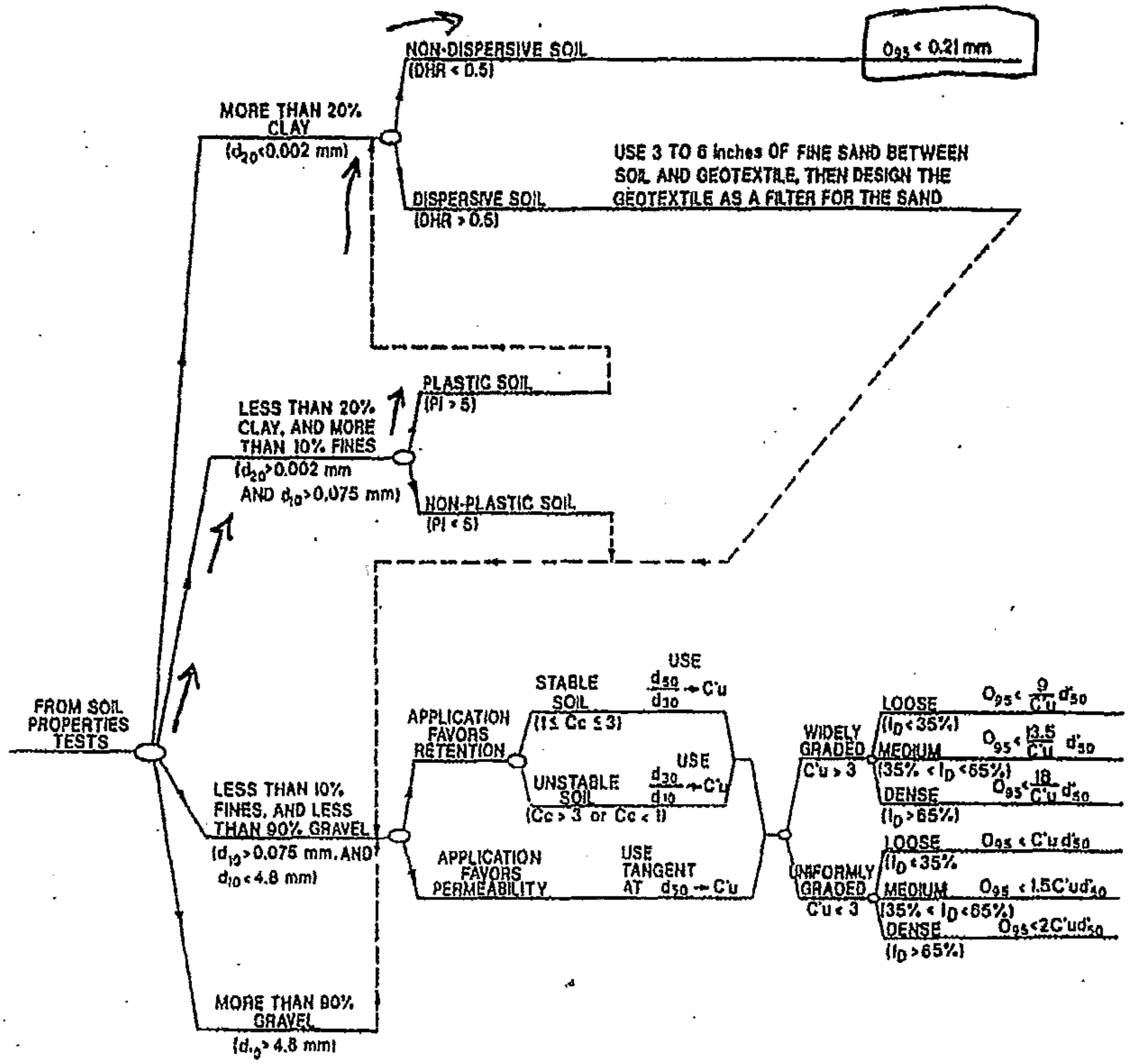
*The table does not distinguish between different types of plastic, or between smooth wall [illegible] pipes with perforations.

Source: After Fox and McDonald [9].

Koerner, R.M., "Designing with Geosynthetics," 4th Ed, 1999

Attachment F4

CHART 1
SOIL RETENTION CRITERIA FOR STEADY-STATE FLOW CONDITIONS



NOTES:

d_x is the particle size of which x percent is smaller

$C'u = \sqrt{\frac{d'_{100}}{d'_0}}$ where: d'_{100} and d'_0 are the extremities of a straight line drawn through the particle-size distribution, as directed above; and d'_{50} is the midpoint of this line.

$Cc = \frac{(d_{30})^2}{d_{60} \times d_{10}}$

I_D is the relative denisty of the soil

PI is the plasticity index of the soil

DHR is the double-hydrometer ratio of the soil

Portions of this flow chart modified from Giroud (1988)

Source: Luettich, S.M., Giroud, J.P., and Bachus, R.C. (1991). "Geotextile Filter Design Manual". Report prepared for Nicolon Corporation, Norcross, Georgia.

Attachment G 1/3

4.2 Define the Hydraulic Gradient for the Application (i_s)

The hydraulic gradient will vary depending on the application of the filter. Anticipated hydraulic gradients for various applications may be estimated using Figure 3.

4.3 Determine the Minimum Allowable Geotextile Permeability (k_g)

After determining the soil hydraulic conductivity and the hydraulic gradient, the following equation can be used to determine the minimum allowable geotextile permeability [Giroud, 1988]:

$$k_g > i_s \, k_s$$

The hydraulic conductivity (permeability) of the geotextile can be calculated from the permittivity test method ASTM D 4491; this value can often be obtained from the manufacturer's literature as well. The geotextile permeability is defined as the product of the permittivity, ψ, and the geotextile thickness, t_g:

$$k_g > \varphi \, t_g$$

STEP 5. DETERMINE ANTI-CLOGGING REQUIREMENTS

To minimize the risk of clogging, the following criteria should be met:

- Use the largest opening size (O_{95}) that satisfies the retention criteria.
- For nonwoven geotextiles, use the largest porosity available, but not less than 30 percent.
- For woven geotextiles, use the largest percent open area available, but not less than 4 percent.

Source: Luettich, S.M., Giroud, J.P., and Bachus, R.C. (1991). "Geotextile Filter Design Manual". Report prepared for Nicolon Corporation, Norcross, Georgia.

Attachment G 2/3

Table 4-5

Typical Hydraulic Gradients[a]

DRAINAGE APPLICATION	TYPICAL HYDRAULIC GRADIENT
Standard Dewatering Trench	1.0
Vertical Wall Drain	1.5
Pavement Edge Drain	1[b]
Landfill LCDRS	1.5
Landfill LCRS	1.5
Landfill SWCRS	1.5
Inland Channel Protection	1[b]
Shoreline Protection	10[b]
Dams	10[b]
Liquid Impoundments	10[b]

NOTES: [a] Table developed after Giroud [1988].

[b] Critical applications may require designing with higher gradients than those given.

Attachment 9
3/3

AMOCO WASTE RELATED GEOTEXTILES

MINIMUM PHYSICAL PROPERTIES
(Minimum Average Roll Values)

Property	Test Method	Units	4504	4506	4508	4510	4512	4516
Unit Weight	ASTM D-3776	Oz./yd.²	4.0 *	6.0	8.0	10.0	12.0	16.0
Grab Tensile	ASTM D-4632	lbs.	95	150	200	235	275	350
Grab Elongation	ASTM D-4632	%	50	50	50	50	50	50
Mullen Burst	ASTM D-3787	psi	225	350	450	550	650	750
Puncture	ASTM D-4833	lbs.	55	80	130	165	185	220
Trapezoid Tear	ASTM D-4533	lbs.	35	65	80	95	115	130
Apparent Opening Size	ASTM D-4751	US Sieve Number	70	70	100	100	100	100
Permittivity	ASTM D-4491	gal/min/ft² sec⁻¹	100 2.0	90 1.7	80 1.5	70 1.1	60 0.9	50 0.7
Permeability	ASTM D-4491	cm/sec	.2	.2	.2	.2	.2	.2
Thickness	ASTM D-1777	mils	40 *	65	90	110	130	175
U.V. Resistance	ASTM D-4355[1]	%[2]	70	70	70	70	70	70

1. Fabric conditioned per ASTM D-4355 2. Percent of minimum grab tensile after conditioning.

TYPICAL PHYSICAL PROPERTIES

Property	Test Method	Units	4504	4506	4508	4510	4512	4516
Grab Tensile	ASTM D-4632	lbs.	130/115	225/200	275/270	315/310	410/370	510/470
Grab Elongation	ASTM D-4632	%	75	65	65	65	65	65
Mullen Burst	ASTM D-3786	psi	285	410	575	650	825	920
Puncture	ASTM D-4833	lbs.	75	120	170	190	210	270
Trapezoid Tear	ASTM D-4533	lbs.	60/60	100/80	140/120	160/140	185/165	220/180
Apparent Opening Size	ASTM D-4751	US Sieve Number	70/120	70/140	100/200	100+	100+	100+
Permittivity	ASTM D-4491	gal/min/ft² sec⁻¹	150 3.1	110 2.0	100 1.8	80 1.5	70 1.3	60 1.0
Permeability	ASTM D-4491	cm/sec	.35	.31	.27	.26	.25	.23
Thickness	ASTM D-1777	mils	50	75	115	130	150	195

PACKAGING

Dimensions		4504	4506	4508	4510	4512	4516
Roll Width	ft.	15	15	15	15	15	15
Roll Length	ft.	1200	900	600	600	450	300
Gross Weight	lbs.	600	550	500	600	650	500
Area	sq. yds.	2000	1500	1000	1000	750	500

The information contained herein is furnished without charge or obligation and the recipi[...] conditions of use and handling may vary and are beyond our control we make no represent[...] accuracy or reliability of said information or the performance of any product. Any specif[...] provided as information only and in no way modify, amend, enlarge or create any warra[...] permission or as a recommendation to infringe any patent.

"Amoco Fabrics & Fibers Company, 1991. "Amoco Waste Related Geotextiles" H 1/1

Amoco Fabrics and Fibers Company 900 Circle 75 Parkway, Suite 300 Atlanta, Georgi[...]

Code #19100512;20,050;6/91

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**              HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                  **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**              USAE WATERWAYS EXPERIMENT STATION                           **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      C:\HLP3\IUC\IUC30.D4
TEMPERATURE DATA FILE:        C:\HLP3\IUC\IUC30.D7
SOLAR RADIATION DATA FILE:    C:\HLP3\IUC\IUC30.D13
EVAPOTRANSPIRATION DATA:      C:\HLP3\IUC\IUC30.D11
SOIL AND DESIGN DATA FILE:    C:\HLP3\IUC\Cell4B.D10
OUTPUT DATA FILE:             C:\HLP3\IUC\Cell4B.OUT


TIME:  12:18      DATE:   8/30/2007


******************************************************************************

    TITLE:  IUC Slimes Drain Analysis Cell 4B

******************************************************************************


    NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
           COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                 LAYER  1
                                 --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER   0
         THICKNESS                  =     36.00   INCHES
         POROSITY                   =      0.4700 VOL/VOL
         FIELD CAPACITY             =      0.2220 VOL/VOL
         WILTING POINT              =      0.1000 VOL/VOL
         INITIAL SOIL WATER CONTENT =      0.1980 VOL/VOL
         EFFECTIVE SAT. HYD. COND.  =  0.520000001000E-03 CM/SEC


                                 LAYER  2
                                 --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
```

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4700	VOL/VOL
FIELD CAPACITY	=	0.2220	VOL/VOL
WILTING POINT	=	0.1040	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2220	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.520000001000E-03	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	75.0	FEET

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 7 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 1.% AND A SLOPE LENGTH OF 75. FEET.

SCS RUNOFF CURVE NUMBER	=	88.80	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	16.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.689	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	7.520	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.600	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	8.458	INCHES
TOTAL INITIAL WATER	=	8.458	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM GRAND JUNCTION COLORADO

STATION LATITUDE	=	39.07	DEGREES
MAXIMUM LEAF AREA INDEX	=	1.00	
START OF GROWING SEASON (JULIAN DATE)	=	109	
END OF GROWING SEASON (JULIAN DATE)	=	293	
EVAPORATIVE ZONE DEPTH	=	16.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.10	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	60.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	36.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	36.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	57.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR GRAND JUNCTION COLORADO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC

0.64	0.54	0.75	0.71	0.76	0.44
0.47	0.91	0.70	0.87	0.63	0.58

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR GRAND JUNCTION COLORADO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
25.50	33.50	41.90	51.70	62.10	72.30
78.90	75.90	67.10	54.90	39.60	28.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR GRAND JUNCTION COLORADO
AND STATION LATITUDE = 39.07 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.44	0.44	0.65	0.81	0.75	0.52
	0.39	1.08	0.58	1.00	0.94	0.54
STD. DEVIATIONS	0.23	0.30	0.31	0.44	0.53	0.63
	0.30	0.48	0.44	0.63	0.52	0.31
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.441	0.542	0.627	0.714	0.941	1.152
	0.511	0.980	0.481	0.737	0.589	0.454
STD. DEVIATIONS	0.213	0.272	0.280	0.352	0.544	0.560
	0.398	0.510	0.395	0.637	0.250	0.224
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0000	0.0000	0.0009	0.0011	0.0002	0.0008
	0.0003	0.0000	0.0000	0.0000	0.0010	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0020	0.0027	0.0008	0.0019

0.0009 0.0000 0.0000 0.0000 0.0032 0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET	PERCENT
PRECIPITATION	8.16	(1.320)	29628.1	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	8.168	(1.5732)	29651.33	100.079
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.00442	(0.00727)	16.060	0.05420
CHANGE IN WATER STORAGE	-0.011	(0.7860)	-39.33	-0.133

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0
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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	0.86	3121.800
RUNOFF	0.000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.003089	11.21440
SNOW WATER	0.72	2615.3926

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2271

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1000

****

0
****

FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	6.9017	0.1917
2	1.3320	0.2220

SNOW WATER 0.116

****
****

APPENDIX I

SETTLEMENT MONITORING STRATEGY

I.1 INTRODUCTION

This appendix outlines the strategy for monitoring of settlement of the cover surface on tailings management Cells 2, 3, 4A, and 4B after placement of the reclamation cover. Initial settlement monitoring of the interim cover surface is conducted prior to final cover construction. After construction of the final cover system, settlement monitoring will be conducted (as outlined below) as part of post-reclamation performance monitoring.

I.2 OBJECTIVES

There are two objectives for monitoring settlement associated with the tailings management cells: (1) assurance that the materials in the tailings management cells have stabilized prior to construction of the final cover system, and (2) after final cover construction, verification that the final cover surface is not experiencing significant settlement. These objectives are assessed by measurement of the elevations of monitoring points at selected locations across the cell surfaces.

I.3 MONITORING

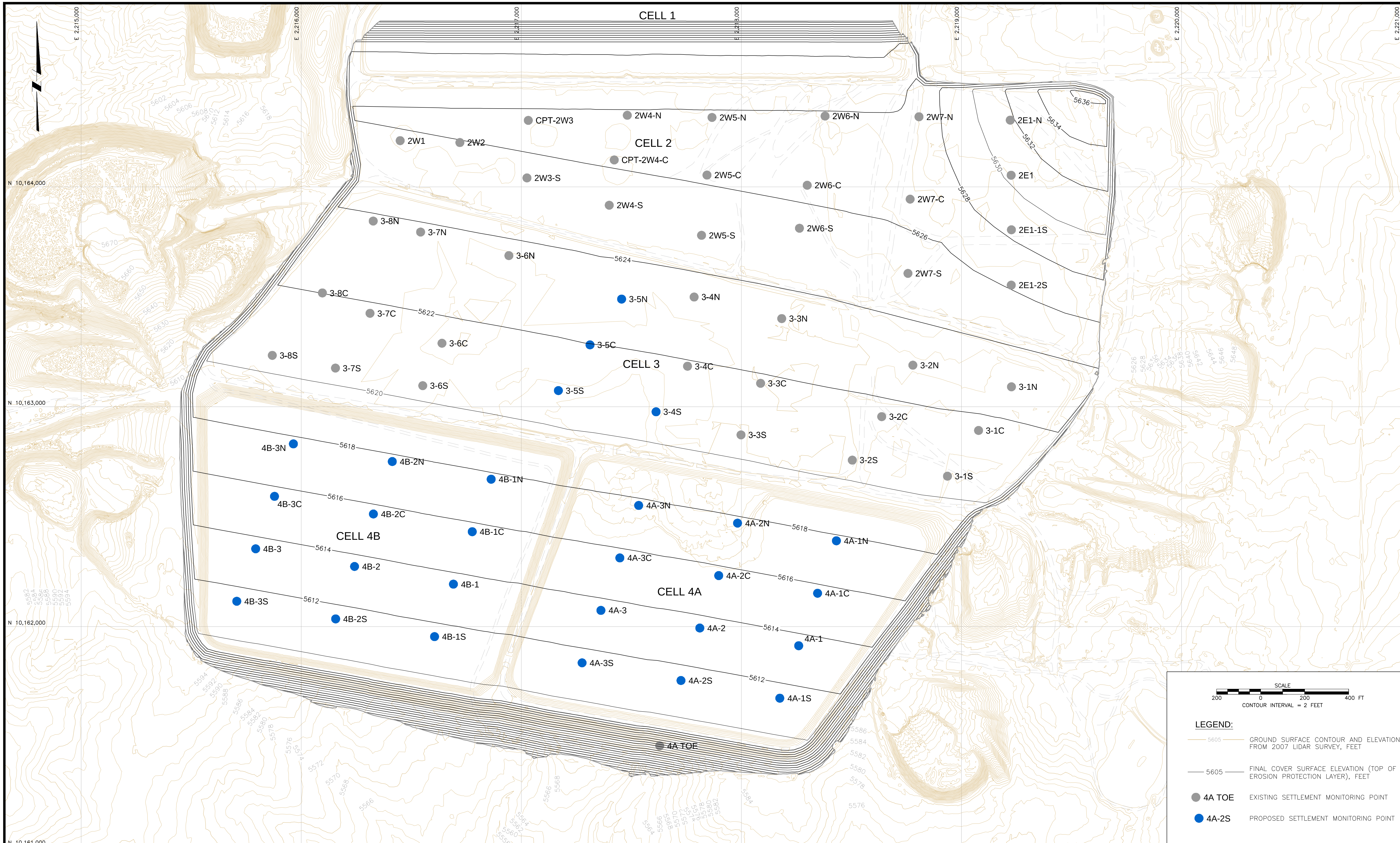
To meet these objectives, settlement monitoring for the top surface of the tailings management cells would consist of two phases: (1) monitoring the interim cover surface prior to final cover system construction, and (2) monitoring the top-of-cover surface after final cover system construction. The proposed and existing monitoring point locations are shown on Figure I.1. These points are located on an approximate grid spacing of 225 feet by 425 feet (north-south by east-west).

Monitoring of the existing settlement monuments in Cell 2 and Cell 3 follows the Settlement Monitoring Plan approved by DWMRC for the site. After placement of final cover material, the existing settlement monuments will be extended or replaced to monitor settlement of the final cover surface.

For areas without settlement monuments, settlement monuments will be installed per the Technical Specifications after interim cover placement. Settlement monuments will be extended during or installed after final cover placement per the Technical Specifications. Settlement monitoring will be conducted in accordance with the most recent version the DWMRC approved Settlement Monitoring Plan.

Monitoring of the interim cover surface is conducted at the end of operations to measure rates and locations of settlement prior to construction of the final cover system. Decreasing trends in settlement followed by maximum of 0.1 feet (30 mm) of cumulative settlement over 12 months (for 90 percent of the settlement monuments) is considered acceptable to proceed with placement of the final cover.

After construction of the final cover system, settlement monitoring will be conducted as part of post-closure performance monitoring to verify that the final cover surface is not experiencing significant settlement. It is recommended that settlement monuments be monitored weekly for the first month after final cover construction, biweekly for the second month, and monthly thereafter for the first two years. Monitoring frequency is recommended as quarterly after two years. A minimum monitoring period of 5 years is recommended. Decreasing trends in settlement followed by maximum of 0.1 feet (30 mm) of cumulative settlement over 12 months (for 90 percent of the settlement monuments) is recommended as acceptable for defining when the final cover surface is no longer experiencing significant settlement.



ENERGY FUELS

PROJECT
WHITE MESA MILL TAILINGS RECLAMATION

TITLE
SETTLEMENT MONITORING POINTS

MWH

DATE
MAY 2016

FIGURE I.1

FILE NAME
1009740 SETLMON

L:\Design-Drafting\Clients-A-H\ENERGY FUELS\013-Sheet Set\2015-08-31 COVER DSGN FIGS\1009740 SETLMON

APPENDIX J

REVEGETATION PLAN

J.1 INTRODUCTION

Revegetation of the tailing cells at the White Mesa Mill Site will be completed following construction of the cover system. The revegetation process will establish a grass-forb-shrub community consisting primarily of native, long-lived perennial grasses, forbs, and shrubs that are highly adapted to the climatic and edaphic conditions of the site. Revegetation methods will follow state-of-the-art techniques for soil amendments, seedbed preparation, seeding and mulching. In addition, quality assurance and quality control procedures will be followed to ensure that revegetation methods are implemented correctly and the results of the process meet expectations.

J.2 PLANT SPECIES AND SEEDING RATES

The following 15 species (11 grasses, 2 forbs, and 2 shrubs) are proposed for the ET cover system at the White Mesa Mill site. These species were selected for their adaptability to site conditions, compatibility, and long-term sustainability. Species were also selected based on the assumption that institutional controls will exclude grazing by domestic livestock. The proposed species are:

- Western wheatgrass, variety Arriba (*Pascopyrum smithii*)
- Bluebunch wheatgrass, variety Goldar (*Pseudoroegneria spicata*)
- Slender wheatgrass, variety San Luis (*Elymus trachycaulus*)
- Streambank wheatgrass, variety Sodar (*Elymus lanceolatus ssp. psammophilus*)
- Pubescent wheatgrass, variety Luna (*Thinopyrum intermedium ssp. barbulatum*)
- Indian ricegrass, variety Paloma (*Achnatherum hymenoides*)
- Sandberg bluegrass, variety Canbar (*Poa secunda*)
- Sheep fescue, variety Covar (*Festuca ovina*)
- Squirreltail, variety Toe Jam Creek (*Elymus elymoides*)
- Blue grama, variety Hachita (*Bouteloua gracilis*)
- Galleta, variety Viva (*Hilaria jamesii*)
- Common yarrow, no variety (*Achillea millefolium*)
- White sage, variety Summit (*Artemisia ludoviciana*)
- Fourwing saltbush, variety Wytana (*Atriplex canescens*)
- Rubber rabbitbrush (*Ericameria nauseosus*).

The ecological characteristics of these species are described in detail in Appendix D.

Table J.1 presents broadcast seeding rates for each species. Seeding rates were developed based on the objective of establishing a permanent cover of grasses, forbs, and shrubs in a mixture that would promote compatibility among species and minimize competitive exclusion or loss of species over time. Seeding rates were developed on the basis of number of seeds per unit area (e.g. number of seeds per square foot) and then converted to weight per unit area (e.g. pounds per acre).

Table J.1. Species and seeding rates proposed for ET cover at the White Mesa Mill Site

Scientific Name	Common Name	Varietal Name	Native/ Introduced	Seeding Rate (lbs PLS/acre)†	Seeding Rate (# seeds/ft^2)
Grasses					
Pascopyrum smithii	Western wheatgrass	Arriba	Native	3.0	7.9
Pseudoroegneria spicata	Bluebunch wheatgrass	Goldar	Native	3.0	9.6
Elymus trachycaulus	Slender wheatgrass	San Luis	Native	2.0	6.2
Elymus lanceolatus	Streambank wheatgrass	Sodar	Native	2.0	7.3
Elymus elymoides	Squirreltail	Toe Jam	Native	2.0	8.8
Thinopyrum intermedium	Pubescent wheatgrass	Luna	Introduced‡	1.0	1.8
Achnatherum hymenoides	Indian ricegrass	Paloma	Native	4.0	14.7
Poa secunda	Sandberg bluegrass	Canbar	Native	0.5	11.4
Festuca ovina	Sheep fescue	Covar	Introduced‡	1.0	11.5
Bouteloua gracilis	Blue grama	Hachita	Native	1.0	16.5
Hilaria jamesii	Galleta	Viva	Native	2.0	7.3
Forbs					
Achillea millefolium, variety occidentalis	Common yarrow	VNS*	Native	0.5	32
Artemisia ludoviciana	White sage	VNS	Native	0.5	45
Shrubs					
Atriplex canescens	Fourwing saltbush	Wytana	Native	3.0	3.4
Ericameria nauseosus	Rubber rabbitbrush	VNS	Native	0.5	4.6
Total				26.5	188

†Seeding rate is for broadcast seed and presented as pounds of pure live seed per acre (lbs PLS/acre).
‡Introduced refers to species that have been 'introduced' from another geographic region, typically outside of North America. Also referred to as 'exotic' species. * VNS=Variety Not Specified but seed source would be designated from sites similar to the Mill Site.

Seeding rates are calculated from an expected field emergence for each species and the desired number of plants per unit area. For purposes of calculation, field emergence for small seeded grasses and forbs is assumed to be around 50 percent if germination is greater than 80 percent. Field emergence is assumed to be around 30 percent if germination is between 60 and 80 percent. The Natural Resource Conservation Service recommends a seeding rate of 20 to 30 pure live seeds per square foot as a minimum number of seeds when drill seeding single species in areas with an annual precipitation between 6 and 18 inches. Twenty pure live seeds per square foot, with an expected field emergence of 50 percent should produce an adequate number of plants on the seeded area to control erosion and suppress annual invasion. This seeding rate is primarily for favorable growing conditions, soils that are not extreme in texture, gentle slopes, north or east facing aspect, good moisture, adequate soil nutrients and single species vs. multiple species in a mixture. When conditions are less favorable when the seed is broadcast, or when multiple species are in a mixture the seeding rates are increased.

A Quality Assurance/Quality Control Plan for application rates and procedures for confirming that specified application rates are achieved is as follows. The first step begins with a seed order. Seed would be purchased as pounds of pure live seed. Each State has a seed certifying agency and certification programs may be adopted by seed growers. Certification of a container of seed assures the customer that the seed is correctly identified and genetically pure. The State agency responsible for seed certification sets minimum standards for mechanical purity and germination for each species of seed. When certified, a container of seed must be labeled as to origin, germination percentage, date of the germination test, percentage of pure seed (by weight), other crop and weed seeds, and inert material. The certification is the consumer’s best guarantee that the seed being purchased meets minimum standards and the quality specified.

Once the seed is obtained, seed labels would be checked to determine the percent PLS and the date that the seed was tested for percent purity and percent germination. If the test date is greater than 6 months old, the seed would be tested again before being accepted. Seed will be applied using a broadcasting method as described below.

J.3 SOIL FERTILIZATION AND ORGANIC MATTER AMENDMENT

The physical and chemical characteristics of the soil that will be used for the cover system are presented in Appendix D. Based on this analysis, there are three soil properties that appear to be deficient for sustained plant growth and will need to be treated prior to seeding and to ensure that the soil provides adequate carbon and plant essential nutrients for initial plant establishment and long-term sustainability. The soil properties that will need treatment include percent organic matter, total nitrogen, and plant available potassium (Appendix D). The upper 15 cm of the water storage layer will be treated with an organic matter amendment to alleviate the existing deficiencies. This treatment will be applied after the water storage layer is in place and before placement of the topsoil-gravel erosion protection layer. Further chemical analysis will be conducted prior to placement of the water storage layer to verify the chemical properties of this material and to finalize the proposed treatment. In order for the potential cover soil to function as a normal soil and provide long-term sustainable support for the vegetation component of the ET cover, it will be amended to improve organic matter content, nitrogen and potassium levels. An organic matter amendment will also improve available water holding capacity and cation exchange capacity. The proposed organic amendment is composted biosolids. Composted biosolids have been successfully used in mined land reclamation over the past 40 years. This amendment would also provide a source of soil microorganisms that will function to cycle nutrients over time and ensure sustainable plant growth. Composted biosolids would be applied at a rate of 10 tons/acre and incorporated into the upper six inches of the water storage layer of the cover system. Composted biosolids are also a source of nitrogen, phosphorous and potassium and will serve to improve organic matter content and soil fertility.

The topsoil-gravel erosion control layer will not be amended for organic matter or nutrients to avoid the stimulation of undesirable weedy species. The addition of nutrients, especially nitrogen, during revegetation is known to stimulate the growth of annual weeds at the potential detriment of seeded perennial species. Withholding nutrient additions from the topsoil-gravel cover will allow the seeded species to establish without the unwanted competition from undesirable weedy species.

J.4 SEEDBED PREPARATION

Following placement of the topsoil-gravel erosion protection layer, the area will be harrowed to reduce any compaction that may have occurred during placement of the cover and to create an uneven surface for optimum seedbed conditions. Since seeding will be conducted with a broadcast method it is critical for the soil surface to be loose and uneven, but also have a firmness below the soil surface to allow proper seeding depth and to promote optimum seed-soil contact for germination and initial plant establishment.

J.5 SEEDING

Seed will be applied using a broadcasting method as soon as practicable following seedbed preparation. This procedure will use a centrifugal type broadcaster (or similar implement), also called an end-gate seeder. These broadcasters operate with an electric motor and are usually mounted on the back of a small tractor and generally have an effective spreading width of about 20 feet or more. Prior to seeding, a known area will be covered with a tarp and seed will be distributed using the broadcaster and simulating conditions that would exist under actual seeding conditions. Seed will then be collected and weighed to determine actual seeding rate in terms of pounds per acre. This process will be repeated until the specified seeding rate is obtained. During the seeding process, the seeding rate will be verified at least once by comparing pounds of seed applied to the size of the area seeded. In addition, seed will be applied in two separate passes. One-half of the seed will be spread in one direction and the other half of seed will be spread in a perpendicular direction. This will ensure that seed distribution across the site is highly uniform and also provide the opportunity to adjust the seeding rate if the specified rate is not being achieved. Seeding will not occur if wind speeds exceed 10 mph.

Immediately following seeding, the area will be lightly harrowed to provide seed coverage and to maximize seed-soil contact. This step in the revegetation process will ensure that the seed is placed at an optimum seeding depth and in good soil contact for proper germination conditions.

Seeding will take place as soon as practical after the cover system is in place. Successful seeding in southeastern Utah can occur either in late fall (e.g. October) as a dormant seeding, with germination and establishment occurring the following spring or can be conducted in June, prior to the summer monsoon season. The timing for seeding will be dependent upon the construction schedule for the cover system.

J.6 MULCHING

A mulch will be applied immediately following seeding to conserve soil moisture for seed germination and initial plant establishment. Mulching will also provide additional soil erosion protection from both wind and water until a plant cover is established. A weed-free, wood-fiber mulch will be applied to the seeded area at a rate of 1.5 tons/acre. Wood fiber mulch will consist of specially prepared wood fibers and will not be produced from recycled material such as sawdust, paper, cardboard, or residue from pulp and paper plants. The fibers will be dyed an appropriate color, non-toxic, water-soluble dye to facilitate visual metering during application. Wood fiber mulch will be supplied in packages and each package will be marked by the manufacturer to show the air-dry weight.

The wood fiber mulch will be applied by means of hydraulic equipment that utilizes water as the carrying agent. The mulch will be applied in a uniform manner at a minimum rate of 1.0 ton/acre. A continuous agitator action, that keeps the mulching material and approved additives in uniform suspension, will be maintained throughout the distribution cycle. The pump pressure will be capable of maintaining a continuous non-fluctuating stream of slurry. The slurry distribution lines will be large enough to prevent stoppage and the discharge line will be equipped with a set of hydraulic spray nozzles that will provide an even distribution of the mulch slurry to the seedbed. Mulching will not be done in the presence of free surface water resulting from rains, melting snow, or other causes.

A tackifier will be used with the wood fiber mulch to improve adhesion. The tackifier will be a biodegradable organic formulation processed specifically for the adhesive binding of mulch. In addition, the tackifier will uniformly disperse when mixed with water and will not be detrimental to the homogeneous properties of the mulch slurry. Tackifier may be added either during the manufacturing of the mulch or incorporated during mulch application. Tackifier will have characteristics of hydrating and dispersing in circulating water to form a homogeneous slurry and remain in such a state in the hydraulic mulching unit when mixed with the wood fiber mulch. When applied, the tackifier will form a loose chain-like protective film, but not a plant inhibiting membrane, which will allow moisture to percolate into the underlying soil, while helping bind seeds to the soil surface during germination and initial seedling growth, after which the tackifier will break down through natural processes.

APPENDIX K

DURABILITY

ATTACHMENT

ROCK TEST RESULTS

BLANDING AREA GRAVEL PITS

PREPARED BY

INTERNATIONAL URANIUM (USA) CORP.

INDEPENDENCE PLAZA

1050 17TH STREET, SUITE 950

DENVER, CO 80265

TO: Harold R. Roberts cc: William N. Deal

FROM: Robert A. Hembree

DATE: November 20, 1998

SUBJECT: Rock Test Results – Blanding Area Gravel Pits

Attached you will find the results for lab tests that were performed on rock samples obtained from three gravel sources around the White Mesa Mill. These samples were taken from the Cow Canyon pit located just north of Bluff (15 miles south of the mill), the Brown Canyon pit located on the east side of Recapture Canyon four miles northeast of the mill, and the North Pit located one mile northeast of Blanding. A 75 pound sample of material was collected from each site, each sample was crushed and screened to a +1/2 –1 ½ inch size. Testing was performed by Western Colorado Testing in Grand Junction, Colorado. All samples were tested for specific gravity, absorption, sulfate soundness and L.A. Abrasion.

Test results indicate that all three sites score high enough to be used as rip rap sources for the reclamation cover at the mill (see attached scoring calculations). The Cow Canyon site scores high enough that there would be no over-sizing required; it is suitable for use in channels as well as on side and top slopes. The Brown Canyon site requires the most over-sizing at nineteen percent (19%). The North Pit material would require over-sizing of 9.35%. These test results prove that there are sources of rip rap material within a reasonable distance of the mill site. The average over-sizing factor for the three sites is 9.5%, which is well below the 25% number used in the 1996 reclamation cost estimate. The over-sizing factor used in the Titan Design Study was also 25%.

Based on the results of the testing IUC could use any of these three sites. The North Pit would be the most reasonable choice of material sites since it has a lower over-sizing factor than the Brown Canyon site and is closer to the mill than the Cow Canyon site. The North Pit also has the advantage of being an established public pit on BLM administered land.

RAH/rah

International Uranium (USA) Corp.
WHITE MESA MILL RECLAMATION

NRC Rip Rap Scoring Calculations

Weighting Factors for Igneous Rocks
Oversizing for side slopes, top slopes, and well drained toes and aprons
Rock Scoring less than 50% is rejected, rock scoring over 80% does not require oversizing

Cow Canyon Pit (Bluff)

Lab Test	Lab Results	Score	Weight	Score x Weight	Max. Score
Specific Gravity	2.63	7.5	9	67.5	90
Absorption, %	0.47	8.25	2	16.5	20
Sodium Sulfate Sound., %	0.2	10	11	110	110
L.A. Abrasion, %	6.4	7.5	1	7.5	10
Totals				201.5	230

Overall Score 87.61 %

Oversizing none %

Brown Canyon Site

Lab Test	Lab Results	Score	Weight	Score x Weight	Max. Score
Specific Gravity	2.525	5.5	9	49.5	90
Absorption, %	2.61	1.75	2	3.5	20
Sodium Sulfate Sound., %	5.5	7.5	11	82.5	110
L.A. Abrasion, %	10.3	4.75	1	4.75	10
Totals				140.25	230

Overall Score 60.98 %

Oversizing 19.02 %

North Pit (N. Blanding)

Lab Test	Lab Results	Score	Weight	Score x Weight	Max. Score
Specific Gravity	2.557	6.25	9	56.25	90
Absorption, %	2.84	1.25	2	2.5	20
Sodium Sulfate Sound., %	3.2	8.75	11	96.25	110
L.A. Abrasion, %	6.3	7.5	1	7.5	10
Totals				162.5	230

Overall Score 70.65 %

Oversizing 9.35 %

WESTERN COLORADO TESTING, INC.
529 25 1/2 Road, Suite B-101
Grand Junction, Colorado 81505
(970) 241-7700 • Fax (970) 241-7783

November 16, 1998
WCT #811898

International Uranium USA Corporation
Independence Plaza
1050 17th Street
Denver, Colorado 80265

Attention: Mr. Bob Hembree

Reference: Rock Durability Testing

As requested, three (3) potential sources of riprap for use in reclamation of tailings ponds in Blanding, Utah were tested for rock durability. The riprap material was obtained, crushed to testing size, and delivered to Western Colorado Testing, Inc. by the client. The three sources of material were tested for specific gravity and absorption (ASTM C127), Sodium Sulfate Soundness (ASTM C88), and Los Angeles Abrasion (ASTM C131). The results of the testing are provided below.

Material Source: Cow Canyon	
Test	**Result**
Bulk Specific Gravity, g/cc	2.630
SSD Specific Gravity, g/cc	2.642
Apparent Specific Gravity, g/cc	2.663
Water Absorption, %	0.47
Sodium Sulfate Soundness, Avg. % Loss	0.2
L.A. Abrasion, % Loss @ 100 Rev.	6.4

Material Source: Brown Canyon	
Test	**Result**
Bulk Specific Gravity, g/cc	2.460
SSD Specific Gravity, g/cc	2.525
Apparent Specific Gravity, g/cc	2.629
Water Absorption, %	2.61
Sodium Sulfate Soundness, Avg. % Loss	5.5
L.A. Abrasion, % Loss @ 100 Rev.	10.3

Material Source: North Pit	
Test	**Result**
Bulk Specific Gravity, g/cc	2.485
SSD Specific Gravity, g/cc	2.557
Apparent Specific Gravity, g/cc	2.674
Water Absorption, %	2.84
Sodium Sulfate Soundness, Avg. % Loss	3.2
L.A. Abrasion, % Loss @ 100 Rev.	6.3

If there are any questions or if additional testing is needed, please feel free to contact our office.

Respectfully Submitted:
WESTERN COLORADO TESTING, INC.

Kyle Alpha
Construction Services Manager

KA/mh
Meb:jobs\8118L1118

APPENDIX L

CELL 2 RECLAMATION COVER IMPLEMENTATION AND PERFORMANCE ASSESSMENT PLAN

L.1 INTRODUCTION

This appendix presents the plan for implementing final cover placement on the White Mesa Cell 2 tailings cell. Discussion on cover performance assessment and monitoring is also provided. The White Mesa Uranium Mill (Mill) is located in San Juan County in southeastern Utah, approximately 6 miles south of Blanding, Utah. The site is located on White Mesa, a flat area bounded on the east by Corral Canyon, to the west by Westwater Creek, and to the south by Cottonwood Canyon.

Energy Fuels Resources (USA) Inc. (EFRI) facilities at the site consist of a uranium processing mill and five lined tailings/process solution storage cells located within an approximately 686-acre restricted area. The tailings management system is located south of the Mill and comprise the following:

- Cell 1 – 55 acres, used for the evaporation of process solutions
- Cell 2 – 65 acres, used for storage of barren tailings sands (which has been filled with tailings sands and covered with a minimum of approximately 3 feet of interim cover across the cell)
- Cell 3 – 70 acres, used for storage of barren tailings sands (which has been partially covered with a minimum of approximately 3 feet interim cover across the majority of the cell, except the center of the cell which is currently receiving mill waste)
- Cell 4A – 40 acres, used for storage of barren tailings sands and evaporation of process solutions
- Cell 4B – 40 acres, currently being used for evaporation of process solutions

Cell 2 ceased receiving tailings in 1995 and 11e.(2) byproduct materials in 2000 and is no longer in operation. EFRI placed interim fill in stages on Cell 2 from 1991 through 2008. Additional minor volumes of interim fill (less than 1 foot in thickness) were placed on Cell 2 in select areas after 2008.

L.1.1 Terms of Reference

On November 11, 2015, the Utah Department of Environmental Quality Division of Waste Management and Radiation Control (DWMRC) recommended EFRI develop a plan to begin reclamation of the tailings management system. This plan would consist of placing the proposed cover system presented in White Mesa Reclamation Plan, Revision 5.1 on the Cell 2 and demonstrating acceptable cover performance via a performance monitoring program. Cover performance monitoring was recommended to follow NUREG/CR-7028 (Benson et al. 2011).

This document has been prepared for EFRI by MWH, Inc. (MWH) as an appendix to the Updated Tailings Cover Design Report and to provide specific information regarding construction and monitoring of the evapotranspiration (ET) cover to be placed on Cell 2.

L.1.2 Scope of Document

This document presents construction requirements, construction sequencing, and the plan for performance monitoring and assessment of the proposed Cell 2 reclamation cover system. This document also presents a brief overview of the design of the Cell 2 reclamation cover system.

The White Mesa reclamation cover system design, regulatory criteria, and design analyses are presented in the main text of the Updated Tailings Cover Design Report.

L.2 COVER DESIGN

The cover system for reclamation of the tailings cells is designed as a monolithic ET cover. A monolithic ET cover is the preferred design to minimize infiltration, meet the radon emanation standard, minimize maintenance over the short and long term, and to promote sustainability. The proposed ET cover has been designed with sufficient thickness to protect against frost penetration, to attenuate radon flux, to minimize both plant root and burrowing animal intrusion, and to provide adequate water storage capacity to minimize the rate of infiltration into the underlying tailings. Furthermore, the cover is designed to be stable under both static and anticipated seismic conditions, and to provide tailings isolation under long-term wind and water erosion conditions. The cover system design and associated analyses are presented in the Updated Tailings Cover Design Report.

L.2.1 Cover System Layers

The Cell 2 reclamation cover system will have a minimum thickness of 10.5 feet, and will consist of the following layers listed below from top to bottom:

- Layer 4 - 0.5 ft (15 cm) thick Erosion Protection Layer (topsoil-gravel admixture or topsoil)
- Layer 3 - 3.5 ft (107 cm) thick Growth Medium Layer acting as a Water Storage/Biointrusion/Frost Protection/Secondary Radon Attenuation Layer (loam to sandy clay)
- Layer 2 - 4.0 ft (122 cm) thick Compacted Cover acting as the Primary Radon Attenuation Layer (highly compacted loam to sandy clay)
- Layer 1 - 2.5 ft (76 cm) thick (minimum) Interim Fill Layer acting as a Secondary Radon Attenuation and Grading Layer (loam to sandy clay)

All the layers combined comprise the monolithic ET cover system. Layer 1 was placed in stages on Cell 2 as interim cover from 1991 through 2008 and is approximately 3 feet thick. Additional minor volumes of interim fill (less than 1 foot in thickness) were placed in select areas of Cell 2 after 2008. Layer 1 will provide the platform for the remaining cover system and act as a secondary radon attenuation layer. Layer 2 is the compacted cover layer and will act as the primary radon attenuation layer. It will be 4 feet thick and compacted to 95 percent of standard Proctor density. Layer 3 will be the growth medium layer. Layer 3 will also act as a secondary radon attenuation layer and a protection layer for the primary radon attenuation layer (Layer 2). Layer 3 will be 3.5 feet thick and placed at 85 percent of standard Proctor density to optimize water storage and rooting characteristics for plant growth. Layer 4 will be a 0.5-foot thick erosion protection layer. This layer will consist of topsoil in areas where the cover is sloped at 0.5 percent and topsoil-gravel admixture in areas where the cover is sloped at 1 percent. The topsoil-gravel admixture will consist of topsoil (75 percent) mixed with 1-inch minus gravel (25 percent).

L.2.2 Cover Surface Slopes and Erosion Protection

The top surface of the Cell 2 final cover will be sloped at 0.5 to 1 percent as shown in the Cell 2 cover design drawings (Drawings; provided in Attachment L.1). External side slopes of the embankments will be graded to 5H:1V (horizontal: vertical). Temporary cover slopes will be located along the berms between Cells 2 and 1, and between Cells 2 and 3 (details shown in Attachment L.1). At these locations, the cover will be sloped at 5H:1V for a width of approximately 25 to 50 feet from the edge of the berms, along the full length of the berms. During reclamation of Cell 1 and Cell 3, the temporary cover slope sections on Cell 2 will be tied into the Cell 1 and Cell 3 cover systems to provide a consistent slope (0.5 to 1 percent) for the final reclamation cover across the tailings cells.

Cell 2 erosion protection will consist of the following:

- The portions of Cell 2 with a top surface slope of 0.5 percent will be constructed as a vegetated slope with 6 inches of topsoil.
- The portions of Cell 2 with a top surface slope of 1 percent will be constructed as a vegetated slope with 6 inches of topsoil (75 percent by weight) mixed with gravel (25 percent by weight; maximum diameter of 1 inch).
- External side slopes graded to 5H:1V will be covered with 6 inches of rounded riprap with a median rock size of 1.7 inches.
- A rock apron will be constructed in the transition areas along the toes of the north and west side slopes and the east side slope of Cell 2. The rock apron will consist of a 1-foot thick layer of rounded riprap with a median rock size of 3.4 inches.
- The erosion protection layer for the temporary 5H:1V cover slopes (along the berms between Cells 2 and 1 and Cells 2 and 3) will be covered with 6 inches of topsoil (75 percent by weight) mixed with gravel (25 percent by weight; maximum diameter of 1 inch).

L.3 COVER PLACEMENT AND REVEGETATION

As outlined in Section L.2, the Cell 2 reclamation cover system will be a minimum of 10.5-feet thick, with four layers at varying amounts of compaction. Layer 1 of the reclamation cover was placed on Cell 2 as interim cover primarily from 1991 through 2008, and is approximately 3 feet thick. The remaining reclamation cover layers will be placed in two phases (Phases 1 and 2) on Cell 2. Between the first and second phases of cover placement, additional cover material would be placed as needed in low areas to maintain positive drainage of the Phase 1 cover surface. The top surface of the final cover will be vegetated after Phase 2 cover construction is completed.

Drawings for Cell 2 reclamation are provided in Attachment L.1. Technical specifications (Technical Specifications) and a construction quality assurance/quality control plan (CQA/QC Plan) for reclamation of the Site are provided as Attachments A and B, respectively, to the White Mesa Reclamation Plan, Revision 5.1. Cell 2 Cover construction will be performed in accordance with these documents. Additional discussion of cover placement and revegetation is provided in the following sections.

L.3.1 Phase 1 Cover Construction

Phase 1 cover construction includes placement of: (1) additional interim cover to achieve design grades prior to placement of cover Layer 2 and (2) the entirety of Layer 2. Cell 2 Phase 1 cover placement began in April 2016 and is expected to be completed in 2017. A cover performance monitoring test section (Primary Test Section) was constructed in the fall of 2017 within the Cell 2 cover concurrently with the Phase 1 cover placement. Construction of this test section is discussed in Section L.4. A Supplemental Test Section will be constructed north of the tailings management cells relating to vegetative cover and erosion control.

Instrumentation for monitoring Cell 2 after Phase 1 cover placement will include settlement monuments and piezometers. Existing settlement monuments will be extended upward during Phase 1 cover construction. Standpipe piezometers were installed in June 2016 across Cell 2 during Phase 1 Cell 2 cover construction to monitor water levels within the tailings. Piezometer locations are shown in Figure L.1. The majority of the piezometer locations are adjacent to the settlement monuments. These locations were selected to minimize damage to the piezometers during cover construction, while providing sufficient locations to evaluate the water levels within the tailings. A few additional locations were selected near the Cell 2 sump to evaluate migration of water towards the sump. Further discussion of settlement monitoring and monitoring of water levels in the tailings is provided in Section L.4.4.

An as-built report for Cell 2 Phase 1 cover placement and Primary test section construction will be provided to DWMRC within 90 days after construction completion and receipt of laboratory testing results. A construction report summarizing the Supplemental Test Section construction will be provided to DWMRC within 90 days after construction of the Supplemental Test Section.

L.3.2 Phase 2 Cover Construction

Phase 2 cover construction consists of placement of Layer 3 and Layer 4 of the cover. Cell 2 Phase 2 cover will be placed after meeting the following milestones:

- Test section performance monitoring is complete (see Section L.4.2 for discussion on test section monitoring)

- Phase 1 cover settlement criteria has been met (see Section L.4.4 for discussion on settlement criteria)
- DWMRC approval of performance of the Cell 2 cover test section

Phase 2 cover construction is expected to be completed in one construction season. The final Phase 2 cover surface will then be revegetated.

Monitoring instrumentation after Phase 2 cover placement will include settlement monuments and piezometers. Existing settlement monuments will be extended during Phase 2 cover construction. Piezometers installed across Cell 2 during Phase 1 cover construction will also be extended.

An as-built report for Cell 2 Phase 2 cover placement will be provided to DWMRC within 90 days after construction completion.

L.3.3 Material Sources

Table L.1 presents estimated volumes of materials required to complete the Cell 2 reclamation cover system (Phase 1 and Phase 2), and erosion protection. Estimated quantities of materials available for construction of the cover are also provided in Table L.1. Sufficient quantities are available from on-site sources for the topsoil and random fill materials. Gravel materials will be obtained from off-site commercial sources. Sufficient quantities of riprap and gravel materials have been identified at three commercial sources: (i) the Cow Canyon pit located 15 miles south of the mill, (ii) the Brown Canyon pit located four miles northeast of the mill, and (iii) the North Pit located one mile northeast of Blanding. Additional discussion of these off-site sources are presented in the main text of the Updated Tailings Cover Design Report.

Table L.1. Cell 2 Reclamation Cover Material Quantity Summary

Material	Quantity Required for Reclamation (cy)	Quantity Available (Identified Sources) (cy)
Random Fill (total for Phase 1 cover placement)	717,200	3,597,000 (on-site stockpiles)
Random Fill (total for Phase 2 cover placement, less erosion protection layer)	200,800	
Topsoil (for Layer 4 - Erosion Protection Layer)	45,200	284,100 (on-site stockpiles)
Gravel (1-inch minus for Layer 4 - Erosion Protection Layer)	8,000	Sufficient quantity available (off-site commercial source)
Riprap (D_{50} = 1.7 in for external side slopes)	1,700	Sufficient quantity available (off-site commercial source)
Riprap (D_{50} = 3.4 in for rock aprons)	700	Sufficient quantity available (off-site commercial source)

On-site cover material borrow stockpiles locations are shown on Figure L.2 along with the estimated volumes available from each stockpile. Stockpiles to be used for Phase 1 cover material will be selected to represent the range of cover soil properties, while still allowing for efficient construction and minimization of haul road distances. The design engineer will provide input on stockpile selection.

L.3.4 Revegetation

The tailings management system at the Mill site will be revegetated following construction of the cover system over each cell. Revegetation of the Cell 2 cover will take place at the end of Phase 2 cover construction.

The revegetation process will establish a grass-forb-shrub community consisting primarily of native, long-lived perennial grasses, forbs, and shrubs that are highly adapted to the climatic and edaphic conditions of the site. Revegetation methods will follow state-of-the-art techniques for soil amendments, seedbed preparation, seeding and mulching. In addition, quality assurance and quality control procedures will be followed to ensure that revegetation methods are implemented correctly and the results of the process meet expectations. A revegetation plan presenting seedbed preparation, soil amendments, plant species, seeding rates, and quality assurance is included in Appendix J.

L.4 COVER PERFORMANCE ASSESSMENT

EFRI constructed a performance monitoring test section (Primary Test Section) within the Cell 2 cover concurrently with the 2016 Phase 1 cover placement. The test section was constructed as a design-build project using the guidelines provided in this appendix. The test section will be monitored to assess performance of the cover system for the tailings cells. The test section location is shown in the Drawings (Attachment L.1). Discussion on the test section design and plan is provided in Section L.4.1, and discussion on the test section monitoring program is provided in Section L.4.2. A Supplemental Test Section will be constructed north of the tailings management cells relating to vegetative cover and erosion control. This test section is discussed in Section L.4.3.

L.4.1 Primary Test Section Design and Construction

Design Basis

The design of the Primary Test Section is adopted from the installation instructions for the test sections used in the Alternative Cover Assessment Program (ACAP) (Benson et al., 1999) and incorporates performance monitoring recommendations provided in NUREG/CR-7028 (Benson et al., 2011) and site-specific recommendations provided by Dr. Craig H. Benson (personal communication).

The test section was constructed as a large ACAP-style drainage lysimeter that provides direct measurement of all water balance components except evapotranspiration. Evapotranspiration will be calculated from the other measured water balance components. In-situ soil water content and temperature measurements of the cover soils will be taken within the test section and a weather data from the station installed adjacent to the test section. Installation instructions used for the test section are provided in Attachment L.2 and are patterned after the ACAP test section installation instructions (Benson et al., 1999) with the following exceptions:

- Soil water tension sensors were not installed. Experience in ACAP showed that data collected from the soil water tension sensors had little value for evaluating cover performance. Additionally, soil water tension sensors can be challenging to calibrate and operate. Soil water content sensors (water content reflectometers) and temperature sensors were installed. Although soil water content and temperature are not direct measures of cover performance, data from these sensors are useful information for interpreting cover performance data, especially when performance metrics are not satisfied.
- The water content reflectometers were installed in two nests rather than the three nests used in ACAP. Experience at the ACAP test sites has shown little spatial variability within the test sections, such that data from the three sets of nested sensors was very similar (Craig H. Benson, personal communication, May 8, 2012). Two sensor nests were used to provide a redundant set of water content measurements, as recommended in NUREG/CR-7028 (Benson et al., 2011).
- A sediment basin was not installed for the surface run-off drainage. Experience with the ACAP test sections showed that sediment control is not needed (Craig H. Benson, personal communication, May 8, 2012).

Location

The primary objectives for siting the test section were (1) access to a power source, (2) ease of access for monitoring, and (3) constructability. Although the monitoring equipment can be set up to be powered by solar panels and with cellular telecommunications, data collection is more reliable and efficient when the system is connected to a conventional power source and a land-line for telecommunications. The northeast, east, and southeast edge of Cell 2 were evaluated as potential test section locations. The southeast corner of Cell 2 was selected for the test section. This location allows for power access and has better constructability and monitoring access than the other locations. The location is also in an area where differential settlement is more likely to cause concern than the northeast or east edge of Cell 2. This location allows for assessment of the impact of potential differential settlement on the cover system. The test section is in an area with 1 percent cover slopes requiring topsoil-gravel admixture erosion protection. It is expected that the topsoil-gravel admixture will be associated with higher rates of infiltration than areas with topsoil for erosion protection.

Size

An ACAP-style test section with a drainage lysimeter will be used for performance monitoring, as recommended in NUREG/CR-7028 (Benson et al., 2011). The lysimeter within the test section is 32 ft x 64 ft in size. The longer side is oriented parallel to the cover slope, and centered within the 100 ft x 100 ft test section. Design dimensions for the lysimeter and test section are shown in the Drawings (see Attachment L.1). The buffer area outside the lysimeter minimizes hydrological and thermal boundary effects and will be used for periodic destructive sampling. Area surrounding the lysimeter will be used for periodic sampling of soils and biota, as needed. These attributes are the same as those in the monitoring test section recommended in NUREG/CR-7028 (Benson et al., 2011).

The design cover thicknesses for the tailings cells are 10.5 ft, 10 ft, and 9.5 ft for Cell 2, Cell 3, and Cells 4A/4B, respectively. The minimum design cover thickness of 9.5 ft was used for the lysimeter area of the test section to evaluate the lower bound reclamation cover thickness for the tailings cells. The remaining area within the test section was constructed to the full-depth Cell 2 cover profile (10.5 ft).

Components of Lysimeter

The lysimeter includes the following components as shown in the Drawings:

- Geomembrane-lined (LLDPE) base and vertical side slopes
- Geocomposite drainage layer draining percolation to a collection sump above the LLDPE base
- Geosynthetic root barrier layer above Layer 1 (lower layer of cover system)
- Earthen surface run-off collection berm that diverts surface run-on and channels run-off to a single collection point
- Separate PVC drainage pipes for percolation and surface run-off that drain to separate measurement stations

Construction Quality Assurance and Quality Control

Cover placement for the test section followed the Technical Specifications and CQA/QC Plan provided as Attachments A and B, respectively, to the White Mesa Reclamation Plan, Revision 5.1. Additional CQA/QC procedures were required for sampling and testing the cover soils within the performance monitoring section during construction. Sampling and testing required for the lysimeter, in addition to requirements in the Technical Specifications, is provided in the next section.

Revegetation of the test section followed recommendations provided in the revegetation plan (Appendix J). The revegetation plan includes information on seedbed preparation, soil amendments, plant species, seeding rates, and quality assurance.

Cover Soil Sampling and Testing

Testing of cover soil properties for the performance monitoring section will include measurement of index properties and organic matter. These tests will be conducted following test section construction to verify that the cover soils in the performance monitoring section are representative of the as-built cover soils in other areas of the final cover system. EFRI is not proposing to test the soils throughout the operational period to determine changes in properties with time. Monitoring the change in soil properties with time, such as that done for the NUREG/CR-7028 (Benson et al., 2011) is useful as a research endeavor to understand the evolution of the cover system, but is unnecessary as a direct performance-based metric for the cover system. Performance of the cover system will be evaluated by percolation from the cover as discussed in Section L.4.2. Additional discussion on testing is provided below.

Index Properties. Disturbed soil samples were collected during construction of the lysimeter with shovels and placed in 20-L buckets. These samples will be used for determination of particle size analysis (ASTM D422), Atterberg limits (ASTM D4318), specific gravity of solids (ASTM D854), and organic matter content (ASTM D422). The Unified Soil Classification will be assigned based on each set of index properties following the method in ASTM D2487.

Hydraulic Properties. Undisturbed samples were collected as 350-mm-diameter cylindrical blocks following the method in ASTM D7015 and Benson et al. (1995) for hydraulic properties testing (saturated hydraulic conductivity and soil water characteristic curve, SWCC). These samples will also be used for conformation of water content and dry unit weight. Sampling and testing frequencies for the undisturbed samples are summarized in Table 1. Saturated hydraulic conductivity of each block sample will be measured using methods in ASTM D5084. The SWCC will be measured on the same sample using the methods in ASTM D6836, after the hydraulic conductivity measurement.

Compaction. In situ tests were conducted with a nuclear densometer to measure the dry unit weight of the soils placed in the lysimeter. Methods in ASTM D6938 were used for the nuclear density tests.

Sampling Frequency. The sampling and testing frequencies for the disturbed and undisturbed samples are summarized in Table L.2. Testing frequencies for the lysimeter soils are higher than for full-scale construction so that an adequate data set is available for evaluating the hydraulic performance of the cover.

Table L.2. Material Sampling and Testing Frequency for Lysimeter*

Soil Attribute	Sampling Method	Soil Property	ASTM Method	Sampling & Testing Frequency	Minimum Total Number of Samples or Tests
Index Properties	Disturbed	Particle size distribution	D422	2 per lift	18
		Atterberg limits	D4318	2 per lift	18
		Specific gravity	D851	2 per lift	18
		Organic matter	D2974	2 per lift	18
		Particle size distribution	D422	2 per lift	18
Hydraulic Properties	Undisturbed	Saturated hydraulic conductivity	D5084	One block per lift	9
		Soil water characteristic curve	D6836	One block per lift	9
Compaction	In Situ	Dry unit weight	D6938	2 per lift (excluding erosion protection layer)	16

*All samples will be collected within the lysimeter.

L.4.2 Primary test Section Monitoring

Cover system performance will be assessed by monitoring the cover test section constructed within Cell 2. The performance monitoring requirements follow NUREG/CR-7028 (Benson et al., 2011) and incorporate site-specific recommendations from Dr. Craig H. Benson (personal communication). These recommendations have developed from more than 25 years of experience, including 15 years of experience in monitoring systems for US EPA's Alternative Cover Assessment Program (ACAP) (Benson et al., 2001, Albright et al., 2004).

Monitoring System and Instrumentation

The monitoring system includes instruments to measure all components of the water balance for the cover system, including percolation from the base of the cover, runoff, interflow (internal lateral flow), and on-site meteorological conditions. The system will also measure state variables (water content and temperature) at discrete locations within the cover. A complementary surveillance program will be performed according to the criteria presented in Appendix D to monitor the vegetative community, edaphic properties of the cover soils, and pedogenic evolution of the cover profile, as suggested in NUREG/CR-7028. Comparisons will be made between the monitoring data and predictions and assumptions made during cover design.

Precision tipping buckets and pressure transducers mounted in drainage basins will be used to provide redundant measurements of percolation, interflow, and surface runoff. The drainage basins are equipped with flouts to provide consistent repeatable basin flushing. Water content reflectometers (WCR) employing time domain reflectometry will be used to measure water content of the cover soils in the lysimeter. A Type-T thermocouple mounted on the head of each WCR will be used to monitor soil temperature. The co-located WCRs and thermocouples were installed at the quarter points along the centerline of the test section as shown in the Drawings (Attachment L.1). Each nest consists of eight WCRs and thermocouples, as shown in the Drawings. All WCRs will be calibrated for the soils in the lysimeter and will include temperature compensation following the methods in Benson and Wang (2006).

A meteorological station located immediately outside of the lysimeter area will be used to monitor climatic variables. Installing a dedicated meteorological station reduces the effort and inconsistencies that can be associated with integrating data from a site-wide weather station. Collecting meteorological data adjacent to the lysimeter will also ensure that conditions at the lysimeter are represented accurately. The meteorological station includes a shielded Geonor weighing precipitation gauge that monitors frozen and unfrozen precipitation, a Visalia shielded temperature and humidity probe to monitor air temperature and relative humidity, a Druck barometric pressure sensor, a Visalia pyranometer to measure net solar radiation, and a RM Young wind sentry to measure wind speed and direction. All sensors were calibrated after installation and will be calibrated annually.

All measurement devices are connected to a single datalogger that can be accessed remotely. The datalogger is programed to collect data from all sensors on hourly intervals. Downloads from the datalogger will occur daily using an automated algorithm. The datalogger algorithm will monitor flows and meteorological variables continuously, and will reduce the sampling interval to as short as 15 s if needed to ensure data with adequate frequency to capture flows reliably. In most cases, data will be aggregated into daily quantities for reporting.

Vegetation sampling and monitoring procedures will follow recommendations outlined in Appendix D. Live plant cover, shrub density, and overall plant community health and sustainability are included in the monitoring.

Monitoring Time Period and Frequency

EFRI will monitor the test section in two stages: (i) calibration monitoring and (ii) performance monitoring. Calibration monitoring will be conducted for two full calendar years after construction is complete to confirm that the monitoring systems are functioning properly and the cover has equilibrated prior to entering the performance monitoring period. The first calendar year of calibration monitoring will begin on January 1 after construction of the test section has been completed. Official performance monitoring of the cover test section will commence on January 1 after the two calendar years of calibration monitoring are complete. Performance monitoring will be conducted for five years.

The monitoring frequency will vary depending on the parameters measured. All hydrological sensors will be interrogated hourly, and aggregated into daily quantities for water balance analysis. Vegetation properties will be measured annually. Soil properties will be tested during test section construction. In-service soil properties will be determined during the last year of the monitoring period via sampling and testing in the buffer area of the test section outside the lysimeter.

Performance Criteria

Percolation rate from the base of the lysimeter will be used as the performance parameter for the cover system. Data from secondary variables (i.e. meteorological conditions, water balance quantities, soil water content, soil temperature, in-service soil and vegetation properties, etc.) related to the primary performance parameter will be used for interpretative purposes, as recommended in NUREG/CR-7028 (Benson et al., 2011). Although performance criteria are not suggested in NUREG/CR-7028 for these parameters and are not stipulated herein, monitoring of these parameters is recommended so that the percolation data can be interpreted mechanistically.

Performance of the test section will be assessed using the average annual percolation rate measured during the performance monitoring period. The objective of this assessment is to determine if the hydrological modeling approach presented in the Infiltration and Contaminant Transport Modeling (ICTM) report (MWH, 2010) and in updates to the modeling presented in EFRI (2015) provides a realistic prediction (or conservative over-prediction) of percolation. The cover design will be considered to have performed adequately, without the need for any additional modeling, if the average annual percolation rate is 2.3 mm/yr or less. This is the average annual percolation rate estimated from the ICTM for Base Case soil conditions and average climate conditions.

Meteorological data recorded during the monitoring period will be compared to the meteorological data used as input in the hydrological modeling, which is based on a 100-yr record.

Particle size data collected from the test section will be used to determine whether the soil properties are characteristic of Base Case, Upper Bound, or Lower Bound conditions. This evaluation will be specific to the test section, which will be constructed with a small volume of soil relative to the full-scale cover. Because the full-scale cover will be constructed from large volumes of soil, the spatial average across the full-scale cover is most likely to resemble the Base Case. Thus, the percolation rate from the test section may or may not represent the percolation rate for full-scale conditions depending on whether the soils for the test section are representative of Base Case, Upper Bound, or Lower Bound conditions.

For each layer in the test section, the average and standard deviation of the gravel content, sand content, and fines content will be computed from the data collected during construction, with the size fractions defined using ASTM D422. These statistics will be used to identify a particle size band for each soil layer in the test section. These particle size bands for the test section will be compared to the particle size distributions associated with the Base Case, Upper Bound, and Lower Bound soils used in the hydrological modeling. Particle size distributions used in the modeling will be identified that overlap, or are most closely aligned with the as-built particle size bands for the test section.

Percolation rates measured from the test section that are equal to or less than the percolation rate of 2.3 mm/yr and within the precision of measurement, will confirm that the hydrological modeling approach provides a realistic prediction (or conservative over-prediction) of percolation, and confirms that if the average cover over the entire cell uses base case soils, as expected, the percolation rates will be as predicted.

The performance evaluation will be based on data collected during the performance monitoring period. However, data collected during the calibration period will be compared with the data from the performance monitoring period. If these two periods are not different statistically and no temporal trend in percolation rate is found, then the average percolation rate over the entire seven-year monitoring period will also be compared to the appropriate percolation rate in the Table L.3.

The vegetation component of the Primary Test Section will be evaluated for applicable acceptance criteria as presented in Appendix D. Vegetation monitoring will commence one year after seeding and continue for a minimum of five years after calibration monitoring of the cover test section is complete. The vegetation component will be considered successful if a minimum vegetation cover of 40 percent and acceptable vegetation diversity per Appendix D (perennial grasses, forbs and shrubs) is met for the Primary Test Section by the end of the Performance

Period. The revegetation acceptance goal of 40 percent cover assumes average annual precipitation during the Performance Period (based on long-term on-site averages) and an accelerated rate of plant growth in this semi-arid environment that can take as long as 10 years to achieve. If precipitation during the Performance Period is “Dry” or if it appears that more time is needed to satisfy the vegetation performance criteria a new acceptance goal would need to be established.

L.4.3 Supplemental Test Section

EFRI will construct a supplemental vegetation monitoring test section (Supplemental Test Section) concurrently with the Phase 1 cover placement. The Supplemental Test Section will be constructed at a location north of the tailings management cell, to be agreed to by EFRI and the Director that will be representative of cover slope conditions on the tailings management system cells. The test section will be 100 ft by 100 ft in size to match the dimensions of the Primary Test Section. Construction will occur in the fall of 2017 and consist of removal of existing vegetation by physically scraping the site and amending the remaining topsoil with composted biosolids at the same rate applied to the Primary Test Section. Following the application of composted biosolids, the site will be seeded and mulched. Placement of biosolids and seeding the test section will follow recommendations provided in the revegetation plan (Appendix J) and the Technical Specifications. The test section slope will be greater than 1 percent. The cover design includes addition of gravel to the topsoil for slopes greater than 0.5 percent. However, gravel will not be added to the topsoil for the test section to allow for evaluation of the short-term impact of erosion on the vegetative cover without gravel addition. The mulch will provide adequate erosion protection for the seeds during germination and early seedling growth. Successful test section performance will then translate to both the cover with or without the addition of gravel for erosion protection.

The Supplemental Test Section will be evaluated for performance using the same procedures and for the same time period defined for the Primary Test Section in Section L.4.2.

L.4.4 Additional Monitoring

EFRI currently monitors settlement monuments on Cell 2. Monitoring of these monuments will continue and the results reported after Phase 1 Cell 2 cover construction is complete. Existing settlement monuments will be extended upward during cover construction (see Figure L.1 for existing settlement monument locations). Standpipe piezometers were installed across Cell 2 during Phase 1 Cell 2 cover construction to monitor water levels within the tailings (see Figure L.1 for piezometer locations). After Phase 1 cover construction is complete, it is recommended that settlement monuments and piezometers be monitored weekly for the first month, biweekly for the second month, and monthly thereafter.

Settlement and dewatering data will be evaluated after the cover performance monitoring is complete. The evaluation will determine if sufficient settlement has occurred to facilitate Phase 2 cover placement and minimize maintenance of the final cover surface. Decreasing trends in settlement followed by maximum of 0.1 feet (30 mm) of cumulative settlement over 12 months (for at least 90 percent of the settlement monuments) will be considered acceptable to proceed with placement of the Phase 2 Cell 2 cover.

EFRI currently measures and reports radon emanation rates from the top surface of Cell 2. This monitoring and reporting will continue after construction of the Phase 1 cover system and test section. The average radon emanation rate over the entire surface of Cell 2 is required to be less than or equal to 20 pCi/m^2-s.

Monitoring of Cell 2 will also occur after Cell 2 Phase 2 cover construction is complete and will include radon, settlement, and vegetation monitoring. Closure monitoring is discussed in more detail in the main text of the Updated Tailings Cover Design Report.

L.4.5 Reporting

Three types of reports will be prepared on data collected from the test section: monthly data quality analyses (DQA), quarterly data quality reports (DQRs), and a comprehensive annual report. In addition, the annual report will include a summary of settlement and standpipe piezometer measurements and trends.

Data Quality Analyses (DQAs)

A comprehensive data quality analysis will be conducted monthly to ensure that all sensors are operating properly and that the data are reliable. DQAs consist of a graphical review of the output from each sensor and a comparison of the data within expected bounds (e.g., does the volumetric water content reported from each sensor fall within physical bounds – 0.0 to porosity?). DQAs are conducted primarily to identify problems in the monitoring system so that corrections can be made before significant loss of data occurs. DQAs are maintained as internal reports as part of internal data quality control and assurance.

Data Quality Reports (DQRs)

Data quality reports (DQR) are issued quarterly to demonstrate that the monitoring system is functioning properly and the data being collected are reliable. Graphs are reported for each sensor and comparisons are made with physical bounds as well as expected temporal trends. Meterological data are compared with data from the closest representative meteorological station operated by the National Weather Service (NWS) to ensure the meteorological data are representative and reliable. Corrective actions are described if problems are found in the monitoring data or the monitoring system. A water balance summary is also provided. Vegetation monitoring will be conducted on an annual basis and the results included in the annual report. DQRs are submitted quarterly to DWMRC for review and discussion, if necessary.

Annual Reports

An annual report will be issued annually around the end of the first quarter of the subsequent year. This report will include a review of the water balance data, comparisonsof the data to other data collected globally on the hydrology of earthen covers (e.g., data from Apinwantragoon et al. 2014), and a discussion of any problems and corrective actions that were undertaken. The annual report will also summarize settlement and standpipe piezometer monitoring, and include results from annual vegetation monitoring for both test sections. Presenting the annual report to DWMRC by WebEx is recommended.

L.5 REFERENCES

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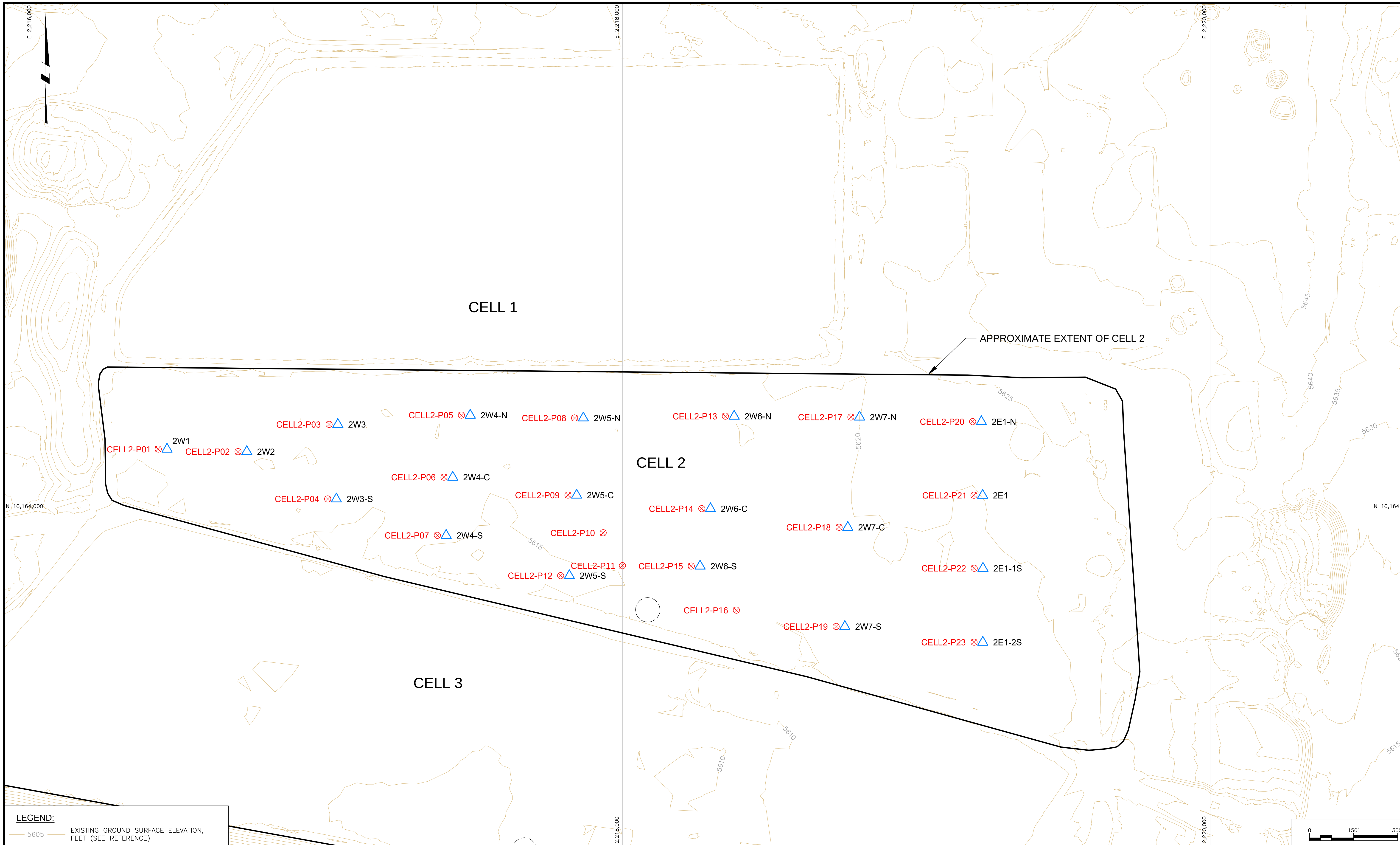


LEGEND:

5605 EXISTING GROUND SURFACE ELEVATION, FEET (SEE REFERENCE)

△ EXISTING SETTLEMENT MONITORING POINT

⊗ CELL 2 PIEZOMETER LOCATIONS

APPROXIMATE SUMP AND DRAIN ACCESS LOCATION

DRAWING REFERENCE(S):

- EXISTING TOPOGRAPHY BASED UPON FILE PROVIDED FROM ENERGY FUELS ON JULY 20, 2015. PER ENERGY FUELS, GROUND SURFACE CONTOURS ARE FROM 2012 AERIAL SURVEY CONDUCTED BY JONES & DeMILLE ENGINEERING INC., EXCEPT FOR CELLS 2 AND 3. CELL 2 TOPOGRAPHY FROM ENERGY FUELS SURVEY CONDUCTED OCTOBER 2013. CELL 3 TOPOGRAPHY FROM ENERGY FUELS SURVEY CONDUCTED ON JULY 8, 2014.

ENERGY FUELS

PROJECT LOCATION	BLANDING, UTAH
PROJECT	WHITE MESA TAILINGS CELL 2 PIEZOMETER INSTALLATION
TITLE	TAILINGS CELL 2 PIEZOMETER LOCATIONS

MWH

FIGURE L.1

REVISION A

FILE NAME PIEZOMETERS

DATE AUG 2016

L:\Design-Drafting\Clients-A-H\ENERGY FUELS\013-Sheet Set\2016-4-6 CELL 2 DESIGN DRAWINGS\PIEZOMETERS

LEGEND

5582.6	EXISTING SPOT ELEVATION
5630	ELEVATION OF PROPOSED TOP OF CELL 2 COVER
5560	EXISTING GROUND CONTOUR (2011 LIDAR SURVEY)
(dashed outline)	APPROX LIMITS OF BORROW STOCKPILE

ESTIMATED STOCKPILE VOLUMES

BORROW STOCKPILE ID	ESTIMATED STOCKPILE VOLUME (CY)
E1	15,900
E2	92,000
E3	16,800
E4	66,600
E5	68,800
E6	100,700
E7	74,900
E8	227,300
W1	85,700
W2	584,500
W3	84,800
W4	90,000
W5	2,001,160
W6	93,400
W7	39,500
W8	178,411
W9	60,250

DRAWING REFERENCE(S):

- EXISTING TOPOGRAPHY BASED UPON FILE PROVIDED FROM ENERGY FUELS ON JULY 20, 2015. PER ENERGY FUELS, GROUND SURFACE CONTOURS ARE FROM 2012 AERIAL SURVEY CONDUCTED BY JONES & DeMILLE ENGINEERING INC., EXCEPT FOR CELLS 2 AND 3. CELL 2 TOPOGRAPHY FROM ENERGY FUELS SURVEY CONDUCTED OCTOBER 2013. CELL 3 TOPOGRAPHY FROM ENERGY FUELS SURVEY CONDUCTED ON JULY 8, 2014.

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA TAILINGS CELL 2 RECLAMATION

TITLE: COVER MATERIAL BORROW STOCKPILE LOCATIONS

MWH

FIGURE L.2

REVISION: A

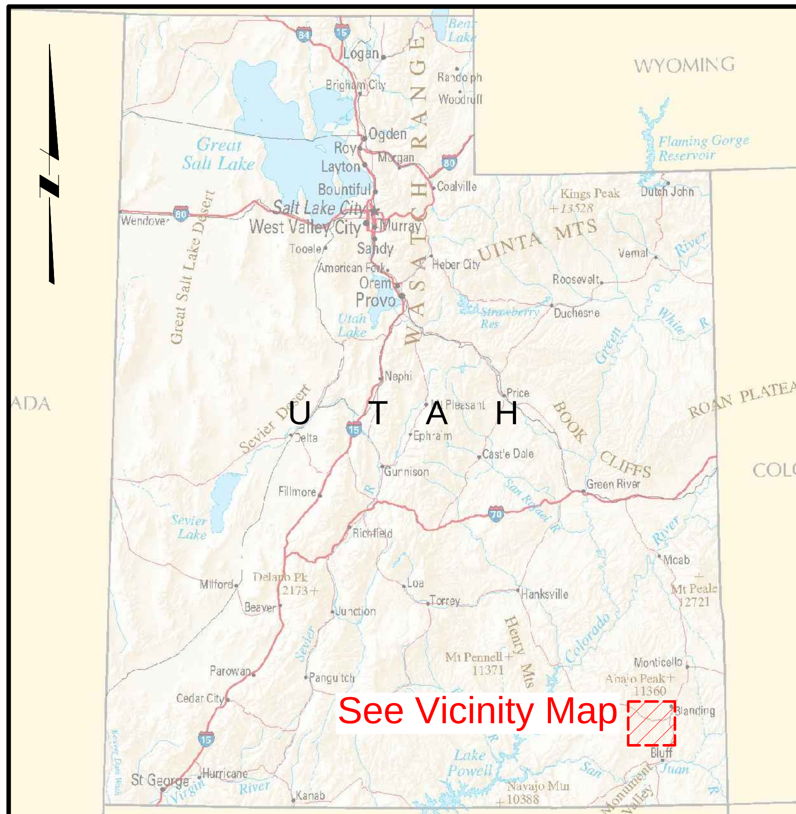
FILE NAME: BORROW

DATE: MAY 2016

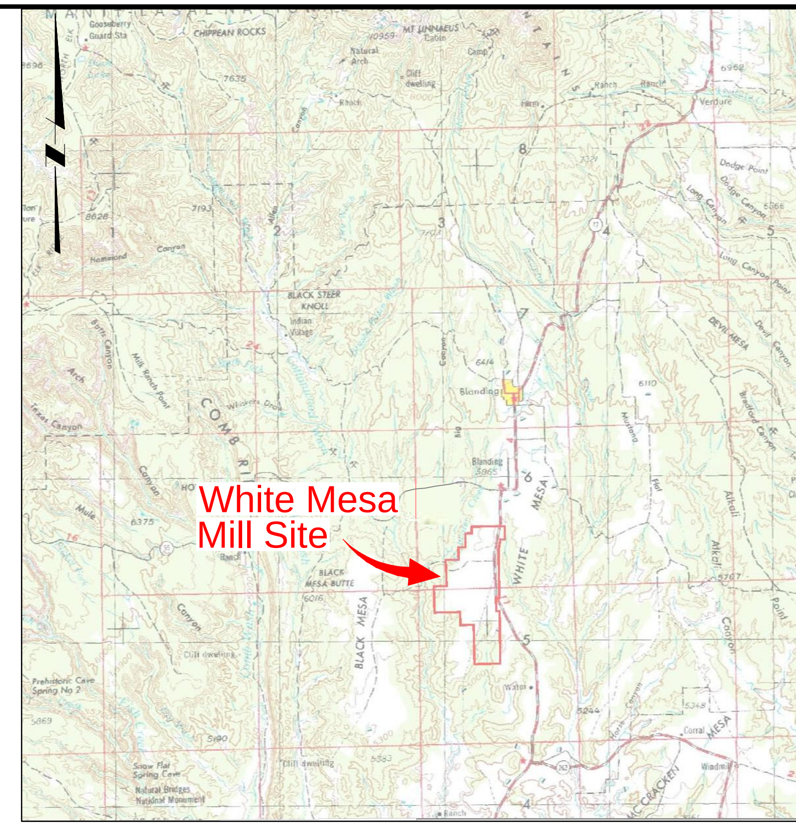
L:\Design-Drafting\Clients-A-H\ENERGY FUELS\013-Sheet Set\2016-4-6 CELL 2 DESIGN DRAWINGS\BORROW

ATTACHMENT L.1

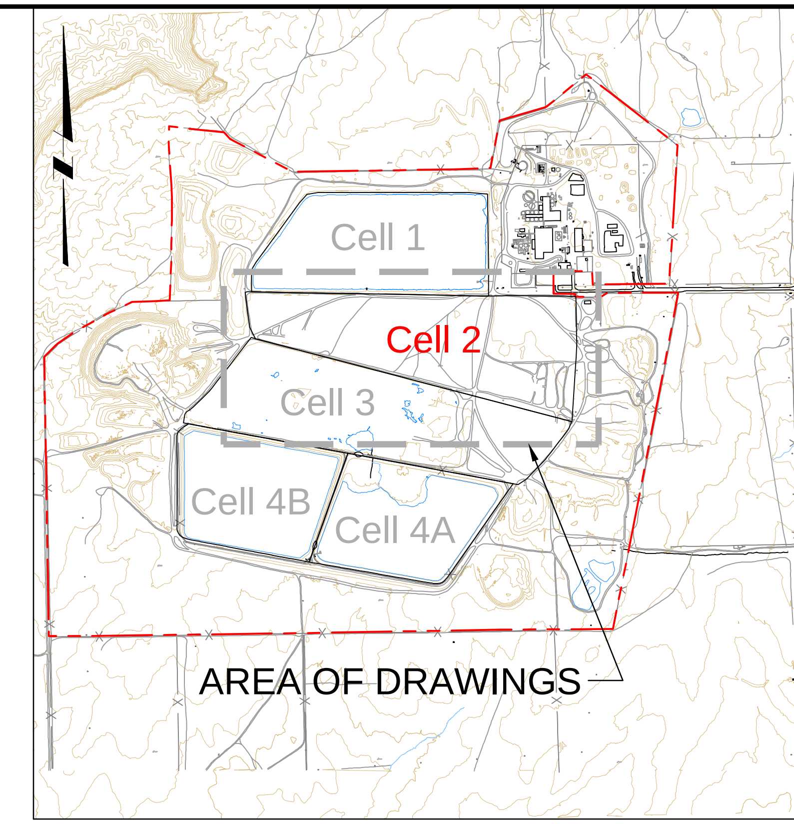
WHITE MESA MILL TAILINGS CELL 2 RECLAMATION DRAWINGS



LOCATION MAP
NOT TO SCALE



VICINITY MAP
NOT TO SCALE



SITE MAP
NOT TO SCALE

INDEX OF DRAWINGS

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CELL 2 - 1	TITLE SHEET AND PROJECT LOCATION MAP	A
CELL 2 - 2	PLAN VIEW CELL 2 FINAL COVER AND TEST SECTION	A
CELL 2 - 3	PHASE 1 GRADING PLAN - TOP OF ADDITIONAL INTERIM FILL	A
CELL 2 - 4	PHASE 1 GRADING PLAN - TOP OF COMPACTED COVER	A
CELL 2 - 5	PHASE 1 GRADING PLAN - TOP OF GROWTH MEDIUM LAYER	A
CELL 2 - 6	PHASE 2 GRADING PLAN - TOP OF GROWTH MEDIUM LAYER	A
CELL 2 - 7	PHASE 2 GRADING PLAN - FINAL COVER SURFACE LAYOUT	A
CELL 2 - 8	PHASE 2 - COVER EROSION PROTECTION PLAN	A
CELL 2 - 9	COVER OVER CELL 2 CROSS SECTIONS (SHEET 1 OF 2)	A
CELL 2 - 10	COVER OVER CELL 2 CROSS SECTIONS (SHEET 2 OF 2)	A
CELL 2 - 11	RECLAMATION COVER DETAILS (SHEET 1 OF 2)	A
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CELL 2 - 13	TEST SECTION PLAN	A
CELL 2 - 14	TEST SECTION CROSS SECTION	A
CELL 2 - 15	TEST SECTION SUBGRADE GRADING PLAN	A
CELL 2 - 16	TEST SECTION DETAILS (SHEET 1 OF 3)	A
CELL 2 - 17	TEST SECTION DETAILS (SHEET 2 OF 3)	A
CELL 2 - 18	TEST SECTION DETAILS (SHEET 3 OF 3)	A
140440_6' X 12' VAULT	6' X 12' VAULT (DRAWING BY OLDCASTLE PRECAST)	

WHITE MESA MILL TAILINGS CELL 2 RECLAMATION

prepared for

ENERGY FUELS RESOURCES (USA) INC.

SAN JUAN COUNTY, UTAH

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
A	ISSUED FOR UPDATED TAILINGS COVER DESIGN REPORT	KR	MD	07–16

DESIGNED BY	M DAVIS	07–16
DRAWN BY	K REED	07–16
CHECKED BY	C STRACHAN	07–16
APPROVED BY	C STRACHAN	07–16
PROJECT MANAGER	M DAVIS	07–16
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH
PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION
TITLE: TITLE SHEET AND PROJECT LOCATION MAP

MWH

SHEET: CELL 2 - 1
REVISION: A
FILE NAME: WMM COVER
DATE: AUG 2016

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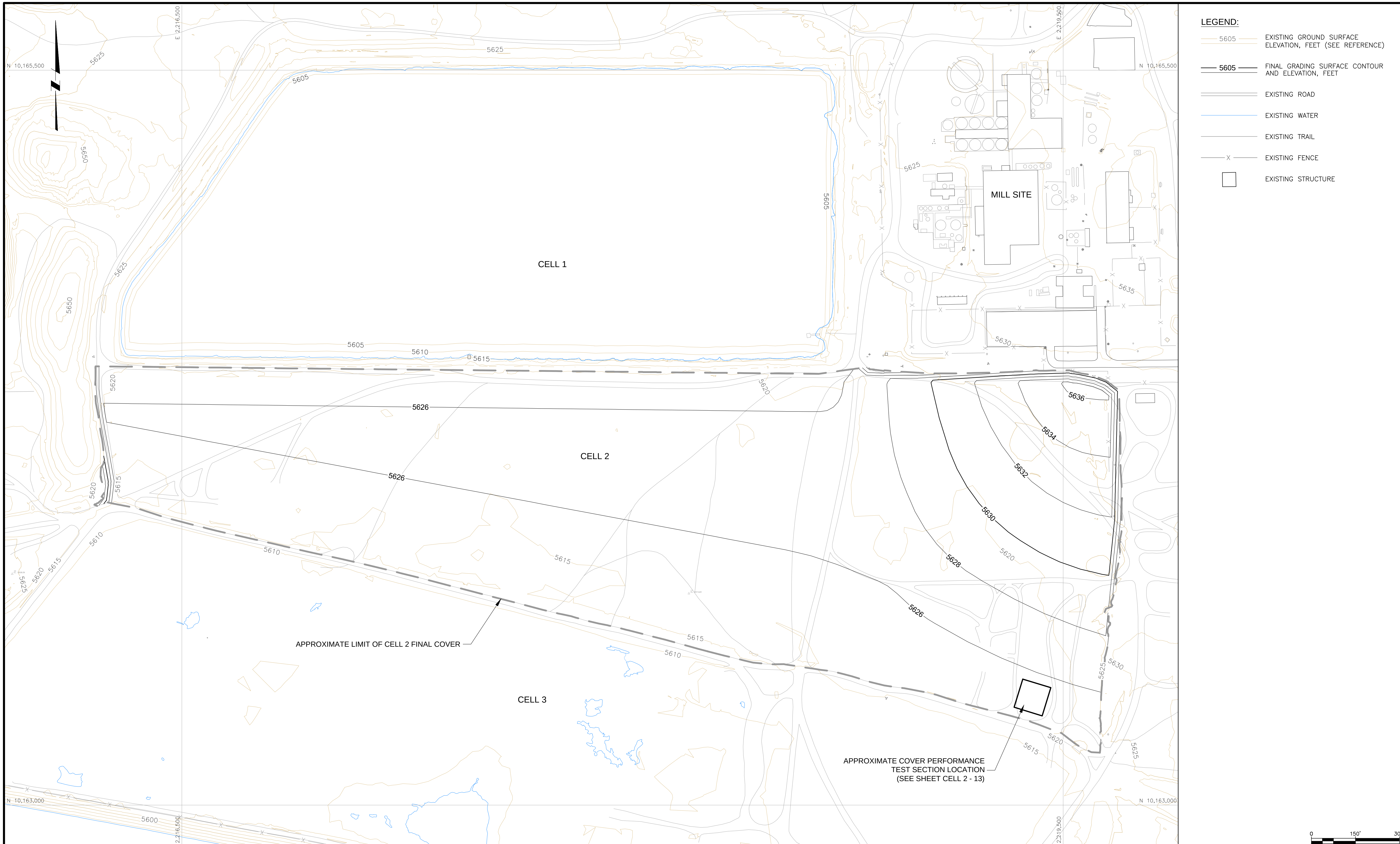

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
A	ISSUED FOR UPDATED TAILINGS COVER DESIGN REPORT	KR	MD	07–16

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DESIGNED BY	M DAVIS	07–16
DRAWN BY	K REED	07–16
CHECKED BY	C STRACHAN	07–16
APPROVED BY	C STRACHAN	07–16
PROJECT MANAGER	M DAVIS	07–16
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION

TITLE: PLAN VIEW CELL 2 FINAL COVER AND TEST SECTION

MWH

SHEET: CELL 2 - 2
REVISION: A
FILE NAME: WMM REC-1
DATE: AUG 2016

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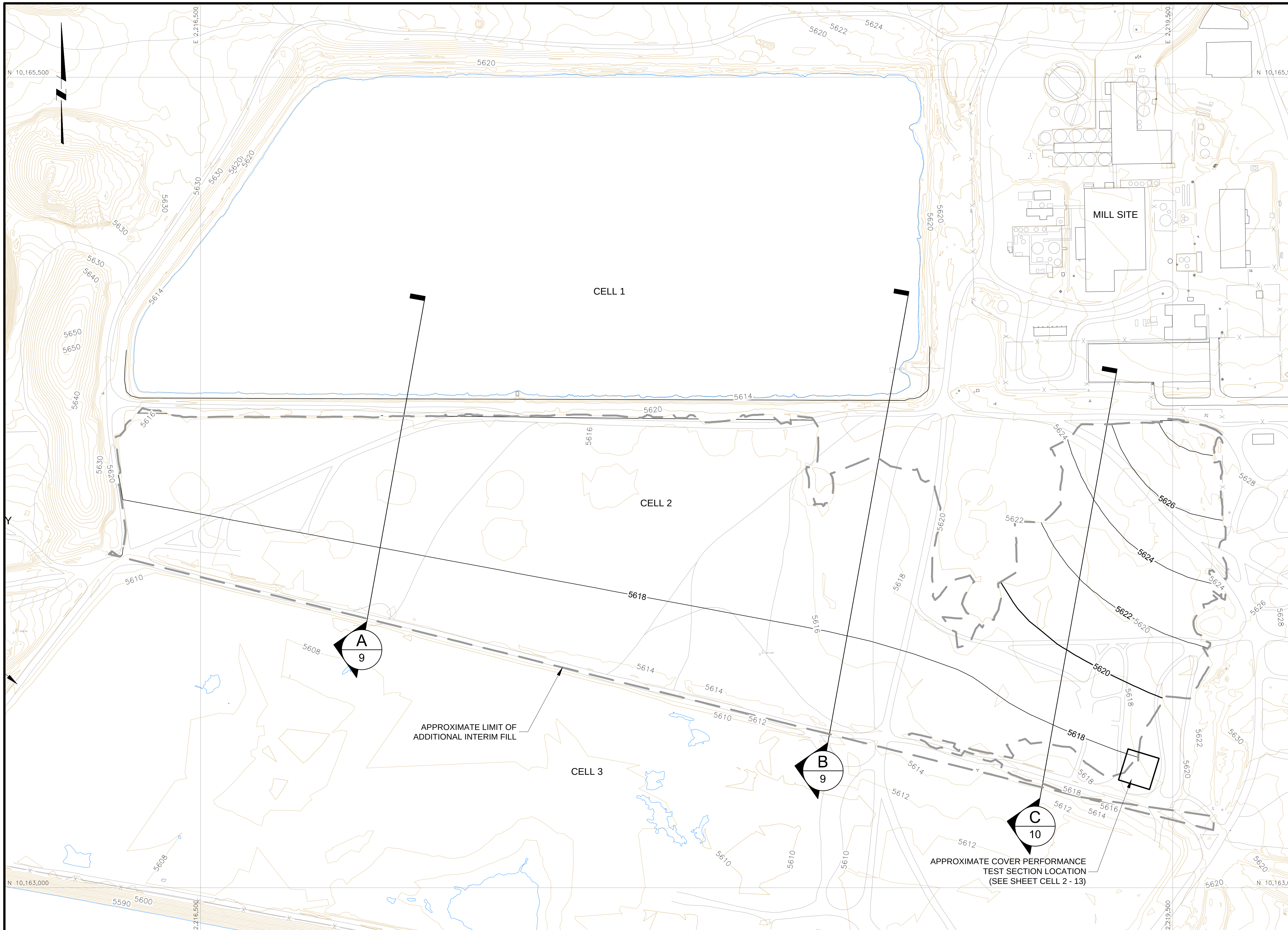

LEGEND:

5605 (existing contour)	EXISTING GROUND SURFACE ELEVATION, FEET (SEE REFERENCE)
5605 (heavy contour)	TOP OF ADDITIONAL INTERIM FILL CONTOUR AND ELEVATION, FEET
	EXISTING ROAD
	EXISTING WATER
	EXISTING TRAIL
—X—	EXISTING FENCE
□	EXISTING STRUCTURE

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
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CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION

TITLE: PHASE 1 GRADING PLAN - TOP OF ADDITIONAL INTERIM FILL

MWH

SHEET: CELL 2 - 3
REVISION: A
FILE NAME: WMM TRC-1
DATE: AUG 2016

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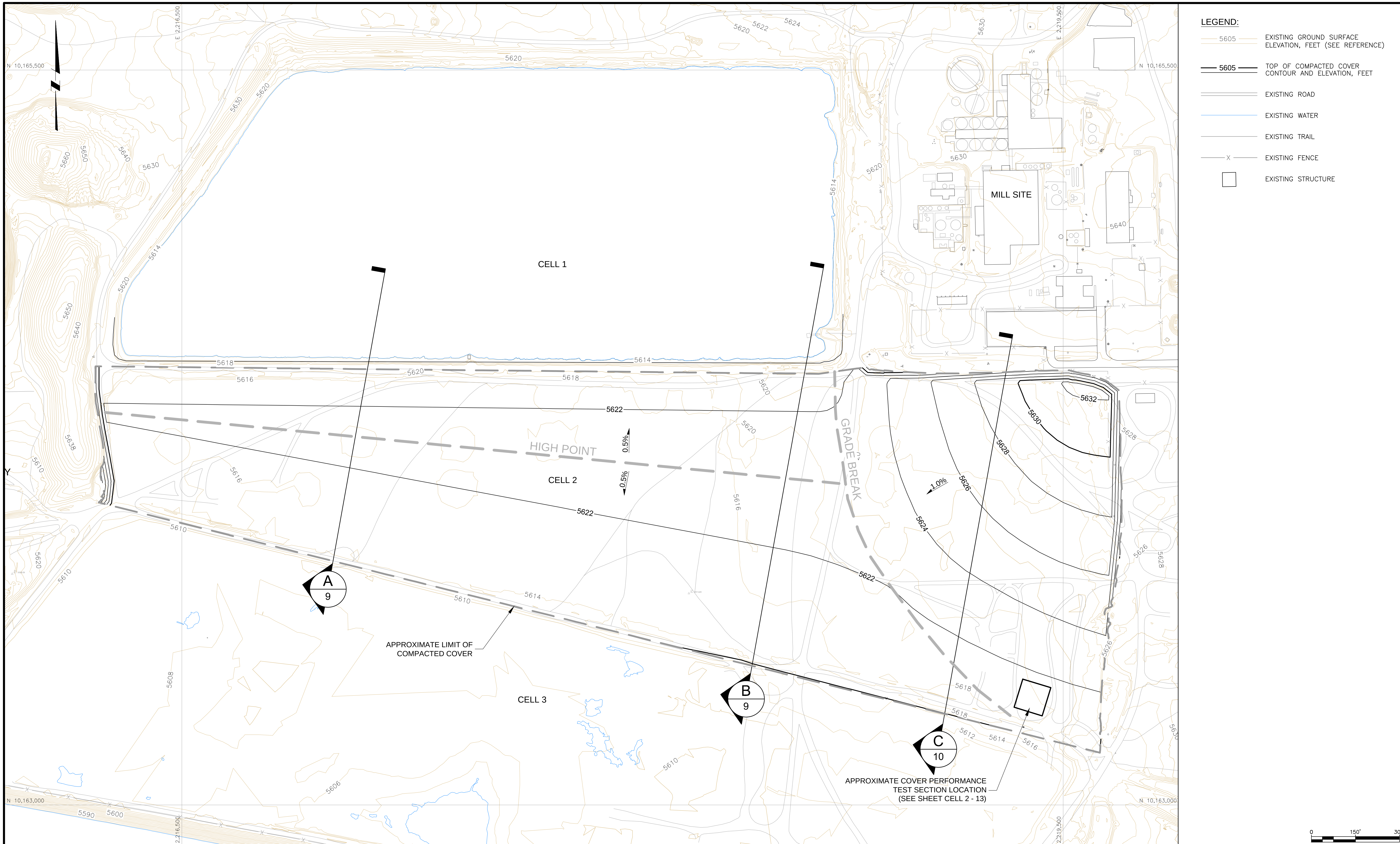

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ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
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ENERGY FUELS

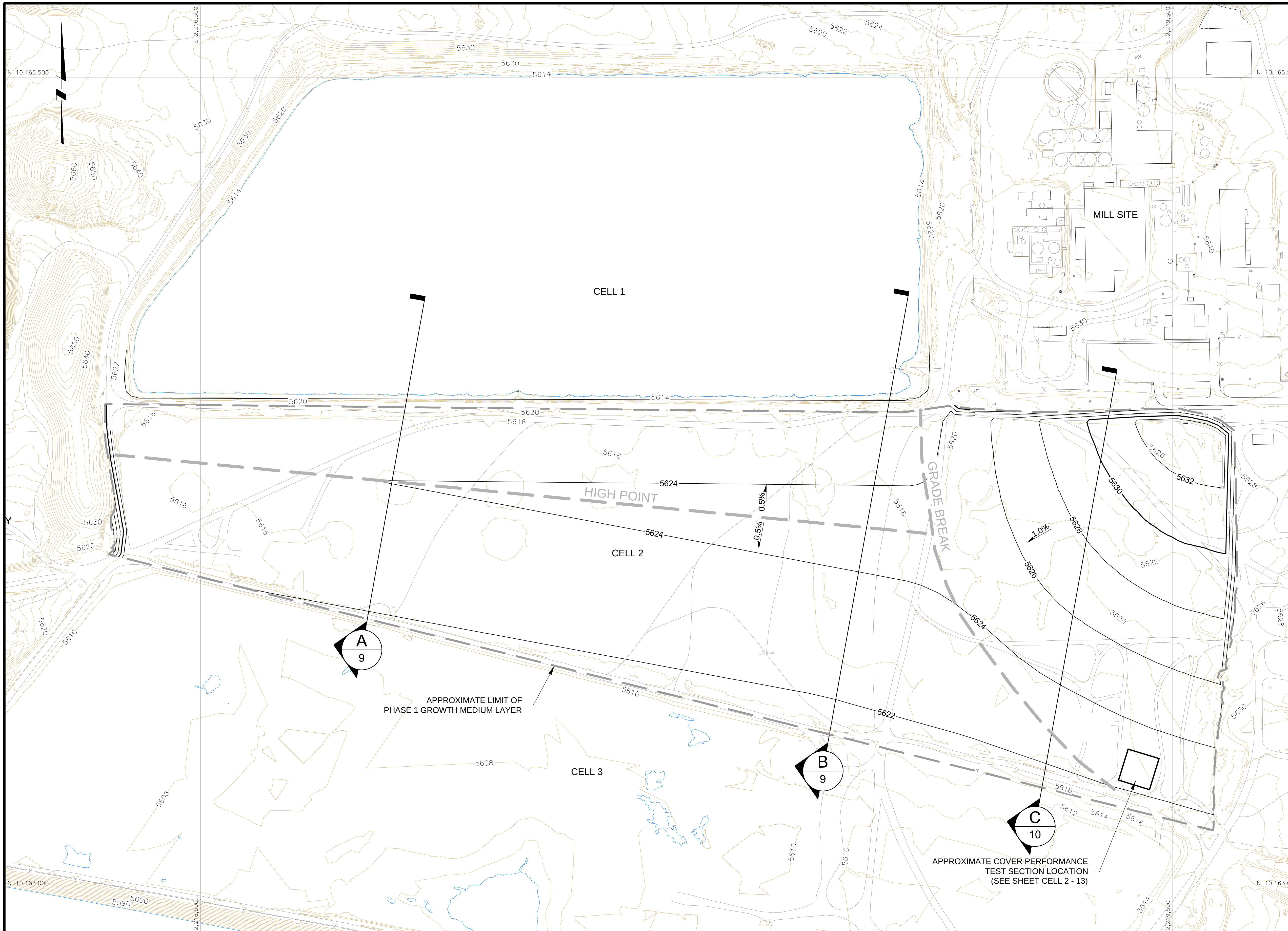
PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION

TITLE: PHASE 1 GRADING PLAN - TOP OF COMPACTED COVER

MWH

SHEET: CELL 2 - 4
REVISION: A
FILE NAME: WMM TRC-2
DATE: AUG 2016



LEGEND:

5605	EXISTING GROUND SURFACE ELEVATION, FEET (SEE REFERENCE)
5605	TOP OF PHASE 1 GROWTH MEDIUM LAYER CONTOUR AND ELEVATION, FEET
	EXISTING ROAD
	EXISTING WATER
	EXISTING TRAIL
X	EXISTING FENCE
	EXISTING STRUCTURE

0 150' 300'

ISSUE	DESCRIPTION	TECH	ENG	DATE
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ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION

TITLE: PHASE 1 GRADING PLAN - TOP OF GROWTH MEDIUM LAYER

SHEET: CELL 2 - 5 | REVISION: A

FILE NAME: PH1 GROWTH MEDIUM | DATE: AUG 2016

MWH

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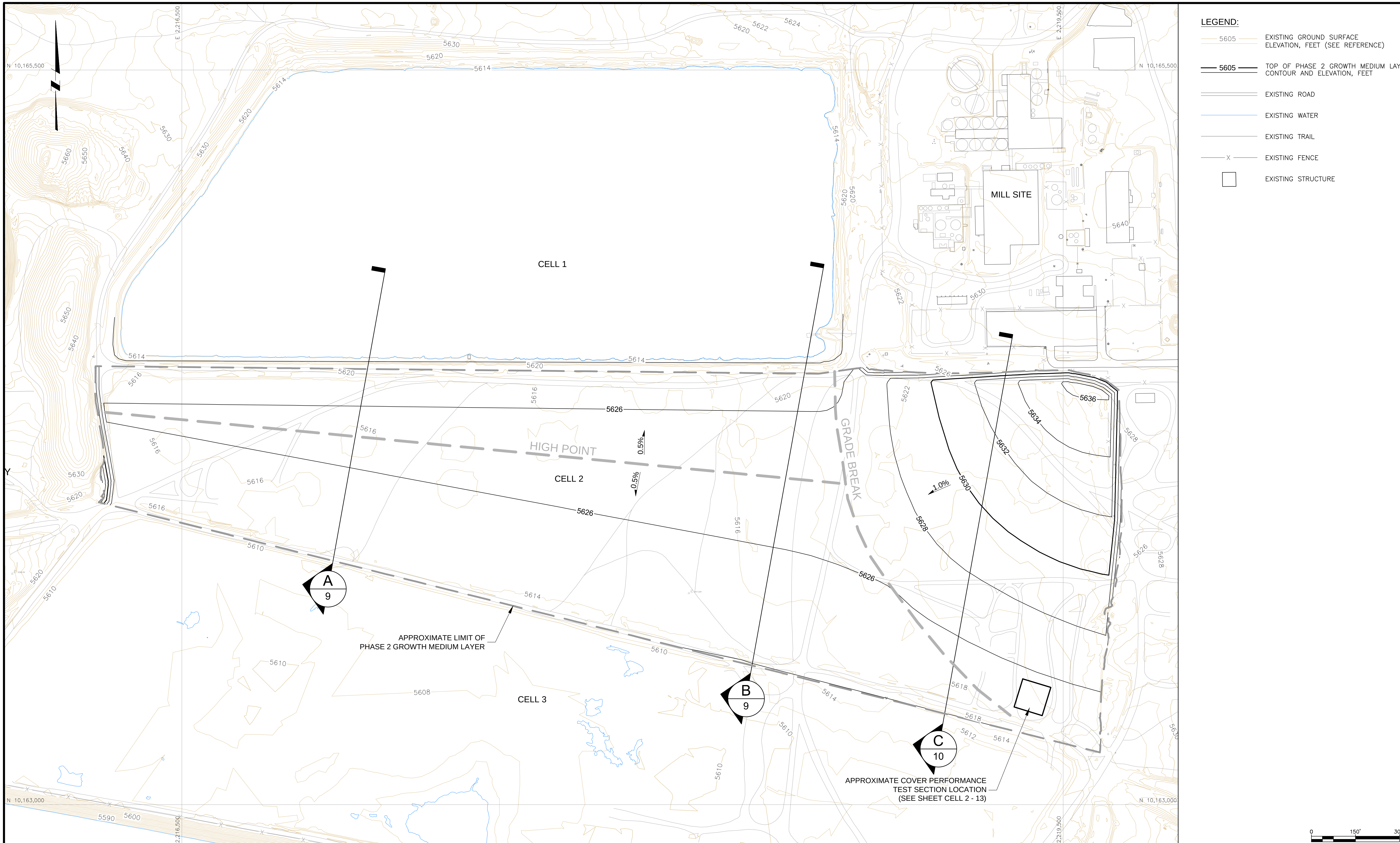

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CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION

TITLE: PHASE 2 GRADING PLAN - TOP OF GROWTH MEDIUM LAYER

MWH

SHEET: CELL 2 - 6 | REVISION: A

FILE NAME: PH2 GROWTH MEDIUM | DATE: AUG 2016

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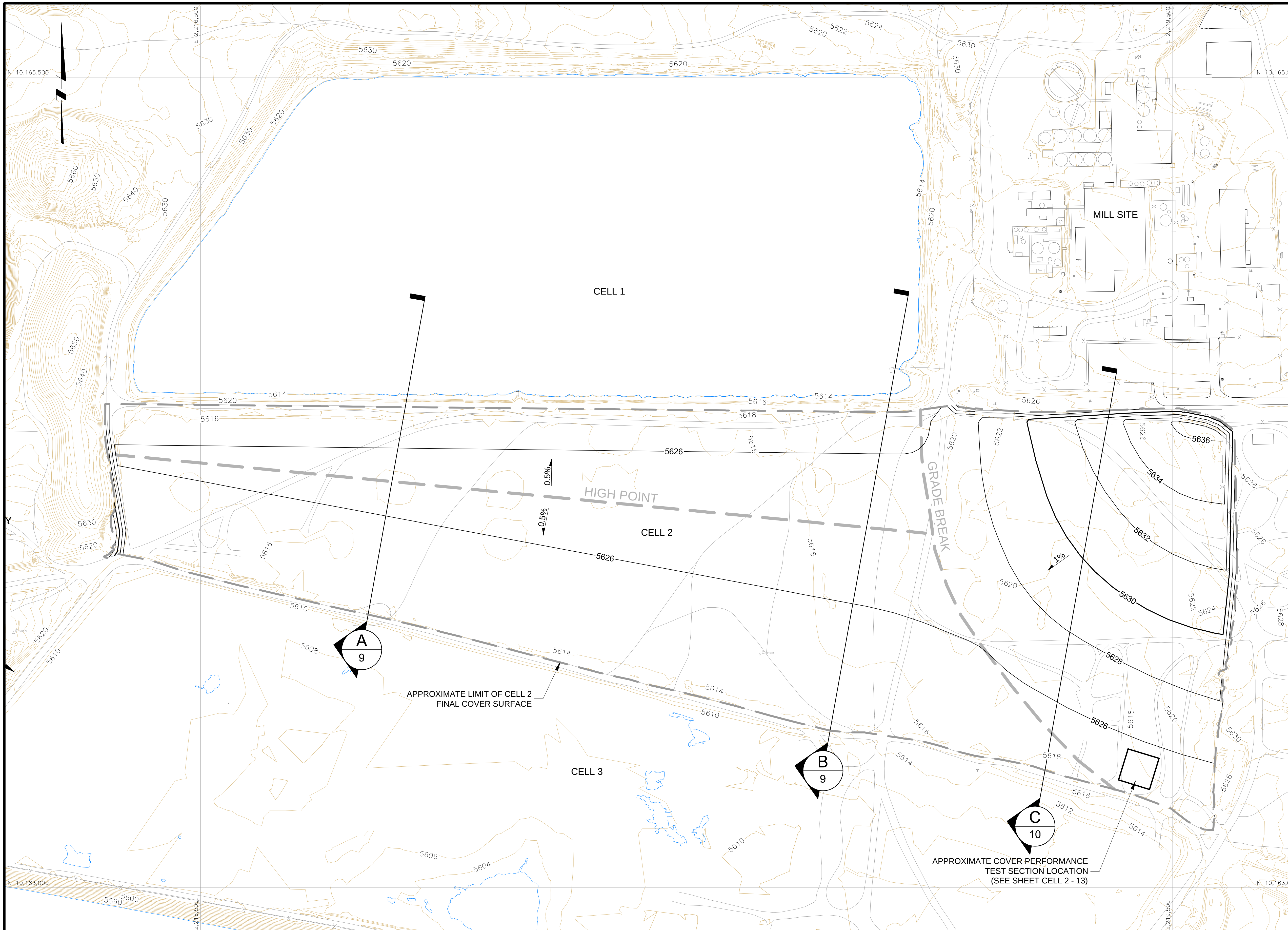

LEGEND:

5605	EXISTING GROUND SURFACE ELEVATION, FEET (SEE REFERENCE)
5605	TOP OF FINAL COVER CONTOUR AND ELEVATION, FEET
	EXISTING ROAD
	EXISTING WATER
	EXISTING TRAIL
X	EXISTING FENCE
	EXISTING STRUCTURE

L:\Design-Drafting\Clients-A-H\ENERGY FUELS\013-Sheet Set\2016-01-27 CELL 2 DESIGN DRAWINGS\WMM TRC-3

ISSUE	DESCRIPTION	TECH	ENG	DATE
A	ISSUED FOR UPDATED TAILINGS COVER DESIGN REPORT	KR	MD	07-16

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PROJECT MANAGER	M DAVIS	07-16
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

ENERGY FUELS

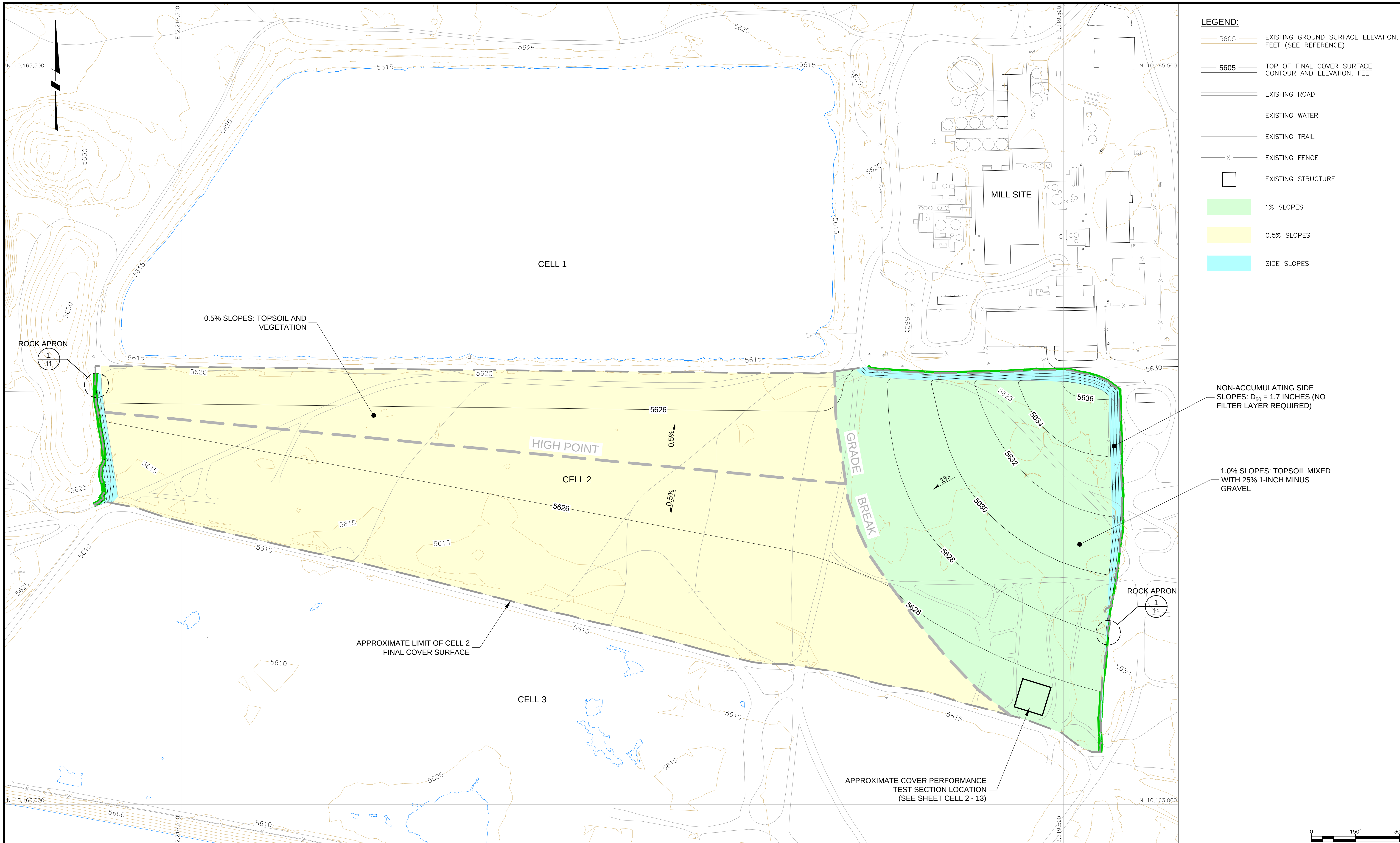
PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION

TITLE: PHASE 2 GRADING PLAN - FINAL COVER SURFACE LAYOUT

MWH

SHEET: CELL 2 - 7
REVISION: A
FILE NAME: WMM TRC-3
DATE: AUG 2016



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ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
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CLIENT APPROVAL		
CLIENT REFERENCE NO.		

ENERGY FUELS

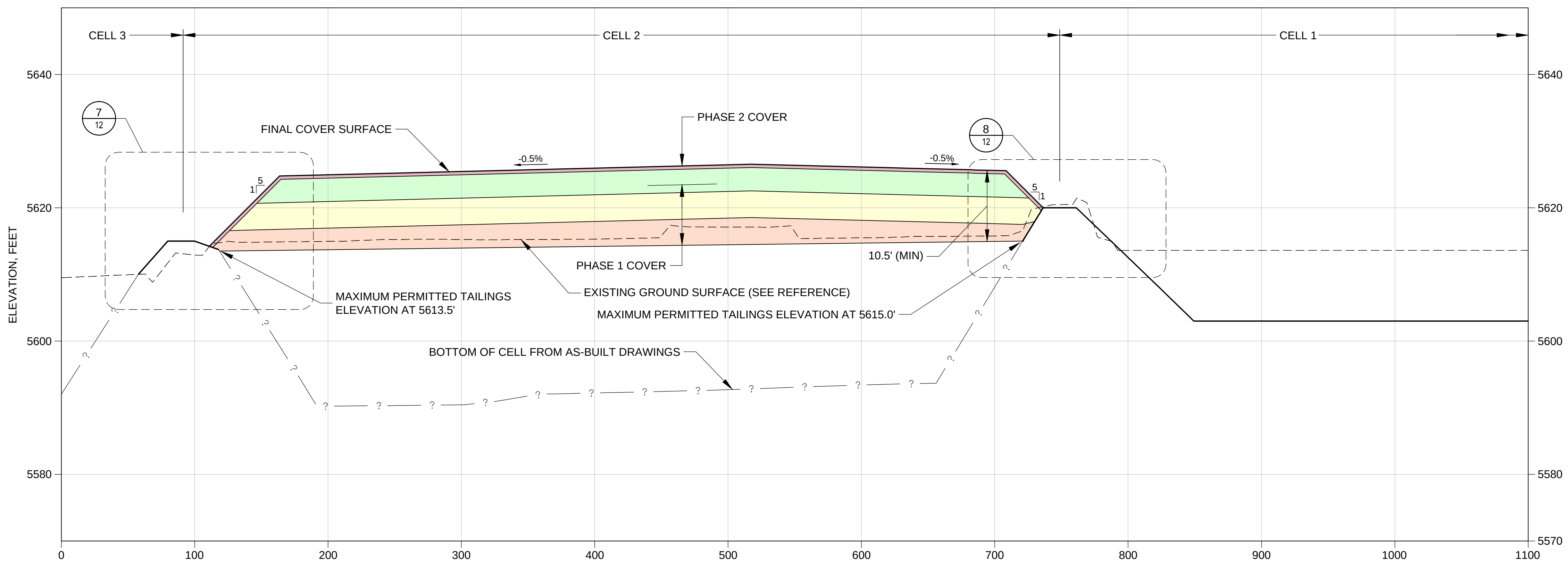
PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION

TITLE: PHASE 2 - COVER EROSION PROTECTION PLAN

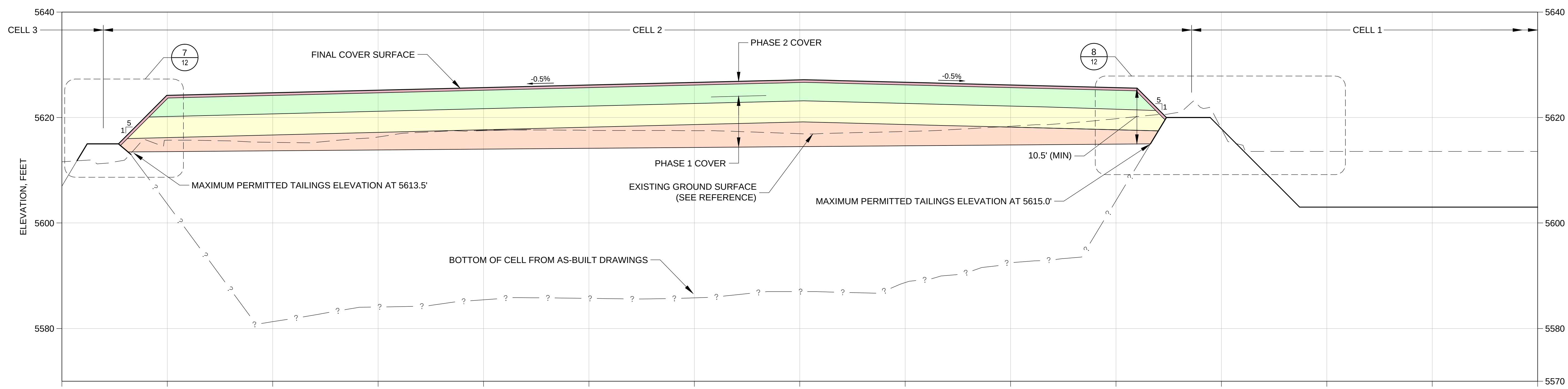
MWH

SHEET: CELL 2 - 8
REVISION: A
FILE NAME: WMM TRC-4
DATE: AUG 2016



A / 9 TAILINGS COVER

HORZ 0 50 100
VERT 0 10 20
SCALE IN FEET
VERTICAL EXAGGERATION = 5X



B / 9 TAILINGS COVER

HORZ 0 50 100
VERT 0 10 20
SCALE IN FEET
VERTICAL EXAGGERATION = 5X

LEGEND:

- EROSION PROTECTION
- GROWTH MEDIUM
- COMPACTED COVER
- INTERIM FILL

ISSUE REV	DESCRIPTION	TECH	ENG	DATE
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CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION

TITLE: COVER OVER CELL 2 CROSS SECTIONS (SHEET 1 OF 2)

MWH

SHEET: CELL 2 - 9
REVISION: A
FILE NAME: WMM TRC-5
DATE: AUG 2016

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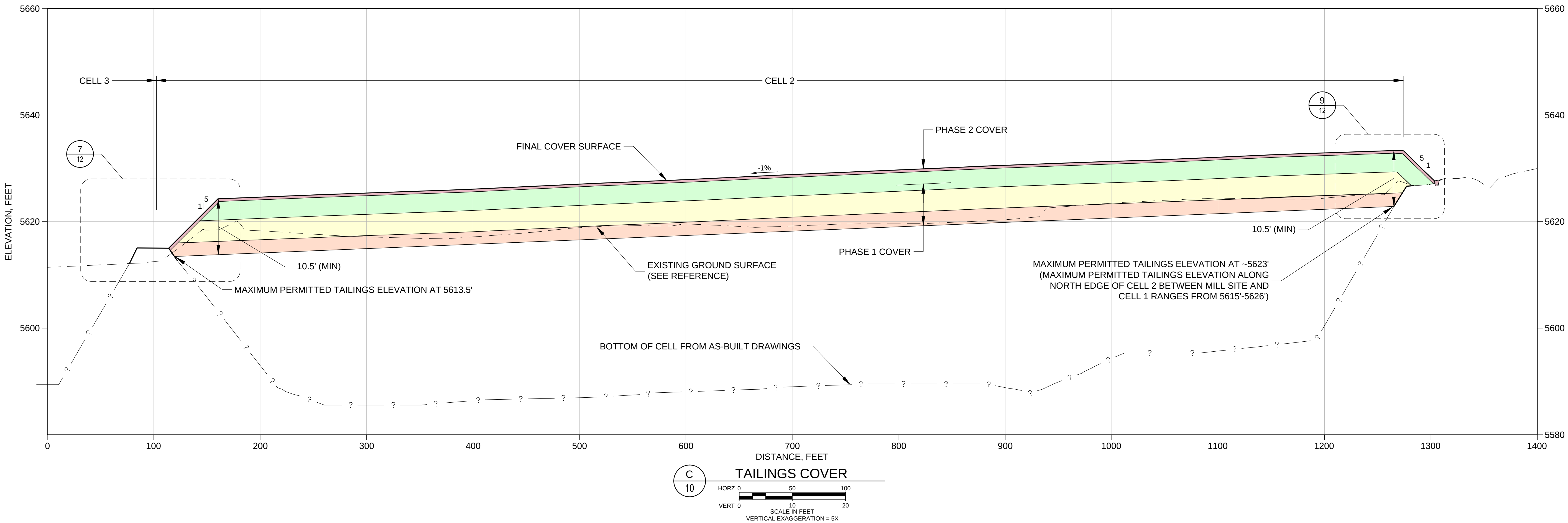

C 10 TAILINGS COVER

LEGEND:

- EROSION PROTECTION
- COMPACTED COVER
- GROWTH MEDIUM
- INTERIM FILL

ISSUE	DESCRIPTION	TECH	ENG	DATE
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APPROVED BY	C STRACHAN	V
PROJECT MANAGER	M DAVIS	07-16
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION

TITLE: COVER OVER CELL 2 CROSS SECTIONS (SHEET 2 OF 2)

MWH

SHEET: CELL 2 - 10 | REVISION: A

FILE NAME: WMM TRC-5 | DATE: AUG 2016

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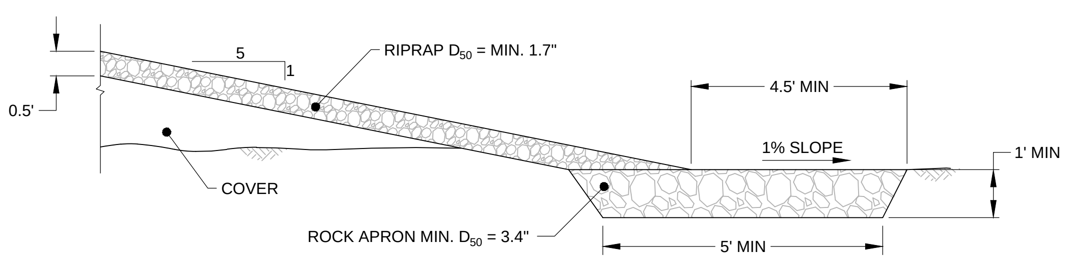
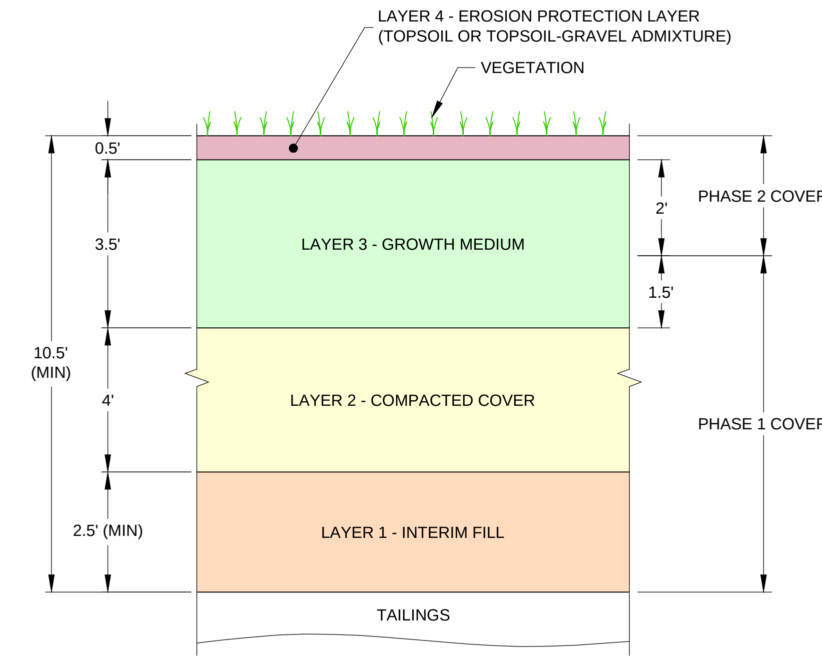


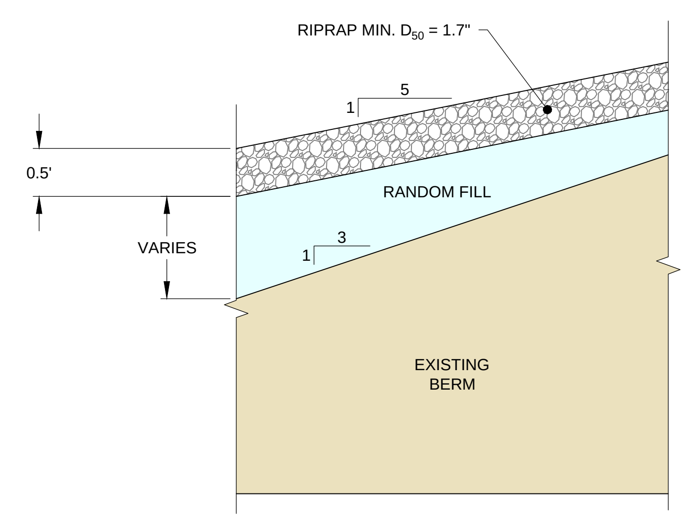
ELEVATION

1
11
ROCK APRON AT BASE OF CELL 2 TOE OUTSLOPES

0 2 4
SCALE IN FEET



2
11
COVER DETAIL FOR TOP SURFACE OF TAILINGS
CELL 2
NOT TO SCALE



LEGEND:

- EROSION PROTECTION
- GROWTH MEDIUM
- COMPACTED COVER
- INTERIM FILL
- RANDOM FILL
- EXISTING BERM
- RIPRAP

3
11
COVER DETAIL FOR CELL 2 SIDE SLOPES
NOT TO SCALE

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
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CLIENT APPROVAL		
CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH
PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION
TITLE: RECLAMATION COVER DETAILS (SHEET 1 OF 2)
SHEET: CELL 2 - 11
REVISION: A
FILE NAME: WMM TRC-9
DATE: AUG 2016

MWH

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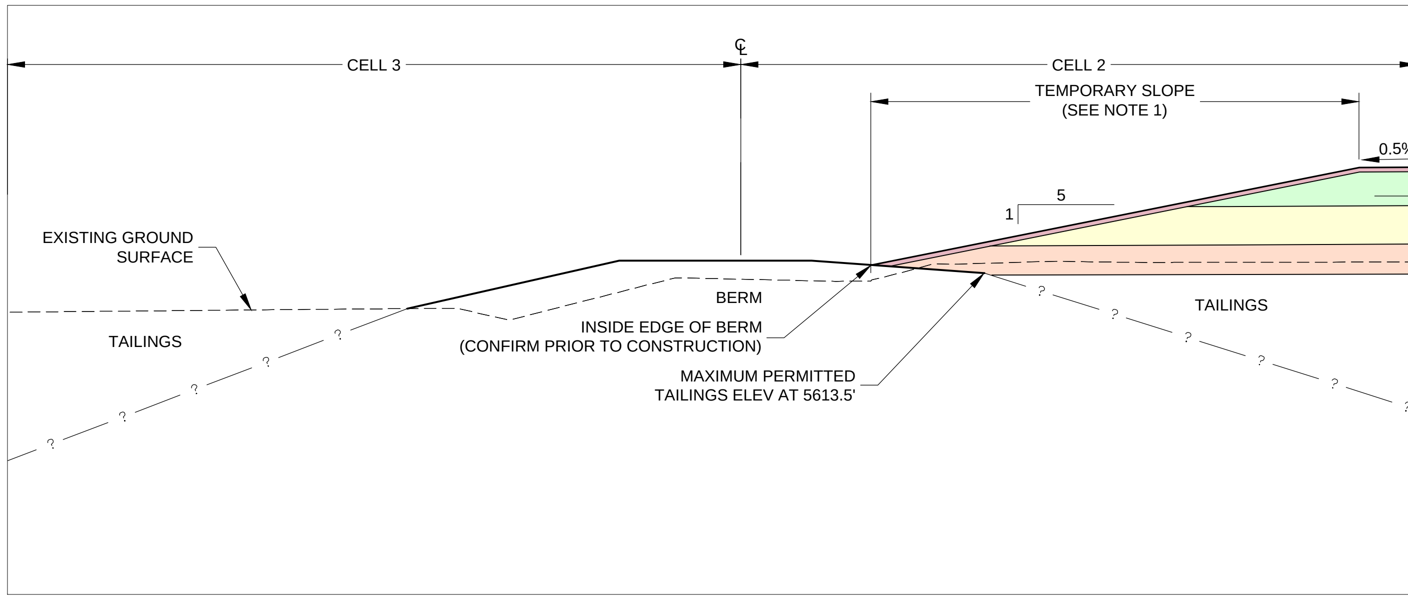
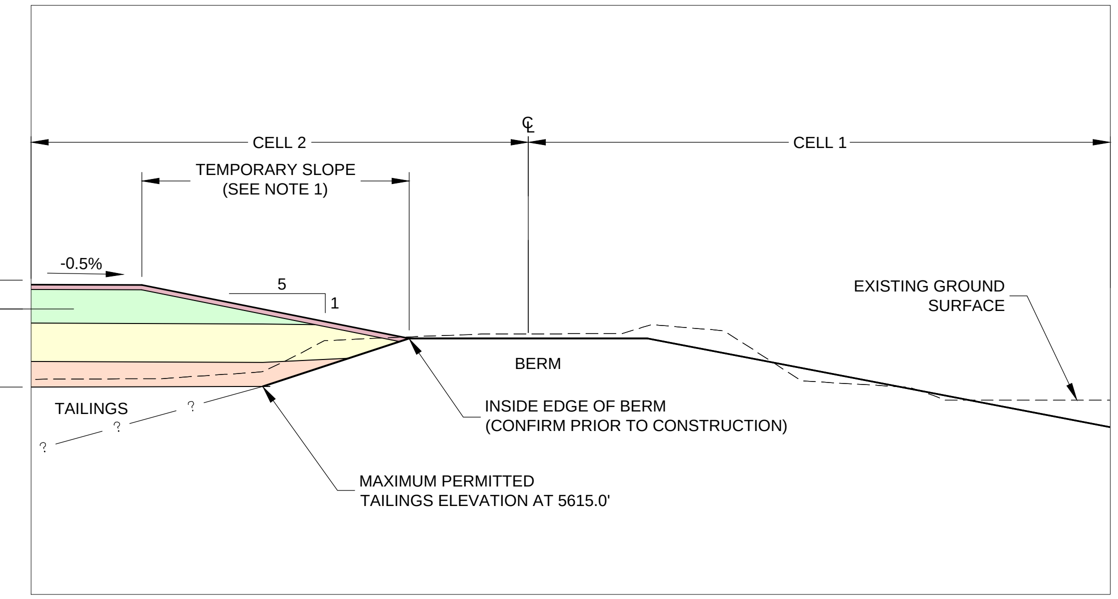
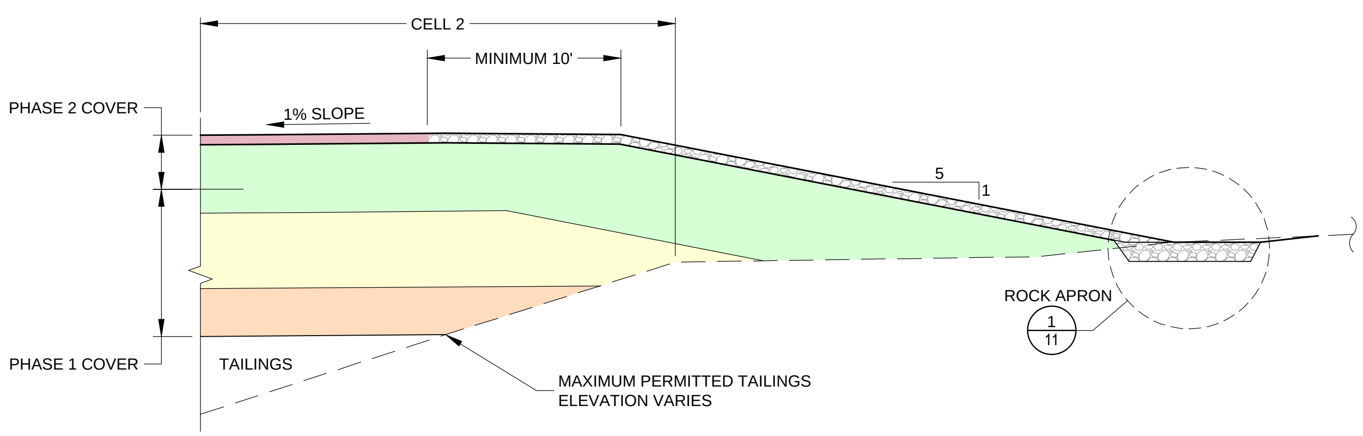


7/12 CELL 2 COVER TIE-IN DETAIL OVER BERM BETWEEN CELL 2 AND CELL 3

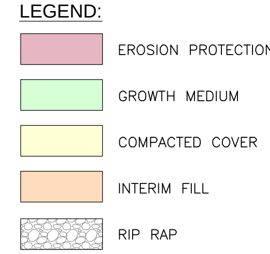


8/12 CELL 2 COVER TIE-IN DETAIL OVER BERM BETWEEN CELL 1 AND CELL 2



9/12 COVER DETAIL OVER BERM - NORTHEASTERN EDGE OF CELL 2

LEGEND:



NOTE:

1. THE CELL 2 TEMPORARY SLOPES WILL BE IN PLACE PRIOR TO CONSTRUCTION OF CELL 1 AND CELL 3 FINAL COVERS. DURING FINAL CELL 1 AND CELL 3 COVER CONSTRUCTION, THE EROSION PROTECTION LAYER ON THE CELL 2 TEMPORARY SLOPES WILL BE REMOVED AND THE CELL 2 FINAL COVER SYSTEM WILL BE TIED INTO THE CELL 1 AND CELL 3 FINAL COVER SYSTEMS.

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
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CHECKED BY	C STRACHAN	07–16
APPROVED BY	C STRACHAN	07–16
PROJECT MANAGER	M DAVIS	07–16
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION

TITLE: RECLAMATION COVER DETAILS (SHEET 2 OF 2)

MWH

SHEET: CELL 2 - 12 | REVISION: A

FILE NAME: WMM TRC-10 | DATE: AUG 2016

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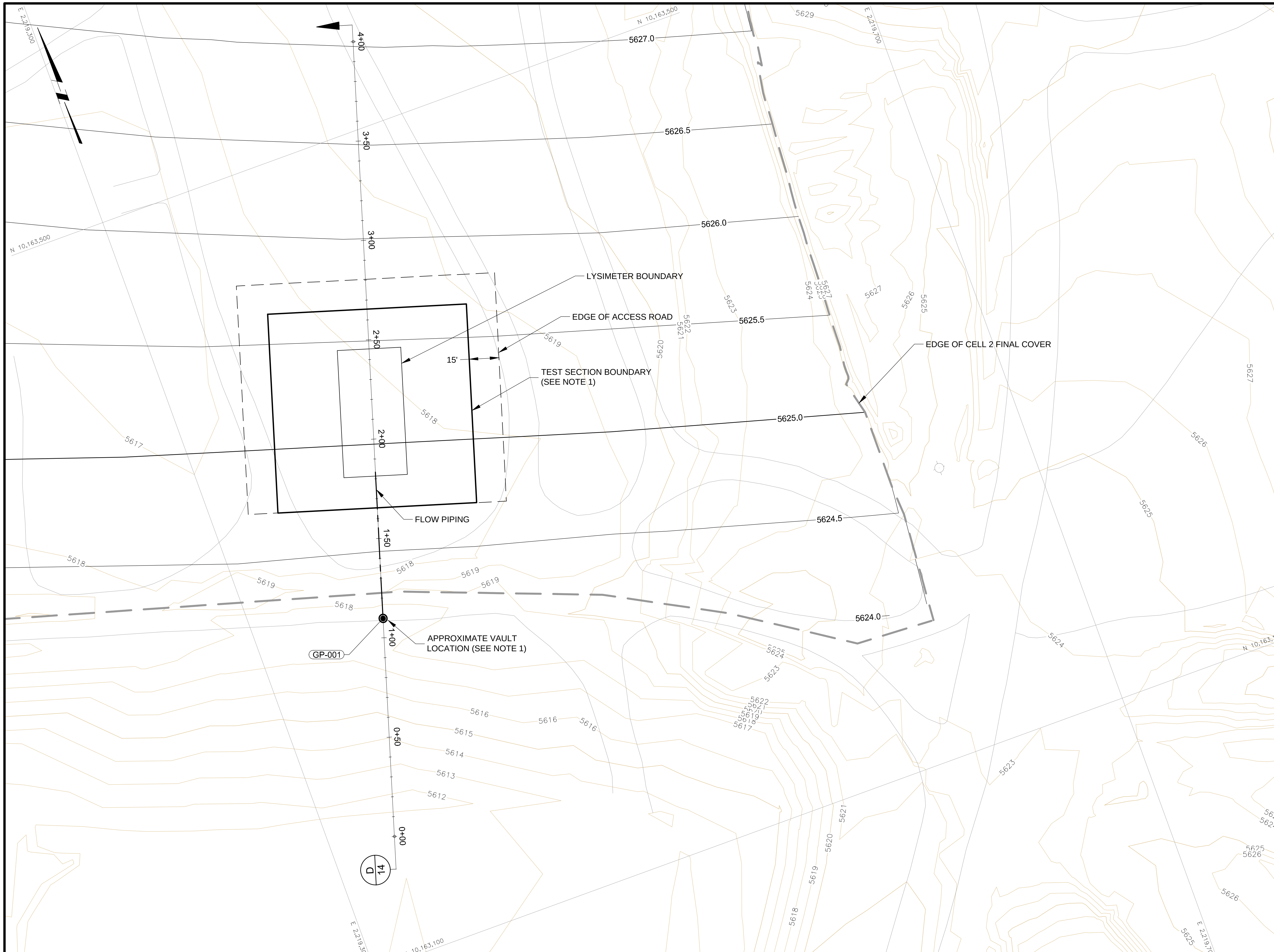

LEGEND:

5605	EXISTING GROUND SURFACE ELEVATION, FEET (SEE REFERENCE)
5605	FINAL GRADING SURFACE CONTOUR AND ELEVATION, FEET
	EXISTING ROAD
	EXISTING WATER
	EXISTING TRAIL
X	EXISTING FENCE

NOTE:
1. TEST SECTION AND VAULT LOCATIONS SHOWN ARE APPROXIMATE. FINAL LOCATIONS WILL BE ESTABLISHED IN THE FIELD.

TABLE 1:
VAULT LOCATION

POINT NO.	NORTHING (FT)	EASTING (FT)	DESCRIPTION
GP-001	10163264.8	2219364.4	CENTER OF MANHOLE

ISSUE REV	DESCRIPTION	TECH	ENG	DATE
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CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION

TITLE: TEST SECTION PLAN

MWH

SHEET: CELL 2 - 13
REVISION: A
FILE NAME: TEST SECTION PLAN
DATE: AUG 2016

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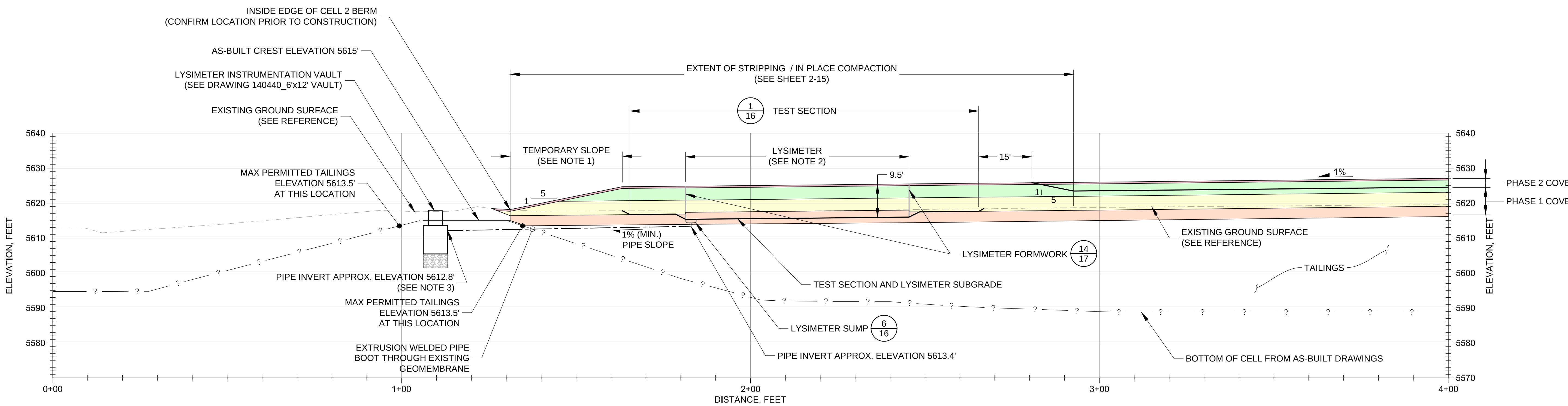

8/14 TEST SECTION CROSS SECTION

0 15 30

NOTES:

1. THE CELL 2 TEMPORARY SLOPES WILL BE IN PLACE PRIOR TO CONSTRUCTION OF CELL 1 AND CELL 3 FINAL COVERS. DURING FINAL CELL 1 AND CELL 3 COVER CONSTRUCTION, THE EROSION PROTECTION LAYER ON THE CELL 2 TEMPORARY SLOPES WILL BE REMOVED AND THE CELL 2 FINAL COVER SYSTEM WILL BE TIED INTO THE CELL 1 AND CELL 3 FINAL COVER SYSTEMS.

2. LYSIMETER THICKNESS IS 9.5' WHICH IS THE MINIMUM DESIGN THICKNESS FOR THE RECLAMATION COVER ACROSS THE TAILINGS CELLS. (THE COVER DESIGN THICKNESS FOR CELL 2, CELL 3, AND CELLS 4A/4B IS 10.5', 10', AND 9.5', RESPECTIVELY).

3. VAULT LOCATION SHOWN IS APPROXIMATE. FINAL LOCATION WILL BE ESTABLISHED IN THE FIELD.

LEGEND:

- EROSION PROTECTION
- COMPACTED COVER
- GROWTH MEDIUM
- INTERIM FILL
- SUMP PERCOLATION PIPE
- CRUSHED ROCK OR GRAVEL

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
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DRAWING REFERENCE(S):
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CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION

TITLE: TEST SECTION CROSS SECTION

MWH

SHEET: CELL 2 - 14 | REVISION: A

FILE NAME: TEST SECTION PLAN | DATE: AUG 2016

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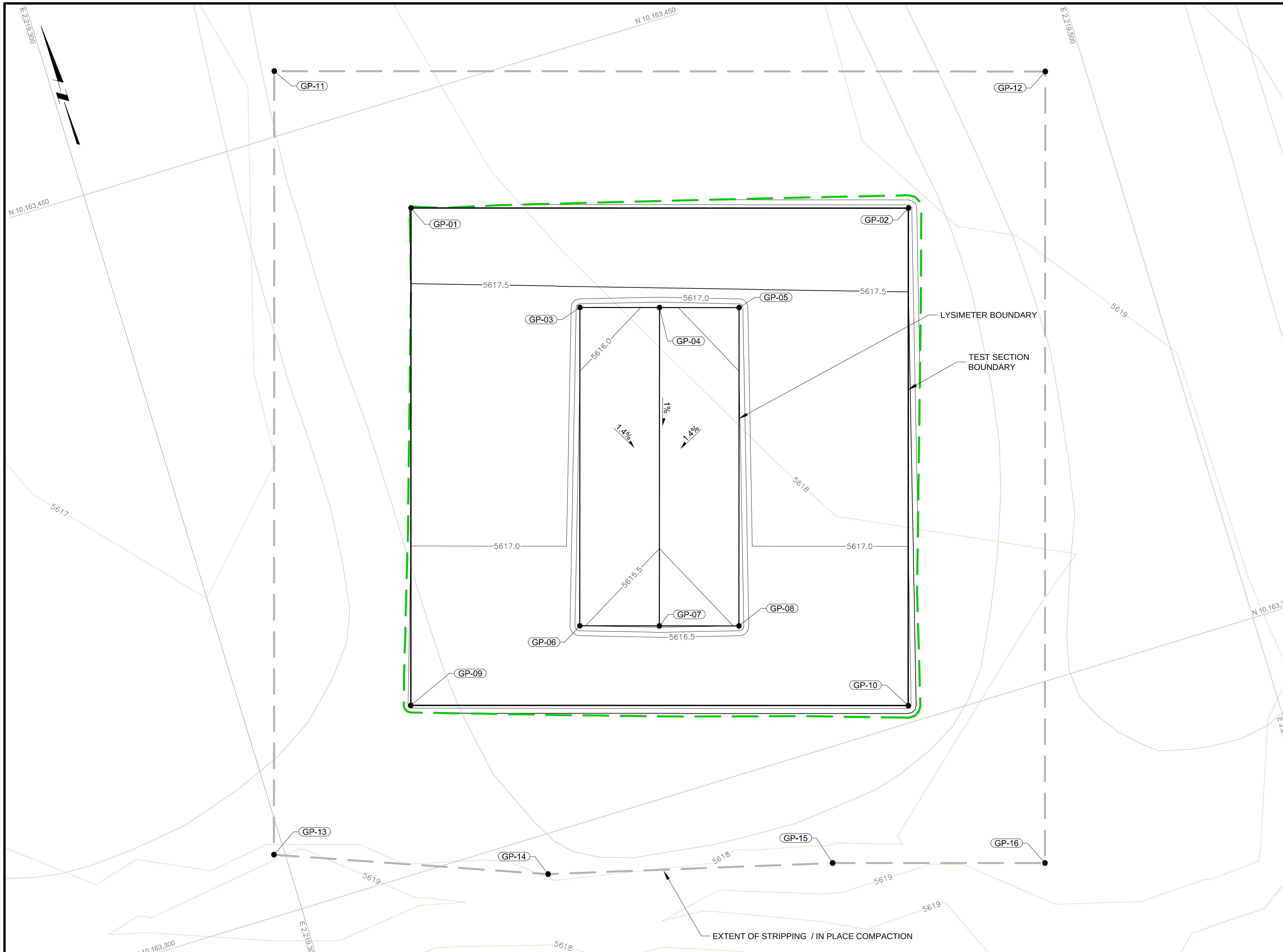

LEGEND:

5605	EXISTING GROUND SURFACE ELEVATION, FEET (SEE REFERENCE)
5605	FINAL GRADING SURFACE CONTOUR AND ELEVATION, FEET
	EXISTING ROAD
	EXISTING WATER
	EXISTING TRAIL
X	EXISTING FENCE
GP-001	GRADING POINT (SEE TABLES 1 AND 2)

NOTE:

1. TOP OF INTERIM COVER GRADING POINTS CORRESPOND TO EXTENTS OF STRIPPING / IN PLACE COMPACTION TO BE PERFORMED AS PART OF TEST SECTION CONSTRUCTION.

TABLE 1:
TEST SECTION SUBGRADE GRADING POINTS

POINT NO.	NORTHING (FT)	EASTING (FT)	ELEVATION (FT)
GP–01	10163428.3	2219362.2	5617.6
GP–02	10163399.0	2219457.8	5617.7
GP–03	10163399.2	2219388.8	5616.1
GP–04	10163394.5	2219404.1	5616.0
GP–05	10163389.9	2219419.4	5616.1
GP–06	10163338.0	2219370.1	5615.5
GP–07	10163333.3	2219385.4	5615.4
GP–08	10163328.7	2219400.7	5615.5
GP–09	10163332.7	2219332.9	5616.7
GP–10	10163303.4	2219428.5	5616.7

TABLE 2:
TOP OF INTERIM COVER GRADING POINTS (SEE NOTE 1)

POINT NO.	NORTHING (FT)	EASTING (FT)	ELEVATION (FT)
GP–11	10163462.6	2219344.0	5617.9
GP–12	10163417.3	2219492.2	5617.9
GP–13	10163312.0	2219297.8	5618.7
GP–14	10163292.2	2219349.4	5617.9
GP–15	10163277.6	2219404.7	5618.4
GP–16	10163265.1	2219445.6	5618.4

0 10' 20'

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CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

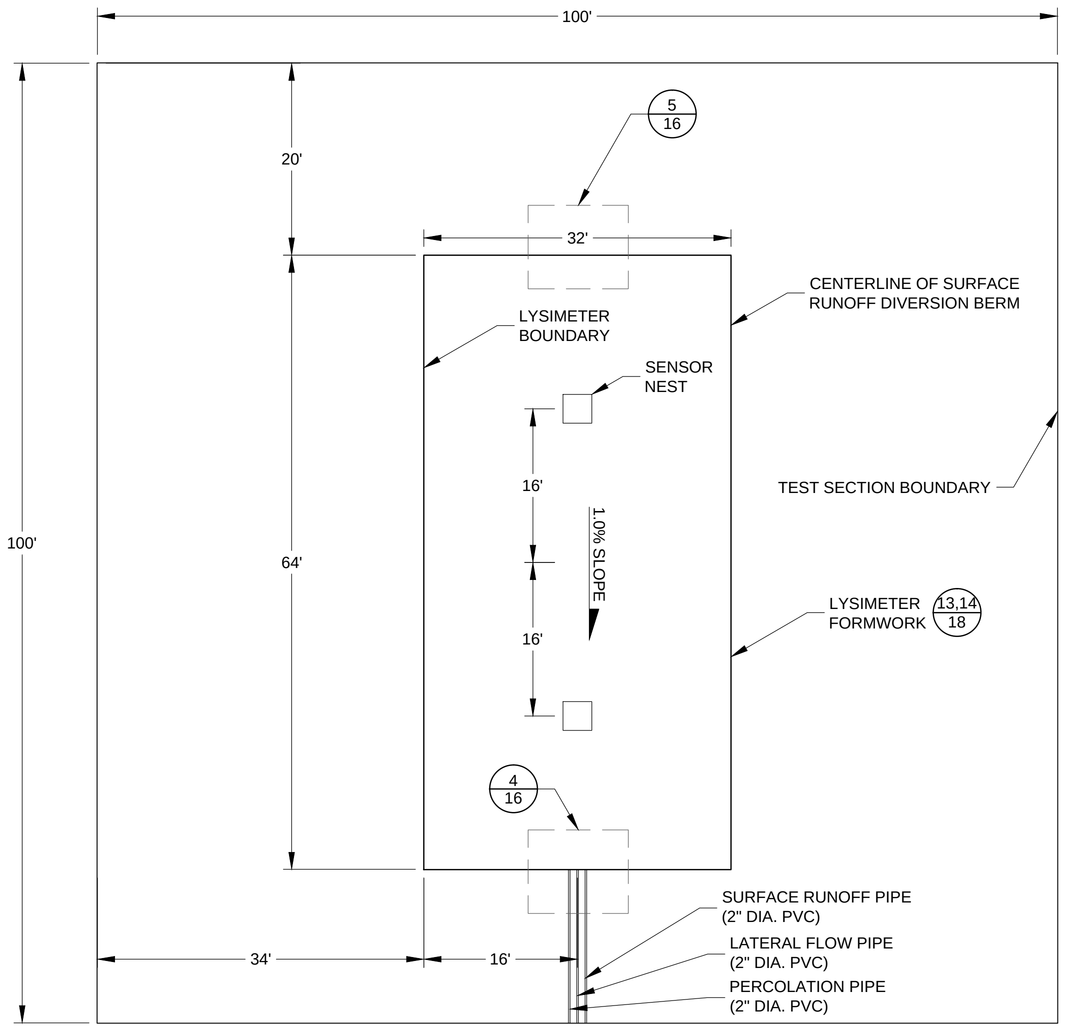
PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION

TITLE: TEST SECTION SUBGRADE GRADING PLAN

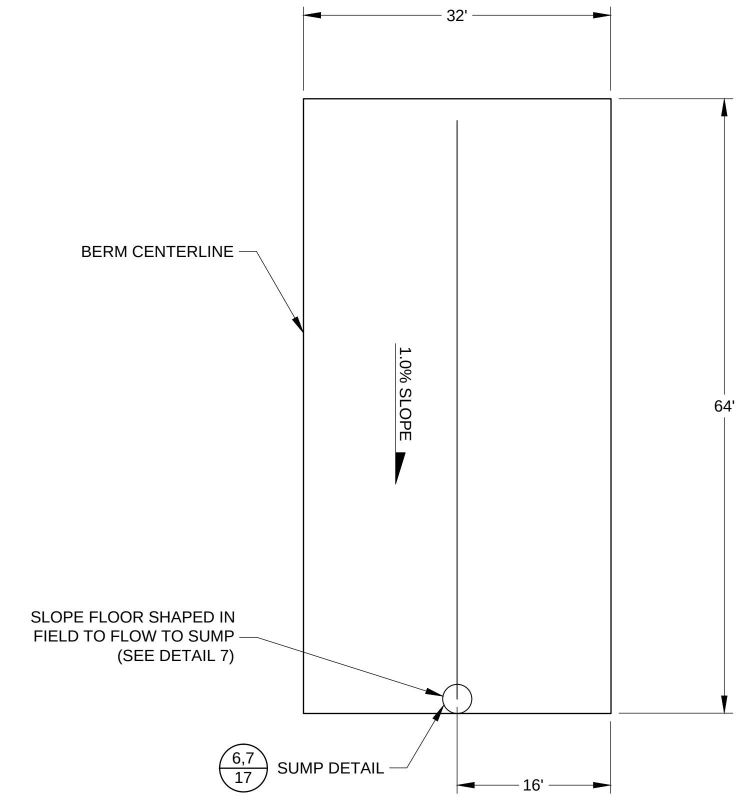
MWH

SHEET: CELL 2 - 15 | REVISION: A

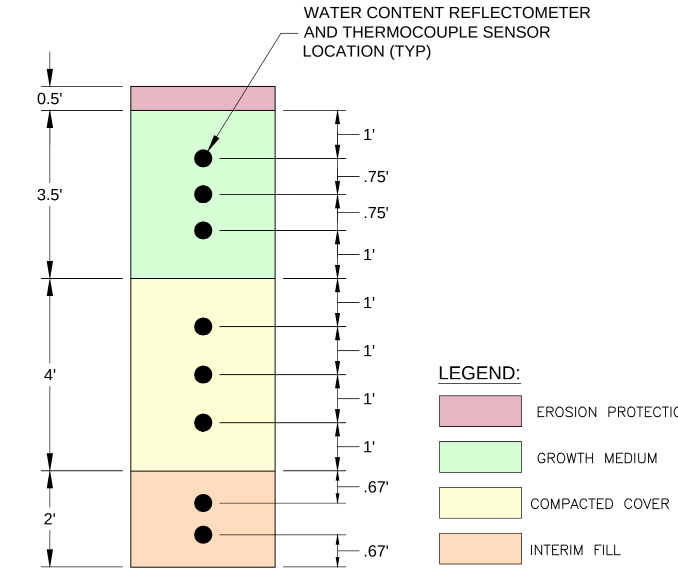
FILE NAME: TEST SECTION PLAN | DATE: AUG 2016



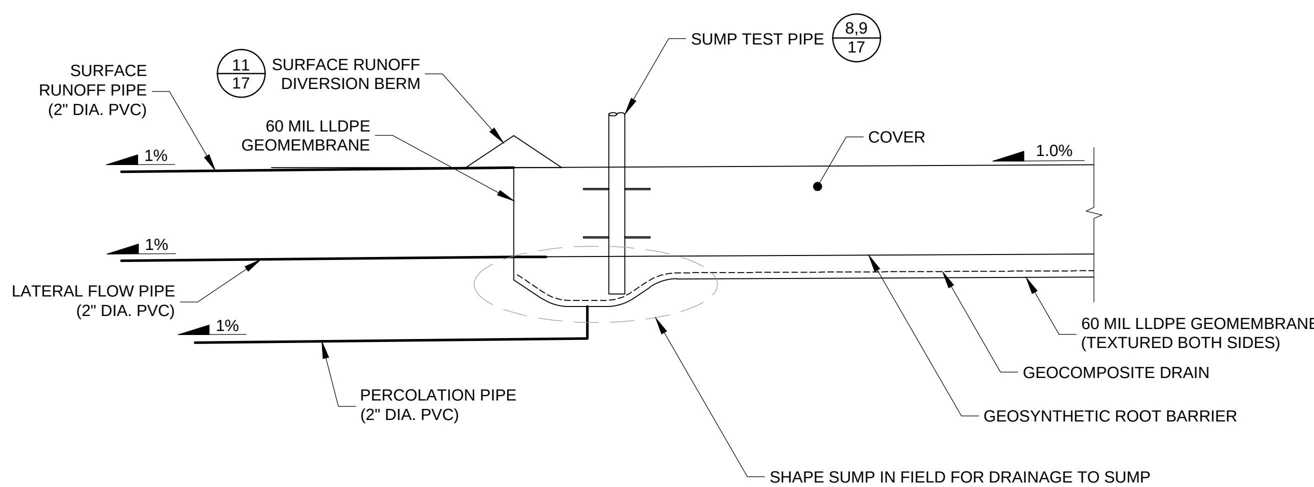
1 / 16 TEST SECTION PLAN VIEW



2 / 16 LYSIMETER SUBGRADE PLAN VIEW

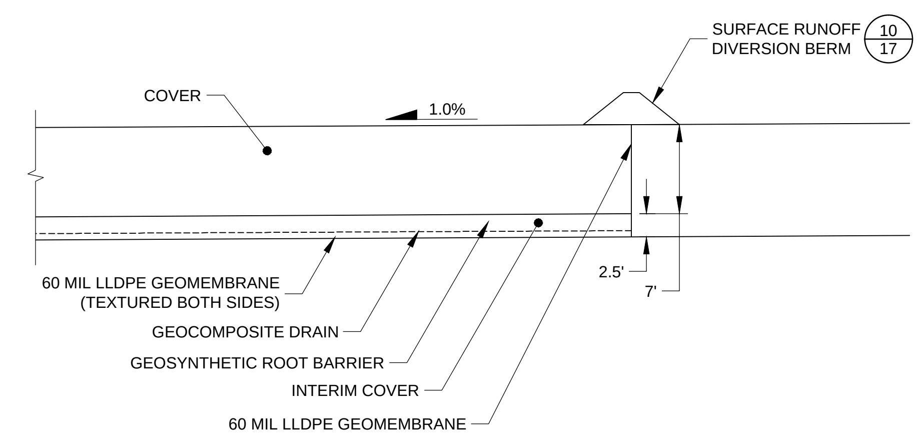


3 / 16 COVER PROFILE WITH SENSOR DEPTHS



4 / 16 TEST SECTION - LYSIMETER DOWN GRADIENT END

NOT TO SCALE



5 / 16 TEST SECTION - LYSIMETER UP GRADIENT END

NOT TO SCALE

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
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CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION

TITLE: TEST SECTION DETAILS (SHEET 1 OF 3)

MWH

SHEET: CELL 2 - 16 | REVISION: A

FILE NAME: TEST SECTION DETAILS | DATE: AUG 2016

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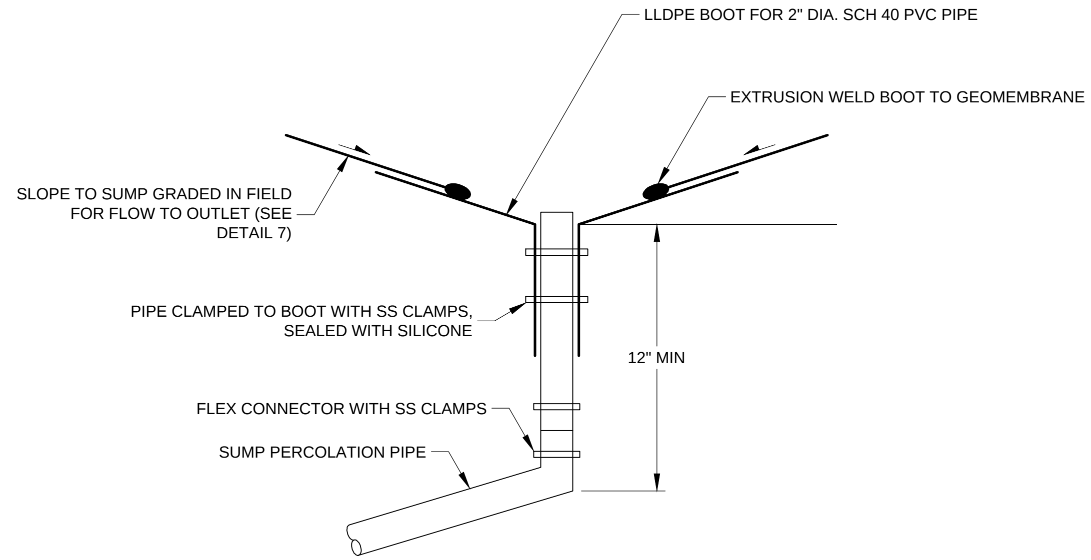
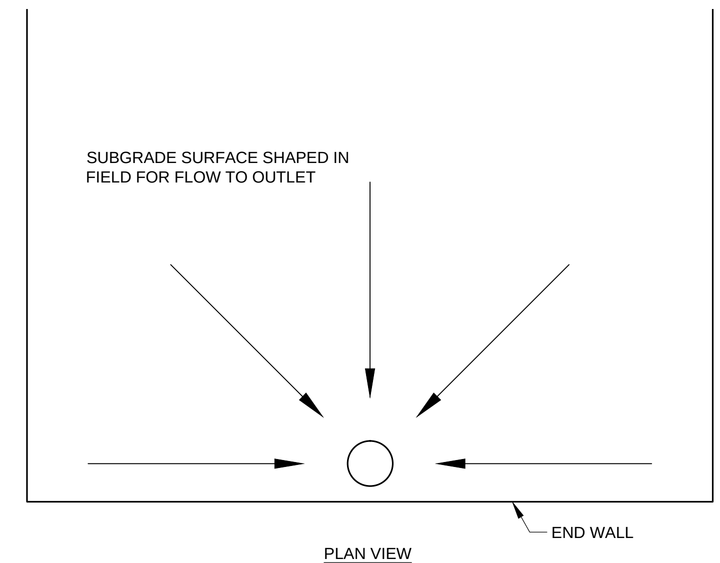


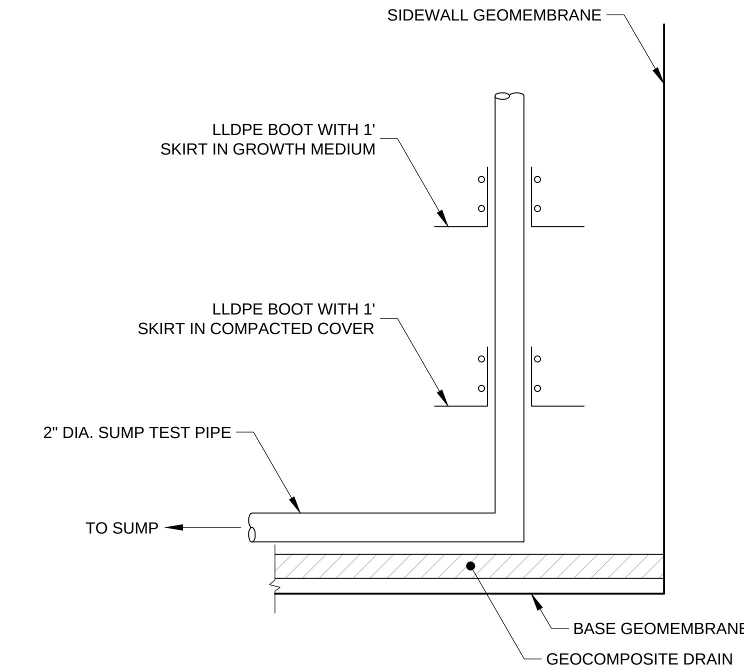
6/17 SCHEMATIC OF LYSIMETER SUMP

NOT TO SCALE



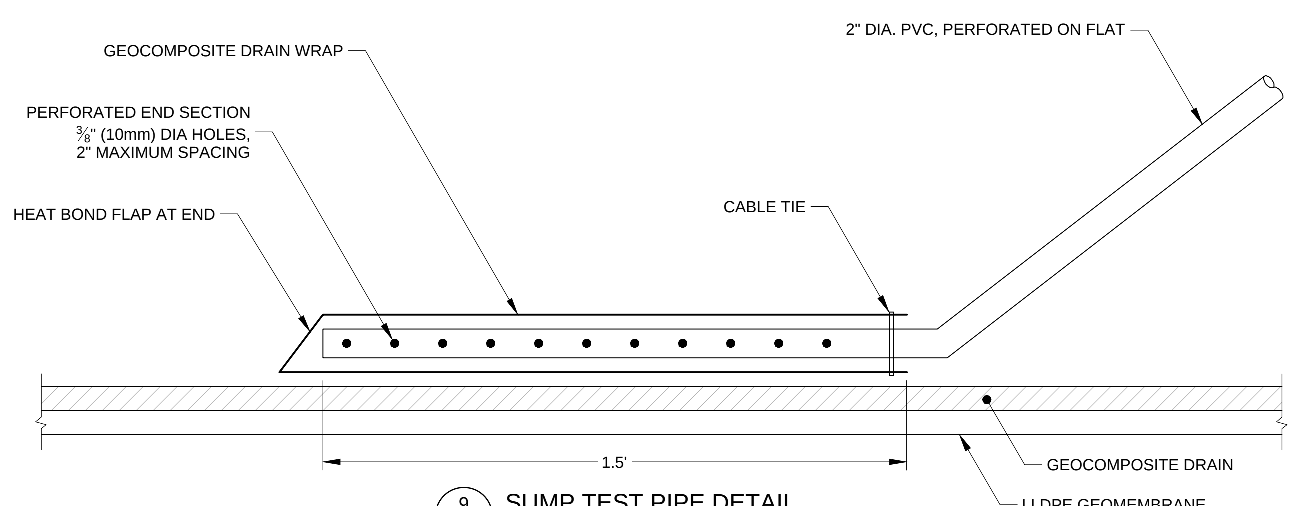
7/17 DOWNSLOPE END OF LYSIMETER SUBGRADE SURFACE

NOT TO SCALE



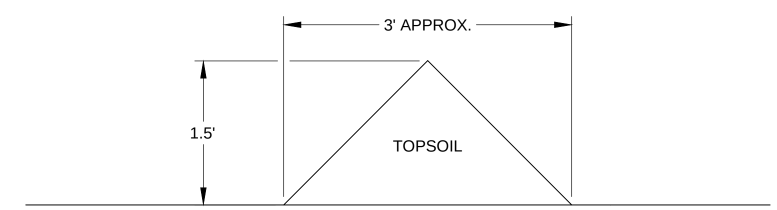
8/17 SUMP TEST PIPE RISER DETAIL

NOT TO SCALE



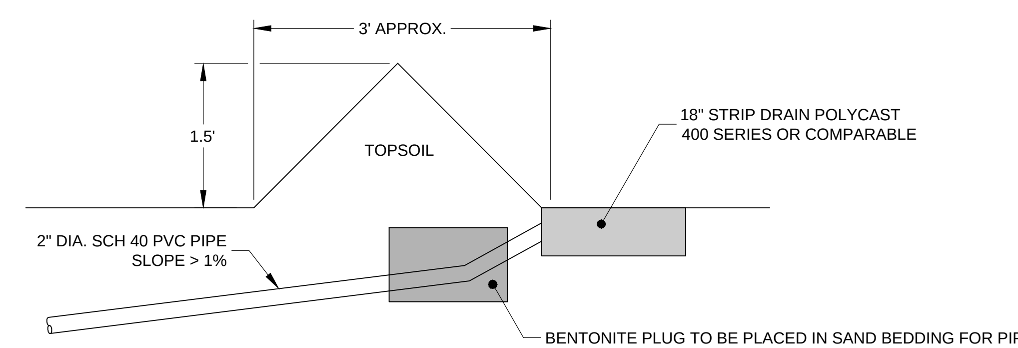
9/17 SUMP TEST PIPE DETAIL

NOT TO SCALE



10/17 SURFACE RUNOFF DIVERSION BERM

NOT TO SCALE



11/17 STRIP DRAIN AND COLLECTION PIPE FOR SURFACE RUNOFF

NOT TO SCALE

ISSUE/REV	DESCRIPTION	TECH	ENG	DATE
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ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION

TITLE: TEST SECTION DETAILS (SHEET 2 OF 3)

MWH

SHEET: CELL 2 - 17 | REVISION: A

FILE NAME: TEST SECTION DETAILS | DATE: AUG 2016

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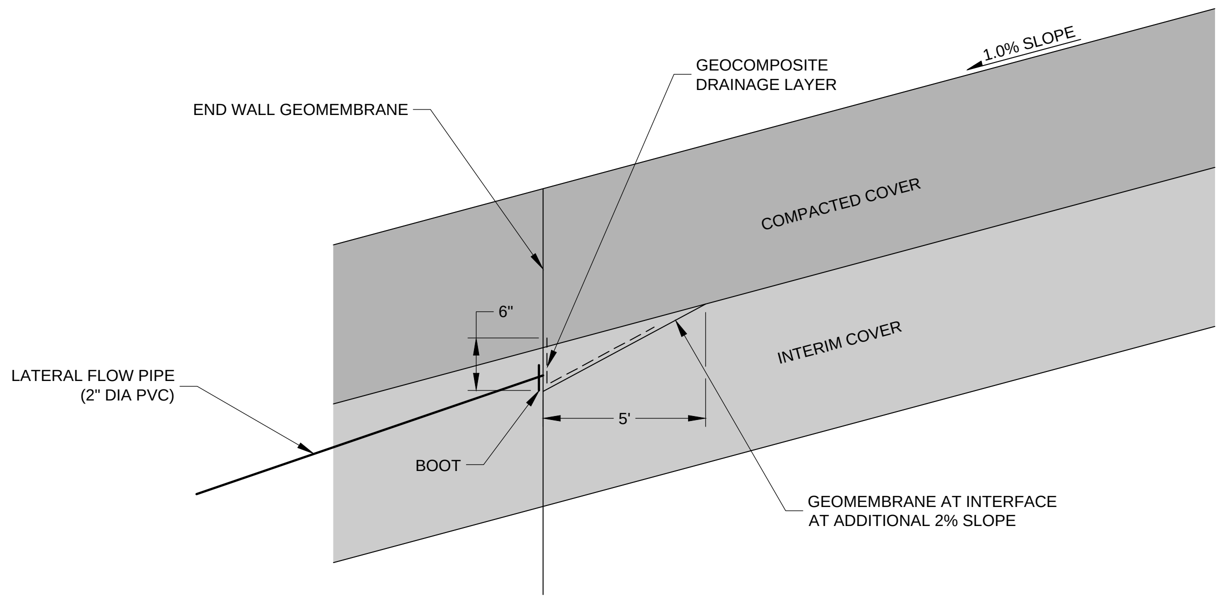
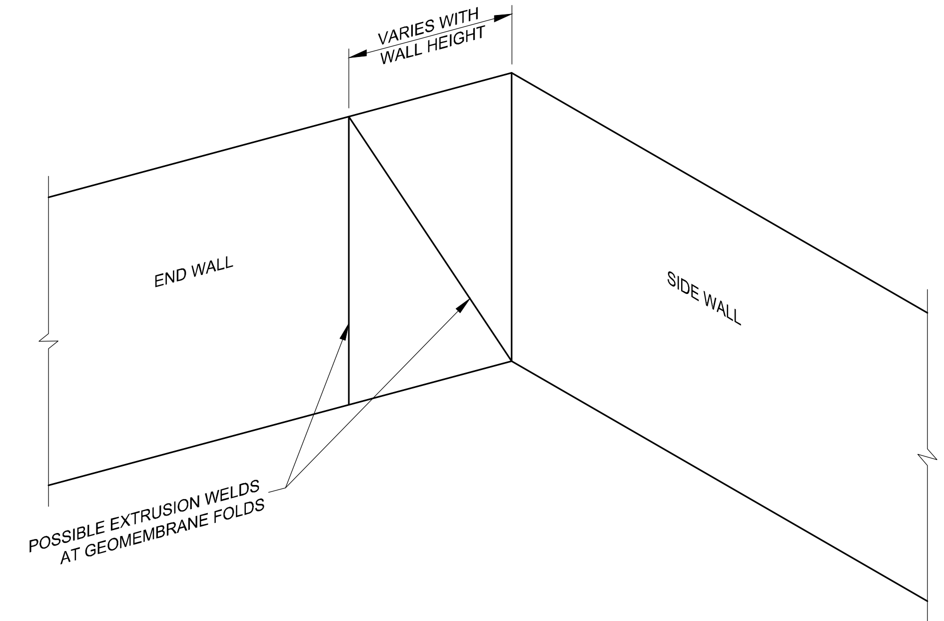


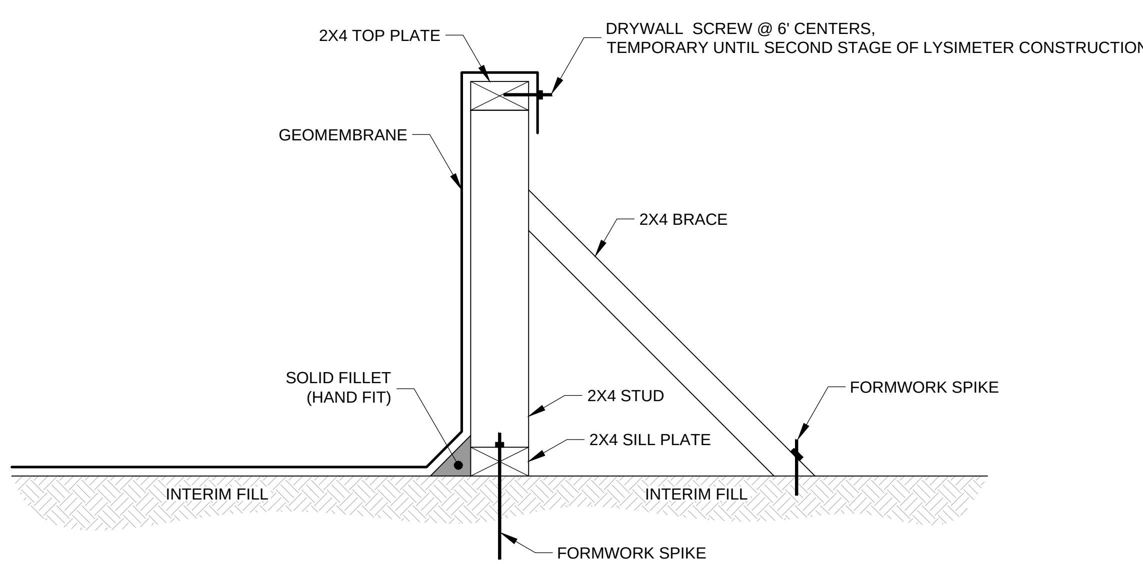
12/18 INTERFLOW COLLECTION SUMP FOR LYSIMETER

NOT TO SCALE



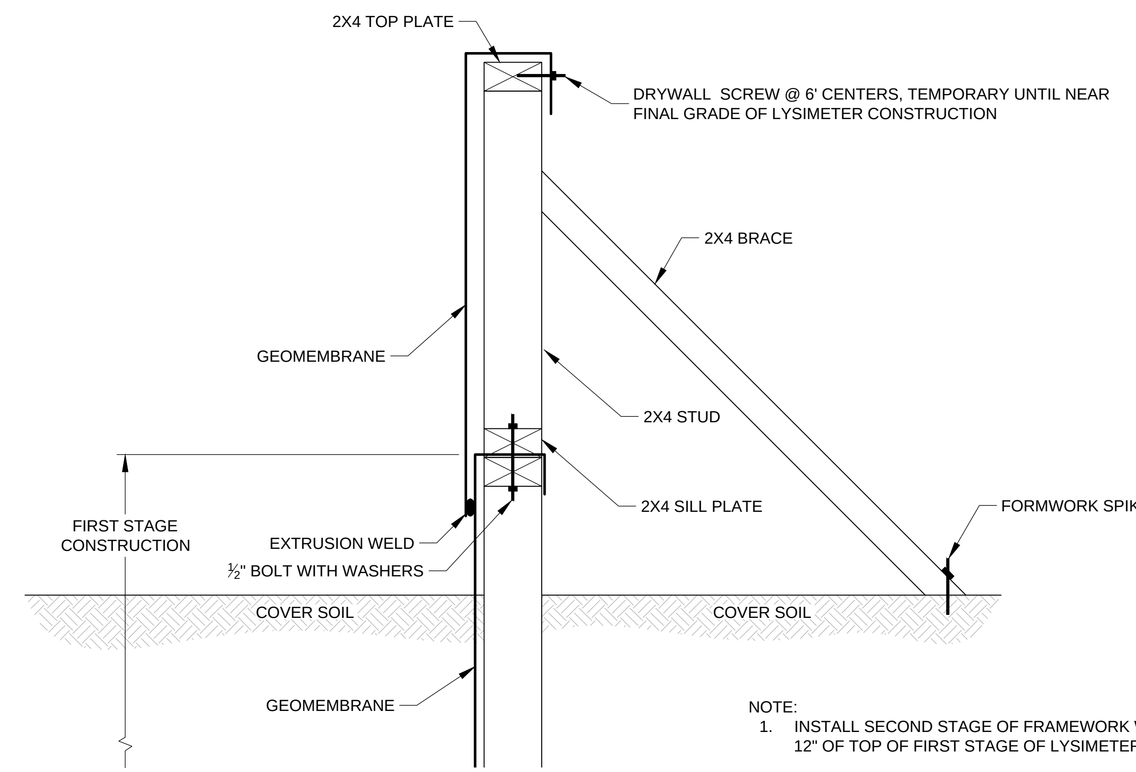
13/17 WELDING OF SIDE WALL GEOMEMBRANES FOR LYSIMETER

NOT TO SCALE



14/18 LYSIMETER FORMWORK - FIRST STAGE OF LYSIMETER CONSTRUCTION

NOT TO SCALE



NOTE:
1. INSTALL SECOND STAGE OF FRAMEWORK WHEN COVER WITHIN 12" OF TOP OF FIRST STAGE OF LYSIMETER FRAMEWORK

15/18 LYSIMETER FORMWORK - SECOND STAGE OF LYSIMETER CONSTRUCTION

NOT TO SCALE

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CLIENT REFERENCE NO.		

ENERGY FUELS

PROJECT LOCATION: BLANDING, UTAH

PROJECT: WHITE MESA MILL TAILINGS CELL 2 RECLAMATION

TITLE: TEST SECTION DETAILS (SHEET 3 OF 3)

MWH

SHEET: CELL 2 - 18 REVISION: A

FILE NAME: TEST SECTION DETAILS DATE: AUG 2016

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ATTACHMENT L.2

COVER TEST SECTION INSTALLATION INSTRUCTIONS

1.0 INTRODUCTION

This document describes the installation procedures for the test section to be constructed to assess the performance of the White Mesa reclamation cover for the tailings cells. These procedures and the design of the cover performance monitoring section are adopted from the installation instructions for the test sections used in the Alternative Cover Assessment Program (ACAP) (Benson et al., 1999). The procedures incorporate the performance monitoring recommendations provided in NUREG/CR-7028 (Benson et al., 2011) and site-specific recommendations provided by Dr. Craig H. Benson.

The test section is to be located in the southeast corner of Cell 2, as shown in the Drawings (Attachment L.1). The test section will be 100 ft x 100 ft, with a 32 ft x 64 ft lysimeter centered within the test section. The longer side of the lysimeter will be oriented parallel to the cover slope. Design dimensions for the lysimeter and test section are shown in the Drawings. The lysimeter will collect percolation from the base of the cover, surface runoff, and interflow from the textural interface between the interim fill (Layer 1) and compacted cover (Layer 2). Sensors monitor hydrologic state variables (temperature and water content) within the cover. Percolation rate, lateral drainage, runoff, internal state conditions, and meteorological data are recorded continuously using a datalogger located near the southern edge of the test section.

The following sections describe each of the major steps required to install the test section.

2.0 SUBGRADE PREPARATION AND FORMWORK INSTALLATION

The subgrade for the lysimeter should consist of well-compacted interim cover at least 6 inches thick with no particle protruding from the surface more than 0.5 inches. Ridges, depressions, equipment tracks, or other variations in the subgrade surface should not exceed 0.5 inches. If such variations exist, they should be smoothed and subsequently compacted by hand to the satisfaction of the Resident Engineer (RE). The surface grade of the subgrade must be set so that all water in the lysimeter drains to the sump.

The entire surface should be proof-rolled with a smooth drum compactor to the satisfaction of the RE. Soft or otherwise inferior materials should be over-excavated and replaced with new materials. The final surface of the subgrade must be approved by the RE before placement of overlying cover soils or geosynthetics.

Formwork will be used to retain the lysimeter side walls during construction (see Drawings). The formwork will be constructed in two stages, both 4 ft in height, from 0.50-in plywood (4 ft x 8 ft panels) stiffened with 2x4 lumber around the perimeter. The second stage of formwork will be installed when the cover is within 12 in of the top of the first stage of the lysimeter construction.

A 2x4 stiffener will be installed vertically at the center of each panel. The 2x4 stiffeners will be attached to the formwork for each stage using 2-inch deck screws on 6-inch centers. The formwork will be anchored to the subgrade using at least two formwork stakes extending at least 1.5 ft through 0.6-in holes drilled in the bottom 2x4 stiffeners at the quarter points. Braces comprised of 2x4 lumber will be placed on 8-ft centers and anchored with formwork stakes for each stage. Formwork panels will be joined together at each end with 3-inch deck screws that fasten adjacent 2x4 stiffeners. The upper and lower panels will be bolted together as shown in the Drawings.

Sixteen formwork panels are required for each side wall and eight formwork panels are required for each end wall to create a lysimeter 64 ft long and 32 feet wide. The 4 ft x 8 ft panels will be used to create 8 ft of the 9.5-ft-high side walls and end walls. The upper 1.5 ft of the lysimeter will be constructed without formwork. The lower end wall and both side walls will be installed at the start of construction and before soil placement begins. The upper end wall will be installed after the soil and geosynthetic layers have been placed in the lysimeter. All walls are to be installed vertically (end walls are not perpendicular to the slope).

3.0 LYSIMETER SUMP

3.1 Sump Drainage Pipe

The sump at the base of the lysimeter (see Drawings) will be drained by 2-inch Schedule 40 polyvinyl chloride (PVC) pipe. The pipe will be installed in a narrow trench in the subgrade and extend from the lowest point in the sump to the collection basin. The pipe will be bedded in clean dense sand at least 3-inches thick beneath the pipe and 6-inches thick above the pipe. The sand is to be compacted with a vibratory plate compactor before placing the pipe and after the pipe trench is backfilled. The pipe slope must be maintained at least 1 percent away from the sump. All PVC pipe joints are to be solvent welded following instructions provided by the pipe manufacturer. The upper surface of the pipe riser will be temporarily sealed with duct tape or other material to prevent entry of soil or other materials during construction.

3.2 Sump

The sump boot is to be installed on a section of 2-inch Schedule 40 PVC pipe as illustrated by the detail in Figure 1 and shown in the Drawings. Liberally smear silicone caulk (GE Silicon II or equivalent) between the boot and the pipe, and then clamp the boot to the pipe using stainless steel hose clamps. Fill the groove on the surface between the riser pipe and boot with caulk. Remove any excess caulk from the surface of the boot and allow the caulk to cure for at least 120 minutes.

A flexible rubber coupling will be used to join the 2-inch Schedule 40 PVC pipe in the trench to the 2-inch Schedule 40 PVC riser that will emanate from the subgrade (see Drawings and Figure 1). This coupling will provide flexibility within the boot as the lysimeter is constructed. Adjust the elevation of the riser pipe so that the geomembrane rests flush against the subgrade, and tighten the stainless steel clamps on the pipe coupler with wrenches. A gap of approximately 0.75 inches will exist between the pipe ends within the coupler to ensure sufficient flexibility in the sump coupling.

Backfill any open area surrounding the riser pipe with subgrade soil and form a firm surface for the geomembrane. Place a small section of geosynthetic clay liner (GCL) on the subgrade and over the pipe before installing the sump and add a thin fillet of granular bentonite (CETCO CG-50 or equivalent) around the perimeter of the pipe. Check the surface grade of the subgrade to ensure all water will flow into the sump. A completed sump installation is shown in Figure 2.

4.0 DEPLOY GEOMEMBRANE

Linear low density polyethylene (LLDPE) geomembrane textured on both sides will be used to line the lysimeter. The geomembrane will be at least 1.5 mm (60 mil) thick. High-density polyethylene (HDPE), polypropylene, or PVC geomembrane will not be used. The geomembrane used for the base of the lysimeter will also be used for the end walls and the side walls. To ensure sufficient geomembrane for the end walls, cut the geomembrane at least 12 ft (or more, as needed) longer than needed to cover the length of the base of the lysimeter (Figure 3) for the first stage construction. For the second stage of construction, the upper section of geomembrane will be welded to the lower geomembrane as shown in the Drawings.

Weld geomembranes panels in accordance with the manufacturer's recommendations using a dual-track hot-wedge or extrusion welding technique. Check the welds for leaks using air pressure per ASTM D 5820 (ASTM, 2011b) or a vacuum box. Inspect the entire area of the geomembrane for defects. Repair any leaks or defects in accordance with the manufacturer's recommendations and to the satisfaction of the RE. The RE, along with the geosynthetic installer, can adjust these procedures as needed.

After the geomembrane has been placed, locate the sump and carefully cut a hole (<6 in) in the geomembrane so the sump is visible. Extrusion-weld the boot to the geomembrane (Figure 4) and check the weld using a vacuum box per ASTM D 5641 (ASTM, 2011a) or a spark test per ASTM D 6365 (ASTM, 2011c). Identify and repair any leaks identified until the criteria in ASTM D 5641 (ASTM, 2011a) are met and to the satisfaction of the RE. Cover the pipe opening in the sump with a non-woven geotextile to prevent entry of debris.

Extend the geomembrane up and over the edge of the formwork extending around the periphery of the lysimeter. Secure the geomembrane to the upper edge of the formwork using deck screws installed 6 inches on center. Use a small block of 2x4 lumber or similar material to provide stress distribution between the screw head and the geomembrane. The geomembrane will be held in place temporarily at the top of the formwork for both stages shown in the Drawings. Weld the panels of the geomembrane near the corners of the formwork as shown in Figure 5 and the Drawings.

5.0 DEPLOY GEOCOMPOSITE DRAIN

Geocomposite drainage layer (GDL) will be used for collecting percolation from the cover soils and directing the percolation to the sump. The geocomposite drainage layer should have non-woven polypropylene or polyethylene geotextiles on both sides that are heat-bonded to a polyethylene geonet in the interior. The geotextiles should have a mass per unit area of at least 16 oz/yd^2.

A rubsheet consisting of 4 mil smooth polyethylene will be used to facilitate installation of the geocomposite drain. Unroll the rubsheet adjacent to the side wall on one side of the lysimeter. Lightly anchor the rubsheet with soil, sand bags, or other materials along the periphery. Move a roll of GDL to the top of the lysimeter by hand or using a loader equipped with a gantry bar or similar equipment, and unroll the GDL onto the rubsheet. Adjust the position of the GDL to conform to the base of the lysimeter, and then retrieve the rubsheet. Deploy another panel of GDL along the side wall using the same technique and then complete the installation with a panel deployed along the centerline of the lysimeter. Join the panels following the manufacturer's recommendations and heat bond the flaps along the edge to prevent debris from entering the GDL. Figure 6 shows an example of a fully deployed GDL.

Installation of the geomembrane and GDL must be completed within one day. By the end of this day, the sump area should surcharged with a load of soil (approximately 1 cy) placed directly on top of the GDL in the sump area. This surcharge ensures that the sump remains in firm contact with subgrade while other construction activities are taking place. This **surcharge must be placed before the end of the work day**, as cooling of the geomembrane overnight can impose stresses in the sump area sufficient to catastrophically damage the sump.

6.0 PLACEMENT OF INTERIM COVER SOIL AND ROOT BARRIER

6.1 Interim Cover Soil

The interim cover soil (Layer 1) will be the first soil layer placed on top of the GDL. The interim cover soil should be deployed as a working platform so that the construction equipment does not contact the geosynthetics or displace the geosynthetics. The interim cover soil will be 2.5 ft thick and placed using methods expected for full-scale construction (except low pressure equipment should be used). Extreme caution must be used when placing the interim cover so that large particles do not damage the lysimeter geosynthetics. Any particles larger than 3 inches should be removed from the lower layer of interim cover prior to construction traffic on the interim cover.

Compact soil on both sides of the side wall geomembrane with a motorized hand tamper (jumping jack) to ensure a tight interface between the soil and geomembrane. Compact the remaining interim cover soil using low ground pressure equipment to the conditions stipulated per the Technical Specifications. After compaction, place a fillet of granular bentonite (1 lb/ft of CETCO CG-50 or equivalent) around the periphery of the interior of the lysimeter to promote sealing between the side wall geomembrane and interim cover soil.

Soil placement will occur through the upper end of the lysimeter and will extend at least 10 ft upslope from the upper end wall when the first stage of the lysimeter is constructed. Before placing the soil, 0.75-inch plywood panels should be placed over the geomembrane extending upward from the end of the lysimeter (Figure 7). This section of geomembrane will be folded up to create the upper end wall after the soil and geosynthetic layers have been placed in the lysimeter. The plywood panels will protect the geomembrane for the end wall from damage due to construction traffic.

6.2 Root Barrier Layer

Place the root barrier layer (Reemay Biobarrier or equivalent) directly on top of the interim cover following the manufacturer's instructions. Ensure that the polyethylene nodules are oriented upward and that contact does not exist between the root barrier and the GDL or bottom geomembrane in the lysimeter.

7.0 PLACEMENT OF FINAL COVER SOILS AND COVER GEOSYNTHETICS

Place the final cover soils following methods described in the Technical Specifications (Attachment A to Reclamation Plan, Revision 5.1) both inside and outside the lysimeter in the areas shown in the Drawings. The thickness of each lift should be verified using surveys of the bottom and top of each lift and should meet the criteria in the Technical Specifications.

Place cover soils around the inside and outside edges of the lysimeter directly adjacent to the side wall geomembrane. Compact soil on both sides of the side wall with a motorized hand tamper (jumping jack) to ensure a tight interface between the soil and geomembrane. After compaction, place a fillet of granular bentonite (1 lb/ft of CETCO CG-50 or equivalent) around the periphery of the interior of the lysimeter to promote sealing between the side wall geomembrane and cover soil.

Grade the upper surface of the uppermost layer of cover soil so surface water will flow to the surface runoff sump located at along the centerline of the test section and above the percolation sump (see Section 9).

8.0 INTERFLOW COLLECTION

Interflow is to be collected at the contact between the interim fill (Layer 1) and compacted cover (Layer 2). Liquid is to be collected along the lower end wall of the lysimeter using a sump and routed to a collection basin. Schematics of the sump to be used are shown in the Drawings. The interflow sump is to be located at the centerline of the lower end wall. Sump is to be placed with a 2 percent increase in slope within 2 ft of the end wall to promote flow to the slump. The cross-slope along the end wall should be at 1 percent towards the sump.

A 2-ft long capture strip of GDL will extend across the breadth of the lower end wall and will be buried 2 inches below the surface of the interim cover layer adjacent to the end wall as shown in the Drawings. The depth of embedment of the GDL in the interim cover will taper to zero at the upslope end of the GDL capture strip. A 6-inch tall strip of GDL will also to be placed in direct contact with the end wall extending from the GDL buried in the interim cover and into the compacted cover layer. The GDL strip placed in direct contact with the end wall will capture flow at the interface of the layers at the end wall. The buried GDL strip and the GDL strip in contact with the end wall can also be installed as one contiguous material along with a sharp bend at the end wall.

Drainage will occur through a 2-inch Schedule 40 PVC pipe using a boot as shown in the Drawings. Field fitting of the sump details may be required and is acceptable. Any field fit must be approved by the RE.

9.0 SURFACE RUNOFF COLLECTION

9.1 Diversion Berms

Construct berms for surface runoff collection having the geometry shown in Drawings along the periphery of the lysimeter. Compact the berm with a hand tamper and/or with construction equipment until the soil is firm. Slope the interior swale along the bottom berm towards the center of the lysimeter to ensure surface water flows to the collection point near the centerline of the test section.

9.2 Collection Point

Surface runoff will be collected in an 18-inch strip drain located along the centerline of the test section and adjacent to the bottom diversion berm as shown in the Drawings. A 2-inch Schedule 40 PVC pipe will be used direct flow from the strip drain to the collection basins. Adapters may be needed between the strip drain and the PVC pipe, as indicated in the manufacturer’s instructions. Bed the PVC pipe in sand and use a plug of bentonite to ensure that surface runoff cannot seep into the pipe trench.

Grade the interior berm to ensure water drains into the strip drain. Cover the entry grate of the strip drain with a strip of non-woven geotextile sourced from the roll of GDL. Anchor the GDL strip with spikes or rip rap cobbles.

10.0 FLOW COLLECTION AND METERING SYSTEM

10.1 Collection Basin Vault

Collection basins for surface runoff, interflow, and percolation are to be installed in a concrete vault located downslope of the lysimeter as shown in the Drawings. The location should be field fit to ensure that all drainage pipes emanating from the lysimeter maintain a slope of at least 1 percent. The slope on the percolation pipe should control the location and elevation of the base of the vault. Install vault following the manufacturer's instructions. Ensure vault is covered with at least 1.5 ft of soil at the shallowest location (up to 3 ft is acceptable at the shallowest location).

10.2 Collection Basins and Piping

Install three collection basins each with a flout (Orenco Model PBF-C) to collect and meter flow from the surface runoff, interflow, and percolation pipes. Install the basins following the manufacturer's instructions. In each basin, install a pressure transducer (Campbell Scientific CS450-L60), float switch (Orenco FS-48), and tipping bucket (Hydrological Services America TB1L or TB1L/70) as described in Benson et al. (1999, 2001).

Route piping for runoff, interflow, and percolation through knock-outs near the surface of vault and field fit piping to reach each collection basin. After installation, seal each pipe and knock-out with polyurethane foam.

Route effluent pipes from the basins through knockouts at the base of the vault. Bury the drainage pipes in vertical French drains at least 2 ft x 2 ft in surface area and 4 ft deep that are backfilled with coarse rock. Cover the surface of the coarse rock with a section of GDL after installation of the piping to prevent ingress of fines from overlying materials. Seal the pipe and knock-out with polyurethane foam. Install a floor drain with a trap that flows to a French drain beneath the vault. Seal the annulus in the floor drain with polyurethane foam.

Calibrate each basin by measuring the volume of water required to initiate discharge by the flout. Mark the elevation at which discharge begins. Repeat this procedure two more times to check the calibration. If the calibration or flush elevation deviates significantly, find the source of the problem, correct it, and re-calibrate the dosing siphon. Calibrate the tipping bucket and the pressure transducer following the manufacturer's instructions and Benson et al. (1999).

11.0 SOIL AND METEOROLOGICAL SENSORS

11.1 Soil State Variables

Water content reflectometers (WCRs, Campbell Scientific CS616) and thermocouples (TCs, Omega Type T) are to be installed in two nests located at the quarter points along the centerline of the test section as shown in the Drawings. A WCR and TC are to be placed at each of the depths shown and should be installed immediately after the lift corresponding to the sensor elevation has been placed. Press the WCR horizontally (or at the angle of the slope) into the cover soil by hand following the manufacturer's instructions. Tape the end of the TC to the head of the WCR using duct tape. Route the sensor cables in 1-inch PVC conduit along the surface of the most recent lift to a vertical riser for all sensor cables (Figure 8).

11.2 Weather Station

Install the weather station tripod and grounding rod for the weather station following the manufacturer's instructions adjacent to the test section. Bolt the data acquisition cabinets to the tripod and install the pyranometer, temperature and humidity sensor, and wind sentry on the tripod following the manufacturer's recommendations. Wire all sensors, including those installed in the test section, following the manufacturer’s instructions. Install the precipitation gage (Geonor T-200B) following the manufacturer’s instructions. Install cabling in conduit between the weather station, precipitation gage, and sensors. Seal all open ends of conduit with polyurethane foam.

12.0 VEGETATION

Prepare and seed the surface of the test section following the procedure adopted for reclamation at White Mesa and outlined in Appendix D of the Updated Tailings Cover Design Report. Employ the same procedures that will be used for the remainder of the cover. If the surface layer is disturbed during seeding, use care to avoid damaging any of the sensors or cables near the surface.

13.0 REFERENCES

ASTM International, 2011a. ASTM D5641-94, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.

ASTM International, 2011b. ASTM D5820-95, Standard Practice for Pressurized Air channel Evaluation of Dual Seamed Geomembranes.

ASTM International, 2011c. ASTM D6365-99, Standard Practice for the Nondestructive Testing of Geomembrane Seams using the Spark Test.

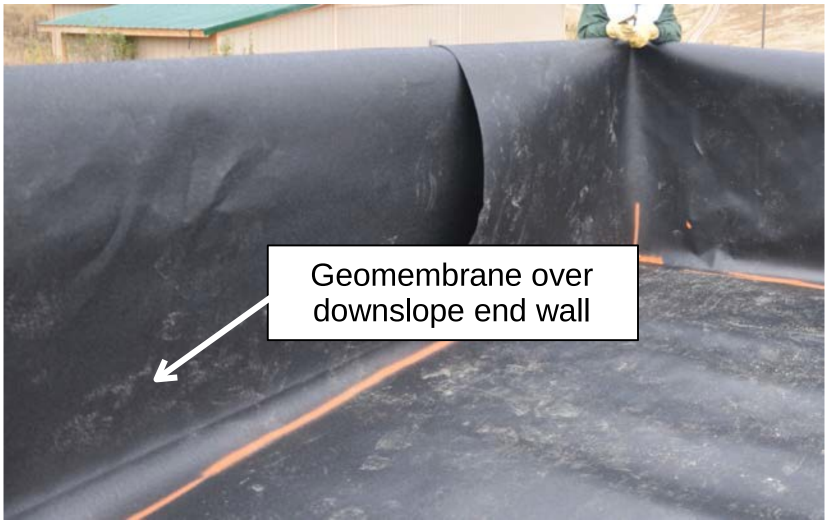
Benson, C., Abichou, T., Albright, W., Gee, G., and Roesler, A. (2001), Field Evaluation of Alternative Earthen Final Covers, *International J. Phytoremediation*, 3(1), 1-21.

Benson, C., Abichou, T., Wang, X., Gee, G., and Albright, W. (1999), Test Section Installation Instructions – Alternative Cover Assessment Program, Geotechnics Report 99-3, Geological Engineering, University of Wisconsin-Madison.

FIGURES

Figure 1. Rubber coupling used to ensure flexibility of boot for sump (Photo courtesy of Dr. Craig H. Benson)

Figure 2. Sump installed on subgrade with duct tape sealing pipe opening and panel of GCL directly beneath sump.
(Photo courtesy of Dr. Craig H. Benson)



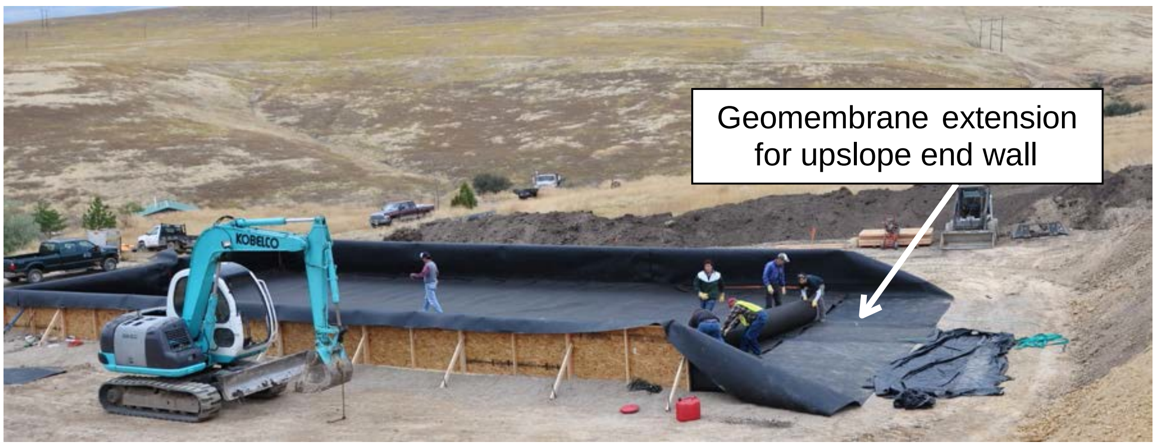


Figure 3. Geomembrane extending over downslope end wall (upper) and deployed out the upslope end of lysimeter for upper end wall (lower).
(Photos courtesy of Dr. Craig H. Benson)

Figure 4. Welding geomembrane on base of lysimeter to percolation sump (upper left), completed weld and visible pipe for percolation (upper right), and non-woven geotextile secured over sump to prevent entry of debris into pipe (bottom).

(Photos courtesy of Dr. Craig H. Benson)

Figure 5. Example of folding of geomembrane sheet for corner welds. (Photo courtesy of Dr. Craig H. Benson)

Figure 6. GDL being deployed on geomembrane (upper) and GDL fully deployed with heat- bonded overlap (lower).

(Photos courtesy of Dr. Craig H. Benson)

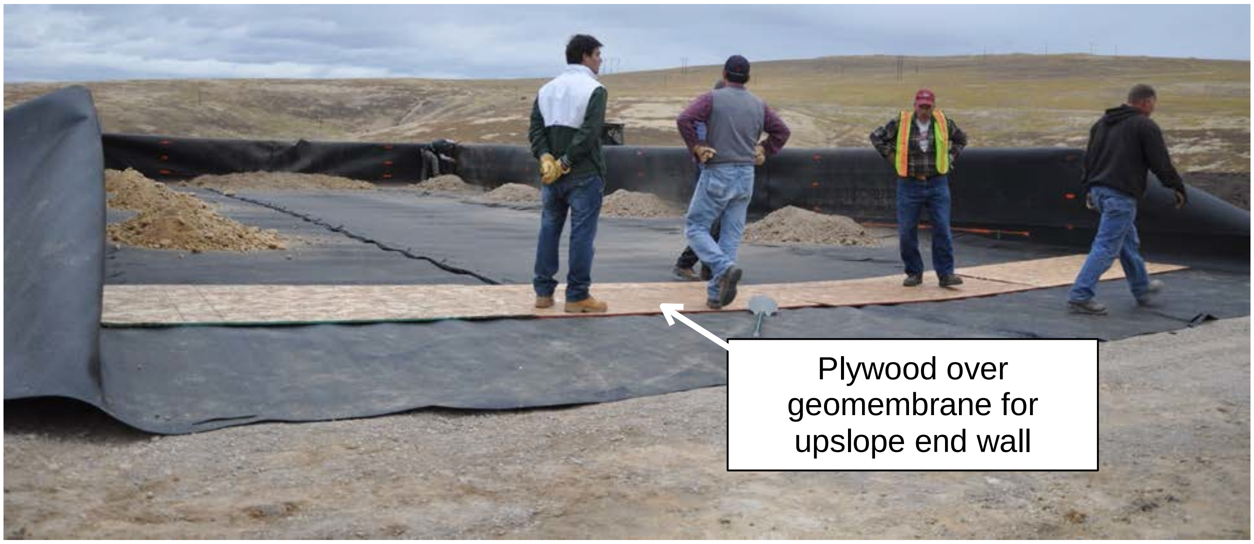


Figure 7. Plywood deployed over geomembrane at upper end of test section to prevent damage from equipment traffic.

(Photo courtesy of Dr. Craig H. Benson)

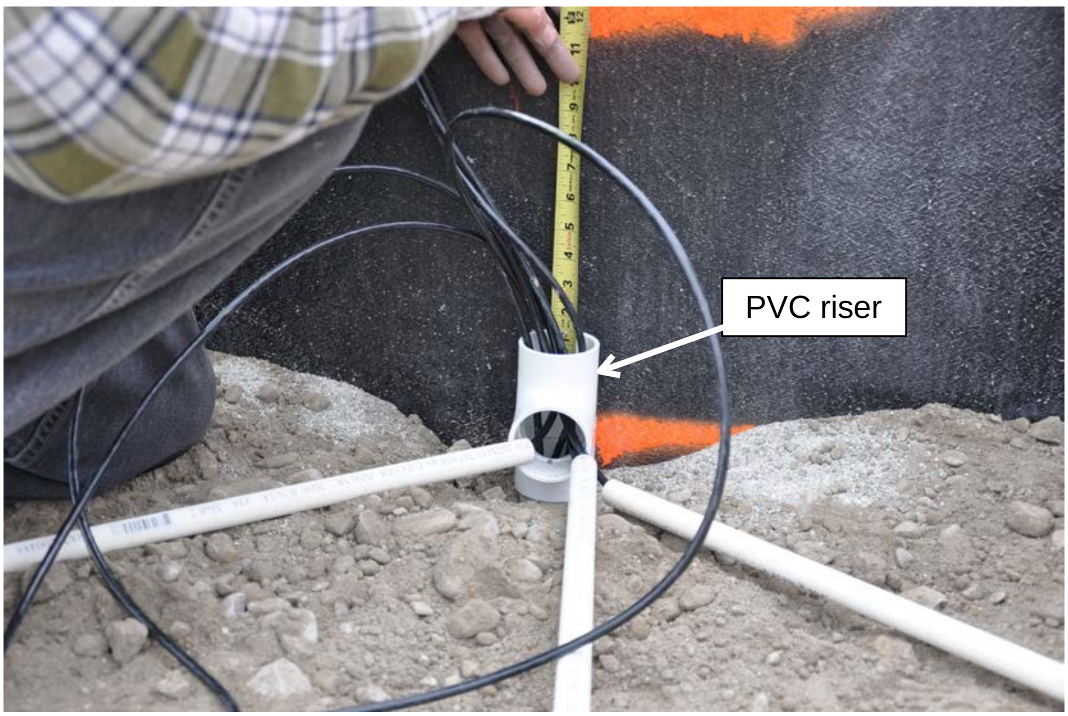


Figure 8. PVC conduit for sensor cables from specific elevation (upper) and vertical riser for all cables (lower).
(Photos courtesy of Dr. Craig H. Benson)

Energy Fuels Resources (USA) Inc.

WHITE MESA MILL

Preliminary Mill Decommissioning Plan

August 2016

MWH®

BUILDING A BETTER WORLD

3665 JFK Parkway
Suite 206
Fort Collins, CO USA

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LIST OF FIGURES

1.0 SPECIAL PROVISIONS

1.1 Scope of Document

This document outlines the preliminary plans for decommissioning the Energy Fuels Resources (USA) Inc. (EFRI) White Mesa Uranium Mill (Mill) site near Blanding, Utah. These plans are consistent with the previous decommissioning information provided in the 2011 Reclamation Plan, Revision 5.0 (Denison, 2011) with a few revisions. This report has been updated to incorporate information provided in EFRI response to interrogatories and review comments from Utah Department of Environmental Quality (UDEQ), Division of Waste Management and Radiation Control (DWMRC) on Reclamation Plan, Revision 5.0 (Denison, 2012; EFRI, 2012; EFRI, 2015). EFRI (2015b). This plan has been prepared by MWH Americas, Inc. (MWH) for EFRI for review and approval by the DWMRC. A final decommissioning plan will be submitted to the Utah DRC for approval within twelve months prior to commencement of decommissioning activities.

1.2 Definitions

Sections referred to in this document are specific sections of the Preliminary Mill Decommissioning Plan, referred to as the Plan. The Drawings referred to in this document are drawings provided in Attachment A to the Reclamation Plan, Revision 5.1 that form a necessary component of this Plan.

For this Plan, EFRI is referred to as the Owner, with overall responsibility for site reclamation and decommissioning. For consistency, EFRI is used throughout this document.

The Contractor is defined as the group (or groups) selected by EFRI and responsible for conducting the work tasks outlined in Section 1.4 under the direction of and under contract with EFRI.

The Reclamation Project manager is defined as the person appointed by EFRI responsible for ensuring that preparatory work, demolition, material placement, and reclamation site activities, are conducted according to this Plan.

The Radiation Safety Officer (RSO) is defined as the person appointed by EFRI responsible for worker safety and personnel monitoring. The RSO will be responsible for personnel safety training, personnel monitoring, and documentation. These tasks will be conducted in accordance with the EFRI Radiation Protection Manual for Reclamation Activities (EFRI, 2015b).

1.3 Decommissioning Goals and Implementation Strategy

The project goals for mill decommissioning are outlined below.

1. Attain an as low as reasonably achievable (ALARA) dose outcome for:
   a. workers doing the decommissioning,
   b. other on-site personnel, and
   c. off-site individuals.
2. Optimize the effectiveness of the mill decommissioning plan.
3. Complete decommissioning as soon as practical.

The implementation strategy to achieve the goals for mill decommissioning is listed below.

1. Utilize commercially available demolition equipment to minimize exposures by: (i) minimizing time of demolition and (ii) keeping personnel from close proximity to actual demolition activities.
2. Plan the components and establish a work system for these components.
3. Train the work force.
4. Follow the work plan.
5. Evaluate the work plan through project oversight and quality assurance.
6. Modify and continuously improve the work plan.

1.4 Scope of Work

The work outlined in this Plan consists of execution of the following major tasks associated with facility decommissioning.

1. Setup of health and safety procedures for safety equipment, personnel protective equipment, personnel monitoring, and personnel exit screening.
2. Execution of pre-decommissioning activities, such as establishing permanent utility shutoff, material haulage routes, and equipment screening areas.
3. Demolition of above-ground facilities in the process area.
4. Demolition of below-ground facilities in the process area (foundations, paved areas, concrete pads, roadways, and underground utilities) and placement of these materials in the last active tailings cell or the Cell 1 Disposal Area.
5. Excavation of contaminated subsoils from the process area and placement in the last active tailings cell or the Cell 1 Disposal Area.
6. Clean-up of windblown contamination and placement in the last active tailings cell or the Cell 1 Disposal Area.
7. Regrading and revegetation.

This Plan describes these elements as well as the requirements prior to demolition and the procedures to be used for specific areas of the process area. The facilities described in this Plan are shown in Figures 1 and 2.

2.0 GENERAL REQUIREMENTS AND PROCEDURES

2.1 General

This section outlines the general requirements and procedures to be used during mill decommissioning.

2.2 Applicable Regulations and Standards

The work shall conform to applicable Federal, State, and County environmental and safety regulations. The work shall conform to applicable conditions in the Radioactive Materials License with the Utah DRC. Safety practices, procedures, and monitoring shall be conducted as specified by the Mine Safety and Health Administration (MSHA) and the current EFRI health and safety procedures in place.

2.3 Health and Safety Requirements

Work outlined in this Plan shall be conducted under the EFRI Radiation Protection Manual for Reclamation Activities (EFRI, 2015b), as directed by the RSO. The RSO (and approved assistants as needed) shall conduct full-time, on-site training, personnel monitoring, and inspection of construction activities while the site decommissioning work is in progress. The responsibilities and duties of the RSO for site reclamation and decommissioning shall be as outlined in the EFRI Radiation Protection Manual for Reclamation Activities (EFRI, 2015b).

The Contractor shall suspend construction or demolition operations, or implement necessary precautions whenever (in the opinion of the Reclamation Project Manager or RSO), unsatisfactory conditions exist due to rain, snow, wind, cold temperatures, excessive water, or unacceptable traction or bearing capacity conditions. The Reclamation Project Manager and RSO each have the authority to stop Contractor work if unsafe conditions or deviations from the Plan are observed.

Process area demolition work will be conducted in accordance with the EFRI Radiation Protection Manual for Reclamation Activities (EFRI, 2015b), as directed by the RSO. Due to the different work activities and potential hazards involved with process area demolition, more specific procedures will be utilized for demolition work (documented as special operating procedures or work permits). These procedures will define personal protective equipment and personnel monitoring (as necessary), regular safety meetings, and communication.

Records pertinent to decommissioning procedures for protection of health and safety will be stored on-site at the Safety Office during decommissioning. After decommissioning activities are complete and prior to the site being turned over to the Department of Energy (DOE), pertinent records will be stored on-site in a temporary storage facility or at the EFRI office in Lakewood, Colorado.

2.4 Environmental Requirements

2.4.1 Contractor Activities

The Contractor shall store materials, confine equipment, and maintain construction operations according to applicable law as, ordinances, or permits for the project site. Fuel, lubricating oils, and chemicals shall be stored and dispensed in such a manner as to prevent or contain spills and prevent said liquids from reaching local streams or ground water. If quantities of fuel, lubricating oils or chemicals exceed the threshold quantities specified in the Utah regulations, the Contractor shall prepare and follow a Spill Prevention Control and Countermeasures Plan (SPCCP) as prescribed in applicable Utah regulations. EFRI shall approve said plan. Used lubricating oils shall be disposed of or recycled at an appropriate facility.

2.4.2 Environmental Monitoring

Existing environmental monitoring programs will continue during the time period in which reclamation and decommissioning is conducted as applicable. This includes monitoring of surface and groundwater, airborne particulates, radon, soils and vegetation, according to the existing License conditions as applicable. As site features are reclaimed, monitoring programs for those features may cease. Any changes will be approved by DWMRC prior to the cessation of monitoring. In general, no changes to the extent of the existing programs are expected because reclamation activities are not expected to increase exposure potential beyond the current levels.

2.5 Medical Emergency Procedures

The following procedures will be used when medical services are required, based on two priority levels.

2.5.1 Level One Priority

For a minor emergency requiring medical treatment (level one priority), the procedures listed below will be followed.

1. The specific work crew will suspend activities.
2. A member of the work crew will assist the victim and perform first aid.
3. If available, other crew members will contact EFRI personnel or the EFRI Safety Coordinator and emergency services personnel.
4. EFRI radiation safety personnel will perform a contamination survey on victim and decontaminate as appropriate.
5. After medical services have been provided, EFRI radiation safety personnel will perform a contamination survey on emergency personnel and equipment.
6. Contaminated equipment or clothing will be retained for evaluation and decontamination.

2.5.2 Level Two Priority

For a major emergency requiring medical treatment (level two priority), the procedures listed below will be followed.

1. The specific work crew will suspend activities.
2. If injuries are life threatening, emergency services will be performed immediately and the victim transported to the nearest emergency medical facility.
3. Surveys for decontamination will be performed after medical services have been provided. The survey will also be performed on emergency personnel and equipment for alpha contamination.
4. Contaminated equipment or clothing will be retained for evaluation and decontamination.
5. Follow other steps as listed for Level One as appropriate.

2.6 Water and Contaminant Management

Management of water and site contaminants is outlined below.

2.6.1 Runon/Runoff Control

Procedures for control of runon and runoff of meteoric water and containment of other liquids are outlined below. In addition to the procedures listed below, runon and runoff controls will also follow the most current revision of the Stormwater Best Management Practices Plan (.

1. Water usage for outdoor dust suppression will be controlled to minimize runoff.

2. Runoff generated from decommissioning operations will be contained on concrete or asphalt pads or in building sumps.
3. Runon diversion berms will be installed up slope of the facility, if and as necessary, to minimize storm runon into the decommissioning work area.
4. Runoff retention berms will be installed down slope of the facility, if and as necessary, to minimize runoff of decontamination liquids and sediment. The liquids contained will be pumped to a collection sump for removal and be transferred to appropriate receiving ponds.
5. The control berms will be inspected periodically, and modified or extended during decommissioning operations, as needed.
6. In addition to berms, the existing runoff control devices and others, such as silt fences, may be utilized, if and as necessary.
7. The Contractor shall construct and maintain all temporary diversion and protective works required to divert stormwater from around work areas. The Contractor shall furnish, install, maintain, and operate all equipment required to keep excavations and other work areas free from water in order to construct the facilities as specified.
8. Water required by the Contractor for dust suppression or soil moisture conditioning shall be obtained from wells or surface water storage areas identified by EFRI.

2.6.2 Residue Management

Procedures for control of residues are outlined below.

1. Water usage for dust suppression and decontamination washing will be required during decommissioning operations. Water required by the Contractor for dust suppression or soil moisture conditioning shall be obtained from wells or surface water storage areas identified by EFRI.
2. Liquids identified during these activities will be contained in the building sumps, area tanks or on concrete or asphalt pads.
3. The liquid, sediment, and solids collected will either be reused or transported to the last active tailings cell or the Cell 1 Disposal Area, or treated for permitted discharge.

2.6.3 Contamination Control

Every effort will be made to prevent or minimize the spread of contamination during the decommissioning operations. Procedures for control of contaminants are outlined below.

1. Personnel, vehicles, and testing equipment shall be surveyed for contamination prior to leaving the restricted area of the facility.
2. All workers involved in decommissioning operations shall be surveyed for contamination at the exit screening station and will shower if necessary prior to leaving the facility. As far as practical, the specific limits will be stated in each section of this Plan, as determined during the area evaluation.
3. Work area access will be restricted to only authorized personnel during demolition operations. Access will be restricted during active operations and at the disposal cell. Signs and /or barrier tape will be used to post areas where access is restricted.

2.6.4 Dust Control

Dust generation will be minimized during all preparation, salvage and demolition activities. Procedures for control of dust are outlined below.

1. During demolition and removal operations, the equipment and structure surfaces will be sprayed with water to prevent dust generation.
2. A chemical fixant may be applied to surfaces prone to dust generation.
3. The use of HEPA vacuuming equipment may be utilized.
4. Equipment shall be used in an efficient manner to avoid dust generation.
5. Haul roads, loading, off-loading, material evaluation and disposal areas will be sprayed with water periodically to control dust generation.
6. Water required by the Contractor for dust suppression or soil moisture conditioning shall be obtained from wells or surface water storage areas identified by EFRI.

2.6.5 Historical and Archaeological Considerations

The Contractor shall immediately notify EFRI if materials are discovered or uncovered that are of potential historical or archeological significance. EFRI may stop work in a specific area until the materials can be evaluated for historical, cultural, or archeological significance. All materials determined to be of significances shall be protected as determined by appropriate regulatory agencies, including removal or adjustment of work areas.

3.0 SITE REQUIREMENTS AND PROCEDURES

3.1 General

This section outlines the site-specific requirements and procedures to be used during decommissioning.

3.2 Site Location

The EFRI Mill site is located six miles south of Blanding, Utah on U.S. Highway 191 on a parcel of land encompassing all or part of Sections 21, 22, 27, 28, 29, 32, and 33 of T37S, R22E, and Sections 4, 5, 6, 8, 9, and 16 of T38S, R22E, Salt Lake Base and Meridian. The location description is provided in more detail in Section 3.1 of the Reclamation Plan, Revision 5.1. The site encompasses approximately 5,415 acres. The EFRI facilities are primarily located within the approximately 686-acre restricted area.

3.3 Climate and Soil Conditions

The climate in the vicinity of the Mill can be considered as semi-arid. Average annual precipitation is 13.32 inches. Average annual evaporation is approximately 68 inches for Class A Pan data (EFRI, 2016)

The Mill is located within the Blanding Basin of the Colorado Plateau physiographic province. The site is underlain by unconsolidated alluvium and indurated sedimentary rocks consisting primarily of sandstone and shale. The alluvial materials consist mostly of aeolian silts and fin-grained aeolian sands with thicknesses ranging from a few feet up to 30 feet. The alluvium is underlain by Mancos Shale (thickness of less than 5 feet), Dakota Sandstone (thickness of approximately 60 feet) and the Burro Canyon Formation (sandstone with thickness of approximately 100 feet).

3.4 Site Layout and Facilities

A general layout of the Mill area is shown in Figure 2.

3.4.1 Operation History

The Mill was developed in the 1970s by Energy Fuels Nuclear, Inc. (EFN) and started operations on May 6, 1980. The Mill processed conventional ores for approximately two and one-half years before ceasing operations in February 1983. Union Carbide Corporation's (UCC) Metals Division obtained a majority ownership interest in 1984. UCC's Metals Division later became Umetco Minerals Corporation (Umetco), a wholly owned subsidiary of UCC. Umetco became the Mill operator starting in 1984. The Mill did not operate in 1984. The Mill processed conventional ores for part of each year from October 1985 through December 1987 and from July 1988 through November 1990. Mill operations ceased again from 1991 through 1994. EFN reacquired sole ownership on May 26, 1994 and processed conventional ores from August 1995 through January 1996. EFN processed alternate feed material (calcium fluoride) from May 1996 through September 1996. Denison (then named International Uranium (USA) Corporation) and its affiliates acquired the Mill in May 1997 and processed alternate feed from various sources from 1997 through early 1999, and processed conventional ore from the middle of 1999 through early 2000. Denison processed alternate feed materials from government cleanup projects in 2002 and 2003, and processed other alternate feed materials in 2007. Denison processed uranium and vanadium ores from April 2008 through May 2009. Mill operations for conventional ore processing were suspended in May 2009 and resumed in March 2010. Conventional ore processing was again suspended in July 2011, resumed in November 2011 through March 2012, and suspended in April 2012. Denison became EFRI after July 25, 2012. Conventional ore processing resumed in August 2012 through June 2013, was suspended in July 2013, resumed in May 2014 through August 2014, and was suspended again in September 2014. Alternate feed materials were still processed during the time periods of suspended conventional ore processing operations.

From the early 1990s through today, the Mill has processed alternate feed materials when the Mill is not processing conventional ores. An alternate feed circuit was added to the Mill in June 2009 to allow for processing alternate feed materials at the same time as conventional ores.

3.4.2 Access and Security

The access and security at the Mill site during decommissioning will follow the most current revision of the Mill's Security Program. Access control will be maintained at the Restricted Area boundary to ensure employees and equipment are released from the site in accordance with the current License conditions. The Restricted Area is enclosed by a combination of barbed wire and chain link fencing. The access gates are padlocked and controlled by EFRI personnel. EFRI personnel are on-site 24-hours a day, regardless if the mill is in operation. Contractors must have required training before entering the restricted area.

3.4.3 Utilities

Utilities on site will be maintained by EFRI outside of work areas (areas to be decommissioned or reclaimed). Utilities inside work areas will be provided and maintained by the Contractor.

3.4.4 Sanitation Facilities

Sanitation facilities will be provided and maintained by the Contractor inside work areas.

3.4.5 Fire Protection

Fire protection will be provided by fire water supply facilities on-site, which include: 1) a 400,000 gallon Storage Tank, of which 250,000 gallons are reserved for fire emergencies; and 2) a centrifugal diesel driven pump rated at 2,000 gpm at 100 psi. This pump starts automatically when the pressure in the fire main drops below 100 psi. These fire protection facilities will decommissioned at the end of the decommissioning schedule. In addition, a fire watchman and fire extinguisher will be required during demolition-related cutting with a torch or welding operations.

3.5 Personnel Protection Requirements

The protection requirements and procedures to be followed have been developed to assure that occupational exposures are maintained within the regulatory requirements and As Low as Reasonably Achievable (ALARA).

1. The standard personnel protection equipment includes full-face respiratory unit (includes eye protection), hard hat, coveralls, rubber boots or shoe covers, and work gloves.
2. Alternative personnel protection requirements (either more or less) may be specified by the area evaluation. If such is the case, each worker will receive a checklist identifying the specific personnel protection equipment required.

3. Long sleeved coveralls and work gloves will be laundered onsite. New clothing and gloves will be issued to replace damaged and non-repairable items.
4. In accordance with the existing tobacco policy at the mill facility, tobacco use is not allowed. Eating or drinking anything, including chewing gum, is only allowed in designated areas.

3.6 Occupational Monitoring Requirements

Programs currently in place for monitoring of exposures to employees will remain in effect throughout the time period during which mill decommissioning and clean up of windblown contamination are conducted. This will include personal monitoring and the ongoing bioassay program. In general, no changes to the existing programs are expected and reclamation and decommissioning activities are not expected to increase exposure potential beyond the current levels. The current requirements to monitor potential personnel exposure to radionuclides are specified in the EFRI Radiation Protection Manual for Reclamation Activities (EFRI, 2015b).

3.7 Operational Issues

The Plan presumes that virtually all structures on the site can be demolished using heavy equipment as described below. As a result, little or no manual labor is anticipated. This approach should accelerate the demolition process, as well as reduce occupational exposures.

The following describes the typical work routine to be followed during demolition.

1. The demolition crew supervisor shall review the Plan requirements and confer with the Reclamation Project Manager for changes made to the Plan. The crew supervisor will inform the work crew of the requirements and any changes to the Plan. The RSO will assist when requested.
2. A staging area will be established near the work area and used as a personnel screening, PPE changing and storage area.
3. Personnel involved in the demolition will don the required PPE and required monitoring equipment.
4. Demolition personnel will be surveyed for contamination, decontaminated if over the specific limits and resurveyed prior to leaving the Restricted Area.
5. All personnel performing demolition work shall be scanned for contamination and may shower before release from the Restricted Area.
6. PPE equipment will be inspected, decontaminated, and maintained in good working order and replaced when damaged.
7. Personnel involved in demolition operations must report problems encountered or changes that need to be made to the Plan to the Reclamation Project Manager. Problems encountered and changes made will be documented in daily progress reports.

3.8 Training

Formal worker training will be required for all decommissioning activities and will be appropriate for the activity to be performed. The training will be given by the RSO or designee, and will include the following information.

1. Goals, strategies and specific tasks encompassed by this Plan.
2. Radiation protection training will be conducted for all contractor employees as specified in the most current revision of the EFRI Radiation Safety Training Program. The general training will include radiological safety procedures, ALARA philosophy and emergency procedures. The personnel will receive instruction pertaining to the risks of radiation exposure, monitoring procedures and personal protective equipment.
3. MSHA training will be required for all contractor employees. This training will be site and job specific, and will include information on industrial safety, building safety, chemical hazards, fire safety, emergency procedures, protective equipment, and an overview of planned activities.
4. Training will be documented as required by MSHA, and the appropriate procedures in the most current revision of the EFRI Radiation Safety Training Program (.

4.0 EQUIPMENT SALVAGE

4.1 General

Equipment and structural materials (if of sufficient value for salvage) may be removed from the facility, decontaminated and surveyed for release from the site for unrestricted use. All salvageable equipment will be decontaminated and surveyed for release as outlined in the Radiation Protection Manual for Reclamation Activities (EFRI, 2015c). Equipment and structural materials that are not of sufficient value or salvage or cannot be feasibly decontaminated will be placed in the in the last active tailings cell or the Cell 1 Disposal Area.

4.2 Decontamination

Decontamination procedures for items to be released for unrestricted use will be developed during reclamation and will be based on the type of equipment and the construction of the equipment (i.e. what the item is constructed of such as metal, glass, plastic etc.). Current Mill procedures will be the basis for the decontamination procedures used at the time of reclamation. If decontamination to the unrestricted release criteria specified in the RPM Section 2.6 is not attainable, the item will be disposed of on site.

Decontamination of potentially salvageable equipment will be conducted based on the nature of contamination, the surfaces to be decontaminated, and worker health and safety. Decontamination methods may include low-pressure washing, followed by surveying of washed surfaces. If contamination remains, decontamination methods may include scraping, steam cleaning, sand blasting, or grinding. Surveying of cleaned surfaces will be conducted on dried surfaces, with release based on criteria specified in the EFRI Radiation Protection Manual for Reclamation Activities (EFRI, 2015c). Equipment and structural materials shall not be release from the site without approval by the RSO.

4.3 Decontamination Procedures

Efforts will be made to minimize the spread of contamination on salvageable equipment. Decontamination liquids or chemicals may be used to aid in equipment contamination removal. General procedures for decontamination are listed below.

1. Wet down areas and equipment surfaces with water spray followed by water washing. Steam cleaning may be required to augment washing.
2. Wash equipment and structures and remove loose residue.
3. Wash insides of equipment and dispose of residues.
4. Collect liquids generated during decontamination activities for disposal.

Material and equipment slated for disposal will be transported to the last active tailings cell or the Cell 1 Disposal Area. Salvageable items meeting unrestricted release criteria will be transported to a designated clean area for storage. Salvageable items meeting restricted release criteria will be transported to a designated restricted release are for storage.

4.4 Decontamination Areas

A decontamination area will be established so that equipment to be offered for salvage may be decontaminated, as necessary. This area is planned to be an existing concrete pad with a water collection area or sump.

A laydown area will be established outside of the facility Restricted Area so that decontaminated, salvageable equipment that has been surveyed and approved for unrestricted release can be stored prior to release from EFRI custody. A separate laydown area will be established within the restricted area for equipment decontaminated for restricted release, if any.

5.0 PRE-DEMOLITION ACTIVITIES

5.1 General

This section describes the preparation of the site areas for reclamation and decommissioning. This work will be conducted according to applicable sections of the EFRI Radiation Protection Manual for Reclamation Activities (EFRI, 2015c). The Contractor shall conduct these activities using written procedures that have been approved by EFRI.

5.2 Area Evaluation Process

For each structure in the process area, a pre-demolition survey and inventory will be conducted. This work (area evaluation process) will include the items listed below.

1. Review health protection requirements (if different from the standard).
2. Review monitoring requirements (if different from the standard).
3. Review utilities to confirm that electrical power lines, high pressure pipelines and other potential hazards to demolition are identified.
4. Perform radiation surveys to identify areas of above-background exposure to ionizing radiation. EFRI's historical survey data may be used for this purpose.
5. Sample air to identify the need for respiratory protection from dust, gases, and airborne radioactivity. This would include radon daughter surveys to identify potential areas of exposure to radon-222 gas.
6. Survey hazardous materials to identify and quantify potentially hazardous materials such as strong acids or bases, oxidizing agents, corrosive materials, flammable materials or pressurized gases.
7. Review asbestos inspection reports (see Section 5.3.4) to determine the presence of asbestos-containing materials and procedures for handling and disposal.
8. Survey residual liquid to identify residual liquids in tanks, vessels, pipelines, and other storage areas that would require liquid management for treatment and disposal.
9. Conduct structural engineering surveys to assess the physical condition of the structure and its supporting members.
10. Identify equipment that will be reused, salvaged, or disposed.
11. Determine what structural members or equipment needs to be cut into manageable sections for transport.
12. Decide if supplemental runoff control berms need to be constructed or modified.
13. Obtain area and equipment contamination measurements.
14. Mark salvageable equipment, if necessary.
15. Plan haulage routes.

5.3 General Preparation Work

5.3.1 Circuit Cleanup

Circuits will be flushed and resultant fluids and solids will be pumped to the appropriate receiving pond. All products will be removed from product storage buildings, prior to demolition of those buildings. Reagents used in the processing will be removed from the site or disposed of as described below.

Process inorganic compounds. Acids, bases or other inorganics that have become contaminated with radioactive materials will be pH-adjusted or otherwise neutralized, if and as necessary, and will be disposed of in the last active tailings cell or the Cell 1 Disposal Area. Inorganics that are unaffected by the process (because they were unused) will be sold or returned to the original vendor, if possible. Otherwise, the pH will be adjusted or otherwise neutralized, if and as necessary, and disposed of in the last active tailings cell or the Cell 1 Disposal Area.

Process organic compounds. Organics used in processing will be stripped with sulfuric acid or other reagents to remove radionuclides and metals and disposed as appropriate. Uncontaminated organics will be returned to the original vendor or sold, if possible.

5.3.2 Laboratory Reagents

Laboratory reagents will be returned to the original vendor, sold, donated to appropriate users or neutralized and placed in the appropriate disposal location.

5.3.3 Oils and Lubricants

New oils will be returned to the original vendor, sold to another party, or disposed as necessary. Used oils will be disposed of in the last active tailings cell.

5.3.4 Asbestos

A facility-wide inspection to determine the presence of asbestos in building materials in the milling facility was conducted for EFRI in 2012. A detailed asbestos survey was conducted, as necessary, on a building-by-building basis to confirm identification of building materials and outline methods of asbestos containment, handling, and disposal. Inspection reports were prepared after the facility-wide inspection and submitted to the DWMRC as attachments to EFRI (2012a) and EFRI (2015b). Asbestos-containing materials will be removed according to pertinent asbestos regulations and procedures presented in the inspection reports and will be placed in the last active tailings cell or the Cell 1 Disposal Area.

5.4 Process Area Preparation

Work in the process area includes the water management tasks outlined below.

1. Removal and/or evaporation of water in existing ponds.
2. Diversion of clean area stormwater runoff from work areas (where facilities demolition and material excavation will take place).
3. Collection of stormwater runoff from within the work areas to be used for disposed material compaction or dust suppression and/or retained in a temporary evaporation pond.

5.5 Staging and Storage Areas

Areas on site used for equipment or material staging or temporary storage will be in approved areas of the site. These areas will be prepared in a manner consistent with EFRI plans for stormwater management. These areas will be prepared in conjunction with facilities demolition and site reclamation work.

6.0 PROCESS AREA DEMOLITION

6.1 General Description

This section outlines the demolition of facilities and structures in the process area. The major structures are shown on Figure 2 and are outlined in this section.

6.2 Mill Area

The uranium and vanadium processing areas of the Mill, including all equipment, structures and support facilities, will be decommissioned and disposed of in tailings or buried on site as appropriate. All equipment, including tankage and piping, agitation equipment, process control instrumentation and switchgear, and contaminated structures will be cut up, removed and buried in tailings prior to final cover placement. Concrete structures and foundations will be broken up and removed. Concrete foundations may be left in place and covered with soil as appropriate.

These decommissioned areas would include, but not be limited to the following:

- Coarse ore bin and associated equipment, conveyors and structures.
- Grind circuit including semi-autogeneous grind (SAG) Mill, screens, pumps and cyclones.
- The three pulp storage tanks to the east of the Mill building, including all tankage, agitation equipment, pumps and piping.
- The seven leach tanks inside the main Mill building, including all agitation equipment, pumps and piping.
- The counter-current decantation (CCD) circuit including all thickeners and equipment, pumps and piping.
- Uranium precipitation circuit, including all thickeners, pumps and piping.
- The two yellow cake dryers and all mechanical and electrical support equipment, including uranium packaging equipment.
- The clarifiers to the west of the Mill building including the preleach thickener (PLT), clarifier and claricone area.
- The boiler and all ancillary equipment and buildings.
- The entire vanadium precipitation, drying and fusion circuit.
- All external tankage not included in the previous list including reagent tanks for the storage of acid, ammonia, kerosene, water, dry chemicals, etc. and the vanadium oxidation circuit.
- The ammonium sulfate pad.
- The uranium and vanadium solvent extraction (SX) circuit including all SX and reagent tankage, mixers and settlers, pumps and piping.
- The SX building.
- The Mill building.
- The Alternate Feed processing circuit.

- Decontamination pads.
- The office building.
- The shop and warehouse building.
- The sample plant building.
- The Reagent storage building.

6.3 Demolition Strategy

As described above, a number of pre-demolition activities will be completed prior to actual demolition of the structures and buildings. This approach assumes that the facility equipment, buildings, and structures will have any product, reagents, residues and other fluids removed. Utilities for individual buildings will be disconnected on a building-by-building basis.

6.3.1 Staging of Decommissioning

Although different types of decommissioning equipment will be used to demolish each different type of structure or equipment, demolition will proceed according to the general staging process described below while allowing for maximum use of the support areas of the facility such as the office and shop areas. The first stage consists of demolition of above-ground structures such as piping and tanks, then building and enclosed structures. The second stage consists of concrete removal (structure floor slabs, below-ground walls, and footings). The third stage consists of removal of underground utilities (most likely conducted at the same time as concrete removal). The fourth stage is excavation and removal of contaminated soils.

6.3.2 Remote Demolition

The strategy for demolition is based on current equipment and procedures used for structural demolition and used successfully at uranium mill sites in the western United States. This strategy consists of use of mechanized equipment specially designed for equipped for demolition work, minimizing manual labor. Heavier duty equipment will allow remote-controlled water sprays to be directed as necessary, will require fewer staff, and will lower occupational exposures.

6.3.3 Demolition Equipment

The anticipated demolition equipment is described below. All heavy equipment to be used for demolition should have an enclosed operator's cabin that is equipped with a HEPA filter and an air conditioning system. This enclosure will reduce potential internal exposures from airborne materials.

Hydraulic shear. This is a hydraulically operated attachment on the end of the arm of a track-mounted excavator or crane. This shear will be used to cut piping, I-beams, tanks and other steel into pieces that will fit onto trucks for transport to the last active tailings cell or the Cell 1 Disposal Area.

Grapple. This is a hydraulically operated attachment on the end of the arm of the track-mounted excavator or crane. The grapple is either an excavator bucket with a thumb, or a grasping attachment with several "fingers." The grapple will be used to load dismantled pieces of piping, tanks, and concrete onto trucks for transport to the last active tailings cell or the Cell 1 Disposal Area.

Hydraulic excavator. A large hydraulic excavator will be used to load dismantled pieces of piping, tanks, and concrete onto trucks for transport to the last active tailings cell or the Cell 1 Disposal Area. Also, excavator buckets with different widths may be used to excavate solids from tanks or cemented soils from around deeper foundations or pilings.

Front-end loader. In areas with smooth ground conditions and free from debris that may damage rubber tires, a front-end loader will be used to load soil, dismantled pieces of piping, tanks, or concrete onto trucks for transport to the last active tailings cell or the Cell 1 Disposal Area.

Concrete shear. This is a hydraulically operated attachment on the end of the arm of a track-mounted excavator or crane. The concrete shear is similar to the steel shear, used to break concrete walls, slabs, and other facilities that will fit into the jaws of the shear. The shear breaks the concrete into pieces that can be loaded for transport to the last active tailings cell or the Cell 1 Disposal Area.

Concrete impactor. For concrete foundations that are of dimensions that cannot be broken with the concrete shear, a concrete impactor will be used. This is another attachment on the end of the arm of a track-mounted excavator or crane. The impactor use a vibratory tip (similar to a jack-hammer) to break concrete into pieces that can be loaded into trucks for transport to the last active tailings cell or the Cell 1 Disposal Area.

Trucks. Dump trucks as large as are practical and available will be used to transport dismantled equipment, concrete, and soils to the last active tailings cell or the Cell 1 Disposal Area with minimal handling. The size of the truck beds will dictate the size of the facility debris to be broken or cut.

Scraper. For soils excavated during the later phase of contaminated soil excavation, scrapers may be used in place of trucks and loaders. Push-loading scrapers would most likely be used for soil excavation, transport, and placement.

Soil ripper. To expedite contaminated soil excavation, a dozer or grader-mounted soil ripper or ripping bar will be used to break up cemented soil or sedimentary rock to enable scrapers or loaders to load contaminated soils.

Water truck. A water truck or similar rubber-tired watering equipment will be routinely used for dust suppression to wet haul roads from the specific demolition site to the area of the last active tailings cell and the Cell 1 Disposal Area.

Grader. A road grader or blade will be used to smooth haul roads and other work surfaces on a routine basis. Debris, rock, or wet materials generated by the blade work will be transported to the last active tailings cell or the Cell 1 Disposal Area.

6.4 Utilities Management

All utilities to the facility will be disconnected prior to starting demolition operations for a given building, structure or area. The specific procedures and precautionary measures for each utility to be followed are listed below.

6.4.1 Liquefied Natural Gas and Propane Systems Disconnect

1. Shut off main valve at meter.

2. Light heating equipment to burn off residual fuel.
3. Blow out all lines with compressed air.
4. Verify with combustible gas meter that lines are free of fuel.

6.4.2 Electrical System Disconnect

1. Shut down service at electrical substations.
2. Verify with metering equipment that the power is off.
3. Disconnect power feeders to the milling facility.
4. Verify with metering equipment that all systems are disconnected.

6.4.3 Water System Disconnect

1. Disconnect the piping system to the milling facility (if not already disconnected).
2. Check main valve to verify system is off and disconnected.

6.4.4 Phone System

EFRI will also have telephone services maintained in the office building for use during decommissioning and eventually disconnected by the provider.

6.5 Surface Structure Removal

As described in the strategy above, the order in which structures will be demolished and removed is generally determined by the types of tools that are best suited to those types of structures. Therefore, all surface structures will be demolished prior to concrete and contaminated soil removal. All materials will be disposed in last active tailings cell or the Cell 1 Disposal Area.

Depending on the type of building, it may be demolished with equipment and structures remaining inside or the equipment may be removed prior to the building's structure being demolished. Buildings and their associated equipment will be the first major category of demolition that is performed, except for support areas of the facilities such as the office and shop areas. It is anticipated that the type of demolition equipment used to take down buildings will be the same required for outdoor piping and tanks.

6.6 Concrete Removal

Once surface structures, including all buildings, tanks, piping, and pipe racks, have been demolished and disposed, then specialized concrete removal operations may begin.

It is anticipated that the major equipment used will be a concrete shear, a concrete impactor, a large backhoe, and haulage trucks. Each of these will be operated from within an enclosed cab, thus reducing exposure to radioactive materials. Concrete floors and walls of normal size and thickness (up to 1 foot) will be removed using the heavy equipment described above. Concrete shears will be used to cut slabs into pieces that are transportable to the disposal cell.

Concrete below grade and thicker than 1 foot will likely be broken using a combination of the impactor, the shear, and a backhoe that will dig access trenches. Removal of structure foundations, interior floor slabs, and exterior slabs and parking areas will follow the general sequence listed below.

1. Cutting (with a concrete saw) or breaking up (with a hydraulic shear, remote jack hammer or similar vibratory tool) the slab or foundation material into pieces that can be loaded and hauled by construction equipment.
2. Excavation of contaminated soils from under floor areas and around footings.
3. Transport of the concrete pieces and excavated soils to last active tailings cell, the Cell 1 Disposal Area or approved temporary storage location.
4. Placement of the pieces in the disposal cell by dumping and (where possible) working with a dozer or trackhoe to minimize void spaces.
5. Covering the pieces with contaminated soil or similar material, with vibratory compaction to minimize void spaces.

6.7 Utility Removal

Equipment to be used to utilities (both above-ground and below-ground) depend on the location of the structure. It is anticipated that the major equipment used will be a hydraulic shear, a grapple, a large backhoe, and haulage trucks. Each of these will be operated from within an enclosed cab, thus reducing exposure to dust or radioactive materials.

Once the concrete structures are removed, the underground utilities will be located and exposed with a metal detector or conductivity meter in conjunction with existing utility maps will be used to locate pipes and lines. A combination of the backhoe and the grapple will be used to expose the lines, which will be severed using the hydraulic shear.

6.8 Miscellaneous Site-Wide Facilities

An outside contractor will be retained to empty the septic tanks prior to demolition. The septic tanks will be sampled prior to pumping in accordance with Mill procedures. The septic tanks and the drain fields will be excavated and transported to last active tailings cell or the Cell 1 Disposal Area after pumping. Sewer system piping will be excavated and disposed of after flushing.

Miscellaneous facilities to be decommissioned include the boneyard, tailings lines, and mill runoff controls. The boneyard is located to the south of the Mill area and consists of a collection of used and potentially contaminated equipment and equipment parts that have been removed from the Mill or various other buildings over a period of time. The surface tailings lines will be removed one all liquid effluent from the demolition is completed and not more liquid effluent is expected. Mill runoff control systems including underground culverts and miscellaneous concrete structures will be decommissioned.

6.9 Contaminated Soils

Contaminated areas on the Mill site will be primarily superficial and include the ore storage area and surface contamination of some roads, except the claricone and ammonium sulfate pad areas. All ore and alternate feed materials will have been previously removed from the ore stockpile area or will be transported and disposed of as contaminated material. The depth of excavation will vary depending on the extent of contamination and will be governed by the criteria outlined in Attachment A (Technical Specifications) of the Reclamation Plan, Revision 5.1, except for the claricone and ammonium pad areas which had removal depths and extents outlined in letters submitted by EFRI to the DWMRC on 10/26/12 and 12/23/13, respectively.

Contaminated soils will be disposed of in last active tailings cell or the Cell 1 Disposal Area. Contaminated soils will be placed in the last active cell or the Cell 1 Disposal Area as random fill material (material used to fill voids within mill material, achieve desired cover system slopes, and provide a firm base for construction of the cover system). Only uncontaminated soils meeting criteria for cover materials will be used in the cover system over the tailings cells.

6.10 Windblown Contamination

Windblown contamination is defined as Mill derived contaminants dispersed by the wind to surrounding areas. The potential areas affected by windblown contamination will be surveyed as outlined in Attachment A (Technical Specifications) of the Reclamation Plan, Revision 5.1. Areas covered by the existing Mill facilities and ore storage pad, the tailings cells and adjacent stockpiles of random fill, clay and topsoil, will be excluded from the survey. Materials from these areas will be removed in conjunction with final reclamation and decommissioning of the Mill and tailings cells. Windblown contaminated material will be detected by a gamma survey using the criteria in Attachment A (Technical Specifications) of the Reclamation Plan, Revision 5.1 and will be excavated and disposed of in the last active tailings cell or the Cell 1 Disposal Area.

6.11 Preparation of Demolition Debris for Disposal

Because of the wide variety in shape and size of equipment and structural materials, the following guidelines will be used in sizing, handling and disposing of debris. Additional detail on material placement is provided in Attachment A (Technical Specifications) of the Reclamation Plan, Revision 5.1.

1. Material will be cut or dismantled into pieces that can be safely lifted or carried with the equipment being used. Material will also be cut or dismantled to minimize void spaces after disposal.

2. A front-end loader, crawler, hydraulic excavator, or equivalent equipment will be utilized to crush or compact compressible materials. These materials will be laid out in a staging area or other approved area to facilitate crushing or compacting with equipment.

3. Pipe or conduit with an opening or diameter larger than 12 inches that cannot be crushed will be filled with contaminated soil, clean fill soil, or grout and buried.

4. Tanks and vats will be handled according to the wall material and wall thickness. Tanks will be crushed or compacted if possible. Tanks that cannot be crushed will be dismantled, if feasible. Tanks that cannot be crushed or dismantled will be transported to the last active tailings cell or the Cell 1 Disposal Area, filled with contaminated soil, clean fill soil, or grout and buried.

7.0 REGRADING AND REVEGETATION

7.1 Regrading

Regrading will be conducted after completion of contaminated soil excavation. The excavated surface of the mill facility will be regraded to remove depressions and direct storm water runoff in directions and toward areas desired for final site drainage. The completed regraded surfaces will be covered with a layer of topsoil or suitable plant growth media soil at a minimum thickness of six inches.

7.2 Revegetation

Revegetation will consist of establishing a self-sustaining cover of selected vegetation of the completed regraded and covered surfaces of the milling facility. The vegetation species mix, planting methods, weed control procedures, and revegetation success monitoring are provided in Attachment A (Technical Specifications) of the Reclamation Plan, Revision 5.1.

8.0 REFERENCES

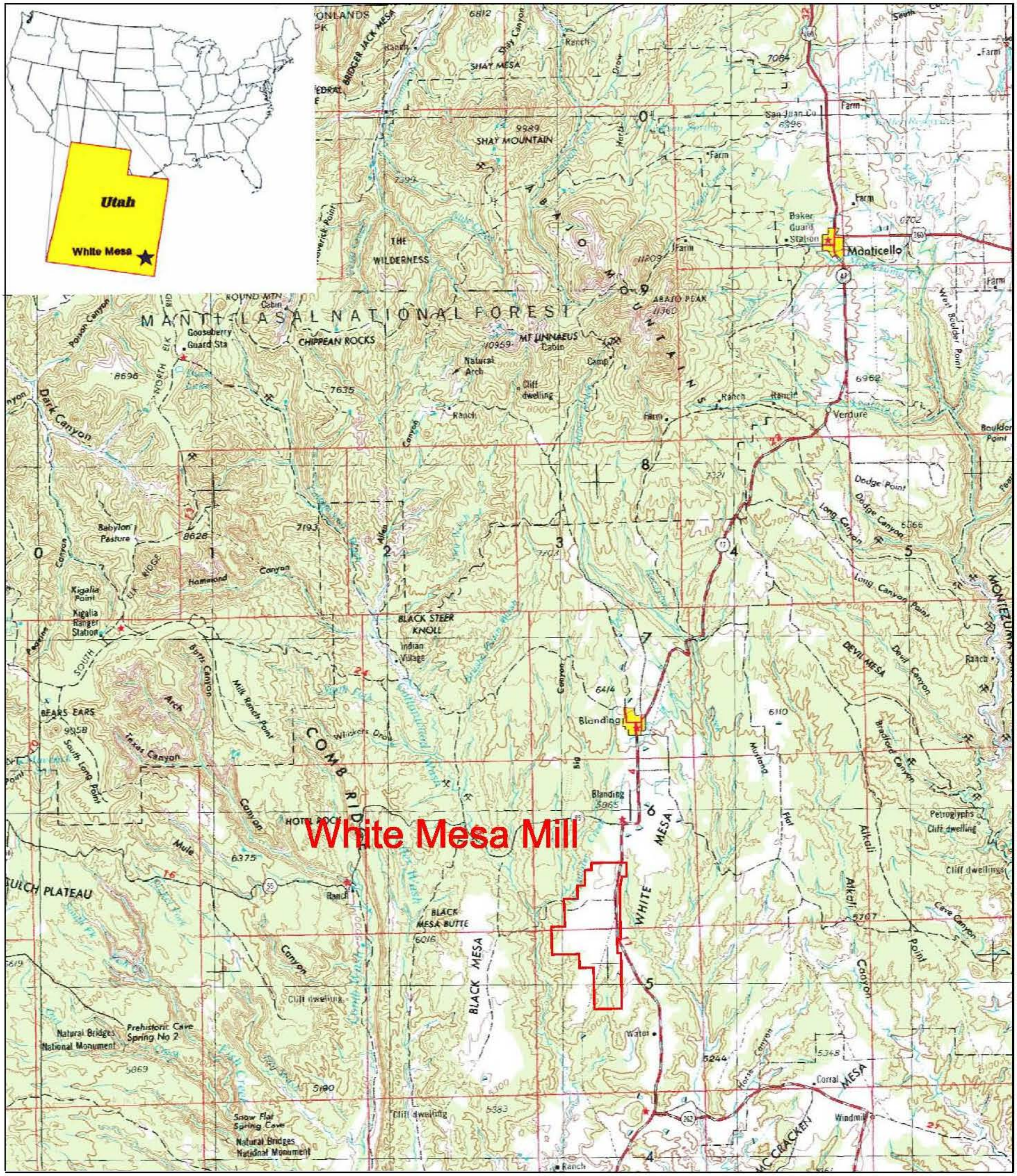
Denison Mines (USA) Corp. (Denison), 2009. Reclamation Plan White Mesa Mill, Blanding, Utah, Revision 4.0. November.

Denison Mines (USA) Corp. (Denison), 2011. Reclamation Plan White Mesa Mill, Blanding, Utah, Revision 5.0. September.

Energy Fuels Resources (USA) Inc. (EFRI), 2012a. Responses to Interrogatories – Round 1 for Reclamation Plan, Revision 5.0, March 2012. August 15.

Energy Fuels Resources (USA) Inc. (EFRI), 2015b. Responses to Review of August 15, 2012 (and May 31, 2012) Energy Fuels Resources (USA) Inc. Responses to Round 1 Interrogatories on Revision 5 Reclamation Plan, White Mesa Mill Site, Blanding Utah, Report Dated September 2011. August 31.

Energy Fuels Resources (USA) Inc. (EFRI), 2015c. White Mesa Mill, Standard Operating Procedures, Book #20, Radiation Protection Manual for Reclamation Activities. August.



REFERENCE:
ADAPTED FROM FIGURE 1–1 IN DENISON MINES (USA) CORPORATION, 2009. RECLAMATION PLAN WHITE MESA MILL, BLANDING, UTAH. VERSION 4.0. NOVEMBER.

ENERGY FUELS	PROJECT: WHITE MESA MILL TAILINGS RECLAMATION	MWH	
	TITLE: REGIONAL LOCATION MAP	DATE: AUG 2016	FIGURE 1
		FILE NAME: 1009740 LOC MAP	

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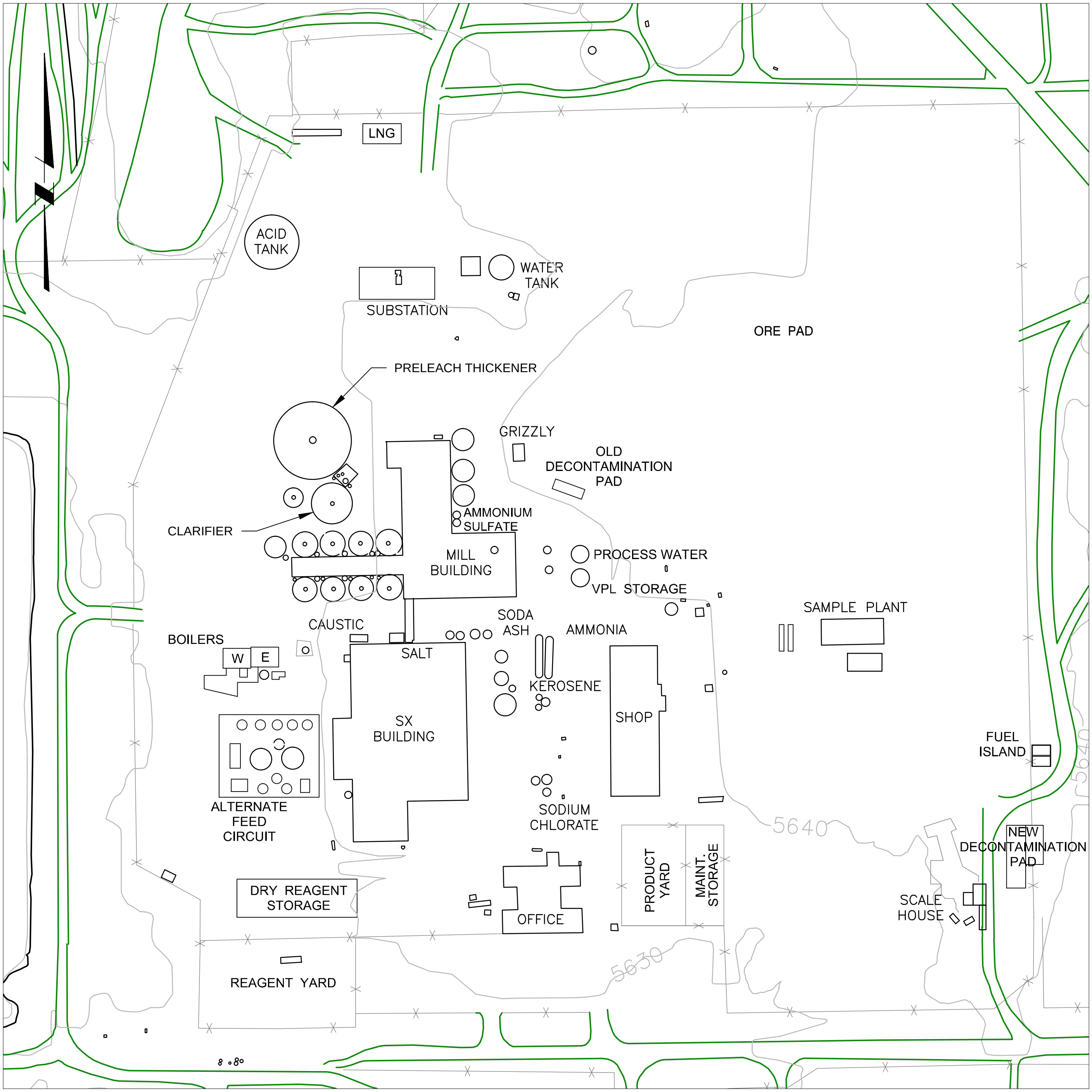

REFERENCE:
ADAPTED FROM FIGURE 3.2.3-1 IN DENISON MINES (USA) CORPORATION, 2009. RECLAMATION PLAN WHITE MESA MILL, BLANDING, UTAH. VERSION 4.0. NOVEMBER.

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ENERGY FUELS

PROJECT
WHITE MESA MILL RECLAMATION

TITLE
SITE MAP OF MILL AREA

MWH

DATE AUG 2016

FIGURE 2

FILE NAME 1009740 SITE MAP_MOD

Reclamation Plan

White Mesa Mill

Blanding, Utah

Radioactive Materials License No. UT1900479

Revision 5.1B

~~December 2016~~February 2018

Prepared by:
Energy Fuels Resources (USA) Inc.
225 Union Blvd., Suite 600
Lakewood, CO 80228

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LIST OF DRAWINGS

LIST OF ATTACHMENTS

LIST OF APPENDICES

INTRODUCTION

This Reclamation Plan (the "Plan") has been prepared by Energy Fuels Resources (USA) Inc. ("EFRI")[1] for EFRI's White Mesa Uranium Mill (the "Mill"), located approximately six miles south of Blanding, Utah. This Plan presents EFRI's plans and estimated costs for the reclamation of cells for the tailings management system, and for decommissioning of the Mill and Mill site.[2] This Plan is an update to the White Mesa Mill Reclamation Plan Revision 3.2b (Denison, 2011b) approved by the Utah Department of Environmental Quality (UDEQ) Division of Radiation Control (DRC) on January 26, 2011.

Summary of Plan

The uranium and vanadium processing areas of the Mill, including equipment, structures and support facilities, will be decommissioned and disposed of in tailings or buried at the Mill site as appropriate. Equipment (including tankage and piping, agitation, process control instrumentation and switchgears, and contaminated structures) will be cut up, removed, and buried in tailings prior to final cover placement. Concrete structures and foundations will be demolished and removed for disposal in tailings or covered in place with soil as appropriate.

The sequence of demolition will proceed so as to allow the maximum use of support areas of the facility, such as the office and shop areas. Uncontaminated or decontaminated equipment to be considered for salvage will be released in accordance with United States Nuclear Regulatory Commission ("NRC") guidance and in compliance with the conditions of the EFRI's State of Utah Radioactive Materials License No. UT1900479 (the "License"). As with the equipment for disposal, contaminated soils from the Mill and surrounding areas and ore or feed materials on the Mill site will be disposed of in the tailings cells in accordance with Attachment A, Technical Specifications. An evapotranspiration cover system is proposed for reclamation of the tailings management system cells.

The estimated reclamation costs for surety are set out in Attachment C. Attachment C will be reviewed and updated in accordance with License requirements. The reclamation costs are based on the approved Reclamation Plan (Denison, 2011b) and incorporate reclamation work completed to date. The reclamation costs will be updated when this Plan is approved and the Cell 2 cover performance test sections (see Sections 3.0, 5.0, and 6.0) are verified based on requirements outlined in a Stipulation and Consent Agreement (SCA) being developed between EFRI and UDEQ Division of Waste Management and Radiation Control (DWMRC) (see Sections 5.0 and 6.0).

Plan Organization

General site characteristics pertinent to this Plan are contained in Section 1.0. Descriptions of the facility construction, operations and monitoring are given in Section 2.0. The reclamation plan itself, including descriptions of facilities to be reclaimed and design criteria, is presented in Section 3.0. Section 4.0 provides an overview of the preliminary mill decommissioning plan. Section 5.0 presents how reclamation would proceed if the "Proposed Cover Design" in Appendix A is not approved. Milestones and schedule commitments for reclamation are outlined in Section 6.0. Design drawings ("Drawings") are attached to this plan following the main text. Attachments A through D comprise the Technical Specifications,

[1] Prior July 25, 2012 EFRI was "Denison Mines (USA) Corp." and prior to December 16, 2006, Denison was named "International Uranium (USA) Corporation."
[2] Cell 1 was previously referred to as Cell 1-I. It is now referred to as Cell 1.

Construction Quality Assurance/Quality Control (QA/QC) Plan, Reclamation Cost Estimate, and Radiation Protection Manual for Reclamation Activities. Attachment E provides documents on the approved "Existing Cover Design" including the Titan Environmental 1996 Tailings Cover Design Report (Attachment E.1) and Technical Specifications (Attachment E.2). Both documents were included in the approved Reclamation Plan Revision 3.2b (Denison, 2011b).

Supporting documents include:

- *Updated Tailings Cover Design Report,* December 2016. MWH, Inc. (Appendix A)
- *Preliminary Mill Decommissioning Plan,* August 2016. MWH, Inc. (Appendix B)

As required by Part I.H.11 of previous revisions of the Mill's State of Utah Ground Water Discharge Permit No. UGW370004 (the "GWDP"), and Part I.H.2 of the current revision of the GWDP, EFRI completed an infiltration and contaminant transport model of the final tailings cover system to demonstrate the long-term ability of the cover to protect nearby groundwater quality (MWH, 2010). The model was updated to address DWMRC comments on the ICTM Report (DRC, 2012; 2013) and to incorporate additional geotechnical and hydrologic data collected as part of field investigations conducted in 2010 and 2012 for cover borrow material and in 2013 for in situ tailings. The updated infiltration modeling results were presented in EFRI (2012b) and EFRI (2015c). The updated cover design is included in the Updated Tailings Cover Design Report, included as Appendix A to this Reclamation Plan, and includes a monolithic evapotranspiration (ET) cover for the tailings cells. The revised cover design and basis was used for this version of the Plan.

The Reclamation Plan is written assuming Cells 2, 3, 4A, and 4B of the tailings management system will receive tailings to the maximum permitted tailings elevations. Cell 2 is full and partially reclaimed. Cell 3 was used for tailings storage, but currently only receives mill waste and byproduct material in accordance with License provisions. Cell 3 is partially full, and partially reclaimed. Cell 4A is the only cell currently receiving tailings and is partially full. Cell 4B is used for evaporation of process solutions and has not been used for tailings disposal. The Plan has been written assuming Cell 4B will be used in the future for permanent tailings disposal.

If Cell 4B is not used in the future for tailings disposal, Cell 4B can be reclaimed for clean closure. This design is not presented in this report.

A Cell 1 Disposal Area is included in the reclamation design to provide additional storage for permanent disposal of contaminated materials and debris from the Mill site decommissioning and windblown cleanup. The current design is approved per the existing License, however this additional storage area is not currently needed for reclamation. If the Cell 1 Disposal Area is required for storage at the time of final Mill decommissioning, the liner system design will be updated to be the same basic design as the liner system for Cell 4B, including the same basic leak detection system. The revised design would be submitted to the Director prior to construction. After approval of the design by the Director, the Plan and surety would be updated to reflect the approved design.

Revisions to this Reclamation Plan include information related to the updated tailings cover design, as well as results of data collection and monitoring since Revision 5.0 of this Plan (Denison, 2011c). Revisions to the attachments and appendices of the Reclamation Plan are listed in a tabular format in Table I-1.

Table I-1
Revisions to Attachments and Appendices in Reclamation Plan

Attachments/ Appendices	**Reclamation Plan Revision 5.0 (2011)**	**Reclamation Plan Revision 5.1B (~~2016~~2018)***
Drawings	Included in Attachment A	**Updated and provided as a standalone attachment**
Attachment A	Plans and Technical Specifications for Reclamation of White Mesa Mill Facility, Blanding, Utah	**Updated -** Technical Specifications for Reclamation of White Mesa Mill Facility, Blanding, Utah
Attachment B	Construction Quality Assurance/Quality Control Plan for Reclamation of White Mesa Mill Facility, Blanding, Utah	**Updated** - Construction Quality Assurance/Quality Control Plan for Reclamation of White Mesa Mill Facility, Blanding, Utah
Attachment C	Cost Estimates for Reclamation of White Mesa Facility in Blanding, Utah	**Updated** - Cost Estimates for Reclamation of White Mesa Facility in Blanding, Utah
Attachment D	Radiation Protection Manual for Reclamation	**Updated -** Radiation Protection Manual for Reclamation Activities
Attachment E	Not included	**Added** – Existing Cover Design Documents
Appendix A	*Semi-Annual Effluent Report* (January through June, 2011), for the Mill	**Deleted to reduce redundancy** (latest report was submitted to DWMRC)
Appendix B	*Hydrogeology of the Perched Groundwater Zone and Associated Seeps and Springs Near the White Mesa Uranium Mill Site, Blanding, Utah*, November 12, 2010, prepared by Hydro Geo Chem, Inc. (the "2010 HGC Report")	**Deleted to reduce redundancy** (latest report was submitted to DWMRC)
Appendix C	The Mill's *Stormwater Best Management Practices Plan*, Revision 1.3, June 12, 2008, *Emergency Response Plan*, Revision 2.1, August 18, 2009, and Spill Prevention, Control, and Countermeasures Plan, 2011.	**Deleted to reduce redundancy** (latest report was submitted to DWMRC)
Appendix D	*Updated Tailings Cover Design Report*, White Mesa Mill, September 2011. MWH Americas, Inc.	**Updated and now Appendix A -** *Updated Tailings Cover Design Report*, White Mesa Mill, December 2016. MWH, Inc.
Appendix E	*National Emission Standards for Hazardous Air Pollutants Radon Flux Measurement Program, White Mesa Mill Site*, 2010, Tellco Environmental	**Deleted to reduce redundancy** (latest report was submitted to DWMRC)
Appendix F	*Semi-Annual Monitoring Report January 1 - June 30, 2010, White Mesa Mill Meteorological Station*, August 19, 2011, McVehil-Monnett Associates, Inc.	**Deleted to reduce redundancy** (latest report was submitted to DWMRC).
Appendix G	*Preliminary Mill Decommissioning Plan*, White Mesa Mill, September 2011, MWH Americas, Inc.	**Updated and now Appendix B** - *Preliminary Mill Decommissioning Plan*, White Mesa Mill, August 2016, MWH, Inc.

*Main Text and Attachment A were updated from Revision 5.1 to 5.1B (see Section 1).

1 SITE CHARACTERISTICS

EFRI operates the Mill, which is located approximately six miles south of Blanding, Utah (see Figures 1-1 and 1-2). The Mill was initially licensed by the NRC in May 1980 under NRC Source Material License No. SUA-1358. Upon the State of Utah becoming an Agreement State for uranium mills in August 2004, the Mill's NRC license was replaced with the Mill's current State of Utah License and the Mill's GWDP.

The License was up for timely renewal on March 31, 2007 in accordance with Utah Administrative Code ("UAC") R313-22-36.[3] In accordance with R313-22-36, EFRI submitted an application to the Director ("Director") of Utah Department of Environmental Quality, Division of Waste Management and Radiation Control ("DWMRC")[4] on February 27, 2007 for renewal of the License under R313-22-37 (the "2007 License Renewal Application"). Similarly, the GWDP was up for timely renewal on March 8, 2010, in accordance with UAC R317-6-6.7. In 2009, 2012, and 2014, EFRI filed an application to the DWMRC for renewal of the GWDP for under R313-6-6.7.

The Mill is also subject to State of Utah Air Quality Approval Order DAQE-AN1205005-06 (the "Air Approval Order") which was re-issued on March 2, 2011 and is not up for renewal at this time.

Revision 3.0 of this Plan was submitted to and approved by NRC in 2000. A copy of Revision 3.0 of this Plan was also submitted to the DWMRC as part of the 2007 License Renewal Application. The most recently approved version of the Reclamation Plan is Revision 3.2b (Denison, 2011a). This version of the Reclamation Plan was approved by DRC under the Mill License on January 26, 2011. A copy of the White Mesa Mill Reclamation Plan, Revision 4.0 was previously submitted to the Director in November 2009 and is on file at the DRC. This version and previous versions of the Reclamation Plan presented design criteria for a multi-layered cover system. Revision 5.0 of this Plan was submitted to the DWMRC in September 2011. EFRI prepared Revision 5.0 of the Plan to incorporate changes since 2009 and to address interrogatories from the DWMRC (DRC, 2010 and 2011). EFRI prepared this Revision 5.1 of the Plan to incorporate changes since 2011 and include updates provided in EFRI response to interrogatories and review comments from DWMRC on Reclamation Plan, Revision 5.0 (Denison, 2012; EFRI, 2012a; EFRI, 2015). EFRI prepared this Revision 5.1B to address select public comments on the White Mesa Mill Groundwater Discharge Permit and Radioactive Materials License. EFRI responses to public comments were documented in EFRI (2017) and an updated Section 6 to Revision 5.1 of the Plan was provided as an attachment. Attachment A (Technical Specifications) has also been updated for Revision 5.1B with a minor revision to address public comments. The remaining attachments and appendices do not require revisions and therefore the designation of Revision 5.1 or reference to Revision 5.1 remain to indicate changes have not been made to these components of the Plan.

This Section 1.0 of the Plan incorporates by reference, updates or supplements, information previously submitted in previous environmental analyses performed at the Mill, as described below.

[3] The License was originally issued by the NRC as a source material license under 10 CFR Part 40 on March 31, 1980. It was renewed by NRC in 1987 and again in 1997. After the State of Utah became an Agreement State for uranium mills in August 2004, the License was re-issued by the DWMRC as a State of Utah Radioactive Materials License on February 16, 2005, but the remaining term of the License did not change.
[4] Prior to 2015, the DWMRC was two separate divisions of UDEQ, the Division of Radiation Control and the Division of Solid and Hazardous Waste.

A Final Environmental Statement Related to Operation of White Mesa Uranium Project, Energy Fuels Nuclear, Inc., May, 1979, Docket No. 40-8681 (the "FES") was prepared by NRC for the original License application in May 1979, which is incorporated by reference into, updated or supplemented by this Section 1.0. The basis for the FES was the *Environmental Report, White Mesa Uranium Project San Juan County, Utah*, dated January 1978, prepared by Dames & Moore (the "1978 ER"). In addition, the following environmental evaluations and other reports have been performed for the Mill and are incorporated by reference into, updated or supplemented by this Section 1.0:

- the Environmental Assessment ("EA") prepared for this Plan in February 2000 by NRC (the "2000 EA");
- the EA prepared in August 2002 by NRC (the "2002 EA") in connection with a License amendment issued by NRC authorizing receipt and processing at the Mill of certain alternate feed materials from the Maywood Formerly Utilized Sites Remedial Action Program site in Maywood, New Jersey;
- the *Statements of Basis* prepared in December 2004 by the State of Utah Department of Environmental Quality ("UDEQ") DWMRC in connection with the issuance of the GWDP revisions (the "GWDP Statement of Basis");
- the *Environmental Report in Support of the License Renewal Application, State of Utah Radioactive Materials License No. UT1900479*, prepared by Denison Mines (USA), Inc., February 28, 2007 (the "2007 ER");
- Background Groundwater Quality Reports, Source Assessment Reports (SARs), Pyrite Investigation Report and pH Report as discussed in Section 1.5.4.

Insert

Figure 1-1 White Mesa Mill Regional Location Map

Insert

Figure 1-2 White Mesa Mill Location Map

1.1 Climate and Meteorology

1.1.1 Regional

The climate of southeastern Utah is classified as dry to arid continental. Although varying somewhat with elevation and terrain, the climate in the vicinity of the Mill is semi-arid with normal annual precipitation of about 13.32 inches (see Table 1.1-1). Most precipitation is in the form of rain with snowfall accounting for about 29 percent of the annual total precipitation. There are two separate rainfall seasons in the region, the first in late summer and early autumn (August to October) and the second during the winter months (December to March). The mean annual relative humidity is about 44 percent and is normally highest in January and lowest in July. The average annual Class A pan evaporation rate is 68 inches (NOAA, 1977), with the largest evaporation rate typically occurring in July. This evaporation rate is not appropriate for determining water balance requirements for the tailings management system and must be reduced by the Class A pan coefficient to determine the latter evaporation rate. Values of pan coefficients range from 60 to 81 percent. EFRI assumes for water balance calculations an average value of 70 percent to obtain an annual lake evaporation rate for the Mill area of 47.6 inches. Given the annual average precipitation rate of 13.32 inches, the net evaporation rate is 34.28 inches per year.

The weather in the Blanding area is typified by warm summers and cold winters. The National Weather Service Station in Blanding, Utah is located about 6.25 miles north of the Mill. Data from the station is considered representative of the local weather conditions (1978 ER, Section 2.7.2). The mean annual temperature in Blanding was 50.3°F, based on the Period of Record Summary (1904 - 2006). January is usually the coldest month and July is usually the warmest month (see Table 1.1-2).

Table 1.1-1
Period of Record General Climate Summary – Precipitation

Station:(420738) BLANDING														
From Year=1904 To Year=2006														
	Precipitation											Total Snowfall		
	Mean	High	Year	Low	Year	1 Day Max.		>= 0.01 in.	>= 0.10 in.	>= 0.50 in.	>= 1.00 in.	Mean	High	Year
	in.	in.	-	in.	-	in.	dd/yyyy or yyyymmdd	# Days	# Days	# Days	# Days	in.	in.	-
January	1.39	5.31	1993	0.00	1972	1.49	15/1978	6	4	1	0	10.8	46.9	1979
February	1.21	3.87	1913	0.00	1906	1.50	03/1908	6	3	1	0	7.3	39.7	1913
March	1.05	3.72	1906	0.00	1932	1.13	01/1970	6	3	1	0	4.4	17.9	1970
April	0.87	4.35	1926	0.00	1908	1.33	04/1987	5	2	0	0	1.9	15.2	1957
May	0.71	2.62	1926	0.00	1910	1.26	25/1994	4	2	0	0	0.2	4.0	1978
June	0.45	2.84	1948	0.00	1906	1.40	28/1938	3	1	0	0	0.0	0.0	1905
July	1.15	3.55	1914	0.00	1920	1.74	21/1985	6	3	1	0	0.0	2.5	1906
August	1.38	4.95	1968	0.03	1985	4.48	01/1968	7	4	1	0	0.0	0.0	1905
September	1.28	4.80	1927	0.00	1912	1.85	29/1905	5	3	1	0	0.0	3.5	1905
October	1.45	7.01	1916	0.00	1915	2.00	19/1908	5	3	1	0	0.3	6.0	1984
November	1.05	4.17	1905	0.00	1929	2.79	27/1919	4	3	1	0	3.3	19.0	1931
December	1.33	6.84	1909	0.00	1917	3.50	23/1909	5	3	1	0	9.8	55.0	1909
Annual	13.32	24.42	1909	4.93	1956	4.48	19680801	62	36	7	1	38.2	121.0	1909
Winter	3.93	11.95	1909	0.29	1964	3.50	19091223	17	10	2	0	27.9	100.2	1979
Spring	2.63	7.77	1926	0.10	1972	1.33	19870404	15	8	1	0	6.5	28.7	1970
Summer	2.98	6.90	1987	0.12	1960	4.48	19680801	16	8	2	0	0.0	2.5	1906
Fall	3.78	8.70	1972	0.50	1917	2.79	19191127	14	9	2	1	3.7	19.5	1908

Table updated on Jul 28, 2006
For monthly and annual means, thresholds, and sums:
Months with 5 or more missing days are not considered
Years with 1 or more missing months are not considered
Seasons are climatological not calendar seasons

Winter = Dec., Jan., and Feb. Spring = Mar., Apr., and May
Summer = Jun., Jul., and Aug. Fall = Sep., Oct., and Nov.

Table 1.1-2
Period of Record General Climate Summary - Temperature

Station:(420738) BLANDING															
From Year=1904 To Year=2006															
	Monthly Averages			Daily Extremes				Monthly Extremes				Max. Temp.		Min. Temp.	
	Max.	Min.	Mean	High	Date	Low	Date	Highest Mean	Year	Lowest Mean	Year	>= 90 F	<= 32 F	<= 32 F	<= 0 F
	F	F	F	F	dd/yyyy or yyyymmdd	F	dd/yyyy or yyyymmdd	F	-	F	-	# Days	# Days	# Days	# Days
January	39.1	17.2	28.2	63	31/2003	-20	12/1963	40.2	2003	12.6	1937	0.0	6.2	30.3	1.8
February	44.9	22.3	33.6	71	28/1906	-23	08/1933	44.2	1995	18.8	1933	0.0	2.0	26.1	0.7
March	52.7	27.8	40.3	86	31/1906	-3	28/1975	51.0	2004	33.0	1948	0.0	0.3	23.4	0.0
April	62.2	34.3	48.2	88	19/1905	10	24/1913	56.9	1992	39.4	1928	0.0	0.0	12.4	0.0
May	72.3	42.1	57.2	98	31/2002	15	16/1910	65.0	2000	50.1	1917	0.4	0.0	2.7	0.0
June	83.3	50.7	67.0	110	22/1905	28	03/1908	75.3	2002	61.2	1907	6.3	0.0	0.2	0.0
July	88.7	57.9	73.3	109	19/1905	36	15/1934	81.1	2003	66.3	1916	15.1	0.0	0.0	0.0
August	86.2	56.2	71.2	106	18/1905	38	23/1968	77.2	1926	65.6	1968	9.0	0.0	0.0	0.0
September	78.2	48.3	63.3	100	01/1905	20	26/1908	70.2	2001	56.6	1922	1.3	0.0	0.3	0.0
October	66.0	38.0	52.0	99	08/1905	10	30/1971	59.6	2003	44.6	1969	0.1	0.0	6.6	0.0
November	51.4	26.7	39.1	74	04/1905	-7	25/1931	47.3	1999	32.4	1952	0.0	0.4	23.6	0.1
December	41.2	19.2	30.2	65	03/1929	-13	23/1990	39.4	1980	19.4	1931	0.0	4.5	30.0	0.9
Annual	63.8	36.7	50.3	110	19050622	-23	19330208	55.1	2003	47.2	1932	32.2	13.5	155.6	3.4
Winter	41.7	19.5	30.7	71	19060228	-23	19330208	37.5	1907	19.3	1933	0.0	12.7	86.4	3.3
Spring	62.4	34.7	48.6	98	20020531	-3	19750328	54.8	2004	43.6	1909	0.4	0.3	38.5	0.0
Summer	86.0	54.9	70.5	110	19050622	28	19080603	76.4	2002	67.4	1941	30.4	0.0	0.2	0.0
Fall	65.2	37.7	51.4	100	19050901	-7	19311125	58.3	1926	47.8	1912	1.4	0.4	30.5	0.1

Table updated on Jul 28, 2006
For monthly and annual means, thresholds, and sums:
Months with 5 or more missing days are not considered
Years with 1 or more missing months are not considered
Seasons are climatological not calendar seasons

Winter = Dec., Jan., and Feb. Spring = Mar., Apr., and May
Summer = Jun., Jul., and Aug. Fall = Sep., Oct., and Nov.

Winds are usually light to moderate in the area, although occasional stronger winds may occur in the late winter and spring. The predominant winds are from the north through north-east (approximately 30 percent of the time) and from the south through south-west (about 25 percent of the time). Winds are generally less than 15 mph, with wind speeds greater than 25 mph occurring less than one percent of the time (1978 ER, Section 2.7.2). As an element of the pre-construction baseline study and ongoing monitoring programs, the Mill operates an onsite meteorological station, described below. Further details about weather and climate conditions are provided in the 1978 ER (Section 2.7) and in the FES (Section 2.1).

1.1.2 Storms (FES Section 2.1.4, updated)

Thunderstorms are frequent during the summer and early fall when moist air moves into the area from the Gulf of Mexico. Related precipitation is usually light, but a heavy local storm can produce over an inch of rain in one day. The maximum 24-hour precipitation reported to have fallen during period 1904-2006 at Blanding was 4.48 inches (11.36 cm). Hailstorms are uncommon in this area. Although winter storms may occasionally deposit comparable amounts of moisture, maximum short-term precipitation is usually associated with summer thunderstorms.

Tornadoes have been observed in the general region, but they occur infrequently. Strong winds can occur in the area along with thunderstorm activity in the spring and summer. The Mill area is susceptible to occasional dust storms, which vary greatly in intensity, duration, and time of occurrence. The basic conditions for blowing dust in the region are created by wide areas of exposed dry topsoil and strong, turbulent winds. Dust storms usually occur following frontal passages during the warmer months and are occasionally associated with thunderstorm activities.

1.1.3 On Site

On-site meteorological monitoring at the Mill was initiated in early 1977 and continues today. The original purpose of the meteorological monitoring program was to document the regional atmospheric baseline and to provide data to assist in assessing potential air quality and radiological impacts arising from operation of the Mill.

After the Mill construction was completed, the monitoring programs were modified to facilitate the assessment of Mill operations. The current meteorological monitoring program includes data collection for wind speed, wind direction, atmospheric stability according to the standard Pasquill scheme (via measurements of deviations in wind direction, referred to as sigma-theta), and precipitation as either rain or snow. The recorded on-site meteorological conditions are reported to EFRI on a semi-annual basis and are described in semi-annual reports maintained at the Mill. Figure 1.1-1 shows the windrose for the Mill site for January – December 2015, the most recent full year of compiled meteorological data.

INSERT

Figure 1.1-1 Wind Rose - 2015

1.2 Topography

The following text is reproduced from Section 2.3 of the FES.

The site is located on a "peninsula" platform tilted slightly to the south-southeast and surrounded on almost all sides by deep canyons, washes, or river valleys. Only a narrow neck of land connects this platform with high country to the north, forming the foothills of the Abajo Mountains. Even along this neck, relatively deep stream courses intercept overland flow from the higher country. Consequently, this platform (White Mesa) is well protected from runoff flooding, except for that caused by incidental rainfall directly on the mesa itself. The land on the mesa immediately surrounding the Mill site is relatively flat.

1.3 Archeological Resources

The following discussion of archeological sites is adapted from Section 2.5.2.3 of the FES.

1.3.1 Archeological Sites

Archeological surveys of portions of the entire Mill site were conducted between the fall of 1977 and the spring of 1979. The total area surveyed contained parts of Section 21, 22, 27, 28, 32, and 33 of T37S, R22E, and encompassed 2,000 acres (809 ha), of which 200 acres (81 ha) are administered by the U. S. Bureau of Land Management ("BLM") and 320 acres (130 ha) are owned by the State of Utah. The remaining acreage is privately owned. During the surveys, 121 archeological sites were recorded and all were determined to have an affiliation with the San Juan Anasazi who occupied this area of Utah from 0 A.D. to 1300 A.D. All but 22 of the sites were within the Mill site boundaries.

Table 1.3-1, adapted from FES Table 2.18, summarizes the recorded sites according to their probable temporal positions. The dates of occupation are the best estimates available, based on professional experience and expertise in the interpretation of archeological evidence. Available evidence suggests that settlement on White Mesa reached a peak in perhaps 800 A.D. Occupation remained at approximately that level until sometime near the end of Pueblo II or in the Pueblo II/Pueblo III transition period. After this period, the population density declined sharply, and it may be assumed that the White Mesa area was, for the most part, abandoned by about 1250 A.D.

Archeological test excavations were conducted by the Antiquities Section, Division of State History, in the spring of 1978, on 20 sites located in the area later to be occupied by Cells 2, 3 and 4 (now comprised of Cell 4A and Cell 4B). Of these sites, 12 were deemed by the State Archeologist to have significant National Register potential and four to have possible significance. The primary determinant of significance in this study was the presence of structures, though storage features and pottery artifacts were also common.

In the fall of 1978, a surface survey was conducted on much of the previously unsurveyed portions of the proposed Mill site. Approximately 45 archeological sites were located during this survey, some of which are believed to be of equal or greater significance than any sites from the earlier study. Determination of the actual significance of all untested sites would require additional field investigation.

Table 1.3-1
Distribution of Recorded Sites According to Temporal Position

Temporal position	Approximate dates (A.D.)*a*	Number of sites
Basket Maker III	575-750	2
Basket Maker III/Pueblo I	575-850	27
Pueblo I	750-850	12
Pueblo I/Pueblo II	850-950	13
Pueblo II	950-1100	14
Pueblo II/Pueblo III	1100-1150	12
Pueblo III	1150-1250	8
Pueblo II+	*B*	
Multicomponent	*C*	3
Unidentified	*D*	14

a Includes transitional periods.
b Although collections at these locations were lacking in diagnostic material, available evidence indicates that the site would have been used or occupied no earlier than 900 A.D. and possibly later.
c Ceramic collections from each of these sites indicate an occupation extending from Pueblo I through Pueblo II and into Pueblo III.
d These sites did not produce evidence strong enough to justify any identification.

Source: Adapted from Dames & Moore (1978b) (1978 ER), Table 2.3-2, FES, Page 2-20, Table 2.18, and from supplementary reports on project archeology.

Pursuant to 10 CFR Part 63.3, the NRC submitted on March 28, 1979, a request to the Keeper of the National Register for a determination of eligibility for the area which had been surveyed and tested. The area contained 112 archeological sites and six historical sites. The determination by the Keeper of the National Register on April 6, 1979, was that the White Mesa Archeological District is eligible for inclusion in the National Register.

1.3.2 Current Status of Excavation

Archeological investigations for the entire Mill site and for Cells 1 through Cell 4 (now comprised of Cell 4A and Cell 4B) were completed with the issuance of four separate reports covering 30 sites, excluding re-investigations. (Lindsay 1978, Nielson 1979, Casjens et al 1980, and Agenbroad et al 1981).

The sites reported as excavated are as follows:

6380	6394	6437
6381	6395	6684
6384	6396	6685
6385	6397	6686
6386	6403	6697
6387	6404	6698
6388	6420	6699
6391	6429	6754
6392	6435	6757
6393	6436	7754

Sites for which excavation has not been required are:

6379	6441	7658	7690
6382	6443	7659	7691
6405	6444	7660	7693

The sites remaining to be excavated or investigated for significance are:

6408	6445	7657	7687
6421	6739	7661	7689
6427	6740	7665	7696
6430	7653	7668	7700
6432	7655	7675	7752
6439	7656	7684	7876

The following site was excavated in 2009 in connection with the construction of the new decontamination pad at the Mill:

42Sa27732

The following sites were excavated in the summer of 2010 in connection with the construction of Cell 4B and a final report was prepared:

42Sa6391	42Sa6431	42Sa28129	42Sa28133
42Sa6392	42Sa6757	42Sa28130	42Sa28134
42Sa6393	42Sa8014	42Sa28131	
42Sa6397	42Sa28128	42Sa28132	

1.4 Surface Water

The following description of undisturbed surface water conditions is adapted from Section 2.6.1 of the FES and Section 3.7.1 of the 2007 ER and is updated to include current data.

The Mill was designed and constructed to prevent run-on or runoff of stormwater by a) diverting runoff from precipitation on the Mill site to the tailings management cells; and b) diverting runoff from surrounding areas away from the Mill site. In addition to these designed control features, the facility has developed a *Stormwater Best Management Practices Plan*, Revision 1.5: May 2, 2016 (EFRI, 2016) which describes site drainage features and the best management practices employed to assure appropriate control and routing of stormwater.

1.4.1 Surface Water Description (FES Section 2.6.1.1)

The Mill site is located on White Mesa, a gently sloping (1 percent SSW) plateau that is physically defined by the adjacent drainages which have cut deeply into regional sandstone formations. There is a small drainage area of approximately 62 acres (25 ha) above the site that could yield surface runoff to the site. Runoff from the Mill area is conducted by the general surface topography to either Westwater Creek, Corral

Creek, or to the south into an unnamed branch of Cottonwood Wash. Local porous soil conditions, topography and low acreage annual rainfall of 13.32 inches cause these streams to be intermittently active, responding to spring snowmelt and local rainstorms (particularly thunderstorms). Surface runoff from approximately 384 acres (155 ha) of the Mill site drains westward and is collected by Westwater Creek, and runoff from another 384 acres (155 ha) drains east into Corral Creek. The remaining southern and southwestern portions of the site drain indirectly into Cottonwood Wash (Dames & Moore, 1978b, p. 2-143). The site and vicinity drainages carry water only on an intermittent basis. The major drainages in the project vicinity are depicted on Figure 1.4-1 and their drainages tabulated in Table 1.4-1. Total runoff from the site area (total yield per watershed area) is estimated to be less than 0.5 inch (1.3 cm) annually (Dames & Moore, 1978b, p. 2-143).

There are no perennial surface waters on or in the vicinity of the Mill site. This is due to the gentle slope of the mesa on which the site is located, the low average annual rainfall of 13.32 inches (33.8 cm) per year at Blanding, local soil characteristics and the porous nature of local stream channels. Prior to construction, three small ephemeral catch basins were present on the site to the northwest and northeast of the Mill site.

Corral Creek is an intermittent tributary to Recapture Creek. The drainage area of that portion of Corral Creek above and including drainage from the eastern portion of the site is about 5 square miles (13 km^2). Westwater Creek is also an intermittent tributary of Cottonwood Wash. The Westwater Creek drainage basin covers nearly 27 square miles (70 km^2) at its confluence with Cottonwood Wash 1.5 miles (2.5 km) west of the Mill site. Both Recapture Creek and Cottonwood Wash are similarly intermittently active, although they carry water more often and for longer periods due to their larger watershed areas. They both drain to the south and are tributaries of the San Juan River. The confluences of Recapture Creek and Cottonwood Wash with the San Juan River are approximately 18 miles (29 km) south of the Mill site. The San Juan River, a major tributary for the upper Colorado River, has a drainage of 23,000 square miles (60,000 km^2) measured at the USGS gauge to the west of Bluff, Utah (Dames & Moore, 1978b, p. 2-130).

Insert

Figure 1.4-1 Drainage Map of the Vicinity of the White Mesa Mill. Adapted from: Dames & Moore (1978b), Plate 2.6-5

Table 1.4-1
Drainage Areas of Project Vicinity and Region

Basin description	Drainage area	
	km²	sq. miles
Corral Creek at confluence with Recapture Creek	15.0	5.8
Westwater Creek at confluence with Cottonwood Wash	68.8	26.6
Cottonwood Wash at USGS gage west of project site	<531	<205
Cottonwood Wash at confluence with San Juan River	<860	<332
Recapture Creek at USGS gage	9.8	3.8
Recapture Creek at confluence with San Juan River	<518	<200
San Juan River at USGS gage downstream at Bluff, Utah	<60,000	<23,000

Source: Adapted from Dames & Moore (1978b), Table 2.6-3

Storm runoff in these streams is characterized by a rapid rise in the flow rates, followed by rapid recession primarily due to the small storage capacity of the surface soils in the area. For example, on August 1, 1968, a flow of 20,500 cfs (581 m^3/sec) was recorded in Cottonwood Wash near Blanding. The average flow for that day, however, was only 4,340 cfs (123 m^3/sec). By August 4, the flow had returned to 16 cfs (0.5 m^3/sec) (Dames & Moore, 1978b, p. 2-135). Monthly streamflow summaries updated from Figure 2.4 of the FES are presented in Figure 1.4-2 for Cottonwood Wash, Recapture Creek and Spring Creek. Flow data are not available for the two smaller water courses closest to the Mill site, Corral Creek and Westwater Creek, because these streams carry water infrequently and only in response to local heavy rainfall and snowmelt, which occurs primarily in April, August, and October. Flow typically ceases in Corral and Westwater Creeks within 6 to 48 hours after precipitation or snowmelt ends.

1.4.2 Surface Water Quality as of the Date of the FES (FES Section 2.6.1.2)

Sampling of surface water quality in the Mill vicinity began in July 1977 and continued through March 1978. Baseline data describe and evaluate existing conditions at the Mill site and vicinity. Sampling of the temporary on-site surface waters (two catch basins) was attempted, but without success because of the lack of naturally occurring water in these basins. Sampling of ephemeral surface waters in the vicinity was possible only during major precipitation events, as these streams are normally dry. See FES Section 2.6.1.2.

Surface water sample sites used prior to Mill operations are presented on Figure 1.4-3. The water quality values obtained for these sample sites are given in Dames & Moore (1978b) Table 2.6-7, and FES Table 2.22. Water quality samples were collected during the spring at several intermittently active streams that drain the Mill area. These streams include Westwater Creek (S1R, S9) Corral Creek below the small irrigation pond (S3R), the junction of Corral Creek and Recapture Creek (S4R), and Cottonwood Creek (S8R). Samples were also taken from a surface pond southeast of the Mill (S5R). No samples were taken at S2R on Corral Creek or at the small wash (S6R) located south of the site.

Insert

Figure 1.4-2 Streamflow Summary in the Blanding, Utah Vicinity (Adapted from Dames & Moore (1978b), Plate 2.6-6, updated)

Insert

Figure 1.4-3 Surface Water Quality Sampling Stations in the White Mesa Mill Vicinity Prior to Mill Operations (Adapted from Dames & Moore (1978b), Plate 2.6-10)

Natural surface water quality in the vicinity of the Mill is generally poor. Waters in Westwater Creek (S1R and S9) were characterized by high total dissolved solids (TDS; mean of 674 mg/liter) and sulfate levels (mean 117 mg of SO_4 per liter). The waters were typically hard (total hardness measured as $CaCO_3$; mean 223 mg/liter) and had an average pH of 8.25. Estimated water velocities for Westwater Creek averaged 0.3 fps (0.08 m/sec) at the time of sampling.

Samples from Cottonwood Creek (S8R) at the time of the FES were generally similar in quality to Westwater Creek water samples, although the TDS and sulfate levels were lower (TDS averaged 264 mg/liter; SO_4 averaged 40 mg/liter) during heavy spring flow conditions (80 fps [24 m/sec] water velocity).

The concentrations of TDS increased downstream in Corral Creek, averaging 3,180 mg/liter at S3R and 6,660 mg/liter (one sample) at S4R. Total hardness averaged in excess of 2,000 mg/liter, and pH values were slightly alkaline. Estimated water velocities in Corral Creek were typically less than 0.1 fps (0.03 m/sec) during sampling.

The spring sample collected at the surface pond south of the Mill site (S5R) indicated a TDS concentration of less than 300 mg/liter. The water was slightly alkaline with moderate dissolved sulfate levels averaging 42 mg/liter.

During heavy runoff, the concentration of total suspended solids in these streams increased sharply to values in excess of 1,500 mg/liter (FES, Table 2.22). High concentrations of certain trace elements were measured in some sampling areas. Levels of mercury (total) were reported as high as 0.002 mg/liter (S3R, 7/25/77; S8R, 7/25/77). Total iron measured in the pond (S5R, 11/10/77) was 9.4 mg/liter. The FES concluded (Section 2.6.1.2 of the FES) that these values appear to reflect groundwater quality in the vicinity and are probably due to evaporative concentration and not due to human perturbation of the environment. Corral Creek was also sampled at the time of the FES, but it has not been included in subsequent operational monitoring at the Mill. See Table 2.22 of the FES for sampling results for Corral Creek.

1.4.3 Surface Water Background Quality

Surface water samples are collected for Cottonwood Wash and Westwater Creek as part of the Mill's operational monitoring program. Samples were also taken prior to Mill construction and summarized in the FES as well as at various times and for various parameters since then. A comparison of the FES results and subsequent sampling results during Mill operation is shown in Table 1.4-2. Surface water values over time for both Cottonwood Wash and Westwater Creek are included in the Semi-Annual Effluent Reports.

Table 1.4-2
Summary of FES and Subsequent Sampling Results For Cottonwood Wash and Westwater Creek

Parameter	FES Cottonwood Wash (7/25/77-3/28/78)*	Cottonwood Wash (9/16/81-6/20/09)	Cottonwood Wash 2010	Cottonwood Wash 2011	Cottonwood Wash 2012	Cottonwood Wash 2013	Cottonwood Wash 2014	Cottonwood Wash 2015	FES Westwater Creek (11/10/77-3/23/78)*	Westwater Creek (2/22/82-6/20/09)	Westwater Creek 2010	Westwater Creek 2011	Westwater Creek 2012	Westwater Creek 2013	Westwater Creek 2014	Westwater Creek 2015
Field Specific Conductivity (μmhos/cm)	240-550	-	1612[3] 1625[3] 1600[3] 513[4] 622[4] 259[4] 785[4]	1402[5] 1631[5] 230[6]	1568[7] 674[8] 201[8]	1634[10] 653.8[11] 703[11] 140[11]	1677[12] 683[13] 785[13] 304[13]	1658[14] 740[15] 792[15] 472[15] 180[15]	320-620	-	1707[3] 1782[3] 1650[3] 1645[4]	1234[5] 806[6]	-	283[11]	412[13]	1372[14] 257[15]
Field pH	6.6 to 8.1	-	6.42[3] 6.67[3] 8.16[4] 8.20[4] 7.94[4] 7.21[4]	7.04[5] 6.84[5] 7.79[6]	7.06[7] 7.84[8] 7.95[8]	7.25[10] 7.98[11] 7.72[11] 8.74[11]	7.18[12] 7.81[13] 8.17[13] 8.77[13]	7.30[14] 6.86[15] 7.43[15] 8.30[15] 7.26[15]	7.6-8.3	-	7.03[3] 6.98[3] 8.16[4]	6.67[5] 7.60[6]	-	7.45[11]	8.64[13]	7.24[14] 7.55[15]
Dissolved Oxygen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temperature (ºC)	6.0 to 35	-	16.17[3] 15.85[3] 15.05[3] 3.19[4] 9.70[4] 21.37[4] 4.50[4]	16.50[5] 15.91[5] 12.60[6]	16.28[7] 9.80[8] 18.07[8]	16.28[10] 8.11[11] 5.48[11] 16.90[11]	16.90[12] 13.61[13] 18.92[13] 17.65[13]	16.40[14] 6.75[15] 16.19[15] 22.39[15] 12.59[15]	3-14	-	17.99[3] 17.21[3] 10.1[3] -0.03[4]	15.13[5] 10.68[6]	-	21.16[11]	17.00[13]	17.52[14] 17.69[15]
Estimated Flow m/hr	0.4 to 80	-	-	-	-	-	-	-	0.28 to 39.9	-	-	-	-	-	-	-
pH	7.5 to 8.21	-	7.47[3]	7.55[5] 8.04[5]	-	-	-	-	8.2 to 8.35	-	7.38[3]	7.20[5]	-	-	-	-
Redox Potential	210 to 260	-	501[3] 492[3]	441[5]	421[7]	259[10]	238[12]	189[14]	186 to 220	-	401[3] 342[3]	-	-	-	-	201[14]
Alkalinity (as $CaCO_3$)	134 to 195	76 to 257*	-	-	-	-	-	-	147 to 229	230*	-	-	-	-	-	-
Hardness, total (as $CaCO_3$)	148 to 195	-	-	-	-	-	-	-	117 to 289	-	-	-	-	-	-	-
Carbonate (as CO_3)	0.0	ND	ND[3]	6[5] mg/L	ND[7]	ND[10]	ND[12]	ND[14]	0.0 to 2.3	ND	ND[3]	ND[5]	-	-	-	ND[14]
Bicarbonate (as HCO3)	-	316 mg/L	340[3] mg/L	316[5] mg/L	326[7] mg/L	280[10] mg/L	251[12] mg/L	271[14] mg/L	-	465 mg/L	450 mg/L	330[5] mg/L	-	-	-	359[14] mg/L
Aluminum, dissolved	0.16 to 3.0	-	-	-	-	-	-	-	0.1 to 4.0	-	-	-	-	-	-	-
Ammonia (as N)	<0.1 to 0.16	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	0.512[14] mg/L	<0.1 to 0.75	ND	0.50[3] mg/L	0.06[5] mg/L	-	-	-	0.123[14] mg/L
Arsenic, total	0.02 to 0.041	-	-	-	-	-	-	-	0.007 to 0.037	-	-	-	-	-	-	-
Arsenic, Dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	12.3[5] ug/L	-	-	-	ND[14]
Barium, total	0.2 to 1.2	-	-	-	-	-	-	-	<0.2 to 0.81	-	-	-	-	-	-	-
Beryllium, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	0.91[5] ug/L	-	-	-	ND[14]
Boron, total	<0.1 to 0.2	-	-	-	-	-	-	-	<0.1 to 0.1	-	-	-	-	-	-	-
Cadmium, total	<0.002 to 0.01	-	-	-	-	-	-	-	<0.002 to 0.006	-	-	-	-	-	-	-
Cadmium, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	0.9[5] ug/L	-	-	-	ND[14]
Calcium, dissolved	54 to 178	90.3 mg/L	92.2[3] mg/L	94.2 – 95.4[5] mg/L	101[7] mg/L	87.9[10] mg/L	99.7[12] mg/L	111[14] mg/L	76 to 172	191 mg/L	179[3] mg/L	247[5] mg/L	-	-	-	150[14] mg/L
Calcium	-	37 to 71*	-	-	-	-	-	-	-	94.5*	-	-	-	-	-	-
Chlorine	-	-	-	-	-	-	-	-	-	41*	-	-	-	-	-	-
Chloride	6 to 24	5 to 33.3*	112[3] mg/L	113 - 134[5] mg/L	149[7] mg/L	118[10] mg/L	128[12] mg/L	133[14] mg/L	17 to 125	76*	40[3] mg/L	21[5] mg/L	-	-	-	32.6[14] mg/L

Table 1.4-2
Summary of FES and Subsequent Sampling Results For Cottonwood Wash and Westwater Creek

Parameter	FES Cottonwood Wash (7/25/77-3/28/78)*	Cottonwood Wash (9/16/81-6/20/09)	Cottonwood Wash 2010	Cottonwood Wash 2011	Cottonwood Wash 2012	Cottonwood Wash 2013	Cottonwood Wash 2014	Cottonwood Wash 2015	FES Westwater Creek (11/10/77-3/23/78)*	Westwater Creek (2/22/82-6/20/09)	Westwater Creek 2010	Westwater Creek 2011	Westwater Creek 2012	Westwater Creek 2013	Westwater Creek 2014	Westwater Creek 2015
Sodium	-	18 to 104*	-	-	-	-	-	-	-	160.5*	-	-	-	-	-	-
Sodium, dissolved	21 to 66	205 mg/L	214[3] mg/L	227 - 229[5] mg/L	247[7] mg/L	217[10] mg/L	227[12] mg/L	251[14] mg/L	31 to 60	196 mg/L	160[3] mg/L	112[5] mg/L	-	-	-	139[14] mg/L
Silver, dissolved	0.002 to <0.005	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	<0.005 to 0.006	ND	ND[3]	ND[5]	-	-	-	ND[14]
Sulfate, dissolved (as SO_4)	39.7 to 564	57 to 245*	389[3] mg/L	389 - 394[5] mg/L	356[7] mg/L	403[10] mg/L	417[12] mg/L	442[14] mg/L	85 to 163	408*	607[3] mg/L	354[5] mg/L	-	-	-	392[14] mg/L
Vanadium, dissolved	<0.005 to <0.018	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	<0.001 to 0.008	ND	ND[3]	34 ug/L[5]	-	-	-	ND[14]
Manganese, dissolved	0.02 to 0.84	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	0.03 to 0.60	37 ug/L	87[3] ug/L	268[5] ug/L	-	-	-	0.171[14] mg/L
Chromium, total	<0.01 to 0.14	-	-	-	-	-	-	-	<0.01 to 0.60	-	-	-	-	-	-	-
Chromium, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Copper, total	0.005 to 0.09	-	-	-	-	-	-	-	<0.005 to 0.05	-	-	-	-	-	-	-
Copper, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	16[5] ug/L	-	-	-	ND[14]
Cobalt, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Fluoride, dissolved	0.2 to 0.36	0.4 mg/L	0.38[3] mg/L	0.34 - 0.38[5] mg/L	0.38[7] mg/L	0.417[10] mg/L	ND[12]	0.318[14] mg/L	0.2 to 0.4	0.7 mg/L	0.60[3] mg/L	0.54[5] mg/L	-	-	-	0.424[14] mg/L
Iron, total	5.9 to 150	-	-		-	-	-	-					-	-	-	-
Iron, dissolved	0.11 to 1.9	ND	ND[3]	ND - 53[5]	ND[7]	ND[10]	ND[12]	ND[14]	0.17 to 2.5	89 ug/L	56[3] ug/L	4540[5] ug/L	-	-	-	ND[14]
Lead, total	0.05 to 0.14	-	-	-	-	-	-		<0.05 to 0.1	-	-	-	-	-	-	-
Lead, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	41.4[5] ug/L	-	-	-	ND[14]
Magnesium	-	10.5 to 38.1*	-	-	-	-	-	-	-	23.5*	-	-	-	-	-	-
Magnesium, dissolved	17 to 28	25 mg/L	24.8[3] mg/L	25.2[5] mg/L	27.7[7] mg/L	23.6[10] mg/L	29.0[12] mg/L	27.4[14] mg/L	13 to 26	-	44.7[3] mg/L	34.7[5] mg/L	-	-	-	34.0[14] mg/L
Mercury, total	0.00006 to 0.002	-	-	-	-	-	-	-	<0.00003 to <0.0005	-	-	-	-	-	-	-
Mercury, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Molybdenum, dissolved	0.002 to 0.10	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	0.002 to 0.006	ND	29[3] ug/L	ND[5]	-	-	-	ND[14]
Nitrate (as N)	0.12 to 1.77	0.1 mg/L	ND[3]	0.1 mg/L[5]	ND[7]	ND[10]	ND[12]	ND[14]	<0.05 to 0.05	0.8 mg/L	ND[3]	ND[5]	-	-	-	ND[14]
Nickel, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	-	ND[3]	29 ug/L[5]	-	-	-	ND[14]
Phosphorus, total (as P)	0.05 to 3.2	-	-	-	-	-	-	-	0.05 to 0.88	-	-	-	-	-	-	-
Potassium, dissolved	1.2 to 6.9	1.77 to 4 mg/L	5.77[3] mg/L	5.9 – 6.0[5] mg/L	6.27[7] mg/L	5.53[10] mg/L	6.18[12] mg/L	5.91[14] mg/L	2.0 to 3.2	4.05*	6.57[3] mg/L	3.9[5] mg/L	-	-	-	1.98[14] mg/L
Selenium, dissolved	<0.005 to 0.08	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	<0.005 to 0.003	ND	ND[3]	ND[5]	-	-	-	ND[14]
Silica, dissolved (as SiO_2)	8 to 18	-	-	-	-	-	-	-	7 to 11	-	-	-	-	-	-	-
Strontium, total	0.34 to 0.64	-	-	-	-	-	-	-	0.44 to 0.76	-	-	-	-	-	-	-
Thallium, dissolved	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Tin, dissolved	-	-	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Uranium, total	0.004 to 0.27	-	-	-	-	-	-	-	0.006 to 0.004	-	-	-	-	-	-	-
Uranium, dissolved	0.004 to 0.015	8.42 ug/L	8.24[3] ug/L	7.87 - 8.68[5] ug/L	8.17[7] ug/L	8.95[10] ug/L	9.62[12] ug/L	9.12[14] mg/L	0.002 to 0.015	15.1 ug/L	46.6[3] ug/L	6.64[5] ug/L	-	-	-	2.10[14] mg/L
Zinc, dissolved	0.008 to 0.06	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	0.04 to 0.12	ND	22[3] ug/L	28[5] ug/L	-	-	-	ND[14]
Total Organic Carbon	7 to 12	-	-	-	-	-	-	-	6 to 16	-	-	-	-	-	-	-
Chemical Oxygen Demand	61 to 163	-	-	-	-	-	-	-	23 to 66	-	-	-	-	-	-	-
Oil and Grease	2	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-

Table 1.4-2
Summary of FES and Subsequent Sampling Results For Cottonwood Wash and Westwater Creek

Parameter	FES Cottonwood Wash (7/25/77-3/28/78)*	Cottonwood Wash (9/16/81-6/20/09)	Cottonwood Wash 2010	Cottonwood Wash 2011	Cottonwood Wash 2012	Cottonwood Wash 2013	Cottonwood Wash 2014	Cottonwood Wash 2015	FES Westwater Creek (11/10/77-3/23/78)*	Westwater Creek (2/22/82-6/20/09)	Westwater Creek 2010	Westwater Creek 2011	Westwater Creek 2012	Westwater Creek 2013	Westwater Creek 2014	Westwater Creek 2015
Total Suspended Solids	146 to 2,025	0 to 24,300*	19 - 5880[4] mg/L	ND - 8860[6] mg/L	15 – 1260[8] mg/L	6 – 21800[10,11] mg/L	12 – 7500[12] mg/L	28 – 2600[15] mg/L	12 to 1940	<4 to 1,190*	13[4] mg/L	ND[6]	-	-	-	4390[15] mg/L
Total Dissolved Solids	253 to 944	10 to 1,130*	202 – 900[3,4] mg/L	425 – 1030[5,6] mg/L	224 – 1040[7,8] mg/L	287 – 996[10,11] mg/L	271 – 968[12] mg/L	218 – 1020[14,15] mg/L	496 to 969	93-1370*	1140 – 1270[3,4] mg/L	853[5]	-	-	-	337 – 896[14,15] mg/L
Gross Alpha	-	<1.0E-9 to 9.0E-7*	-	-	-	-	-	-	1E-10 to 4.5E-9	<1.0E-9*	-	-	-	-	-	-
Gross Alpha minus Rn & U	-	-	ND – 2.0[3,4] pCi/L	ND[5,6]	ND – 3.1[7,8] pCi/L	ND – 10.8[10,11] pCi/L	ND – 13.0[12,13] pCi/L	ND – 14.8[14,15] pCi/L	-	-	ND[3,4] pCi/L	ND - 0.5[5] pCi/L	-	20.4[11] pCi/L	7.5[13] pCi/L	ND – 2.2[14,15] pCi/L
Gross Beta	-	-	-	-	-		-	-	0 to 8E-9	-	-	-	-	-	-	-
Uranium, dissolved	1.02E-9 to 2.79E-9	2.23E-9 to 6.02E-6*	0.0060 – 0.0116[3,4] mg/L	0.00787 – 0.0102[5,6] mg/L	0.0017 - 0.00817[7,8] mg/L	0.0084 - 0.0090[10,11] mg/L	ND - 0.009620[12,13] mg/L	0.0022 – 0.00912[14,15] mg/L	1.03E-9 to 1.35E-9	8.8E-7*	0.0057 – 0.0466[3,4] mg/L	ND – 0.00664[5,6] mg/L	-	0.0108[11] mg/L	0.0046[13] mg/L	0.0013 – 0.0021[14,15] mg/L
Uranium, total[2]	21.83E-7	-	-	-	-	-	-	-	6.09E-7	-	-	-	0.08[8,9] mg/kg	-	-	-
Uranium, suspended	-	<2.0E-10 to 2.0E-7*	ND - 0.0014[4] mg/L	ND[6]	0.0035[8] mg/L	ND – 0.0005[11] mg/L	ND[13]	0.0004 – 0.0069[14,15] mg/L	0 to 1E-9	6.09E-7*	0.0005[4] mg/L	0.0014[6] mg/L		0.0176[11] mg/L	0.0017[13] mg/L	0.0026[15] mg/L
Th-230, dissolved	-	<2.0E-10 to 4.14E-6*	ND - 0.05[4] pCi/L	ND[6]	7.2[8] pCi/L	ND[11]	ND[13]	ND[15]	-	<2.0E-10*	ND[4] pCi/L	ND[6]	-	0.02[11] pCi/L	ND[13]	ND[15]
Th-230, suspended	-	<2.0E-10 to <9.0E-7*	ND - 0.7[4] pCi/L	ND[6]	3.1[8] pCi/L	ND – 0.2[11] pCi/L	0.1[13] pCi/L	ND – 2.0[15] pCi/L	2E-10	3.0E-10*	0.2[4] pCi/L	0.7 pCi/L[6]	-	8.7[11] pCi/L	1.1[13] pCi/L	1.2[15] pCi/L
Ra-226, dissolved	-	<2.0E-10 to 2.0E-9*	0.26 – 1.8[4] pCi/L	ND[6]	0.53[8] pCi/L	0.16 – 1.8[11] pCi/L	0.39[13] pCi/L	0.05 – 7.8[15] pCi/L	-	2.0E-10*	0.18[4] pCi/L	ND[6]	-	0.68[11] pCi/L	0.24[13] pCi/L	0.49[15] pCi/L
Ra-226, suspended	-	<2.0E-10 to <2.0E-7*	ND - 1.3[4] pCi/L	ND[6]	4.4[8] pCi/L	ND – 0.68[11] pCi/L	ND[13]	0.39 – 6.7[15] pCi/L	7E-10 to 1.1E-9	<2.0E-10*	4.3[4] pCi/L	0.3 pCi/L[6]	-	28[11] pCi/L	6.5[13] pCi/L	3.4[15] pCi/L
Ra-226, total	-	-	-	-	-	-	-	-	-	-	-	-	0.05[8,9] pCi/g	-	-	-
Pb-210	-	-	-	-	-	-	-	-	0 to 1E-10	-	-	-	-	-	-	-
Acetone	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Benzene	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Carbon Tetrachloride	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Chloroform	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Chloromethane	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Methyl ethyl ketone	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Methylene chloride	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Napthalene	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Toluene	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]
Xylenes, total	-	ND	ND[3]	ND[5]	ND[7]	ND[10]	ND[12]	ND[14]	-	ND	ND[3]	ND[5]	-	-	-	ND[14]

Source: FES Table 2.22 and Mill Sample Data
*Data are from historical sampling events. All other data were collected during the 2009 annual Seeps and Springs and Semi-Annual Effluent Report (SAER) sampling events.
[2] Calculated by EFRI for activity comparison using the Specific Activity for U-nat (6.77E-7 Ci U-nat/g U-nat)
[3] Data are from the 2010 Seeps and Springs sampling event.
[4] Data are from 2010 SAER sampling events.
[5] Data are from 2011 Seeps and Springs sampling event.
[6] Data are from 2011 SAER quarterly sampling events.
[7] Data are from 2012 Seeps and Springs sampling event.
[8] Data are from 2012 SAER quarterly sampling events.
[9] Sediment samples are collected in the 4th quarter in lieu of surface water when Westwater Creek is dry throughout the year.
[10] Data are from 2013 Seeps and Springs sampling event.
[11] Data are from 2013 SAER quarterly sampling events.
[12] Data are from 2014 Seeps and Springs sampling event.
[13] Data are from 2014 SAER quarterly sampling events.
[14] Data are from 2015 Seeps and Springs sampling event.
[15] Data are from 2015 SAER quarterly sampling event.

1.5 Groundwater

Groundwater investigation and monitoring at the Mill focus on the perched groundwater zone, which is the shallowest groundwater encountered beneath the site. Although this section focuses primarily on the perched water zone, deeper groundwater is discussed as needed, and the site geology is addressed to the extent necessary for interpretive context. A more extensive discussion of site geology is provided in Section 1.6.

Sections 1.5.1 and 1.5.2 are based primarily on the following reports prepared by Hydro Geo Chem, Inc. ("HGC"): *Hydrogeology of the Perched Groundwater Zone and Associated Seeps and Springs Near the White Mesa Uranium Mill Site* (HGC, 2010b), and *Hydrogeology of the White Mesa Uranium Mill, Blanding, Utah* (HGC, 2014). Information abstracted from these reports presented here is updated with information collected subsequent to June 6, 2014.

HGC (2010b) and HGC (2014) supplement the "HGC 2009" report summarized in Revision 4.0 of the Reclamation Plan. They provide additional information in response to requirements set out in previous revisions of the GWDP and Part 1F.10 of the current GWDP dated August 24, 2012. Specifically, the additional information contained in HGC (2010b) and HGC (2014) include data on seeps and springs in the vicinity of the Mill, the relationship of the seeps and springs with the perched water system, and estimated travel times for shallow groundwater to travel from the tailings cells to the nearest discharge points. This information addresses requirements set out in previous revisions of the GWDP and Part 1F.10 of the current GWDP dated August 24, 2012. HGC (2014) contains refined estimates of shallow groundwater travel times downgradient of the tailings cells based on data collected from DR-series piezometers installed south, southwest, and west of the tailings cells in 2011, as described in *Second Revision, Hydrogeology of the Perched Groundwater Zone in the Area Southwest of the Tailings Cells, White Mesa Uranium Mill Site, Blanding Utah* (HGC 2012b; the "southwest area investigation" report).

Sections 1.5.3, 1.5.5, and 1.5.6 are based primarily on groundwater sampling programs at the Mill and Section 1.5.4 is based primarily on the analysis of groundwater analytical data by INTERA, Inc. (INTERA). INTERA performed extensive analysis of background perched water quality data and established site-specific groundwater compliance limits ("GWCLs"). Reports detailing work by INTERA include *Revised Background Groundwater Quality Report: Existing Wells For Denison Mines (USA) Corp.'s White Mesa Mill Site, San Juan County, Utah* (INTERA 2007a), and subsequent reports, as discussed in Section 1.5.4.

1.5.1 Groundwater Characteristics

Groundwater investigations at the Mill have been ongoing for more than 38 years, beginning with the initial investigation by Dames and Moore in 1977 and 1978 (Dames and Moore 1978a and 1978b). The initial investigation by Dames and Moore pre-dated Mill construction and operation.

Although more than 35 years of perched groundwater monitoring at the Mill indicates that tailings cell operation has not impacted perched groundwater (as will be discussed in Section 1.5.4), perched groundwater was impacted by disposal of laboratory wastes to two (now abandoned) sanitary leach fields (prior to about 1980) before the Mill and tailings cells were operational. Disposal of laboratory wastes is considered the source of a chloroform plume (defined by concentrations greater than 70 micrograms per liter [μg/L]) located upgradient to cross-gradient (northeast to east) of the tailings cells. A nitrate plume (defined by concentrations greater than 10 milligrams per liter [mg/L]) that contains elevated chloride (exceeding 100 mg/L) extends from upgradient (northeast) of the tailings cells to a portion of the area beneath the tailings cells. The precise source(s) of the nitrate plume are not well defined; however, because the majority of the plume exists upgradient (northeast) of the tailings cells, the sources must be located upgradient (northeast) of the tailings cells. Based on the investigation and source evaluations, there are no known current unidentified or unaddressed sources. There appear to have been a number of known and potential historical sources; however, it has not been possible to confirm or quantify the contribution of each source.

The northwest portion of the chloroform plume commingles with the nitrate plume. Both chloroform and nitrate plumes are under corrective action by pumping.

1.5.1.1 Geologic Setting

The Mill is located within the Blanding Basin of the Colorado Plateau physiographic province. Typical of large portions of the Colorado Plateau province, the rocks underlying the site are relatively undeformed. The average site elevation is approximately 5,600 ft (1,707 m) above mean sea level (amsl).

The site is underlain by unconsolidated alluvium and indurated sedimentary rocks consisting primarily of sandstone and shale. The indurated rocks are relatively flat lying with dips generally less than 3 degrees. The alluvial materials consist mostly of aeolian silts and fine-grained aeolian sands with a thickness varying from a few feet to as much as 25 to 30 ft (7.6 to 9.1 m) across the site. The alluvium is underlain by the Dakota Sandstone and Burro Canyon Formation, which are sandstones with a total thickness ranging from approximately 55 to 140 ft (17 to 43 m). Beneath the Burro Canyon Formation lies the Morrison Formation, consisting (in descending order) of the Brushy Basin Member, the Westwater Canyon Member, the Recapture Member, and the Salt Wash Member. Kirby (2008) indicates that the contact between the Morrison Formation and the Burro Canyon Formation (between the Brushy Basin Member of the Morrison and the Burro Canyon Formation) near Blanding, Utah is disconformable with "local erosional relief of several feet". Data collected from perched borings at the site that penetrate the Brushy Basin Member are consistent with a disconformable, erosional contact in agreement with Kirby (2008).

The Brushy Basin and Recapture Members of the Morrison Formation, classified as shales, are fine-grained and have a low permeability. The Westwater Canyon and Salt Wash Members also have a low average vertical permeability due to the presence of interbedded shales. See Figure 1.5-1 for a generalized stratigraphic column for the region.

Beneath the Morrison Formation lies the Summerville Formation, an argillaceous sandstone with interbedded shales, and the Entrada Sandstone. Beneath the Entrada Sandstone lies the Navajo Sandstone. The Navajo and Entrada Sandstones constitute the primary aquifer in the area of the site. The Entrada and Navajo Sandstones are separated from the Burro Canyon Formation by approximately 1,000 to 1,100 ft (305 to 335 m) of materials with a low average vertical permeability. Groundwater within this system is under artesian pressure in the vicinity of the site, and is used only as a secondary source of water at the site. Water in WW-series supply wells completed across these sandstone units at the site rises approximately 800 feet above the base of the overlying Summerville Formation (Titan, 1994a).

Insert

Figure 1.5-1 Generalized Stratigraphy of White Mesa Mill (Adapted from the 2007 ER, Figure 3.7-1)

1.5.1.2 Hydrogeologic Setting

The site is located within a dry to arid continental climate region with an average annual precipitation of less than 13.3 in. and an annual lake evaporation rate of approximately 47.6 inches. Recharge to aquifers (such as the Entrada/Navajo) occurs primarily along the mountain fronts (for example, the Henry, Abajo, and La Sal Mountains), and along the flanks of folds such as Comb Ridge Monocline.

The Entrada/Navajo aquifer can yield significant quantities of water to wells (hundreds of gallons per minute [gpm]). Although the water quality and productivity of the Entrada/Navajo aquifer are generally good, the depth of the aquifer (approximately 1,200 ft below land surface [bls]) makes access difficult.

1.5.1.3 Perched Zone Hydrogeology

Perched groundwater beneath the site occurs primarily within the Burro Canyon Formation, although in areas having greater saturated thicknesses, perched groundwater extends into the overlying Dakota Sandstone. Perched groundwater originates mainly from precipitation and local recharge sources such as unlined reservoirs (Kirby, 2008). Perched groundwater at the site has a generally low quality due to high total dissolved solids (TDS) and is used primarily for stock watering and irrigation in the areas upgradient (north) of the site. As of the first quarter of 2016, TDS concentrations measured in water sampled from on-site perched monitoring wells range between approximately 1,000 and 8,300 mg/1. The saturated thickness of the perched water zone generally increases to the north of the site, increasing the yield of the perched zone to wells installed north of the site. Perched water is supported within the Burro Canyon Formation by the underlying, fine-grained Brushy Basin Member.

The Brushy Basin Member is primarily composed of bentonitic mudstones, siltstones, and claystones and is considered an aquiclude. Figure 1.5-2 is a contour map showing the approximate elevation of the contact of the Burro Canyon Formation with the Brushy Basin Member, which essentially forms the base of the perched water zone at the site. The elevations of Ruin Spring and Westwater Seep, which occur at the contact between the Brushy Basin Member and the Burro Canyon Formation, are included in the contouring. Abandoned borings/wells, monitoring wells, and piezometers shown on Figure 1.5-2 consist of surveyed perched zone monitoring wells and piezometers that include temporary perched zone borings and monitoring wells associated with the chloroform and nitrate plumes located east and northeast (cross gradient to upgradient) of the tailings cells. TW-4-series wells, MW-4, MW-26, and MW-32 are chloroform program wells and TWN-series wells are nitrate program wells. Contact elevations are based on monitoring well drilling and geophysical logs and surveyed land surface elevations.

As indicated on Figure 1.5-2, the contact generally dips to the south/southwest beneath the site. A structural high that is evident in the Brushy Basin Member/Burro Canyon Formation contact extends from beneath Cell 4B southwest to the vicinity of abandoned boring DR-18. A paleovalley in the Brushy Basin Member surface is present along the western mesa rim to the west of the structural high.

The permeability of the Dakota Sandstone and Burro Canyon Formation at the site is generally low. No significant joints or fractures within the Dakota Sandstone or Burro Canyon Formation have been documented in any wells or borings installed across the site (Knight Piésold, 1998). Any fractures observed in cores collected from site borings are typically cemented, showing no open space.

Insert

Figure 1.5-2 Approximate Elevation of Top of Brushy Basin

Based on samples collected during installation of wells MW-16 (immediately downgradient of tailings cell 3 and abandoned prior to construction of cell 4B) and MW-17 (cross-gradient of the tailings cells complex (Figure 1.5-2)), porosities of the Dakota Sandstone range from 13.4 percent to 26 percent, averaging 20 percent. Water saturations range from 3.7 percent to 27.2 percent, averaging 13.5 percent. The average volumetric water content is approximately 3 percent. The hydraulic conductivity of the Dakota Sandstone, based on packer tests in borings installed at the site, ranges from 2.71E-06 centimeters per second (cm/s) to 9.12E-04 cm/s, with a geometric average of 3.89E-05 cm/s (Titan, 1994a).

The average porosity of the Burro Canyon Formation is similar to that of the Dakota Sandstone. Based on samples collected from the Burro Canyon Formation at MW-16 (abandoned), porosity ranges from 2 percent to 29.1 percent, averaging 18.3 percent. Water saturations of unsaturated materials range from 0.6 percent to 77.2 percent, averaging 23.4 percent. Titan (1994a) reported that the hydraulic conductivity of the Burro Canyon Formation ranges from 1.9E-07 to 1.6E-03 cm/s, with a geometric mean of 1.1E-05 cm/s, based on the results of 12 pump/recovery tests performed in monitoring wells and 30 packer tests performed in borings prior to 1994.

Subsequent hydraulic testing of perched zone wells yielded a site-wide hydraulic conductivity range of 2 x 10^{-8} to 0.01 cm/s (HGC, 2014). In general, the highest permeabilities and well yields are immediately northeast and east (upgradient to cross gradient) of the tailings cells. A relatively continuous, higher permeability zone (associated with poorly indurated coarser-grained materials in the general area of the chloroform plume) has been inferred to exist in this portion of the site. Analysis of drawdown data collected from this zone during long-term pumping of MW-4, MW-26 (formerly TW4-15), and TW4-19 yielded estimates of hydraulic conductivity ranging from 4E-05 to 1E-03 cm/s. The decrease in perched zone permeability south, southwest, and southeast of TW4-4, based on hydraulic tests at TW4-6, TW4-23, TW4-26, TW4-27, TW4-29 through TW4-31, and TW4-33 through TW4-35 indicate that this higher permeability zone “pinches out”.

Hydraulic tests performed at groups of wells and piezometers located northeast (upgradient) of, in the immediate vicinity of, and southwest (downgradient) of the tailings cells indicate generally lower permeabilities compared with the area of the chloroform plume. The following results from HGC (2014) are based on analysis of automatically logged slug test data using the KGS solution available in AQTESOLVE (HydroSOLVE, 2000).

Testing of 19 TWN-series wells installed in the northeast portion of the site as part of nitrate investigation activities yielded a hydraulic conductivity range of approximately 3.6 x 10^{-7} to 0.01 cm/s with a geometric average of approximately 6 x 10^{-5} cm/s. The value of 0.01 cm/s estimated for TWN-16 is the highest measured at the site, and the value of 3.6 x 10^{-7} cm/s estimated for TWN-7 is one of the lowest measured at the site. Testing of MW-series wells MW-23 through MW-32 installed between and at the margins of the tailings cells in 2005 (and using the higher estimate for MW-23) yielded a hydraulic conductivity range of approximately 2 x 10^{-7} to 1 x 10^{-4} cm/s with a geometric average of approximately 2 x 10^{-5} cm/s. Hydraulic tests conducted at DR-series piezometers installed as part of the southwest area investigation downgradient of the tailings cells yielded hydraulic conductivities ranging from approximately 2 x 10^{-8} to 4 x 10^{-4} cm/s with a geometric average of 9.6 x 10^{-6} cm/s. The low permeabilities and shallow hydraulic gradients downgradient of the tailings cells result in average perched groundwater pore velocity estimates that are among the lowest on site (approximately 0.26 feet per year (ft/yr) to 0.91 ft/yr).

The extensive hydraulic testing of perched zone wells at the site indicates that perched zone permeabilities are generally low with the exception of the apparently isolated zone of higher permeability associated with the chloroform plume east to northeast (cross-gradient to upgradient) of the tailings cells. The geometric average hydraulic conductivity (less than 1 x 10^{-5} cm/s) of the DR-series piezometers which cover an area nearly half the size of the total monitored area at White Mesa (excluding MW-22), is nearly identical to the geometric average hydraulic conductivity of 1.01 x 10^{-5} cm/s reported by Titan (1994a), and is within the range of 5 to 10 feet per year (ft/yr) [approximately 5 x 10^{-6} cm/s to 1 x 10^{-5} cm/s] reported by Dames and Moore (1978b) for the (saturated) perched zone during the initial site investigation.

Because of the generally low permeability of the perched zone beneath the site, well yields are typically low (generally less than 0.5 gpm). Many of the perched monitoring wells purge dry and take several hours to more than a day to recover sufficiently for groundwater samples to be collected. Sufficient productivity can generally be obtained only in areas where the saturated thickness is greater, which is the primary reason that the perched zone has been used on a limited basis as a water supply to the north (upgradient) of the site, but has not been used downgradient of the site. Within areas on the east side of the site that have greater saturated thicknesses due to proximity to the two northern wildlife ponds, and that intercept the higher permeability materials associated with the chloroform plume, well yields of as much as 4 gpm were achievable. However, since water delivery to the two northern wildlife ponds ceased in 2012, saturated thicknesses and well productivities in this area have diminished. As of the fourth quarter of 2015, sustainable, average pumping rates at chloroform and nitrate pumping wells ranged from less than 0.1 to approximately 1 gpm

1.5.1.4 Perched Groundwater Flow

Perched groundwater flow at the site is generally from northeast to southwest. Figure 1.5-3 displays the local perched groundwater elevation contours at the Mill, as measured in the first quarter of 2016. Depression of the perched water table occurs near chloroform pumping wells MW-4, MW-26, TW4-1, TW4-2, TW4-4, TW4-11, TW4-19, TW4-20, TW4-21, TW4-22 and TW4-37, and near nitrate pumping wells TW4-22, TW4-24, TW4-25, and TWN-2. These wells are pumped to reduce chloroform and nitrate mass in the perched zone east and northeast of the tailings cells. As shown on Figure 1.5-3, beneath and south of the tailings management cells, in the west central portion of the site, perched water flow is south-southwest to southwest. Flow on the western margin of the mesa is generally south, approximately parallel to the rim (where the Burro Canyon Formation [and perched water zone] is terminated by erosion). On the eastern side of the site perched water flow is also generally to the south. Because of mounding near wildlife ponds, flow direction ranges locally from westerly (west of the ponds) to easterly (east of the ponds).

Dry areas in the perched zone southwest of the tailings management cells occur along the structural high in the Brushy Basin Member/Burro Canyon Formation contact that extends from beneath tailings cell 4B southwest to the vicinity of abandoned boring DR-18. In places along this structural high the contact rises above the perched water elevation creating the dry areas shown on Figure 1.5-3.

An apparent groundwater divide occurs west of Cell 4B near DR-2. Water north of the apparent divide flows primarily north-northeast to Westwater Seep and water south of the apparent divide flows south toward Ruin Spring.

Insert

Figure 1.5-3 Kriged 1st Quarter, 2016 Water Levels

Perched zone hydraulic gradients currently range from a maximum of approximately 0.096 ft/ft east of tailings cell 2 (north of pumping well TW4-11) to approximately 0.0042 ft/ft west-southwest of Cell 4B (between DR-7 and DR-5). The overall average site hydraulic gradient of approximately 0.011 ft/ft (between TWN-19 and Ruin Spring) is similar to the average hydraulic gradient downgradient of the tailings management cells of approximately 0.012 ft/ft (between MW-37 and Ruin Spring).

1.5.1.5 Perched Zone Hydrogeology Beneath and Downgradient of The Tailings Management Cells

Based on measurements at non-pumping wells, 1st Quarter, 2016 perched water depths ranged from approximately 32 feet in the northeastern portion of the site (adjacent to the wildlife ponds) to approximately 114 feet at the southwest margin of Cell 3 (Figure 1.5-4). Based on measurements at non-pumping wells, 1st Quarter, 2016 perched zone saturated thicknesses ranged from approximately 83 ft in the northeast portion of the site to less than 1 ft in the southwest portion of the site (Figure 1.5-5). The relatively large saturated thicknesses in the northeastern portion of the site are related to past seepage from the northern wildlife ponds located northeast of the tailings management cells.

Water levels in DR-22 and chloroform pumping well TW4-11 are below the top of the Brushy Basin Member, yielding saturated thicknesses of zero. Casings in DR-22 and TW4-11 extend approximately 2.5 feet and 11.5 feet, respectively, below the Brushy Basin Member contact. Although water is present in the bottom of the DR-22 casing, the level is below the Brushy Basin contact. The water level in TW4-11 is maintained at or below the Brushy Basin contact by pumping.

Areas of small saturated thickness (less than 5 feet) occur west and southwest of the tailings management cells. As shown in Figures 1.5-4 and 1.5-5, an area of small saturated thickness extends between Westwater Seep and the southwest portion of Cell 4B, encompassing DR-6 and DR-10. As discussed in HGC (2014), perched water flows westward from the area of the tailings cells through the area of low saturated thickness between DR-6 and DR-10, into an area having saturated thicknesses several times larger than at DR-6 and DR-10. The transmissivity (the product of hydraulic conductivity and saturated thickness) of the area of low saturated thickness is two to three orders of magnitude lower than for the area of larger saturated thickness to the west (near DR-2 [abandoned], DR-5, and DR-9). Water flows out of the area of larger saturated thickness (near DR-2 [abandoned] and DR-5) to the northeast toward known discharge point Westwater Seep and to the south through a paleovalley in the Brushy Basin Member surface towards known discharge point Ruin Spring. The relationship between perched water and seeps and springs is discussed in more detail in Section 1.5.2.

Darcy's Law calculations presented in HGC (2014) indicate that an additional water source is needed to maintain the relatively large saturated thicknesses west of the area of low saturated thickness encompassing DR-6 and DR-10; otherwise Westwater Seep and the paleovalley to the south would drain the area of larger saturated thickness more quickly than water was supplied. The most likely source of additional water to the area of larger saturated thickness is infiltration of precipitation.

Insert

Figure 1.5-4 1st Quarter, 2016 Depths to Perched Water (from Measuring Point)

Insert

Figure 1.5-5 1st Quarter, 2016 Perched Zone Saturated Thicknesses

As discussed above, perched zone hydraulic gradients currently range from a maximum of approximately 0.096 feet per foot (ft/ft) east of Cell 2 to approximately 0.0042 ft/ft west-southwest of the tailings management cells, between DR-7 and DR-5. The average hydraulic gradient between the downgradient edge of tailings Cell 4B and Ruin Spring is approximately 0.012 ft/ft, similar to the overall site hydraulic gradient (between TWN-19 and Ruin Spring) of approximately 0.011 ft/ft. The combination of relatively low hydraulic conductivities (geometric average of approximately 1 x 10^{-5} cm/s) and relatively flat hydraulic gradients downgradient of the tailings management cells imply small groundwater velocities and large travel times.

1.5.2 Seep and Spring Occurrence and Hydrogeology

Perched groundwater discharges in seeps and springs located to the west, south, east, and southeast of the site along the margins of White Mesa.

All seeps and springs examined have associated cottonwood trees that suggest a relatively consistent source of water. Seeps and springs occurring at the margins of White Mesa are typically associated with sandstones of the Burro Canyon Formation, except Cottonwood Seep, which is associated with the lower portion of the Brushy Basin Member of the Morrison Formation. Figure 1.5-6 shows the December 2009 surveyed locations of seeps and springs and the Frog Pond. As shown on Figure 1.5-6, all springs and seeps are located within drainages, and except for Cottonwood Seep, are located at the mesa margins. Table 1.5-1 provides surveyed locations and elevations of the seeps and springs and the Frog Pond. The December 2009 seep and spring survey data shown in Table 1.5-1 were used in subsequent reporting where seep and spring locations and elevations were relevant.

Table 1.5-1
Surveyed Locations and Elevations of Seeps and Springs and the Frog Pond
(December 2009)

Location	Latitude (N)	Longitude (W)	Elevation
FROG POND	37°33'03.5358"	109°29'04.9552"	5589.56
CORRAL CANYON	37°33'07.1392"	109°29'12.3907"	5623.97
ENTRANCE	37°32'01.6487"	109°29'33.7005"	5559.71
CORRAL SPRINGS	37°29'37.9192"	109°29'35.8201"	5383.35
RUIN SPRING	37°30'06.0448"	109°31'23.4300"	5380.03
COTTONWOOD	37°31'21.7002"	109°32'14.7923"	5234.33
WEST WATER	37°31'58.5020"	109°31'25.7345"	5468.23
Re-Surveyed July 2010			
RUIN SPRING	37°30'06.0456"	109°31'23.4181"	5380.01
COTTONWOOD	37°31'21.6987"	109°32'14.7927"	5234.27
WEST WATER	37°31'58.5013"	109°31'25.7357"	5468.32

Insert

Figure 1.5-6 Seeps and Springs on USGS Topographic Base, White Mesa (Adapted from HGC, 2014, Figure E.1)

As discussed in Section 1.1.5.4, Figure 1.5-3 shows first quarter 2016 perched water level contours and the locations and elevations of seeps and springs. Perched water level contours are based on water levels measured in the perched groundwater monitoring wells shown on Figure 1.5-3, and include elevations of all seeps and springs except Cottonwood Seep. Based on Figure 1.5-3, Corral Canyon Seep is located upgradient of the tailings management cells, and Entrance Spring and Corral Springs are located cross gradient of the tailings management cells. Both Entrance Spring and Corral Springs are separated from the tailings management cells by a groundwater divide. Westwater Seep is the closest discharge point west of the tailings management cells and Ruin Spring is the closest discharge point south-southwest of the tailings management system. Ruin Spring is located downgradient of approximately the southeastern 2/3 of the tailings management system, and Westwater Seep appears to be downgradient of approximately the northwestern 1/3 of the tailings management system. Cottonwood Seep is neither cross gradient nor downgradient of the tailings management cells because it is interpreted to receive water from a source other than the perched groundwater system hosted by the Burro Canyon Formation.

The relationship between seeps and springs and the geology of White Mesa are shown on Figure 1.5-7. The geology on Figure 1.5-7 is based on Kirby (2008) and Hintze, et al. (2000), and has been modified locally by field reconnaissance. The Burro Canyon Formation and the Dakota Sandstone are undifferentiated on the geologic map. As shown on Figure 1.5-7, all seeps and springs except Cottonwood Seep are associated with outcrops of the Burro Canyon Formation (and/or Dakota Sandstone). Some are also associated with mixed eolian and alluvial deposits stratigraphically above the Burro Canyon Formation and/or Dakota Sandstone. Ruin Spring and Westwater Seep are located at the contact between the Burro Canyon Formation and underlying Brushy Basin Member. Westwater Seep (where typically sampled) occurs within alluvium at the Burro Canyon Formation/Brushy Basin Member contact whereas Ruin Spring occurs at the contact but above the alluvium in the associated drainage. Corral Canyon Seep, Entrance Spring, and Corral Springs occur within alluvium near the contact of the alluvium with the Burro Canyon Formation, but at an elevation above the contact between the Burro Canyon Formation and Brushy Basin Member. In contrast, Cottonwood Seep is mapped within the Brushy Basin Member, approximately 1,500 feet west of the termination of the Burro Canyon Formation at the western mesa rim, and stratigraphically more than 200 feet below the contact between the Burro Canyon Formation and Brushy Basin Member.

The Burro Canyon Formation (and perched water zone) does not exist at Cottonwood Seep because it has been eroded. Cottonwood Seep is interpreted to receive water primarily from a source stratigraphically below the Burro Canyon Formation and from a hydrogeologic system other than the perched water system at the site. The primary source of Cottonwood Seep (and “2nd Seep” immediately to the north of Cottonwood Seep) is interpreted to be coarser-grained materials within the lower portion of the Brushy Basin Member or upper portion of the Westwater Canyon Member.

Insert

Figure 1.5-7 Geologic Map on USGS Topographic Base (HGC, 2014 Figure E.2)

Springs occurring within alluvium deposited within drainages cutting the Burro Canyon Formation may or may not receive a contribution from perched water. Except for Ruin Spring (and “2nd Seep” immediately to the north of Cottonwood Seep), each spring and seep occurs in alluvial materials within a drainage that will supply surface water during wet periods and help to recharge any alluvial materials within the drainage as well as bedrock near the drainage. Westwater Seep, Corral Canyon Seep, Entrance Spring, and Corral Springs may therefore receive water from both alluvial and bedrock (perched water) sources. Corral Springs, located immediately downgradient of a stock pond, may receive water primarily from alluvium recharged from the stock pond. Any alluvial materials within the drainage or marginal bedrock that are recharged during precipitation events will likely, at least temporarily, yield water to the seeps.

HGC (2014) discusses the potential for enhanced recharge from precipitation along the mesa margins where Dakota Sandstone and/or Burro Canyon Formation are exposed by erosion. Such recharge is expected to temporarily enhance flow at nearby seeps and springs draining the Burro Canyon Formation and/or Dakota Sandstone. The area of increased saturated thickness west of DR-6 and DR-10 is likely the result of recharge enhanced by the direct exposure of weathered Dakota Sandstone and Burro Canyon Formation, and the thinness or absence of any overlying low permeability materials such as the Mancos Shale (Figure 1.5-7).

Although seep and spring elevations (except Cottonwood Seep) have been included in perched water level contour maps (such as Figure 1.5-3) since the HGC (2010b) investigation, the assumption that the seep or spring elevation is representative of the perched water elevation is likely to be correct only in cases where the feature receives most or all of its flow from the perched water, and where the supply is relatively continuous (for example, Ruin Spring). The uncertainty that results from including seeps and springs in the contouring of perched water levels must be considered when interpreting perched water level data.

Using amethod similar to that presented in HGC (2009a), perched water pore velocities and travel times between the tailings management cells and Ruin Spring and between the tailings management cells and Westwater Seep were calculated in HGC (2014) using first Quarter 2014 water levels. As discussed in more detail in HGC (2014), the calculated travel times between the downgradient margin of cell 4B and Ruin Spring range from approximately 10,650 to 19,650 years. The calculated travel time between the southwest corner of Cell 3 to Westwater Seep is approximately 3,230 years.

1.5.3 Groundwater Quality

1.5.3.1 Entrada/Navajo Aquifer

The Entrada and Navajo Sandstones are relatively prolific aquifers beneath and in the vicinity of the site. Water wells at the site are screened in both of these units, and for the purposes of this discussion they will be treated as a single aquifer. Water in the Entrada/Navajo Aquifer is under artesian pressure, rising 800 to 900 ft above the top of the Entrada’s contact with the overlying Summervillle Formation; static water levels are 390 to 500 ft below ground surface.

Within the region, this aquifer is capable of yielding domestic quality water at rates of 150 to 225 gpm. For that reason, it serves as a secondary source of water for the Mill. Additionally, two domestic water supply wells drawing from the Entrada/Navajo Aquifer are located 4.5 miles southeast of the Mill site on the Ute Mountain Ute Reservation. Although the water quality and productivity of the Navajo/Entrada aquifer are generally good, the depth of the aquifer (greater than1,000 ft bls) makes access difficult.

Table 1.5-2 is a tabulation of groundwater quality of the Navajo Sandstone aquifer as reported in the FES and subsequent sampling. TDS ranges from 216 to 1,110 mg/l in three samples taken over a period from January 27, 1977, to May 4, 1977. High iron concentrations are found in the Navajo Sandstone. Because the Navajo Sandstone aquifer is isolated from the perched groundwater zone by approximately 1,000 to 1,100 ft of materials having a low average vertical permeability, sampling of the Navajo Sandstone is not required under the Mill's previous NRC Point of Compliance monitoring program or under the GWDP. However, samples were taken at two other deep aquifer wells (#2 and #5) on site (see Figure 1.5-8 for the locations of these wells), on June 1, 1999 and June 8, 1999, respectively, and the results are included in Table 1.5-2.

Table 1.5-2
Water Quality of the Navajo Sandstone Aquifer in the Mill Vicinity

Parameter	FES, Test Well (G2R) (1/27/77 - 3/23/78[1])	Well #2 6/01/99[1]	Well #5 6/08/99[1]
Field Specific Conductivity (umhos/cm)	310 to 400		
Field pH	6.9 to 7.6		
Temperature (ºC)	11 to 22		
Estimated Flow m/hr (gpm)	109(20)		
pH	7.9 to 8.16		
Determination, mg/liter			
TDS (@180ºC)	216 to 1110		
Redox Potential	211 to 220		
Alkalinity (as $CaCOS_3$)	180 to 224		
Hardness, total (as $CaCO_3$)	177 to 208		
Bicarbonate		226	214
Carbonate (as CO_3)	0.0	<1.0	<1.0
Aluminum		0.003	0.058
Aluminum, dissolved	<0.1		
Ammonia (as N)	0.0 to 0.16	<0.05	<0.05
Antimony		<0.001	<0.001
Arsenic, total	.007 to 0.014	0.018	<0.001
Barium, total	0.0 to 0.15	0.119	0.005
Beryllium		<0.001	<0.001
Boron, total	<0.1 to 0.11		
Cadmium, total	<0.005 to 0.0	<0.001	0.018
Calcium		50.6	39.8
Calcium, dissolved	51 to 112		
Chloride	0.0 to 50	<1.0	2.3
Sodium		7.3	9.8
Sodium, dissolved	5.3 to 23		
Silver		<0.001	<0.001
Silver, dissolved	<0.002 to 0.0		
Sulfate		28.8	23.6
Sulfate, dissolved (as SO_4)	17 to 83		
Vanadium		0.003	0.003
Vanadium, dissolved	<.002 to 0.16		
Manganese		0.011	0.032
Manganese, dissolved	0.03 to 0.020		
Chromium, total	0.02 to 0.0	0.005	0.005
Copper, total	0.005 to 0.0	0.002	0.086
Fluoride		0.18	0.18
Fluoride, dissolved	0.1 to 0.22		

[1] Zero values (0.0) are below detection limits.

Table 1.5-2
Water Quality of the Navajo Sandstone Aquifer in the Mill Vicinity (continued)

Parameter	FES, Test Well (G2R) (1/27/77 - 3/23/78[1])	Well #2 6/01/99[1]	Well #5 6/08/99[1]
Iron, total	0.35 to 2.1	0.43	0.20
Iron, dissolved	0.30 to 2.3		
Lead, total	0.02 - 0.0	<0.001	0.018
Magnesium		20.4	21.3
Magnesium, dissolved	15 to 21		
Mercury, total	<.00002 to 0.0	<0.001	<0.001
Molybdenum		0.001	<0.001
Molybdenum, dissolved	0.004 to 0.010		
Nickel		<0.001	0.004
Nitrate + Nitrate as N		<0.10	<0.10
Nitrate (as N)	<.05 to 0.12		
Phosphorus, total (as P)	<0.01 to 0.03		
Potassium		3.1	3.3
Potassium, dissolved	2.4 to 3.2		
Selenium		<0.001	<0.001
Selenium, dissolved	<.005 to 0.0		
Silica, dissolved (as SiO_2)	5.8 to 12		
Strontium, total (as U)	0.5 to 0.67		
Thallium		<0.001	<0.001
Uranium, total (as U)	<.002 to 0.16	0.0007	0.0042
Uranium, dissolved (as U)	<.002 to 0.031		
Zinc		0.010	0.126
Zinc, dissolved	0.007 to 0.39		
Total Organic Carbon	1.1 to 16		
Chemical Oxygen Demand	<1 to 66		
Oil and Grease	1		
Total Suspended Solids	6 to 1940	<1.0	10.4
Turbidity		5.56	19.1
Determination (pCi/liter)			
Gross Alpha			<1.0
Gross Alpha ± precision	1.6±1.3 to 10.2±2.6		
Gross Beta			<2.0
Gross Beta ± precision	8±8 to 73±19		
Radium 226 ± precision			0.3±0.2
Radium 228			<1.0
Ra–226 ± precision	0.1±.3 to 0.6±0.4		
Th–230 ± precision	0.1±0.4 to 0.7±2.7		
Pb–210 ± precision	0.0±4.0 to 1.0±2.0		
Po–210 ± precision	0.0±0.3 to 0.0±0.8		

Source: Adapted from FES Table 2.25 with additional Mill sampling data

[1] Zero values (0.0) are below detection limits.

Insert

Figure 1.5-8 Groundwater (Well or Spring) Sampling Stations in the White Mesa Vicinity (Adapted from the 2007 ER, Figure 3.7-8)

1.5.3.2 Perched Groundwater Zone

Perched groundwater in the Dakota/Burro Canyon Formation is used on a limited basis to the north (upgradient) of the site because the saturated thickness generally increases to the north of the site and it is more easily accessible than the Entrada/Navajo aquifer. The quality of the perched water at the site is generally poor and extremely variable. As of the first quarter of 2016, the concentrations of TDS measured in water sampled from upgradient and downgradient wells range between approximately 1,000 and 8,300 mg/1. Sulfate concentrations measured in far upgradient wells MW-1, MW-18 and MW-19 ranged from 580 and 2,000 mg/l, and across the site sulfate varied from 430 mg/L to 6,570 mg/L. The perched groundwater therefore is used primarily for stock watering and irrigation. Section 1.5.3 below provides a more detailed discussion of background groundwater quality in the perched aquifer.

1.5.4 Background Groundwater Quality in the Perched Aquifer

A significant amount of historical groundwater quality data has been collected by EFRI and previous operators of the Mill for many wells at the facility.

At the time of original issuance of the GWDP, the Director had not yet completed an evaluation of the historical data, particularly with regard to data quality, and quality assurance issues. The Director also noted several groundwater quality issues that needed to be resolved prior to a determination of background groundwater quality at the site, such as a number of constituents that exceeded their respective Groundwater Quality Standard ("GWQS") and long-term trends in uranium in downgradient wells MW-14, MW-15 and cross-gradient well MW-17, and a spatial high of uranium in those three wells.

As a result of the foregoing, the Director required that an Existing Well Background Report (INTERA, 2007a) be prepared to address and resolve these issues. Prior to the approval of the Existing Well Background Report, GWCLs were set in Table 2 of the GWDP as 0.25 and 0.5 times the GWQS for Class II and III groundwater respectively.

The Director reviewed the Existing Well Background Report and GWCLs that reflect background groundwater quality were set for all monitoring wells except newly installed MW-35, MW-36, and MW-37. Background data collected for the establishment of GWCLs that reflect background groundwater quality at MW-35, MW-36 and MW-37 were being collected at that time and were subsequently provided in INTERA (2014c).

As required by the GWDP, the Existing Well Background Report addressed all available historical data, which included pre-operational and operational data, for the compliance monitoring wells under the GWDP that existed at the date of issuance of the GWDP. The Regional Background Report (INTERA, 2007b) focused on pre-operational site data and available regional data to develop the best available set of background data that could not conceivably have been influenced by Mill operations. The New Well Background Report (INTERA 2008), which was required by Part I.H.4 of a previous revision of the GWDP, analyzed the data collected from wells MW-3A, MW-23, MW-24, MW-25, MW-27, MW-28, MW-29, MW-30 and MW-31 (the "new" wells), which were installed in 2005, to determine background concentrations for constituents listed in the GWDP for each new well.

The purpose of the Existing Well Background Report and the New Well Background Report was to satisfy several objectives. First, in the case of the Existing Well Background Report, to perform a quality assurance evaluation and data validation of the existing and historical on-site groundwater quality data in accordance with the requirements of Part I.H.3 of a previous revision of the GWDP, and to develop a database consisting of historical groundwater monitoring data for "existing" wells and constituents.

Second, in the case of the New Well Background Report, to compile a database consisting of monitoring results for new wells, which were collected subsequent to issuance of the GWDP, in accordance with the Mill's Groundwater Quality Assurance Plan ("QAP") data quality objectives.

Third, to perform a statistical, temporal and spatial evaluation of the existing well and new well data bases to determine if there have been any impacts to groundwater from Mill activities. Since the Mill is an existing facility that has been in operation since 1980, such an analysis of historical groundwater monitoring data was required in order to ensure that the monitoring results to be used to determine background groundwater quality at the site establish GWCLs that have not been impacted by Mill activities.

Finally, in the event the analysis demonstrates that groundwater has not been impacted by Mill activities, to develop a GWCL for each constituent in each well.

The Regional Background Report was prepared as a supplement to the Existing Well Background Report to provide further support to the conclusion that Mill activities have not impacted groundwater.

In evaluating the historical data for the existing wells, INTERA used the following approach:

- If historical data for a constituent in a well do not demonstrate a statistically significant upward trend (or downward trend in pH), then the proposed GWCL for that constituent is accepted as representative of background, regardless of whether or not the proposed GWCL exceeds the GWQS for that constituent. This is because the monitoring results for the constituent can be considered to have been consistently representative since commencement of Mill activities or installation of the well; and
- If historical data for a constituent in a monitoring well represent a statistically significant upward trend (or downward trend in the case of pH), then the data is further evaluated to determine whether the trend is the result of natural causes or Mill activities. If it is concluded that the trend results from natural causes, then the GWCL proposed in the Existing Well Background Report will be appropriate.

After applying the foregoing approach, INTERA concluded that, other than some detected chloroform and related organic contamination at the Mill site, which is the subject of a separate investigation and corrective action, and that is the result of pre-Mill activities, there have been no impacts to groundwater from Mill activities.

In reaching this conclusion, INTERA noted that, even though there are a number of increasing trends in various constituents at the site, none of the trends are caused by Mill activities for the following reasons:

- Chloride is unquestionably the best indicator parameter, and there are no significant trends in chloride which are attributable to Mill activities in any of the wells
- There are no noteworthy correlations between chloride and uranium in wells with increasing trends in uranium, other than in far upgradient wells MW-19 and MW-18, which INTERA concluded are not related to potential tailings seepage. MW-18 and MW-19 cannot have been impacted because they are located more than 2,200 feet northeast (upgradient) of the tailings management system and perched water elevations in these wells are approximately 15 to 25 feet higher than perched water elevations beneath the northeast (upgradient) corner of the tailings management cells. INTERA noted that it is inconceivable to have an increasing trend in any other parameter caused by seepage from the Mill tailings without a corresponding increase in chloride

- There are significant increasing trends far upgradient in MW-1, MW-18 or MW-19 in uranium, sulfate, TDS, iron, selenium, thallium, ammonia and fluoride and far downgradient in MW-3 in uranium and selenium, sulfate, TDS and pH (decreasing trend). INTERA concluded that these data provide very strong evidence that natural site phenomena are the cause of increasing trends in these constituents (decreasing with respect to pH) in other site wells and that these data also support the conclusion that natural phenomena are the cause of increasing trends in other constituents
- On a review of the spatial distribution of constituents, it is quite apparent that the constituents of concern are dispersed across the site and not located in any systematic manner that would suggest tailings leakage.

INTERA concluded that, after extensive analysis of the data, and given the conclusion that there have been no impacts to groundwater from Mill activities, the proposed GWCLs set out in Table 16 of the Existing Well Background Report are appropriate, and are indicative of background perched groundwater quality. INTERA did advise, however, that proposed GWCLs for all the trending constituents should be re-evaluated upon GWDP renewal to determine if they are still appropriate at the time of renewal.

In the New Well Background Report, INTERA followed the same approach used in the Existing Well Background Report for evaluating the existing well data. In addition, INTERA compared the groundwater monitoring results for the new wells to the results for the existing wells analyzed in the Existing Well Background Report and to the pre-operational and regional results analyzed in the Regional Background Report. This was particularly important for analysis of the new wells because available historical analytical data for constituents in those wells post-date the commencement of Mill operations. Available data for the new wells may not be sufficient to identify long-term constituent trends. By comparing the means for the constituents in the new wells to those for existing well and regional background data, INTERA was able to determine if the concentrations of constituents in the new wells were consistent with site background.

After applying the foregoing approach, INTERA concluded that the new monitoring wells were not impacted by Mill activities. INTERA also concluded that the new well groundwater monitoring results were consistent with the existing well results provided in the Existing Well Background Report and consistent with the pre-operational and regional well, seep and spring results provided in the Regional Background Report. INTERA noted some detections of chloroform and related organic contamination and degradation products and nitrate and nitrite in the new wells, which are the subject of separate investigations and corrective actions, but that such contamination was the result of pre-Mill activities. Corrective actions for nitrate and chloroform, respectively, are described in: *Nitrate Corrective Action Plan* (CAP), [HGC, 2012a]; and *Groundwater Corrective Action Plan* (GCAP) found in Attachment 1, of the final Stipulation and Consent Order Docket No. UGW20-01, approved on September 14, 2015 by the Utah Department of Environmental Quality Division of Waste Management and Radiation Control (DWMRC) [Utah Department of Environmental Quality Division of Solid Waste and Radiation Control, 2015]).

Given its conclusion that there were no impacts to groundwater from Mill activities, INTERA concluded that the proposed GWCLs for new wells set out in Table 10 of the New Well Background Report were appropriate, and indicative of background perched groundwater quality. Again, INTERA noted that GWCLs for trending constituents should be re-evaluated upon GWDP renewal to determine if they are still appropriate at the time of renewal.

Subsequent investigation of nitrate delineated the nitrate plume and indicated that ammonium sulfate handling in the vicinity of the ammonium sulfate crystal tanks (southeast of well TWN-2) is potentially a source of nitrate to the nitrate plume. There are no known current unidentified or unaddressed sources of the nitrate plume. There appear to have been a number of known and potential historical sources; however, it has not been possible to confirm or quantify the contribution of each source. The conclusion that there were no impacts to perched groundwater from Mill activities has therefore been modified to include a potential contribution to the nitrate plume from Mill and non-mill sources. However, the conclusion that there have been no impacts to perched groundwater from the tailings management system operation is valid.

During the course of discussions with EFRI staff, and further DWMRC review, DWMRC supplemented the analysis provided in the Background Reports by commissioning the University of Utah to perform a geochemical and isotopic groundwater study at the Mill, described in *Summary of work completed, data results, interpretations and recommendations for the July 2007 Sampling Event at the Denison Mines, USA, White Mesa Uranium Mill Near Blanding Utah*, May 2008, prepared by T. Grant Hurst and D. Kip Solomon, Department of Geophysics, University of Utah (the "University of Utah Study" [University of Utah, 2008]). The purpose of the University of Utah Study was to evaluate whether the increasing and elevated trace metal concentrations (such as uranium) found in the monitoring wells at the Mill were due to potential leakage from the on-site tailings management cells. To investigate this potential problem, the study examined groundwater flow, chemical composition, noble gas and isotopic composition, and age of the on-site groundwater. Similar evaluations were also made on samples of the tailings wastewater and nearby surface water stored in the northern wildlife ponds at the facility. Fieldwork for the University of Utah Study was conducted July 17 - 26, 2007. The conclusions in the University of Utah Study supported EFRI's conclusions in the Background Reports that tailings management cells had not impacted groundwater.

Upon approval of the GWDP in 2010, constituents with two consecutive GWCL exceedances were subject to a Source Assessment Report (SAR) as defined in the GWDP. The initial SAR was submitted in October of 2012 (INTERA 2012a) and covered the constituents in wells with consecutive exceedances since the approval of the GWDP in 2010. The October 2012 SAR (INTERA 2012a) presented a geochemical analysis of parameters that exhibited exceedances as well as an analysis of the indicator parameters in each of those wells to determine if the exceedance could be related to potential tailings seepage or Mill-related activities. Since then, additional SARs that include INTERA 2013a, 2013b, 2014a, 2014b, and 2015 cover additional consecutive exceedances. In all cases the exceedances for which the SARs were performed were determined to result from naturally occurring conditions in the groundwater at the site or from other factors that are affecting groundwater but are unrelated to Mill operation. These other factors include the nitrate/chloride plume that is addressed by the nitrate CAP and the site-wide decline in pH that was identified at the time of the Background Report.

With regard to the decline in pH, background analysis and determination of GWCLs for pH were performed using laboratory pH measurements rather than using measurements that are collected in the field at the time of sampling by using a pH probe. Since the latter of these two methods of measuring pH is more reliable, an additional pH analysis was performed in 2012 using only field data. GWCLs for pH were recalculated at this time using the field measurements (INTERA, 2012b). EFRI compared the Mill's groundwater pH data from the second quarter of 2011 and noted that *all* of the June 2011 groundwater results, and many of the other results from the second quarter of 2011, were already outside the revised GWCLs that were to be proposed. Pursuant to teleconferences with DWMRC on December 5, and December 19, 2011, EFRI submitted a Work Plan and Schedule on January 20, 2012 and a revised plan based on DWMRC comments on April 13, 2012. Based on the approved Work Plan and Time Schedule, EFRI and DWMRC entered into a Stipulated Consent Agreement ("SCA") dated July 12, 2012. The SCA required the completion of the pH Report (INTERA, 2012b) and the Pyrite Investigation and associated report (HGC, 2012c). The pH Report and Pyrite Investigation Report were submitted to DWMRC on November 9, 2012 and December 7, 2012 respectively. By letter dated April 25, 2013, DWMRC accepted the conclusions that the out-of-compliance results for pH are due to background effects within the aquifer matrix and are not caused by Mill activities. DWMRC also approved the recalculation of the GWCLs.

HGC (2012c) determined that pH decreases resulted primarily from pyrite oxidation enhanced by oxygen delivery to the perched zone. Pyrite exists naturally in the Burro Canyon Formation and Dakota Sandstone, and is present both above and below the perched water table. Oxygen delivery mechanisms include diffusive and advective gas-phase transport to the Burro Canyon Formation and /or Dakota Sandstone in the vicinities of perched wells via perched well screens, and advective liquid-phase transport dissolved in wildlife pond seepage. HGC (2012c) and HGC (2014) also noted that pyrite may be degraded by nitrate present in the perched water. Pyrite oxidation by either mechanism may release acid and sulfate. The site-wide pH decreases were therefore determined to be unrelated to tailings management cell operation.

1.5.5 Quality of Groundwater at the Compliance Monitoring Point

Analytical results from groundwater sampling are reported quarterly in Groundwater Monitoring Reports, which are filed with the Director pursuant to Part I.F.1 of the GWDP.

1.5.6 Springs and Seeps

As discussed in Section 1.5.1.4, perched groundwater at the Mill site discharges in springs and seeps along Westwater Creek Canyon and Cottonwood Canyon to the west-southwest of the site, and along Corral Canyon to the east of the site, where the Burro Canyon Formation outcrops. Water samples have been collected and analyzed from springs and seeps in the Mill vicinity as part of the baseline field investigations reported in the 1978 ER (See Table 2.6-6 in Dames & Moore, 1978).

During the period 2003-2004, EFRI implemented a sampling program for seeps and springs in the vicinity of the Mill which had been sampled in 1978, prior to the Mill's construction. Four locations were designated for sampling (shown on Figure 1.5-8). These are Ruin Spring (G3R), Cottonwood Seep (G4R), west of Westwater Creek (G5R) and Corral Canyon (G1R). During the 2-year study period only two of the four locations were able to be sampled, Ruin Spring and Cottonwood Canyon. The other two locations, Corral Creek and the location west of Westwater Creek were not flowing (seeping) and samples could not be collected. With regard to the Cottonwood seep, while water was present, the volume was not sufficient to complete all determinations, and only organic analyses were conducted. The results of the organic analysis did not detect any detectable organics.

Samples at Ruin Spring were analyzed for major ions, physical properties, metals, radionuclides, volatile and semi-volatile organic compounds, herbicides and pesticides, and synthetic organic compounds. With the exception of one chloromethane detection, organic determinations were at less than detectable concentrations and are not shown in Table 1.5-3. The detection of chloromethane is not uncommon in groundwater and can be due to natural sources. In fact, chloromethane has been observed by EFRI at detectable concentrations in field blank samples during routine groundwater sampling events.

The results of the 2003/2004 sampling for the other parameters tested are shown in Table 1.5-3. The results of the sampling did not indicate the presence of Mill-derived groundwater constituents and are representative of background conditions.

Table 1.5-3
Results of Quarterly Sampling Ruin Spring (2003-2004)

Parameter	Ruin Spring							
	Q1-03	Q2-03	Q3-03	Q4-3	Q1-04	Q2-04	Q3-04	Q4-04
Major Ions (mg/L)								
Alkalinity	-	-	196	198	193	191	195	183
Carbon Dioxide	-	-	ND	ND	ND	ND	12	ND
Carbonate	-	-	ND	ND	ND	ND	ND	ND
Bicarbonate	-	-	239	241	235	232	238	223
Hydroxide	-		ND	ND	ND	ND	ND	ND
Calcium	153	156	149	158	158	162	176	186
Chloride	28.1	21.5	27.4	28.0	29.3	28.5	26	25
Fluoride	-	-	ND	0.5	0.5	0.6	0.6	0.6
Magnesium	34.8	34.2	31.7	34.2	35.8	35.1	37.1	38.6
Nitrogen, Ammonia As N	ND	ND	ND	ND	ND	0.06	ND	0.06
Nitrogen, Nitrate+Nitrite as N	1.6	1.5	1.4	1.4	1.73	1.85	1.34	1.7
Phosphorous	0.10	ND	-	ND	ND	ND	ND	ND
Potassium	2.6	3.3	3.3	3.9	3.4	3.6	4.0	3.7
Sodium	110	105	103	113	104	110	113	116
Sulfate	503	501	495	506	539	468	544	613
Physical Properties								
Conductivity (umhos/cm)	-	-	1440	1410	1390	1440	1320	1570
pH	-	-	7.91	7.98	-	-		-
TDS (mg/L)	-	-	1040	1000	1050	1110	1050	1070
TSS (mg/L)	-	-	13.5	ND	ND	ND	ND	ND
Turbidity (NTU)	-	-	0.16	0.13	ND	0.12	-	-
Metals-Dissolved (mg/L)								
Aluminum	ND	ND	0.40	ND	ND	ND	ND	ND
Antimony	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	0.001	ND	ND	0.001	ND	ND	ND	ND
Barium	ND	ND	ND	ND	ND	ND	ND	ND
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND

Table 1.5-3
Results of Quarterly Sampling Ruin Spring (2003-2004) (continued)

Parameter	Ruin Spring							
	Q1-03	Q2-03	Q3-03	Q4-3	Q1-04	Q2-04	Q3-04	Q4-04
Major Ions (mg/L)								
Chromium	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ND	ND	0.082	ND	ND	ND	ND	ND
Iron	ND	ND	ND	ND	ND	ND	ND	ND
Lead	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	ND	ND	ND	ND	ND	ND	ND	ND
Mercury	ND	ND	ND	ND	ND	ND	ND	ND
Molybdenum	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	0.013	0.012	0.012	0.012	0.012	0.012	0.012	0.012
Silver	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND	ND
Uranium	0.009	0.011	0.010	0.010	0.011	0.011	0.009	0.010
Vanadium	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	0.014	ND	ND	ND	ND	ND	ND	ND
Radionuclides (pCi/L)								
Gross Alpha Minus Rn & U	-	-	-	-	ND	ND	1.4	ND
Lead 210	42	ND	ND	ND	ND	ND	ND	ND
Radium 226	0.3	ND	0.3	ND	ND	ND	1.3	ND
Thorium 230	0.3	0.2	0.5	ND	ND	ND	0.4	ND
Thorium 232	-	-	ND	ND	ND	ND	ND	-
Thorium 228	-	-	ND	ND	ND	ND	-	-

Source: Table 3.7-9 of 2007 ER.

During 2009, the Mill implemented an annual sampling program for seeps and springs. The seeps and springs sampling program is included in the Sampling Plan for Seeps and Springs in the Vicinity of the White Mesa Uranium Mill Revision: 0, March 17, 2009 (and as submitted to UDEQ for approval, Draft Sampling Plan for Seeps and Springs, Revision 1, June 10, 2011). The annual sampling program for seeps and springs requires sampling once per year at the four seeps and springs described above, plus a fifth seep, Corrals Seep, to the extent water flow is sufficient for sampling. Samples were collected in July 2009; August and November 2010; May and July 2011, June 2012, July 2013, June 2014; and June 2015. Under the Plan only springs and seeps that had sufficient water flow were selected for sampling. The results of the annual sampling are shown in Table 1.5-4.

Table 1.5-4
Seeps and Springs Sampling

Constituent	Ruin Spring							Ruin Spring Duplicate			Cottonwood Spring							Entrance Spring							Dup	Westwater Seep						
Major Ions (mg/L)	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**9**	**10**	**11**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**15**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Carbonate	ND	<1	1	<1	<1	<1	<1	ND	<1	2	ND	<1	6	<1	<1	<1	<1	ND	<1	7	<1	<1	<1	<1	<1	<1	<1	<1				<1
Bicarbonate	233	254	239	237	208	204	200	232	254	236	316	340	316	326	280	251	271	292	332	299	298	292	247	324	326	465	450	371				359
Calcium	151	136	148	147	149	150	162	149	137	147	90.3	92.2	94.2	101	87.9	99.7	111	90.8	96.5	96.6	105	121	103	131	132	191	179	247				150
Chloride	28	23	44	28	26.3	27.1	27.4	27	23	27	124	112	134	149	118	128	133	60	63	64	78	139	76.8	75.6	75.3	41	40	21				32.6
Fluoride	0.5	0.53	0.5	0.52	0.538	<1	0.445	0.5	0.51	0.49	0.4	0.38	0.38	0.38	0.417	<1	0.318	0.7	0.73	0.58	0.64	0.71	<1	0.606	0.6	0.7	0.6	0.54				0.424
Magnesium	32.3	29.7	31.1	31.9	32.1	35.4	31.8	31.6	30.4	30.9	25	24.8	25.2	27.7	23.6	29.0	27.5	26.6	28.9	28.4	32.7	43	34.9	33.3	33.7	45.9	44.7	34.7	Not Sampled - Dry	Not Sampled - Dry	Not Sampled - Dry	34
Nitrogen, Ammonia As N	0.09	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	ND	<0.05	<0.05	ND	<0.05	<0.05	<0.05	<0.05	<0.05	0.0512	0.28	<0.05	0.32	<0.05	<0.05	<0.05	0.202	0.139	<0.05	0.5	0.06				0.123
Nitrogen, Nitrate+Nitrite as N	1.4	1.7	1.6	1.6	1.56	1.54	1.31	1.4	1.7	1.7	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.4	1	0.5	2.8	2.06	3.65	<0.1	0.276	0.8	<0.1	<0.1				<0.1
Potassium	3.3	3.07	3.3	3.5	3.46	3.24	3.14	3.2	3.08	3.3	5.7	5.77	5.9	6.2	5.53	6.18	5.91	2.4	2.74	2.9	2	3.83	1.56	1.62	1.72	1.19	6.57	3.9				1.98
Sodium	104	93.4	111	115	118	119	126	103	97.4	108	205	214	227	247	217	227	251	61.4	62.7	68.6	77.4	127	78.9	93.1	93.8	196	160	112				139
Sulfate	528	447	484	464	553	553	528	520	444	483	383	389	389	256	403	417	442	178	179	171	171	394	219	210	214	646	607	354				392
Physical Properties																																
pH	7.85	7.51	8.14	7.53			7.27	7.7	7.55	8.1	7.73	7.47	8.04	7.53			7.30	7.85	7.56	8.17	7.5			6.57		8.01	7.38	7.2	Not Sampled - Dry			7.24
TDS (mg/L)	1010	903	905	1000	952	984	1000	996	950	911	1010	900	978	1040	996	968	1020	605	661	582	660	828	688	680	708	1370	1270	853				896
Metals-Dissolved (ug/L)																																
Arsenic	ND	<5	<5	<5	<5	<5	<5	ND	<5.0	<5.0	ND	<5	<5	<5	<5	<5	<5	ND	<5	<5	<5	<5	<5	5.02	5.02	<5	<5	12.3				<5.0
Beryllium	ND	< 0.5	< 0.5	<0.5	<0.5	<0.5	<0.5	ND	<0.05	<0.05	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.91				<0.5
Cadmium	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	<0.05	<0.05	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.9				<0.5
Chromium	ND	<25	<25	<25	<25	<25	<25	ND	<25	<25	ND	<25	<25	<25	<25	<25	<25	ND	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25				<25
Cobalt	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10				<10
Copper	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	<10	<10	<10	<10	<10	<10	<10	16	Not Sampled - Dry	Not Sampled - Dry	Not Sampled - Dry	<10
Iron	ND	<30	<30	<30	<30	<30	<30	ND	36	36	ND	<30	<30	<30	<30	<30	<30	ND	<30	55	34	162	37.2	295	298	89	56	4540				<30
Lead	ND	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	ND	<1.0	<1.0	ND	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	ND	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	41.4				<1.0
Manganese	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	ND	<10	<10	<10	<10	<10	<10	54	11	84	<10	259	16.1	367	371	37	87	268				171
Mercury	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	<0.05	<0.05	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5				<0.5
Molybdenum	17	17	17	16	16.1	16.0	18.3	17	17	17	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	<10	<10	<10	<10	<10	29	29	<10				<10
Nickel	ND	<20	<20	<20	<20	<20	<20	ND	<20	<20	ND	<20	<20	<20	<20	<20	<20	ND	<20	<20	<20	<20	<20	<20	<20	<20	<20	29				<20

Table 1.5-4
Seeps and Springs Sampling (continued)

Constituent	Ruin Spring							Ruin Spring Duplicate			Cottonwood Spring							Entrance Spring							Dup	Westwater Seep						
Metals-Dissolved (mg/L)	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**9**	**10**	**11**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**15**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Selenium	12.2	10	10.2	10.8	10.2	12.0	10	12.3	9.5	9.7	ND	<5.0	<5.0	<5.0	<5.0	<5.0	<5	12.1	9.2	5.5	13.2	11.2	15.9	<0.5	<5	<5.0	<5.0	<5.0				<5.0
Silver	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10				<10
Thallium	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	<0.5	<0.5	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<5	ND	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5				<0.5
Tin	ND	<100	<100	<100	<100	<100	<100	ND	<100	<100	ND	<100	<100	<100	<100	<100	<100	ND	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100				<100
Uranium	9.11	8.47	8.63	8.68	9.12	9.61	9.03	9	8.52	8.28	8.42	8.24	8.68	8.17	8.95	9.62	9.12	15.2	17.8	15.3	21.1	38.8	23.2	36	36.1	15.1	46.6	6.64				2.1
Vanadium	ND	<15	<15	<15	<15	<15	<15	ND	<15	<15	ND	<15	<15	<15	<15	<15	<15	ND	<15	<15	<15	<15	<15	<15	<15	<15	<15	34				<15
Zinc	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	ND	<10	<10	<10	<10	<10	<10	ND	<10	<10	<10	<10	<10	<10	<10	<10	<10	28				<10
Radionuclides (pCi/L)																																
Gross Alpha Minus Rn & U	<0.2	<0.2	<- 0.05	<- 0.09	<1.0	<1	<1.0	- 0.02	<0.3	<-0.1	0.3	<0.2	<-0.1	<-0.2	<1.0	<1.0	<1.0	0.9	<0.5	1.6	0.5	2.3	<1	3.05	3.11	< -0.1	<0.3	0.5	Not Sampled - Dry	Not Sampled - Dry	Not Sampled - Dry	<1.0
Volatile Organic Compounds (ug/L)																																
Acetone	ND	ND	ND	<20	<20	<20	<20	ND	ND	ND	ND	ND	ND	<20	<20	<20	<20	ND	ND	ND	<20	<20	<20	<20	ND	ND	ND	ND				<20
Benzene	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND				<1.0
Carbon tetrachloride	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND				<1.0
Chloroform	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND				<1.0
Chloromethane	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND				<1.0
MEK	ND	ND	ND	<20	<20	<20	<20	ND	ND	ND	ND	ND	ND	<20	<20	<20	<20	ND	ND	ND	<20	<20	<20	<20	ND	ND	ND	ND	Not Sampled - Dry	Not Sampled - Dry	Not Sampled - Dry	<20
Methylene Chloride	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND				<1.0
Naphthalene	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND				<1.0
Tetrahydrofuran	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND				<1.0
Toluene	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	1.32	<1.0	ND	ND	ND	ND				<1.0
Xylenes	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	<1.0	<1.0	<1.0	<1.0	ND	ND	ND	ND				<1.0

1.5.7 Groundwater Appropriations Within a Five Mile Radius

Two hundred sixty one groundwater appropriation applications, within a five-mile radius of the Mill site, are on file with the Utah State Engineer's office. A summary of the applications is presented in Table 1.5-5 and shown on Figure 1.5-9. The majority of the applications are by private individuals and for wells drawing small, intermittent quantities of water, less than eight gpm, from the Burro Canyon formation. For the most part, these wells are located upgradient (north) of the Mill site. Domestic water, stock watering, and irrigation are listed as primary uses of the majority of the wells. It is important to note that no water supply wells completed in the perched groundwater of the Burro Canyon formation exist directly downgradient of the site within the five-mile radius. Two water supply wells, which available data indicate are completed in the Entrada/Navajo sandstone, exist approximately 4.5 miles southeast of the site on the Ute Mountain Ute Reservation. These wells supply domestic water for the Ute Mountain Ute White Mesa Community, situated on the mesa along Highway 191 (see Figure 1.5-9). Data supplied by the Tribal Environmental Programs Office indicate that both wells are completed in the Entrada/Navajo sandstone, which is approximately 1,200 feet below the ground surface. Insufficient data are available to define the groundwater flow direction in the Entrada/Navajo sandstone in the vicinity of the Mill.

The yield from wells completed in the Burro Canyon formation within the White Mesa site is generally lower than that obtained from wells in this formation upgradient of the site. For the most part, the documented sustainable pumping rates from on-site wells completed in the Burro Canyon formation are typically less than 1/2 gpm. Even at low pumping rates, on-site wells completed in the Burro Canyon formation are typically pumped dry within a couple of hours, and corrective action pumping wells have to be cycled on and off due to the low productivity.

This low productivity suggests that the Mill is located over a peripheral fringe of perched water, with saturated thickness in the perched zone discontinuous and generally decreasing beneath the site, and with conductivity of the formation being very low. These observations have been verified by studies performed for the U.S. Department of Energy's disposal site at Slick Rock, which noted that the Dakota Sandstone, Burro Canyon formation, and upper claystone of the Brushy Basin Member are not considered aquifers due to the low permeability, discontinuous nature, and limited thickness of these units (U.S. DOE, 1993).

1.6 Geology

The following text is copied, with minor revisions, from the 1978 ER (Dames and Moore, 1978b). The text has been included here for ease of reference and to provide background information concerning the site geology. 1978 ER subsections used in the following text are shown in parentheses immediately following the subsection titles.

The site is near the western margin of the Blanding Basin in southeastern Utah and within the Monticello uranium-mining district. Thousands of feet of multi-colored marine and non-marine sedimentary rocks have been uplifted and warped, and subsequent erosion has carved a spectacular landscape for which the region is famous. Another unique feature of the region is the wide-spread presence of unusually large accumulations of uranium-bearing minerals.

Insert

Table 1.5-5
Wells Located Within a 5-Mile Radius of the White Mesa Uranium Mill (Denison, 2009)

Insert

Figure 1.5-9 Ground Water Appropriation Applications Within a 5-Mile Radius

1.6.1 Regional Geology

The following descriptions of regional physiography; rock units; and structure and tectonics are reproduced from the 1978 ER for ease of reference and as a review of regional geology.

1.6.1.1 Physiography (1978 ER Section 2.4.1.1)

The Mill site lies within the Canyon Lands section of the Colorado Plateau physiographic province. To the north, this section is distinctly bounded by the Book Cliffs and Grand Mesa of the Uinta Basin; western margins are defined by the tectonically controlled High Plateaus section, and the southern boundary is arbitrarily defined along the San Juan River. The eastern boundary is less distinct where the elevated surface of the Canyon Lands section merges with the Southern Rocky Mountain province.

Canyon Lands has undergone epeirogenic uplift and subsequent major erosion has produced the region's characteristic angular topography reflected by high plateaus, mesas, buttes, structural benches, and deep canyons incised into flat-laying sedimentary rocks of pre-Tertiary age. Elevations range from approximately 3,000 feet (914 meters) in the bottom of the deeper canyons along the southwestern margins of the section to more than 11,000 feet (3,353 meters) in the topographically anomalous laccolithic Henry, Abajo and La Sal Mountains to the northeast. Except for the deeper canyons and isolated mountain peaks, an average elevation in excess of 500 feet (1,524 meters) persists over most of the Canyon Lands section.

On a more localized regional basis, the Mill site is located near the western edge of the Blanding Basin, sometimes referred to as the Great Sage Plain (Eardly, 1958), lying east of the north-south trending Monument Uplift, south of the Abajo Mountains and adjacent to the northwesterly-trending Paradox Fold and Fault Belt (Figure 1.6-1). Topographically, the Abajo Mountains are the most prominent feature in the region, rising more than 4,000 feet (1,219 meters) above the broad, gently rolling surface of the Great Sage Plain.

The Great Sage Plain is a structural slope, capped by the resistant Burro Canyon formation and the Dakota Sandstone, almost horizontal in an east-west direction but descends to the south with a regional slope of about 2,000 feet (610 meters) over a distance of nearly 50 miles (80 kilometers). Though not as deeply or intricately dissected as other parts of the Canyon Lands, the plain is cut by numerous narrow and vertical-walled south-trending valleys 100 to more than 500 feet (30 to 152+ meters) deep. Water from the intermittent streams that drain the plain flow southward to the San Juan River, eventually joining the Colorado River and exiting the Canyon Lands section through the Grand Canyon.

1.6.1.2 Rock Units (1978 ER Section 2.4.1.1)

The sedimentary rocks exposed in southeastern Utah have an aggregate thickness of about 6,000 to 7,000 feet (1,829 to 2,134 meters) and range in age from Pennsylvanian to Late Cretaceous. Older unexposed rocks are known mainly from oil well drilling in the Blanding Basin and Monument Uplift. These wells have encountered correlative Cambrian to Permian rock units of markedly differing thicknesses but averaging over 5,000 feet (1,524 meters) in total thickness (Witkind, 1964). Most of the wells drilled in the region have bottomed in the Pennsylvanian Paradox Member of the Hermosa formation. A generalized stratigraphic section of rock units ranging in age from Cambrian through Jurassic and Triassic (?), as determined from oil-well logs, is shown in Table 1.6-1. Descriptions of the younger rocks, Jurassic through Cretaceous, are based on field mapping by various investigators and are shown in Table 1.6-2.

Insert

Figure 1.6-1 Colorado Plateau Geology Map (Adapted from the 2007 ER, Figure 3.4-1)

Table 1.6-1
Generalized Stratigraphic Section of Subsurface Rocks Based on Oil-Well Logs (Table 2.6-1 UMETCO)

Era	Age	Stratigraphic Unit	Thickness* (ft.)	Description
MESOZOIC		Glen Canyon Group:		
	Jurassic and Tnassic (?)	Navajo Sandstone	300 - 400	Buff to light gray, massive, cross-bedded, friable sandstone
	Triassic (?)	Kayenta Formation	100 - 150	Reddish-brown sandstone and mudstone and occasional conglomerate lenses
	Triassic	Wingate Sandstone	250 - 350	Reddish-brown, massive, cross-bedded, fine-grained sandstone
		Chinle Formation:		
		Undivided	600 - 700	Variegated claystone with some thin beds of siltstone and limestone
		Moss Back Member	0 - 100	Light colored, conglomeratic sandstone and conglomerite
		Shinarump Member	0 - 20	Yellowish-gray, fine to coarse-grained sandstone: conglomeratic sandstone and conglomerate
		Unconformity		
	Middle (?) and Lower Triassic	Moenkopi Formation	50 - 100	Reddish-brown mudstone and fine-grained sandstone
		Unconformity		
PALEOZOIC	Permian	Cutler Formation:		
		Organ Rock Member	0 - 600	Reddish-brown, sandy mudstone
		Cedar Mesa Sandstone Member	1100 - 1400	Reddish-brown, massive, fine to medium-grained sandstone
	Pennsylvanian and Permian (?)	Rico Formation	450	Red and gray calcareous, sandy shale: gray limestone and sandstone
	Pennsylvanian	Hermosa Formation:		
		Upper Member	1000 - 1200	Gray, massive limestone: some shale and sandstone
		Paradox Member	1200	Halite, anhydrite, gypsum, shale, and siltstone
		Lower Member	200	Limestone, siltstone, and shale
		Unconformity		
	Mississippian	Leadville Limestone	500	White to tan sucrose to crystalline limestone
	Devonian	Ouray Limestone	100	Light gray and tan, thin-bedded limestone and dolomite
		Zilbert Formation	200	Gray and brown dolomite and limestone with thin beds green shale and sandstone
		Unconformity		
	Cambrian	Ophir Formation and Tintic Quartzite	600	Gray and brown limestone and dolomite, feldspathic sandstone and arkose

* To convert feet to meters, multiply by 0.3043. Average thickness given if range is not shown.

Table 1.6-2
Generalized Stratigraphic Section of Exposed Rocks in the Project Vicinity (Table 2.6-2 UMETCO)

ERA	SYSTEM	SERIES (Age)		STRATIGRAPHIC UNIT	THICKNESS* (ft.)	LITHOLOGY
CENOZOIC	QUATERNARY	Holocene to Pleistocene		Alluvium	2 - 25+	Silt, sand and gravel in arroyos and stream valleys.
				Colluvium and Talus	0 - 15+	Slope wash, talus and rock rubble ranging from cobbles and boulders to massive blocks fallen from cliffs and outcrops of resistant rock.
				Loess	0 - 22+	Reddish-brown to light-brown, unconsolidated, well-sorted silt to medium-grained sand; partially cemented with caliche in some area; reworked partly by water.
				Unconformity		
MESOZOIC	CRETACEOUS	Upper Cretaceous		Mancos Shale	0 - 11(?)	Gray to dark-gray, fissile, thin-bedded marine shale with fossiliferous sandy limestone in lower strata.
				Dakota Sandstone	30 - 75	Light yellowish-brown to light grey-brown, thick bedded to cross-bedded sandstone, conglomeratic sandstone; interbedded thin lenticular grey carbonaceous claystone and impure coal; local course basal conglomerate.
				Unconformity		
		Lower Cretaceous		Burro Canyon Formation	50 - 150	Light-gray and light-brown, massive and cross-bedded conglomeratic sandstone and interbedded green and gray-green mudstone; locally contains thin discontinuous beds of silicified sandstone and limestone near top.
				Unconformity (?)		
	Jurassic	Upper Jurassic	Morrison Formation	Brushy Basin Member	200 - 450	Variegated gray, pale-green, reddish-brown, and purple bentonitic mudstone and siltstone containing thin discontinuous sandstone and conglomerate lenses.
				Westwater Canyon Member	0 - 250	Interbedded yellowish- and greenish-gray to pinkish-gray, fine- to course-grained arkosic sandstone and greenish-gray to reddish-brown sandy shale and mudstone.
				Recapture Member	0 - 200	Interbedded reddish-gray to light brown fine-to medium-grained sandstone and reddish-gray silty and sandy claystone.
				Salt Wash Member	0 - 350	Interbedded yellowish-brown to pale reddish-brown fine-grained to conglomeritic sandstones and greenish- and reddish-gray mudstone.
				Unconformity		
			San Rafael Group	Bluff Sandstone	0 - 150+	White to grayish-brown, massive, cross-bedded, fine- to medium-grained eolian sandstone.
				Summerville Formation	25 - 125	Thin-bedded, ripple-marked reddish-brown muddy sandstone and sandy shale.
				Entrada Sandstone	150 - 180	Reddish-brown to grayish-white, massive, cross-bedded, fine- to medium-grained sandstone.
		Middle Jurassic		Carmel Formation	20 - 100+	Irregularly bedded reddish-brown muddy sandstone and sandy mudstone with local thin beds of brown to gray limestone and reddish- to greenish-gray shale.
				Unconformity		

*To convert feet to meters, multiply feet by 0.3048.

Paleozoic rocks of Cambrian, Devonian and Mississippian ages are not exposed in the southeastern Utah region. Most of the geologic knowledge regarding these rocks was learned from the deeper oil wells drilled in the region, and from exposures in the Grand Canyon to the southwest and in the Uinta and Wasatch Mountains to the north. A few patches of Devonian rocks are exposed in the San Juan Mountains in southwestern Colorado. These Paleozoic rocks are the result of periodic transgressions and regressions of epicontinental seas and their lithologies reflect a variety of depositional environments.

In general, the coarse-grained feldspathic rocks overlying the Precambrian basement rocks grade upward into shales, limestones and dolomites that dominate the upper part of the Cambrian. Devonian and Mississippian dolomites, limestones and interbedded shales unconformably overlay the Cambrian strata. The complete absence of Ordovician and Silurian rocks in the Grand Canyon, Uinta Mountains, southwest Utah region and adjacent portions of Colorado, New Mexico and Arizona indicate that the region was probably epeirogenically positive during these times.

The oldest stratigraphic unit that crops out in the region is the Hermos formation of Middle and Late Pennsylvanian age. Only the uppermost strata of this formation are exposed, the best exposure being in the canyon of the San Juan River at the "Goosenecks" where the river traverses the crest of the Monument uplift. Other exposures are in the breached centers of the Lisbon Valley, Moab and Castle Valley anticlines. The Paradox Member of the Hermosa formation is sandwiched between a relatively thin lower unnamed member consisting of dark-gray shale siltstone, dolomite, anhydrite, and limestone, and an upper unnamed member of similar lithology but having a much greater thickness. Composition of the Paradox Member is dominantly a thick sequence of interbedded slate (halite), anhydrite, gypsum, and black shale. Surface exposures of the Paradox in the Moab and Castle Valley anticlines are limited to contorted residues of gypsum and black shale.

Conformably overlying the Hermosa is the Pennsylvanian and Permian (?) Rico formation, composed of interbedded reddish-brown arkosic sandstone and gray marine limestone. The Rico represents a transition zone between the predominantly marine Hermosa and the overlying continental Cutler formation of Permian age.

Two members of the Cutler probably underlying the region south of Blanding are, in ascending order, the Cedar Mesa Sandstone and the Organ Rock Tongue. The Cedar Mesa is a white to pale reddish-brown, massive, cross-bedded, fine- to medium-grained eolian sandstone. An irregular fluvial sequence of reddish-brown fine-grained sandstones, shaly siltstones and sandy shales comprise the Organ Rock Tongue.

The Moenkopi formation, of Middle (?) and Lower Triassic age, unconformably overlies the Cutler strata. It is composed of thin, evenly-bedded, reddish to chocolate-brown, ripple-marked, cross-laminated siltstone and sandy shales with irregular beds of massive medium-grained sandstone.

A thick sequence of complex continental sediments known as the Chinle formation unconformably overlies the Moenkopi. For the purpose of making lithology correlations in oil wells this formation is divided into three units: The basal Shinarump Member, the Moss Back Member and an upper undivided thick sequence of variegated reddish-brown, reddish- to greenish-gray, yellowish-brown to light-brown bentonitic claystones, mudstones, sandy siltstone, fine-grained sandstone, and limestones. The basal Shinarump is dominantly a yellowish-grey, fine- to coarse-grained sandstone, conglomeratic sandstone and conglomerate characteristically filling ancient stream channel scours eroded into the Moenkopi surface. Numerous uranium deposits have been located in this member in the White Canyon mining district to the west of Comb Ridge. The Moss Back is typically composed of yellowish- to greenish-grey, fine- to medium-grained sandstone, conglomeratic sandstone and conglomerate. It commonly comprises the basal unit of the Chinle where the Shinarump was not deposited, and in a like manner, fills ancient stream channels scoured into the underlying unit.

In the Blanding Basin the Glen Canyon Group consists of three formations which are, in ascending order, the Wingate Sandstone, the Kayenta and the Navajo Sandstone. All are conformable and their contacts are gradational. Commonly cropping out in sheer cliffs, the Late Triassic Wingate Sandstone is typically composed of buff to reddish-brown, massive, cross-bedded, well-sorted, fine-grained quartzose sandstone of eolian origin. Late Triassic (?) Kayenta is fluvial in origin and consists of reddish-brown, irregularly to cross-bedded sandstone, shaly sandstone and, locally, thin beds of limestone and conglomerate. Light yellowish-brown to light-gray and white, massive, cross-bedded, friable, fine- to medium-grained quartzose sandstone typifies the predominantly eolian Jurassic and Triassic (?) Navajo Sandstone.

Four formations of the Middle to Late Jurassic San Rafael Group unconformably overly the Navajo Sandstone. These strata are composed of alternating marine and non-marine sandstones, shales and mudstones. In ascending order, the formations are the Carmel formation, Entrada Sandstone, Summerville formation, and Bluff Sandstone. The Carmel usually crops out as a bench between the Navajo and Entrada Sandstones. Typically reddish-brown muddy sandstone and sandy mudstone, the Carmel locally contains thin beds of brown to gray limestone and reddish- to greenish-gray shale. Predominantly eolian in origin, the Entrada is a massive cross-bedded fine- to medium-grained sandstone ranging in color from reddish-brown to grayish-white that crops out in cliffs or hummocky slopes. The Summerville is composed of regular thin-bedded, ripple-marked, reddish-brown muddy sandstone and sandy shale of marine origin and forms steep to gentle slopes above the Entrada. Cliff-forming Bluff Sandstone is present only in the southern part of the Monticello district thinning northward and pinching out near Blanding. It is a white to grayish-brown, massive, cross-bedded eolian sandstone.

In the southeastern Utah region the Late Jurassic Morrison formation has been divided in ascending order into the Salt Wash, Recapture, Westwater Canyon, and Brushy Basin Members. In general, these strata are dominantly fluvial in origin but do contain lacustrine sediments. Both the Salt Wash and Recapture consist of alternating mudstone and sandstone; the Westwater Canyon is chiefly sandstone with some sandy mudstone and claystone lenses, and the heterogenous Brushy Basin consists of variegated bentonitic mudstone and siltstone containing scattered thin limestone, sandstone, and conglomerate lenses. As strata of the Morrison formation are the oldest rocks exposed in the Mill area vicinity and are one of the two principal uranium-bearing formations in southeast Utah, the Morrison, as well as younger rocks, are described in more detail in Section 1.6.2.2.

The Early Cretaceous Burro Canyon formation rests unconformably (?) on the underlying Brushy Basin Member of the Morrison formation. Most of the Burro Canyon consists of light-colored, massive, cross-bedded fluvial conglomerate, conglomerate sandstone and sandstone. Most of the conglomerates are near the base. Thin, even-bedded, light-green mudstones are included in the formation and light-grey thin-bedded limestones are sometimes locally interbedded with the mudstones near the top of the formation.

Overlying the Burro Canyon is the Dakota Sandstone of Upper Cretaceous age. Typical Dakota is dominantly yellowish-brown to light-gray, thick-bedded, quartzitic sandstone and conglomeratic sandstone with subordinate thin lenticular beds of mudstone, gray carbonaceous shale and, locally, thin seams of impure coal. The contact with the underlying Burro Canyon is unconformable whereas the contact with the overlying Mancos Shale is gradational from the light-colored sandstones to dark-grey to black shaly siltstone and shale.

Upper Cretaceous Mancos Shale is exposed in the region surrounding the project vicinity but not within it. Where exposed and weathered, the shale is light-gray or yellowish-gray, but is dark, to olive-gray where fresh. Bedding is thin and well developed; much of it is laminated.

Quaternary alluvium within the project vicinity is of three types: alluvial silt, sand and gravels deposited in the stream channels; colluvium deposits of slope wash, talus, rock rubble and large displaced blocks on slopes below cliff faces and outcrops of resistant rock; and alluvial and windblown deposits of silt and sand, partially reworked by water, on benches and broad upland surfaces.

1.6.1.3 Structure and Tectonics (1978 ER Section 2.4.1.3)

According to Shoemaker (1954 and 1956), structural features within the Canyon Lands of southeastern Utah may be classified into three main categories on the basis of origin or mechanism of the stress that created the structure. These three categories are: (1) structures related to large-scale regional uplifting or downwarping (epeirogenic deformation) directly related to movements in the basement complex (Monument Uplift and the Blanding Basin); (2) structures resulting from the plastic deformation of thick sequences of evaporite deposits, salt plugs and salt anticlines, where the structural expression at the surface is not reflected in the basement complex (Paradox Fold and Fault Belt); and (3) structures that are formed in direct response to stresses induced by magmatic intrusion including local laccolithic domes, dikes and stocks (Abajo Mountains).

Each of the basins and uplifts within the Mill area region is an asymmetric fold usually separated by a steeply dipping sinuous monocline. Dips of the sedimentary beds in the basins and uplifts rarely exceed a few degrees except along the monocline (Shoemaker, 1956) where, in some instances, the beds are nearly vertical. Along the Comb Ridge monocline, the boundary between the Monument Uplift and the Blanding Basin, approximately eight miles (12.9 kilometers) west of the Mill area, dips in the Upper Triassic Wingate sandstone and in the Chinle formation are more than 40 degrees to the east.

Structures in the crystalline basement complex in the central Colorado Plateau are relatively unknown but where monoclines can be followed in Precambrian rocks they pass into steeply dipping faults. It is probable that the large monoclines in the Canyon Lands section are related to flexure of the layered sedimentary rocks under tangential compression over nearly vertical normal or high-angle reverse faults in the more rigid Precambrian basement rocks (Kelley, 1955; Shoemaker, 1956; Johnson and Thordarson, 1966).

The Monument Uplift is a north-trending, elongated, upwarped structure approximately 90 miles (145 kilometers) long and nearly 35 miles (56 kilometers) wide. Structural relief is about 3,000 feet (914 meters) (Kelley, 1955). Its broad crest is slightly convex to the east where the Comb Ridge monocline defines the eastern boundary. The uniform and gently descending western flank of the uplift crosses the White Canyon slope and merges into the Henry Basin (Figure 1.6-1).

East of the Monument Uplift, the relatively equidimensional Blanding Basin merges almost imperceptibly with the Paradox Fold and Fault Belt to the north, the Four Corners Platform to the southeast and the Defiance Uplift to the south. The basin is a shallow feature with approximately 700 feet (213 meters) of structural relief as estimated on top of the Upper Triassic Chinle formation by Kelley (1955), and is roughly 40 to 50 miles (64 to 80 kilometers) across. Gentle folds within the basin trend westerly to northwesterly in contrast to the distinct northerly orientation of the Monument Uplift.

Situated to the north of the Monument Uplift and Blanding Basin is the most unique structural feature of the Canyon Lands section, the Paradox Fold and Fault Belt. This tectonic unit is dominated by northwest trending anticlinal folds and associated normal faults covering an area about 150 miles (241 kilometers) long and 65 miles (104 kilometers) wide. These anticlinal structures are associated with salt flowage from the Pennsylvanian Paradox Member of the Hermosa formation and some show piercement of the overlying younger sedimentary beds by plug-like salt intrusions (Johnson and Thordarson, 1966). Prominent valleys have been eroded along the crests of the anticlines where salt piercements have occurred or collapses of the central parts have resulted in intricate systems of step-faults and grabens along the anticlinal crests and flanks.

The Abajo Mountains are located approximately 20 miles (32 kilometers) north of the Mill area on the more-or-less arbitrary border of the Blanding Basin and the Paradox Fold and Fault Belt (Figure 1.6-1). These mountains are laccolithic domes that have been intruded into and through the sedimentary rocks by several stocks (Witkind, 1964). At least 31 laccoliths have been identified. The youngest sedimentary rocks that have been intruded are those of Mancos Shale of Late Cretaceous age. Based on this and other vague and inconclusive evidence, Witkind (1964), has assigned the age of these intrusions to the Late Cretaceous or early Eocene.

Nearly all known faults in the region of the Mill area are high-angle normal faults with displacements on the order of 300 feet (91 meters) or less (Johnson and Thordarson, 1966). The largest known faults within a 40-mile (64 kilometer) radius around Blanding are associated with the Shay graben on the north side of the Abajo Mountains and the Verdure graben on the south side. Respectively, these faults trend northeasterly and easterly and can be traced for approximate distances ranging from 21 to 34 miles (34 to 55 kilometers) according to Witkind (1964). Maximum displacements reported by Witkind on any of the faults are 320 feet (98 meters). Because of the extensions of Shay and Verdure fault systems beyond the Abajo Mountains and other geologic evidence, the age of these faults is Late Cretaceous or post-Cretaceous and antedate the laccolithic intrusions (Witkind, 1964).

A prominent group of faults is associated with the salt anticlines in the Paradox Fold and Fault Belt. These faults trend northwesterly parallel to the anticlines and are related to the salt emplacement. Quite likely, these faults are relief features due to salt intrusion or salt removal by solution (Thompson, 1967). Two faults in this region, the Lisbon Valley fault associated with the Lisbon Valley salt anticline and the Moab fault at the southeast end of the Moab anticline have maximum vertical displacements of at least 5,000 feet (1,524 meters) and 2,000 feet (609 meters), respectively, and are probably associated with breaks in the Precambrian basement crystalline complex. It is possible that zones of weakness in the basement rocks represented by faults of this magnitude may be responsible for the beginning of salt flowage in the salt anticlines, and subsequent solution and removal of the salt by groundwater caused collapse within the salt anticlines resulting in the formation of grabens and local complex block faults (Johnson and Thordarson, 1966).

The longest faults in the Colorado Plateau are located some 155 to 210 miles (249 to 338 kilometers) west of the Mill area along the western margin of the High Plateau section. These faults have a north to northeast echelon trend, are nearly vertical and downthrown on the west in most places. Major faults included in this group are the Hurricane, Toroweap-Sevier, Paunsaugunt, and Paradise faults. The longest fault, the Toroweap-Sevier, can be traced for about 240 miles (386 kilometers) and may have as much as 3,000 feet (914 meters) of displacement (Kelley, 1955).

From the later part of the Precambrian until the middle Paleozoic the Colorado Plateau was a relatively stable tectonic unit undergoing gentle epeirogenic uplifting and downwarping during which seas transgressed and regressed, depositing and then partially removing layers of sedimentary materials. This period of stability was interrupted by northeast-southwest tangential compression that began sometime during late Mississippian or early Pennsylvanian and continued intermittently into the Triassic. Buckling along the northeast margins of the shelf produced northwest-trending uplifts, the most prominent of which are the Uncompahgre and San Juan Uplifts, sometimes referred to as the Ancestral Rocky Mountains. Clearly, these positive features are the earliest marked tectonic controls that may have guided many of the later Laramide structures (Kelley, 1955).

Subsidence of the area southwest of the Uncompahgre Uplift throughout most of the Pennsylvanian led to the filling of the newly formed basin with an extremely thick sequence of evaporites and associated interbeds which comprise the Paradox Member of the Hermosa formation (Kelley, 1958). Following Paradox deposition, continental and marine sediments buried the evaporite sequence as epeirogenic movements shifted shallow seas across the region during the Jurassic, Triassic and much of the Cretaceous. The area underlain by the Paradox Member in eastern Utah and western Colorado is commonly referred to as the Paradox Basin (Figure 1.6-1). Renewed compression during the Permian initiated the salt anticlines and piercements, and salt flowage continued through the Triassic.

The Laramide orogeny, lasting from Late Cretaceous through Eocene time, consisted of deep-seated compressional and local vertical stresses. The orogeny is responsible for a north-south to northwest trend in the tectonic fabric of the region and created most of the principal basins and uplifts in the eastern-half of the Colorado Plateau (Grose, 1972; Kelley, 1955).

Post-Laramide epeirogenic deformation has occurred throughout the Tertiary; Eocene strata are flexed sharply in the Grand Hogback monocline, fine-grained Pliocene deposits are tilted on the flanks of the Defiance Uplift, and Pleistocene deposits in Fisher Valley contain three angular unconformaties (Shoemaker, 1956).

1.6.2 Blanding Site Geology

The following descriptions of physiography and topography; rock units; structure; relationship of earthquakes to tectonic structure; and potential earthquake hazards to the Mill area are reproduced from the 1978 ER for ease of reference and as a review of the Mill site geology (see Figure 1.6-2).

1.6.2.1 Physiography and Topography (1978 ER Section 2.4.2.1)

The Mill site is located near the center of White Mesa, one of the many finger-like north-south trending mesas that make up the Great Sage Plain. The nearly flat upland surface of White Mesa is underlain by resistant sandstone caprock which forms steep prominent cliffs separating the upland from deeply entrenched intermittent stream courses on the east, south and west.

Surface elevations across the Mill site range from about 5,550 to 5,650 feet (1,692 to 1,722 meters) and the gently rolling surface slopes to the south at a rate of approximately 60 feet per mile (18 meters per 1.6 kilometer).

Insert

Figure 1.6-2 White Mesa Millsite Geology of Surrounding Area

Maximum relief between the mesa's surface and Cottonwood Canyon on the west is about 750 feet (229 meters) where Westwater Creek joins Cottonwood Wash. These two streams and their tributaries drain the west and south sides of White Mesa. Drainage on the east is provided by Recapture Creek and its tributaries. Both Cottonwood Wash and Recapture Creeks are normally intermittent streams and flow south to the San Juan River. However, Cottonwood Wash has been known to flow perennially in the project vicinity during wet years.

1.6.2.2 Rock Units (1978 ER Section 2.4.2.2)

Only rocks of Jurassic and Cretaceous ages are exposed in the vicinity of the Mill site. These include, in ascending order, the Upper Jurassic Salt Wash, Recapture, Westwater Canyon, and Brushy Basin Members of the Morrison formation; the Lower Cretaceous Burro Canyon formation; and the Upper Cretaceous Dakota Sandstone. The Upper Cretaceous Mancos Shale is exposed as isolated remnants along the rim of Recapture Creek valley several miles southeast of the Mill site and on the eastern flanks of the Abajo Mountains some 20 miles (32 kilometers) north but is not exposed at the Mill site. However, patches of Mancos Shale may be present within the Mill site boundaries as isolated buried remnants that are obscured by a mantle of alluvial windblown silt and sand.

The Morrison formation is of particular economic importance in southeast Utah since several hundred uranium deposits have been discovered in the basal Salt Wash Member (Stokes, 1967).

In most of eastern Utah, the Salt Wash Member underlies the Brushy Basin. However, just south of Blanding in the project vicinity the Recapture Member replaces an upper portion of the Salt Wash and the Westwater Canyon Member replaces a lower part of the Brushy Basin. A southern limit of Salt Wash deposition and a northern limit of Westwater Canyon deposition has been recognized by Haynes et al. (1972) in Westwater Canyon approximately three to six miles (4.8 to 9.7 kilometers), respectively, northwest of the Mill site. However, good exposures of Salt Wash are found throughout the Montezuma Canyon area 13 miles (21 kilometers) to the east.

The Salt Wash Member is composed dominantly of fluvial fine-grained to conglomeratic sandstones, and interbedded mudstones. Sandstone intervals are usually yellowish-brown to pale reddish-brown while the mudstones are greenish- and reddish-gray. Carbonaceous materials ("trash") vary from sparse to abundant. Cliff-forming massive sandstone and conglomeratic sandstone in discontinuous beds make up to 50 percent or more of the member. According to Craig et al. (1955), the Salt Wash was deposited by a system of braided streams flowing generally east and northeast. Most of the uranium-vanadium deposits are located in the basal sandstones and conglomeratic sandstones that fill stream-cut scour channels in the underlying Bluff Sandstone, or where the Bluff Sandstone has been removed by pre-Morrison erosion, in similar channels cut in the Summerville formation. Mapped thicknesses of this member range from zero to approximately 350 feet (0-107 meters) in southeast Utah. Because the Salt Wash pinches out in a southerly direction in Recapture Creek three miles (4.8 kilometers) northwest of the Mill site and does not reappear until exposed in Montezuma Canyon, it is not known for certain that the Salt Wash actually underlies the site.

The Recapture Member is typically composed of interbedded reddish-gray, white, and light-brown fine- to medium-grained sandstone and reddish-gray, silty and sandy claystone. Bedding is gently to sharply lenticular. Just north of the Mill site, the Recapture intertongues with and grades into the Salt Wash and the contact between the two cannot be easily recognized. A few spotty occurrences of uriniferous mineralization are found in sandstone lenses in the southern part of the Monticello district and larger deposits are known in a conglomeratic sandstone facies some 75 to 100 miles (121 to 161 kilometers) southeast of the Monticello district. Since significant ore deposits have not been found in extensive outcrops in more favorable areas, the Recapture is believed not to contain potential resources in the Mill site (Johnson and Thordarson, 1966).

Just north of the Mill site, the Westwater Canyon Member intertongues with and grades into the lower part of the overlying Brushy Basin Member. Exposures of the Westwater Canyon in Cottonwood Wash are typically composed of interbedded yellowish- and greenish-gray to pinkish-gray, lenticular, fine- to coarse-grained arkosic sandstone and minor amounts of greenish-gray to reddish-brown sandy shale and mudstone. Like the Salt Wash, the Westwater Canyon Member is fluvial in origin, having been deposited by streams flowing north and northwest, coalescing with streams from the southwest depositing the upper part of the Salt Wash and the lower part of the Brushy Basin (Huff and Lesure, 1965). Several small and scattered uranium deposits in the Westwater Canyon are located in the extreme southern end of the Monticello district. Both the Recapture Member and the Westwater Canyon contain only traces of carbonaceous materials, are believed to be less favorable host rocks for uranium deposition (Johnson and Thordarson, 1966) and have very little potential for producing uranium reserves.

The lower part of the Brushy Basin is replaced by the Westwater Canyon Member in the Blanding area but the upper part of the Brushy Basin overlies this member. Composition of the Brushy Basin is dominantly variegated bentonitic mudstone and siltstone. Bedding is thin and regular and usually distinguished by color variations of gray, pale-green, reddish-brown, pale purple, and maroon. Scattered lenticular thin beds of distinctive green and red chert-pebble conglomeratic sandstone are found near the base of the member, some of which contain uranium-vanadium mineralization in the southernmost part of the Monticello district (Haynes et al., 1972). Thin discontinuous beds of limestone and beds of grayish-red to greenish-black siltstone of local extent suggest that much of the Brushy Basin is probably lacustrine in origin.

For the most part, the Great Sage Plain owes its existence to the erosion of resistant sandstones and conglomerates of the Lower Cretaceous Burro Canyon formation. This formation unconformably (?) overlies the Brushy Basin and the contact is concealed over most of the Mill area by talus blocks and slope wash. Massive, light-gray to light yellowish-brown sandstone, conglomeratic sandstone and conglomerate comprise more than two-thirds of the formation's thickness. The conglomerate and sandstone are interbedded and usually grade from one to the other. However, most of the conglomerate is near the base. These rocks are massive cross-bedded units formed by a series of interbedded lenses, each lens representing a scour filled with stream-deposited sediments. In places the formation contains greenish-gray lenticular beds of mudstone and claystone. Most of the Burro Canyon is exposed in the vertical cliffs separating the relatively flat surface of White Mesa from the canyons to the west and east. In some places the resistant basal sandstone beds of the overlying Dakota Sandstone are exposed at the top of the cliffs, but entire cliffs of Burro Canyon are most common. Where the sandstones of the Dakota rest on sandstones and conglomerates of the Burro Canyon, the contact between the two is very difficult to identify and most investigators map the two formations as a single unit (Figure 1.6-2). At best, the contact can be defined as the top of a silicified zone in the upper part of the Burro Canyon that appears to be remnants of an ancient soil that formed during a long period of weathering prior to Dakota deposition (Huff and Lesure, 1965).

The Upper Cretaceous Dakota Sandstone disconformably overlies the Burro Canyon formation. Locally, the disconformity is marked by shallow depressions in the top of the Burro Canyon filled with Dakota sediments containing angular to sub-rounded rock fragments probably derived from Burro Canyon strata (Witkind, 1964) but the contact is concealed at the Mill site. The Dakota is composed predominantly of pale yellowish-brown to light gray, massive, intricately cross-bedded, fine- to coarse-grained quartzose sandstone locally well-cemented with silica and calcite; elsewhere it is weakly cemented and friable. Scattered throughout the sandstone are lenses of conglomerate, dark-gray carbonaceous mudstones and shale and, in some instances, impure coal. In general, the lower part of the Dakota is more conglomeratic and contains more cross-bedded sandstone than the upper part which in normally more thinly bedded and marine-like in appearance. The basal sandstones and conglomerates are fluvial in origin, whereas the carbonaceous mudstones and shales were probably deposited in back water areas behind beach ridges in front of the advancing Late Cretaceous sea (Huff and Lesure, 1965). The upper sandstones probably represent littoral marine deposits since they grade upward into the dark-gray siltstones and marine shales of the Mancos Shale.

The Mancos shale is not exposed in the project vicinity. The nearest exposures are small isolated remnants resting conformably on Dakota Sandstone along the western rim above Recapture Creek 4.3 to 5.5 miles (6.9 to 8.9 kilometers) southeast of the Mill site. Additional exposures are found on the eastern and southern flanks of the Abajo Mountains approximately 16 to 20 miles (26 to 32 kilometers) to the north. It is possible that thin patches of Mancos may be buried at the Mill site but are obscured by the mantle of alluvial windblown silt and sand covering the upland surface. The Upper Cretaceous Mancos shale is of marine origin and consists of dark- to olive-gray shale with minor amounts of gray, fine-grained, thin-bedded to blocky limestone and siltstone in the lower part of the formation. Bedding in the Mancos is thin and well developed, and much of the shale is laminated. Where fresh, the shale is brittle and fissile and weathers to chips that are light- to yellowish-gray. Topographic features formed by the Mancos are usually subdued and commonly displayed by low rounded hills and gentle slopes.

A layer of Quaternary to Recent reddish-brown eolian silt and fine sand is spread over the surface of the Mill site. Most of the loess consists of subangular to rounded frosted quartz grains that are coated with iron oxide. Basically, the loess is massive and homogeneous, ranges in thickness from a dust coating on the rocks that form the rim cliffs to more than 20 feet (6 meters), and is partially cemented with calcium carbonate (caliche) in light-colored mottled and veined accumulations which probably represent ancient immature soil horizons.

1.6.2.3 Structure (1978 ER Section 2.4.2.3)

The geologic structure at the Mill site is comparatively simple. Strata of the underlying Mesozoic sedimentary rocks are nearly horizontal; only slight undulations along the caprock rims of the upland are perceptible and faulting is absent. In much of the area surrounding the Mill site the dips are less than one degree. The prevailing regional dip is about one degree to the south. The low dips and simple structure are in sharp contrast to the pronounced structural features of the Comb Ridge Monocline to the west and the Abajo Mountains to the north.

The Mill area is within a relatively tectonically stable portion of the Colorado Plateau noted for its scarcity of historical seismic events. The epicenters of historical earthquakes from 1853 through 1986 within a 200-mile (320 km) radius of the site are shown in Figure 1.6-3. More than 1,146 events have occurred in the area, of which at least 45 were damaging; that is, having an intensity of VI or greater on the Modified Mercalli Scale. A description of the Modified Mercalli Scale is given in Table 1.6-3. All intensities mentioned herein refer to this table. Table 1.6-3 also shows a generalized relationship between Mercalli intensities and other parameters to which this review will refer. Since these relationships are frequently site specific, the table values should be used only for approximation and understanding. Conversely, the border between the Colorado Plateau and the Basin and Range Province and Middle Rocky Mountain

Figure 1.6-3 Seismicity Within 320km of the White Mesa Mill

Table 1.6-3 Modified Mercalli Scale

Modified Mercalli Scale, 1956 Version[a]				
	Intensity	Effects	v. † cm/s	g ‡
M§	I.	Not felt. Marginal and long-period effects of large earthquakes (for details see text).		
3	II.	Felt by persons at rest on upper floors, or favorably placed.		
	III.	Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.		0.0035-0.007
4	IV.	Hanging objects swing. Vibration like passing of heavy trucks or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV wooden walls and frame creak.		0.007-0.015
	V.	Felt outdoors: direction estimated. Sleepers wakened. Liquids disturbed. Some spilled. Small unstable objects displaced or upset. Doors swing close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.	1-3	0.015-0.035
5	VI.	Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc. off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken (visibly, or heard to rustle - CFR).	3-7	0.035-0.07
6	VII.	Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments - CFR). Some cracks in masonry C. Waves on ponds: water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.	7-20	0.07-0.15
	VIII.	Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none is masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.	20-80	0.15-0.35
7	IX.	General panic. Masonry D destroyed, masonry C heavily damaged. Sometimes with complete collapse, masonry B seriously damaged. (General damage to foundations - CFR). Frame structures, if not bolted, shifted off foundations. Frames rocked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated areas sand and mud ejected, earthquake fountains, sand craters.	.80-200	0.35-0.7
8	X.	Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.	200-500	0.7-1.2
	XI.	Rails bent greatly. Underground pipelines completely out of service.		>1.2
	XII.	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.	From Fig. 11.14	

Note: Masonry A, B, C, D. To avoid ambiguity of language, the quality of masonry, brick or otherwise, is specified by the following lettering (which has no connection with the conventional Class A, B, C construction).

- Masonry A : Good workmanship, mortar, and design reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.
- Masonry B: Good workmanship and mortar; reinforced, but not designed to resist lateral forces.
- Masonry C: Ordinary workmanship and mortar; no extreme weaknesses such as non-ded-ia corners, but masonry is neither reinforced nor designed against horizontal forces.
- Masonry D : Week materials such as adobe, poor mortar, low standards of workmanship, week horizontally.

[a]From Richter (1958). [1]Adapted with permission of W. H. Freeman and Company by Hunt (1984).
†Average peak ground velocity, cm/s.
‡Average peak acceleration (away from source).
§Magnitude correlation.

Province some 155 to 240 miles (249 to 386 km) west and northwest, respectively, from the site is one of the most active seismic belts in the western United States.

Only 63 non-duplicative epicenters have been recorded within a 120 mile (200 km) radius of the Mill area (Figure 1.6-4). Of these, 50 had an intensity IV or less (or unrecorded) and two were recorded as intensity VI. The nearest event occurred in the Glen Canyon National Recreation Area approximately 38 miles (63 km) west-northwest of the Mill area. The next closest event occurred approximately 53 miles (88 km) to the northeast. Just east of Durango, Colorado, approximately 99 miles (159 km) due east of the Mill area, an event having local intensity of V was recorded on August 29, 1941 (Hadsell, 1968). It is very doubtful that these events would have been felt in the vicinity of Blanding.

Three of the most damaging earthquakes associated with the seismic belt along the Colorado Plateau's western border have occurred in the Elsinore-Richfield are about 168 miles (270 km) northwest of the Mill site. All were of intensity VIII. On November 13, 1901, a strong shock caused extensive damage from Richfield to Parowan. Many brick structures were damaged; rockslides were reported near Beaver. Earthquakes with the ejection of sand and water were reported, and some creeks increased their flow. Aftershocks continued for several weeks (von Hake, 1977). Following several weeks of small foreshocks, a strong earthquake caused major damage in the Monroe-Elsinore-Richfield area on September 29, 1921. Scores of chimneys were thrown down, plaster fell from ceilings, and a section of a new two-story brick wall collapsed at Elsinore's schoolhouse. Two days later, on October 1, 1921, another strong tremor caused additional damage to the area's structures. Large rockfalls occurred along both sides of the Sevier Valley and hot springs were discolored by iron oxides (von Hake, 1977). It is probable that these shocks may have been perceptible at the Mill site but they certainly would not have caused any damage.

Seven events of intensity VII have been reported within 320 kilometers (km) around Blanding, Utah, which is the area shown in Figure 1.6-3. Of these, only two are considered to have any significance with respect to the Mill site. On August 18, 1912, an intensity VII shock damaged houses in northern Arizona and was felt in Gallup, New Mexico, and southern Utah. Rock slides occurred near the epicenter in the San Francisco Mountains and a 50-mile (80 km) earth crack was reported north of the San Francisco Range (Cater, 1970). Nearly every building in Dulce, New Mexico, was damaged to some degree when shook by a strong earthquake on January 22, 1966. Rockfalls and landslides occurred 10 to 15 miles (16 to 24 km) west of Dulce along Highway 17 where cracks in the pavement were reported (Hermann et al., 1980). Both of these events may have been felt at the Mill site but, again, would certainly not have caused any damage. Figure 1.6-4 shows the occurrence of seismic events within 200 km of Blanding.

1.6.2.4 Relationship of Earthquakes to Tectonic Structures

The majority of recorded earthquakes in Utah have occurred along an active belt of seismicity that extends from the Gulf of California, through western Arizona, central Utah, and northward into western British Columbia. The seismic belt is possibly a branch of the active rift system associated with the landward extension of the East Pacific Rise (Cook and Smith, 1967). This belt is the Intermountain Seismic Belt shown in Figure 1.6-5 (Smith, 1978).

It is significant to note that the seismic belt forms the boundary zone between the Basin and Range - Great Basin Provinces and the Colorado Plateau - Middle Rocky Mountain Provinces. This block-faulted zone is about 47 to 62 miles (75 to 100 km) wide and forms a tectonic transition zone between the relatively simple structures of the Colorado Plateau and the complex fault-controlled structures of the Basin and Range Province (Cook and Smith, 1967).

Insert

Figure 1.6-4 Seismicity Within 200km of the White Mesa Mill

Insert

Figure 1.6-5 Seismicity of the Western United States 1950 to 1976

Another zone of seismic activity is in the vicinity of Dulce, New Mexico, near the Colorado border. This zone, which coincides with an extensive series of tertiary intrusives, may also be related to the northern end of the Rio Grande Rift. This rift is a series of fault-controlled structural depressions extending southward from southern Colorado through central New Mexico and into Mexico. The rift is shown on Figure 1.6-5 trending north-south to the east of the Mill area.

Most of the events south of the Utah border of intensity V and greater are located within 50 miles (80 km) of post-Oligocene extrusives. This relationship is not surprising because it has been observed in many other parts of the world (Hadsell, 1968).

In Colorado, the Rio Grande Rift zone is one of three siesmotectonic provinces that may contribute energy to the study area. Prominent physiographic expression of the rift includes the San Luis Valley in southern Colorado. The valley is a half-graben structure with major faulting on the eastern flank. Extensional tectonics is dominant in the area and very large earthquakes with recurrence intervals of several thousand years have been projected (Kirkham and Rogers, 1981). Mountainous areas to the west of the Rio Grande rift province include the San Juan Mountains. These mountains are a complex domicia uplift with extensive Oligocene and Miocene volcanic cover. Many faults are associated with the collapse of the calderas and apparently have not moved since. Faults of Neogene age exist in the eastern San Juan Mountains that may be related to the extension of the Rio Grande rift. Numerous small earthquakes have been felt or recorded in the western mountainous province despite an absence of major Neogene tectonic faults (Kirkham and Rogers, 1981).

The third seismotectonic province in Colorado, that of the Colorado Plateau, extends into the surrounding states to the west and south. In Colorado, the major tectonic element that has been recurrently active in the Quaternary is the Uncompahgre uplift. Both flanks are faulted and earthquakes have been felt in the area. The faults associated with the Salt Anticlines are collapsed features produced by evaporite solution and flowage (Cater, 1970). Their non-tectonic origin and the plastic deformation of the salt reduce their potential for generating even moderate-sized earthquakes (Kirkham and Rogers, 1981).

Case and Joesting (1972) have called attention to the fact that regional seismicity of the Colorado Plateau includes a component added by basement faulting. They inferred a basement fault trending northeast along the axis of the Colorado River through Canyonlands. This basement faulting may be part of the much larger structure that Hite (1975) examined and Warner (1978) named the Colorado lineament (Figure 1.6-6). This 1,300-mile (2,100 km) long lineament that extends from northern Arizona to Minnesota is suggested to be a Precambrian wrench-fault system formed some 2.0 to 1.7 billion years before present. While it has been suggested that the Colorado lineament is a source zone for larger earthquakes (m = 4 to 6) in the west-central United States, the observed spatial relationship between epicenters and the trace of the lineament does not prove a casual relation (Brill and Nuttli, 1983). In terms of contemporary seismicity, the lineament does not act as a uniform earthquake generator. Only specific portions of the proposed structure can presently be considered seismic source zones and each segment exhibits seismicity of distinctive activity and character (Wong, 1981). This is a reflection of the different orientations and magnitudes of the stress fields along the lineament. The interior of the Colorado Plateau forms a tectonic stress province, as defined by Zoback and Zoback (1980), that is characterized by generally east-west tectonic compression. Only where extensional stresses from the Basin and Range province of the Rio Grande rift extend into the Colorado Plateau would the Colorado lineament in the local area be suspected of having the capability of generating a large magnitude earthquake (Wong, 1984). At present, the well-defined surface expression of regional extension is far to the west and far to the east of the Mill area.

Insert

Figure 1.6-6 Colorado Lineament

Work by Wong (1984) has helped define the seismicity of the whole Colorado Plateau. He called attention to the low level (less than local magnitude, ML = 3.6) but high number (30) of earthquakes in the Capitol Reef Area from 1978 to 1980 that were associated with the Waterpocket fold and the Cainville monocline, two other major tectonic features of the Colorado Plateau. Only five earthquakes in the sequence were of ML greater than three, and fault plane solutions suggest the swarm was produced by normal faulting along northwest-trending Precambrian basement structures (Wong, 1984). The significance of the Capitol Reef seismicity is its relatively isolated occurrence within the Colorado Plateau and its location at a geometric barrier in the regional stress field (Aki, 1979). Stress concentration that produces earthquakes at bends or junctures of basement faults as indicated by this swarm may occur at other locations in the Colorado Plateau Province. No inference that earthquakes such as those at Capitol Reef are precursors for larger subsequent events is implied.

1.6.2.5 Potential Earthquake Hazards to Mill Area

The Mill site is located in a region known for its scarcity of recorded seismic events. Although the seismic history for this region is barely 135 years old, the epicentral pattern, or fabric, is basically set and appreciable changes are not expected to occur. Most of the larger seismic events in the Colorado Plateau occurred along its margins rather than in the interior central region. Based on the region's seismic history, the probability of a major damaging earthquake occurring at or near the Mill site is remote. Studies by Algermissen and Perkins (1976) indicate that southeastern Utah, including the site, is in an area with a 90 percent probability that a horizontal acceleration of four percent gravity (0.04g) would not be exceeded within 50 years. In 2002, the USGS updated the National Seismic Hazard Maps (NSHM), which show peak ground and spectral accelerations at 2 percent and 10 percent probability of exceedance in 50 years. From these maps, it is determined that there is a 98 percent probability that a horizontal acceleration of 0.09g would not be exceeded within 50 years (Tetra Tech, 2006). Furthermore, an updated seismic hazard analysis performed by Tetra Tech (2010) for the site determined that there is a 98 percent probability that a horizontal acceleration of 0.15g would not be exceeded within a 200-year design life of the tailings management cells. The Tetra Tech (2010) report is included in Appendix D.

1.6.3 Site-Specific Probabilistic Seismic Hazard Analysis

A site-specific probabilistic seismic hazard analysis (PSHA) (MWH, 2015a) was conducted for the White Mesa Mill site. The PSHA was performed to better understand the likelihood of potential earthquake sources, to correlate results with previous analyses conducted for the site, and to evaluate the contribution of the seismic sources (e.g. deaggregation). This analysis assessed the site-specific seismic hazard using Ground Motion Prediction Equations (GMPEs) to estimate seismically induced ground motions at the site. Seismic hazard analyses were previously conducted for the design of the Cell 4A and 4B facilities (Tetra Tech, 2006; Tetra Tech, 2010) and in response to DWMRC review of EFRI responses to interrogatories on the Reclamation Plan (MWH, 2012). These analyses indicated that the seismic hazard at the site is dominated by background events in the Colorado Plateau.

The PSHA is based on a seismotectonic model and source characterization of the site and surrounding area. The study evaluated a 200-mile radius surrounding the site. The seismotectonic model identified three general seismic sources in the study area: 1) seismicity of the Intermountain Seismic Belt (ISB), 2) seismicity of the Colorado Plateau (CP), and 3) crustal faults that meet the NRC minimum criteria. Each source zone was characterized to establish input parameters for the seismic hazard analyses. The PSHA was performed using HAZ43 (2014) software developed by Dr. Norman Abrahamson. Operational and long-term design recommendations were developed based on the results from this PSHA and previous seismic investigations at the site.

This study concluded that the maximum horizontal acceleration value at the Mill site for a seismic event associated with an average return period of 10,000 years is 0.15g. Based on this maximum horizontal acceleration, a pseudo-static coefficient of 0.10g was used for seismic stability analyses of the reclaimed tailings impoundments (presented in Appendix A).

1.7 Biota (1978 ER Section 2.9)

1.7.1 Terrestrial (1978 ER Section 2.9.1)

1.7.1.1 Flora (1978 ER Section 2.9.1.1)

The natural vegetation presently occurring within a 25-mile (40-km) radius of the site is very similar to that of the potential, being characterized by pinyon-juniper woodland intergrading with big sagebrush (*Artemisia tridentata*) communities. The pinyon-juniper community is dominated by Utah juniper (*Juniperus osteosperma*) with occurrences of pinyon pine (*Pinus edulis*) as a codominant or subdominant tree species. The understory of this community, which is usually quite open, is composed of grasses, forbs, and shrubs that are also found in the big sagebrush communities. Common associates include galleta grass (*Hilaria jamesii*), green ephedra (*Ephedra viridis*), and broom snakewood (*Gutierrezia sarothrae*). The big sagebrush communities occur in deep, well-drained soils on flat terrain, whereas the pinyon-juniper woodland is usually found on shallow rocky soil of exposed canyon ridges and slopes.

Seven community types are present on the Mill site (Table 1.7-1 and Figure 1.7-1). Except for the small portions of pinyon-juniper woodland and the big sagebrush community types, the majority of the plant communities within the site boundary have been disturbed by past grazing and/or treatments designed to improve the site for rangeland. These past treatments include chaining, plowing, and reseeding with crested wheatgrass (*Agropyron desertorum*). Controlled big sagebrush communities are those lands containing big sagebrush that have been chained to stimulate grass production. In addition, these areas have been seeded with crested wheatgrass. Both grassland communities I and II are the result of chaining and/or plowing and seeding with crested wheatgrass. The reseeded grassland II community is in an earlier stage of recovery from disturbance than the reseeded grassland I community. The relative frequency, relative cover, relative density, and importance values of species sampled in each community are presented in Dames and Moore, (1978b), Table 2.8-2. The percentage of vegetative cover in 1977 was lowest on the reseeded grassland II community (10.7 percent) and highest on the big sagebrush community (33 percent) (Table 1.7-2).

Based upon dry weight composition, most communities on the site were in poor range condition in 1977 (Dames & Moore, 1978b, Tables 2.8-3 and 2.8-4). Pinyon-juniper, big sagebrush, and controlled big sagebrush communities were in fair condition. However, precipitation for 1977 at the Mill site was classed as drought conditions (Dames & Moore, 1978b, Section 2.8.2.1). Until July, no production was evident on the site.

Based on the work completed by Dames & Moore in the 1978 ER, no designated or proposed endangered plant species occur on or near the Mill site (Dames & Moore, 1978b, Section 2.8.2.1). Of the 65 proposed endangered species in Utah at that time, six have documented distributions on San Juan County. A review of the habitat requirements and known distributions of these species by Dames & Moore in the 1978 ER indicated that, because of the disturbed environment, these species would probably not occur on the Mill site. The Navajo Sedge has been added to the list as a threatened species since the 1978 ER.

Table 1.7-1
Community Types and Expanse Within the Project site Boundary

Community Type	Expanse Ha	Expanse Acres
Pinyon-juniper Woodland	5	13
Big Sagebrush	113	278
Reseeded Grassland I	177	438
Reseeded Grassland II	121	299
Tamarisk-salix	3	7
Controlled Big Sagebrush	230	569
Disturbed	17	41

Table 1.7-2
Ground Cover For Each Community Within the Project Site Boundary

	Percentage of Each Type of Cover		
Community Type	Vegetative Cover	Litter	Bare Ground
Pinyon-juniper Woodland[a]	25.9	15.6	55.6
Big Sagebrush	33.3	16.9	49.9
Reseeded Grassland I	15.2	24.2	61.0
Reseeded Grassland II	10.7	9.5	79.7
Tamarisk-salix	12.0	20.1	67.9
Controlled Big Sagebrush	17.3	15.3	67.4
Disturbed	13.2	7.0	80.0

[a]Rock covered 4.4% of the ground.

Insert

Figure1.7-1 Vegetation Community Types on the White Mesa Mill Site

In completing the 2002 EA, NRC staff contacted wildlife biologists from the BLM and the Utah Wildlife Service to gather local information on the occurrences of additional species surrounding the Mill. In the 2002 EA, NRC staff concluded that the Navajo Sedge has not been observed in the area surrounding Blanding, and is typically found in areas of moisture (2002 EA).

In June 2012, the area surrounding the Mill site was surveyed for plant composition to supplement data presented in Dames & Moore (1978b). Survey results confirmed that two principal plant community types in the vicinity of the Mill site. These plant communities are Big Sagebrush shrubland and Juniper woodland. In addition to these two principal plant community types, there are a number of disturbed areas in different stages of successional development. These areas reflect past disturbances such as sagebrush removal (chaining and plowing) and seeding and intense grazing, as evidenced by a complete lack of any understory species in some areas. The vegetation survey conducted in 2012 provides information of species that exist on the Mill site and their relative importance in terms of plant cover. All areas surveyed in 2012 show that big sagebrush (*Artemisia tridentata*) is the dominant species and subdominants are either broom snakeweed (*Gutierrezia sarothroae*) or galleta (*Hilaria jamesii*). Additional discussion on this survey is provided in Appendix A.

1.7.1.2 Fauna (1978 ER Section 2.9.1.2)

Wildlife data have been collected through four seasons at several locations on the site. The presence of a species was based on direct observations, trappings and signs such as the occurrence of scat, tracks, or burrows. A total of 174 vertebrate species potentially occur within the vicinity of the mill (Dames & Moore, 1978b, Appendix D), 78 of which were confirmed (Dames & Moore, 1978b, Section 2.8.2.2).

Although seven species of amphibians are thought to occur in the area, the scarcity of surface water limits the use of the site by amphibians. The tiger salamander (*Ambystoma tigrinum*) was the only species observed. It appeared in the pinyon-juniper woodland west of the Mill site (Dames & Moore, 1978b, Section 2.8.2.2).

Eleven species of lizards and five snakes potentially occur in the area. Three species of lizards were observed: the sagebrush lizard (*Sceloparas graciosus*), western whiptail (*Cnemidophorus tigris*), and the short-horned lizard (*Phrynosoma douglassi*) (Dames & Moore, 1978b, Section 2.8.2.2). The sagebrush and western whiptail lizard were found in sagebrush habitat, and the short-horned lizard was observed in the grassland. No snakes were observed during the field work.

Fifty-six species of birds were observed in the vicinity of the Mill site (Table 1.7-3). The abundance of each species was estimated by using modified Emlen transects and roadside bird counts in various habitats and seasons. Only four species were observed during the February sampling. The most abundant species was the horned lark (*Eremophila aepestis*) followed by the common raven (*Corvus corax*), which were both concentrated in the grassland. Avian counts increased drastically in May. Based on extrapolation of the Emlen transect data, the avian density on grassland of the Mill site during spring was about 123 per 100 acres (305 per square kilometer). Of these individuals, 94 percent were horned larks and western meadowlarks (*Sturnella neglecta*). This density and species composition are typical of rangeland habitats. In late June the species diversity declined somewhat in grassland but peaked in all other habitats. By October the overall diversity decreased but again remained the highest in grassland.

Table 1.7-3
Birds Observed in the Vicinity of the White Mesa Project

Species	Relative Abundance and Status[a]	Species	Relative Abundance and Status[a]
Mallard	CP	Pinyon Jay	CP
Pintail	CP	Bushtit	CP
Turkey Vulture	US	Bewick's Wren	CP
Red-tailed Hawk	CP	Mockingbird	US
Golden Eagle	CP	Mountain Bluebird	CS
Marsh Hawk	CP	Black-tailed Gnatcatcher	H
Merlin	UW	Ruby-crowned Kinglet	CP
American Kestrel	CP	Loggerhead Shrike	CS
Sage Grouse	UP	Starling	CP
Scaled Quail	Not Listed	Yellow-rumped Warbler	CS
American Coot	CS	Western Meadowlark	CP
Killdeer	CP	Red-winged Blackbird	CP
Spotted Sandpiper	CS	Brewer's Blackbird	CP
Mourning Dove	CS	Brown-headed Cowbird	CS
Common Nighthawk	CS	Blue Grosbeak	CS
White-throated Swift	CS	House Finch	CP
Yellow-bellied Sapsucker	CP	American Goldfinch	CP
Western Kingbird	CS	Green-tailed Towhee	CS
Ash-throated Flycatcher	CS	Rufous-sided Towhee	CP
Say's Phoebe	CS	Lark Sparrow	CS
Horned Lark	CP	Black-throated Sparrow	CS
Violet-green Swallow	CS	Sage Sparrow	UC
Barn Swallow	CS	Dark-eyed Junco	CW
Cliff Swallow	CS	Chipping Sparrow	CS
Scrub Jay	CP	Brewer's Sparrow	CS
Black-billed Magpie	CP	White-crowned Sparrow	CS
Common Raven	CP	Song Sparrow	CP
Common Crow	CW	Vesper Sparrow	CS

[a]W. H. Behle and M. L. Perry, *Utah Birds*, Utah Museum of Natural History, University of Utah, Salt Lake City, 1975.

Relative Abundance	Status
C = Common	P = Permanent
U = Uncommon	S = Summer Resident
H = Hypothetical	W = Winter Visitant

Source: Dames & Moore (1978b), Table 2.8-5

Raptors are prominent in the western United States. Five species were observed in the vicinity of the site (Table 1.7-3). Although no nests of these species were located, all (except the golden eagle, *Aquila chrysaetos*) have suitable nesting habitat in the vicinity of the site. The nest of a prairie falcon (*Falco mexicanus*) was found about 3/4 mile (1.2 km) east of the site. Although no sightings were made of this species, members tend to return to the same nests for several years if undisturbed (Dames & Moore, 1978b, Section 2.8.2.2).

Of several mammals that occupy the site, mule deer (*Odocoileus hemionus*) is the largest species. The deer inhabit the project vicinity and adjacent canyons during winter to feed on the sagebrush and have been observed migrating through the site to Murphy Point (Dames & Moore, 1978b, Section 2.8.2.2). Winter deer use of the project vicinity, as measured by browse utilization, is among the heaviest in southeastern Utah [25 days of use per acre (61 days of use per hectare) in the pinyon-juniper-sagebrush habitats in the vicinity of the Mill site]. In addition, this area is heavily used as a migration route by deer traveling to Murphy Point to winter. Daily movement during winter periods by deer inhabiting the area has also been observed between Westwater Creek and Murphy Point. The present size of the local deer herd is not known.

Other mammals present at the site include the coyote (*Canis latrans*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cineroargenteus*), striped skunk (*Mephitis mephitis*), badger (*taxidea taxus*), longtail weasel (*Mustela frenata*), and bobcat (*Lynx rufus*). Nine species of rodents were trapped or observed on the site, the deer mouse (*Peromyscus maniculatus*) having the greatest distribution and abundance. Although desert cottontails (*Sylvilagus auduboni*) were uncommon in 1977, black-tailed jackrabbits (*Lepus californicus*) were seen during all seasons.

In the 2002 EA, NRC staff noted that, in the vicinity of the site, the U.S. Fish and Wildlife Service had provided the list set out in Table 3.12-1 of the 2002 EA, of the endangered, threatened, and candidate species that may occur in the area around the site.

Table 1.7-4
Endangered, Threatened and Candidate Species in the Mill Area

Common Name	Scientific Name	Status
Navajo Sedge	*Carex specuicola*	Threatened
Bonytail Chub	*Gila elegans*	Endangered
Colorado Pikeminnow	*Ptychocheilus Lucius*	Endangered
Humpback Chub	*Gila cypha*	Endangered
Razorback Sucker	*Xyrauchen texanus*	Endangered
Bald Eagle	*Haliaeetus leucocephalus*	Threatened
California Condor	*Gymnogyps californianus*	Endangered
Gunnison Sage Grouse	*Centrocercus minimus*	Candidate
Mexican Spotted Owl	*Strix occidentalis lucida*	Threatened
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	Endangered
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*	Candidate
Black-footed Ferret	*Mustela nigripes*	Endangered

Source: 2002 EA (NRC, 2002)

The 2002 EA also noted that, in addition, the species listed on Table 3.12-2 of the 2002 EA may occur within the Mill area that are managed under Conservation Agreements/Strategies.

Table 1.7-5
Species Managed Under Conservation Agreements/Strategies at the Mill Area

Common Name	Scientific Name
Colorado River Cutthroat Trout	*Oncorhynchus clarki pleuriticus*
Gunnison Sage Grouse	*Centrocercus minimus*

Source: 2002 EA (NRC, 2002)

For the 2002 EA, NRC staff contacted wildlife biologists from the BLM and the Utah Wildlife Service to gather local information on the occurrences of these additional species surrounding the Mill. NRC staff made the following conclusions (2002 EA p. 4):

> While the ranges of the bald eagle, peregrine falcon, and willow flycatcher encompass the project area, their likelihood of utilizing the site is extremely low. The black-footed ferret has not been seen in Utah since 1952, and is not expected to occur any longer in the area. The California Condor has only rarely been spotted in the area of Moab, Utah, (70 miles north) and around Lake Powell (approximately 50 miles south). The Mexican Spotted Owl is only found in the mountains in Utah, and is not expected to be on the Mesa. The Southwestern Willow Flycatcher, Western Yellow-billed Cuckoo, and Gunnison Sage Grouse are also not expected to be found in the immediate area around the Mill site.

1.7.2 Aquatic Biota (*1978 ER Section 2.9.2*)

Aquatic habitat at the Mill site ranges temporally from extremely limited to nonexistent due to the aridity, topography and soil characteristics of the region and consequent dearth of perennial surface water. Two small stock watering ponds, are located on the Mill site a few hundred yards from the ore pad area (see Figure 1.5-3). One additional small "wildlife pond", east of Cell 4A, was completed in 1994 to serve as a diversionary feature for migrating waterfowl (see Figure 1.5-3). Although more properly considered features of the terrestrial environment, they essentially represent the total aquatic habitat on the Mill site. These ponds probably harbor algae, insects, other invertebrate forms, and amphibians.

They also provide a water source for small mammals and birds. Similar ephemeral catch and seepage basins are typical and numerous to the northeast of the Mill site and south of Blanding.

Aquatic habitat in the project vicinity is similarly limited. The three adjacent streams (Corral Creek, Westwater Creek, and an unnamed arm of Cottonwood Wash) are only intermittently active, carrying water primarily in the spring during increased rainfall and snowmelt runoff, in the autumn, and briefly during localized but intense electrical storms. Intermittent water flow most typically occurs in April, August, and October in those streams. Again, due to the temporary nature of these steams, their contribution to the aquatic habitat of the region is probably limited to providing a water source for wildlife and a temporary habitat for insect and amphibian species.

In the 2002 EA, NRC staff concluded that (p. 4) no populations of fish are present on the project site, nor are any known to exist in the immediate area of the site. Four species of fish designated as endangered or threatened (the Bonytail Chub, Colorado Pikeminnow, Humpback Chub and Razorback Sucker) occur in the San Juan River 18 miles south of the site, which Dames & Moore noted in the 1978 ER (Section 2.8.2) is the closest habitat suitable for these species. NRC staff further concluded that there are no discharges of

Mill effluents to surface waters, and therefore, no impacts are expected for the San Juan River due to operations of the Mill.

1.7.3 Background Radiation (*2007 ER, Section 3.13.1*)

All living things are continuously exposed to ionizing radiation from a variety of sources including cosmic and cosmogenic radiation from space and external radiation from terrestrial radionuclides such as uranium, thorium and potassium-40 that occur in the earth's crust, in building materials, in the air we breathe, the food we eat, the water we drink and in our bodies.

Some exposures, such as that from potassium-40, are controlled by our body's metabolism and are relatively constant throughout the world, but exposures from sources such as uranium and thorium in soils and especially from radon in homes can vary greatly, by more than a factor of ten, depending on location.

In order to provide a context for exposures potentially attributable to radioactive emissions from processing ores and alternate feed materials at the Mill, this section provides some general background information on exposures to natural background radiation worldwide, in the United States and in the Colorado Plateau region where the Mill is located.

1.7.3.1 The World

In general terms, the worldwide breakdown of natural background radiation sources can be summarized as follows (UNSCEAR, 2000):

Cosmic and Cosmogenic	39 mrem/yr
Terrestrial	48 mrem/yr
Inhaled (Radon)	126 mrem/yr
Ingested	29 mrem /yr
Total (Average)	**242 mrem/yr (116 mrem/yr excluding radon)**

According to the United Nations Scientific Committee on the Effects of Atomic Radiation ("UNSCEAR"), the actual doses can vary considerably from the nominal values listed above, and around the world vary from this value by more than a factor of 10. For example, the dose from cosmic and cosmogenic radiation varies with altitude. The higher the altitude, the less is the protection offered by the earth's atmosphere. The dose from external gamma radiation can vary greatly depending on the levels of uranium and thorium series radionuclides in the local soil. One example is the elevated gamma fields seen on natural sands containing heavy minerals as for example in regions around the Indian Ocean, in Brazil, and New Jersey. The high variability in indoor radon concentrations is a major source of the variation in natural background dose. The variability in the dose from radon arises from many factors, including: variability in soil radium concentrations from place to place; variation both over time and location in housing stock, heating and ventilating systems; and variations in individual habits. The worldwide average ambient (i.e. outdoor) radon concentration is about 10 Bq/m^3 (UNSCEAR, 2000) and the world average concentration of U-238 and Th-232 in soils is about 0.7 pCi/g (25 Bq/kg) (NRC, 1994).

The definition of "background radiation" in 10 CFR 20.1003 specifically includes global fallout as it exists in the environment from the testing of nuclear explosive devices or from past nuclear accidents such as Chernobyl that contribute to background radiation and are not under the control of the licensee. The calculation of background radiation in Section 3.13.1 of the 2007 ER is conservative because it does not include such fallout in background radiation for the Mill site.

1.7.3.2 United States

In the United States, nominal average levels of natural background radiation are as follows (National Council of Radiation Protection and Measurements ("NCRP"), 1987):

Cosmic and Cosmogenic	28 mrem/yr
Terrestrial	28 mrem/yr
Inhaled (Radon)	200 mrem/yr
Ingested	40 mrem /yr
Total (Average)	**296 mrem/yr (96 mrem/yr excluding radon)**

As shown above, in the United States, the average annual dose from natural background radiation is about 296 mrem/yr (including radon). The actual annual dose from natural background varies by region within the United States. For example, the average dose from external terrestrial radiation for a person living on the Colorado Plateau is in the order of 63 mrem/yr, which is considerably higher than the average dose from terrestrial radiation for a person living in Florida, where the average annual dose from external terrestrial radiation is only about 16 mrem/yr. (NRC, 1994; NCRP, 1987). In the United States, outdoor radon levels vary widely from about 0.1 pCi/l in New York City to about 1.2 pCi/L in Colorado Springs (NCRP, 1987), generally consistent with nominal worldwide values noted in the previous section.

1.7.4 Mill Site Background (*1978 ER Section 2.10*)

Radiation exposure in the natural environment is due to cosmic and terrestrial radiation and to the inhalation of radon and its daughters. Measurements of the background environmental radioactivity were made at the Mill site using thermoluminescent dosimeters ("TLDs"). The results indicate an average total body dose of 142 millirems per year, of which 68 millirems is attributable to cosmic radiation and 74 millirems to terrestrial sources. The cosmogenic radiation dose is estimated to be about 1 millirem per year. Terrestrial radiation originates from the radionuclides potassium-40, rubidium-87, and daughter isotopes from the decay of uranium-238, thorium-232, and, to a lesser extent, uranium-235. The dose from ingested radionuclides is estimated at 18 millirems per year to the total body. The dose to the total body from all sources of environmental radioactivity is estimated to be about 161 millirems per year.

The concentration of radon in the area is estimated to be in the range of 500 to 1,000 pCi/m^3, based on the concentration of radium-226 in the local soil. Exposure to this concentration on a continuous basis would result in a dose of up to 625 millirems per year to the bronchial epithelium. As ventilation decreases, the dose increases; for example, in unventilated enclosures, the comparable dose might reach 1,200 millirems per year.

The medical total body dose for Utah is about 75 millirems per year per person. The total dose in the area of the mill from natural background and medical exposure is estimated to be 236 millirems per year.

1.7.5 Current Monitoring Data

The most recent data for gamma, vegetation, air and stack sampling, groundwater, surface water, meteorological monitoring, and soil sampling discussed in the following sections are found in the Semi-Annual Effluent Report for July through December 2015. See Section 2.3.2.1 for a more detailed discussion of the environmental monitoring programs at the Mill.

1.7.5.1 Environmental Radon

Environmental radon concentrations are determined by using Track Etch detectors. There is one detector at each of eight environmental monitoring stations with a duplicate at BHV-2. See the Semi-Annual Effluent reports, for maps showing these locations.

1.7.5.2 Environmental Gamma

Gamma radiation levels are determined by optically stimulated luminescence dosimeters ("OSLs"). The OSLs are placed at the eight environmental stations located around the perimeter boundary of the Mill site discussed above. The badges are exchanged quarterly. Recent data are presented in the Semi-Annual Effluent Report for July through December 2015.

1.7.5.3 Vegetation Samples

Vegetation samples are collected at three locations around the Mill periphery. The sampling locations are northeast, northwest, and southwest of the Mill facility. Vegetation samples are collected three times per year. Recent vegetation results are included in the Semi-Annual Effluent Report for July through December 2015. No trends are apparent, as concentrations at each sampling location have remained consistent.

1.7.5.4 Environmental Air Monitoring and Stack Sampling

Air monitoring at the Mill is conducted at seven high volume (40 standard cubic feet per minute) stations located around the periphery of the Mill. These locations are shown on Figure 2.3-2. BHV-1 and BHV-8 are located at the northern Mill boundary. BHV-2 is further north at the nearest residence. BHV-4 is south of Cell 3, BHV-5 is just south of the ore storage pad on the eastern boundary of the Mill property, BHV-6 is located on a vector between the Mill site and the White Mesa Ute Community, and BHV-7 is located on the eastern boundary of the Mill north of BHV-5. The Semi-Annual Effluent Reports contain air monitoring data. The results of the quarterly stack samples are also presented in the Semi-Annual Effluent Reports.

Pursuant to NRC License Amendment No. 41 for the Mill's Source Material License No. SUA-1358, air particulate radionuclide monitoring at BHV-3 was discontinued at the end of the third quarter of 1995. Tables in the Semi-Annual Effluent Reports show the radionuclide concentrations at each location. No trends are evident.

1.7.5.5 Surface Water

The results of surface water monitoring are presented in the Semi-Annual Effluent Reports. Cottonwood Creek is sampled semi-annually and Westwater Creek is sampled on an annual basis. No trends are apparent.

1.7.5.6 Meteorological Monitoring

The Semi-Annual Air Quality and Meteorology Monitoring Report for July 1, 2015 through December 31, 2015 was provided by McVehil-Monnett and is available at the Mill.

2 EXISTING FACILITY

The following sections describe the construction history of the Mill; the Mill and Mill tailings management facilities; Mill operations including the Mill circuit and tailings management; and both operational and environmental monitoring.

2.1 Facility Construction History

The Mill is a uranium/vanadium mill that was developed in the late 1970s by Energy Fuels Nuclear, Inc. ("EFN") as an outlet for the many small mines that are located in the Colorado Plateau and for the possibility of milling Arizona Strip ores. At the time of its construction, it was anticipated that high uranium prices would stimulate ore production. However, prices started to decline about the same time as Mill operations commenced.

As uranium prices fell, producers in the region were affected and mine output declined. After about two and one-half years, the Mill ceased ore processing operations altogether, began solution recycle, and entered a total shutdown phase. In 1984, a majority ownership interest was acquired by Union Carbide Corporation's ("UCC") Metals Division which later became Umetco Minerals Corporation ("Umetco"), a wholly-owned subsidiary of UCC. This partnership continued until May 26, 1994 when EFN reassumed complete ownership. In May 1997, Denison (then named International Uranium (USA) Corporation) and its affiliates purchased the assets of EFN. EFRI purchased Denison in July 2012 and is the current owner of the facility.

2.1.1 Mill and Mill Tailings System

The Source Materials License Application for the Mill was submitted to the NRC on February 8, 1978. Between that date and the date the first ore was fed to the Mill grizzly on May 6, 1980, several actions were taken including: increasing Mill design capacity, permit issuance from the United States Environmental Protection Agency ("EPA") and the State of Utah, archeological clearance for the Mill and tailings system, and an NRC pre-operational inspection on May 5, 1980.

Construction on the Mill tailings system began on August 1, 1978 with the movement of earth from the area of Cell 2. Cell 2 was completed on May 4, 1980, Cell 1 on June 29, 1981, and Cell 3 on September 2, 1982. In January 1990 an additional cell, designated Cell 4A, was completed and initially used solely for solution storage and evaporation. Cell 4A was only used for a short time and then taken out of service because of concerns about the synthetic lining system. In 2007, Cell 4A was retrofitted with a new State of Utah approved lining system and was authorized to begin accepting process solutions in September 2008. Cell 4A was put back into service in October 2008. Cell 4B was constructed in 2010 and authorized to begin accepting process solutions in February 2011.

2.2 Facility Operations

In the following subsections, an overview of Mill operations and operating periods are followed by descriptions of the operations of the Mill circuit and tailings management facilities.

2.2.1 Operating Periods

The Mill was operated by EFN from the initial start-up date of May 6, 1980 until the cessation of operations in 1983. Umetco, as per agreement between the parties, became the operator of record on January 1, 1984.

The Mill was shut down during all of 1984. The Mill operated at least part of each year from 1985 through 1990. Mill operations again ceased during the years of 1991 through 1994. EFN reacquired sole ownership on May 26, 1994, and the Mill operated again during 1995 and 1996. After acquisition of the Mill by Denison and its affiliates several local mines were restarted and the Mill processed conventional ore during 1999 and early 2000. With the resurgence in uranium and vanadium prices in 2003, Denison reopened several area mines and again began processing uranium and vanadium ores in April 2008. Mill operations were suspended in May 2009, and resumed in March 2010. Conventional ore processing was again suspended in July 2011, resumed in November 2011 through March 2012, and suspended in April 2012. Denison became EFRI after July 25, 2012. Conventional ore processing resumed from August 2012 through June 2013, was suspended in July 2013, resumed May 2014 through August 2014, and was suspended again in September 2014. Typical employment figures for the Mill are approximately 110 during uranium-only operations and 150 during uranium/vanadium operations.

Commencing in the early 1990s through today, the Mill has processed alternate feed materials from time to time when the Mill has not been processing conventional ores. Alternate feed materials are uranium-bearing materials other than conventionally mined uranium ores. The Mill installed an alternate feed circuit in 2009 that allows the Mill to process certain alternate feed materials simultaneously with conventional ores.

2.2.2 Mill Circuit

While originally designed for a capacity of 1,500 dry tons per day (dtpd), the Mill capacity was boosted to the present rated design of 1,980 dtpd prior to commissioning.

The Mill uses an atmospheric hot acid leach followed by counter current decantation (CCD). This in turn is followed by a clarification stage which precedes the solvent extraction (SX) circuit. Kerosene containing iso-decanol and tertiary amines extracts the uranium and vanadium from the aqueous solution in the SX circuit. Salt and soda ash are then used to strip the uranium and vanadium from the organic phase.

After extraction of the uranium values from the aqueous solution in SX, uranium is precipitated with anhydrous ammonia, dissolved, and re-precipitated to improve product quality. The resulting precipitate is then washed and dewatered using centrifuges to produce a final product called "yellowcake." The yellowcake is dried in a multiple hearth dryer and packaged in drums weighing approximately 800 to 1,000 lbs. for shipping to converters.

After the uranium values are stripped from the pregnant solution in SX, the vanadium values are transferred to tertiary amines contained in kerosene and concentrated into an intermediate product called vanadium product liquor (VPL). An intermediate product, ammonium metavanadate (AMV), is precipitated from the VPL using ammonium sulfate in batch precipitators. The AMV is then filtered on a belt filter and, if necessary, dried. Normally, the AMV cake is fed to fusion furnaces where it is converted to the Mill's primary vanadium product, V_2O_5 tech flake, commonly called "black flake."

The same basic process steps used for the recovery of uranium from conventional ores are used for the recovery of uranium from alternate feed materials, with some variations depending on the particular alternate feed material.

The Mill processed 1,511,544 tons of conventional ore and other materials from May 6, 1980 to February 4, 1983. During the second operational period from October 1, 1985 through December 7, 1987, 1,023,393 tons of conventional ore were processed. During the third operational period from July 1988 through

November 1990, 1,015,032 tons of conventional ore were processed. During the fourth operational period from August 1995 through January 1996, 203,317 tons of conventional ore were processed. In the fifth operational period, from May 1996 through September 1996, the Mill processed 3,868 tons of calcium fluoride alternate feed material. From 1997 to early 1999, the Mill processed 58,403 tons from several additional alternate feed stocks.

With rising uranium prices in the late 1990s, company mines were reopened in 1997, and 87,250 tons of conventional ore were processed in 1999 and early 2000. In 2002 and 2003, the Mill processed 266,690 tons of alternate feed material from government cleanup projects. An additional 40,866 tons of alternate feed materials were processed in 2007. An additional 1,401 tons of alternate feed materials were processed from 2008 through July 2011. From April 2008 through July 2011 the Mill processed an additional 722,843 tons of conventional ore. The Mill processed 340,058 and 24,036 tons of conventional ore and alternate feed materials, respectively, between August 2011 and March 2016.

Inception to date material processed through March 2016 totals 5,298,701 tons. This total is for all processing periods and feeds combined.

2.2.3 Tailings Management Facilities

Tailings produced by the Mill from conventional ores typically contain 30 percent moisture by weight, have an in-place dry density of 86.3 pounds per cubic foot (calculated from Cell 2 volume and tons placed), have a size distribution with a significant -200 to -325 mesh size fraction, and have a high acid and flocculent content. Tailings from alternate feed materials that are similar physically to conventional ores, which comprise most of the tons of alternate feed materials processed to date at the Mill, are similar to the tailings for conventional ores. Tailings from some of the higher grade, lower volume alternate feed materials may vary somewhat from the tailings from conventional ores, primarily in moisture and density content.

The tailings facilities at the Mill currently consist of five cells as follows:

- Cell 1, constructed with a 30 mil PVC earthen-covered liner, is used for the evaporation of process solutions (Cell 1 was previously referred to as Cell 1-I).
- Cell 2, constructed with a 30 mil PVC earthen-covered liner, is used for the storage of barren tailings sands. This Cell is full and has been partially reclaimed.
- Cell 3, constructed with a 30 mil PVC earthen-covered liner, is used for the storage of barren tailings sands and process solutions, but currently only receives mill waste and byproduct material in accordance with License provisions. This cell is partially filled and has been partially reclaimed.
- Cell 4A, constructed with a geosynthetic clay liner, a 60 mil HDPE liner, a 300 mil HDPE geonet drainage layer, a second 60 mil HDPE liner, and a slimes drain network over the entire cell bottom. This cell was placed into service in October 2008 and is used for storage of barren tailings sands and evaporation of process solutions.
- Cell 4B, constructed with a geosynthetic clay liner, a 60 mil HDPE liner, a 300 mil HDPE geonet drainage layer, a second 60 mil HDPE liner, and a slimes drain network over the entire cell bottom. This cell was placed into service in February 2011, is used for evaporation of process solutions, and has not been used for tailings storage.

Total estimated design capacity of Cells 2, 3, 4A, and 4B is approximately eight million tons. Figures 1.5-4 and 1.5-5 show the locations of the tailings management system cells.

2.2.3.1 Tailings Management

Constructed in shallow valleys or swale areas, the lined tailings facilities provide storage below the existing grade and reduce potential exposure. Because the cells are separate and distinct, individual tailings cells may be reclaimed as they are filled to capacity. This phased reclamation approach minimizes the amount of tailings exposed at any given time and reduces potential exposure to a minimum.

Slurry disposal has taken place in Cells 2, 3 and 4A. Tailings placement in Cell 2 and Cell 3 was accomplished by means of the final grade method, described below.

The final grade method used in Cell 2 and Cell 3 calls for the slurry to be discharged until the tailings surface comes up to near final grade. The discharge points are set up in the east end of the cell, and the final grade surface is advanced to the slimes pool area. Coarse tailings sand from the discharge points is graded into low areas to reach the final disposal elevation. When the slimes pool is reached, the discharge points are then moved to the west end of the cell and worked back to the middle. An advantage to using the final grade method is that maximum beach stability is achieved by (1) allowing water to drain from the sands to the maximum extent, and (2) allowing coarse sand deposition to help provide stable beaches. Another advantage is that radon release and dust prevention measures (through the placement of the initial layer of the final cover) are applied as expeditiously as possible.

Slurry disposal in Cell 4A is from several pre-determined discharge points located around the north and east sides of the cell. Slurry discharge is only allowed on skid pads, or protective HDPE sheets, to prevent damage to the synthetic lining system. Once tailings solids have reach the maximum elevation around the perimeter of the cell, discharge points can be moved toward the interior of the cell. Slurry disposal in Cell 4B will be conducted in the same manner as Cell 4A. Cell 4B is currently only accepting process solutions.

2.2.3.2 Liquid Management

As a zero-discharge facility, the Mill must evaporate all of the liquids utilized during processing. This evaporation currently takes place in four areas:

- Cell 1, which is used for solutions only
- Cell 3, in which tailings and solutions exist
- Cell 4A, in which tailings and solutions exist
- Cell 4B, presently used for solutions only

The original engineering design indicated a net water gain into the cells would occur during Mill operations. As anticipated, this has been proven to be the case. In addition to natural evaporation, spray systems have been used at various times to enhance evaporative rates and for dust control. To minimize the net water gain, solutions are recycled back for use in the Mill circuit from the active tailings cells to the maximum extent possible. Solutions from Cells 1, 3, 4A, and 4B are brought back to the CCD circuit where metallurgical benefit can be realized. Recycle to other parts of the Mill circuit are not feasible due to the acidic condition of the solution.

2.3 Monitoring Programs

2.3.1 Monitoring and Reporting Under the Mill's GWDP

2.3.1.1 Groundwater Monitoring

a) Plugged and Excluded Wells

Wells MW-6, MW-7, and MW-8 were plugged because they were in the area of Cell 3, as was MW-13, in the Cell 4A area. Wells MW-9 and MW-10 are dry and have been excluded from the monitoring program. MW-16 is dry and has been plugged as part of the tailings Cell 4B construction.

b) Groundwater Monitoring at the Mill Prior to Issuance of the GWDP

At the time of renewal of the License by NRC in March 1997 and up until issuance of the GWDP in March 2005, the Mill implemented a groundwater detection monitoring program to ensure compliance to 10 CFR Part 40, Appendix A, in accordance with the provisions of the License. The detection monitoring program was in accordance with the report entitled, *Points of Compliance, White Mesa Uranium Mill*, prepared by Titan Environmental Corporation, submitted by letter to the NRC dated October 5, 1994 (Titan, 1994b). Under that program, the Mill sampled monitoring wells MW-5, MW-11, MW-12, MW-14, MW-15 and MW-17, on a quarterly basis. Samples were analyzed for chloride, potassium, nickel and uranium, and the results of such sampling were included in the Mill's Semi-Annual Effluent Monitoring Reports that were filed with the NRC up until August 2004 and with the DWMRC subsequent thereto.

Between 1979 and 1997, the Mill monitored up to 20 constituents in up to 13 wells. That program was changed to the Points of Compliance Program in 1997 because NRC had concluded that:

- The Mill and tailings system had produced no impacts to the perched zone or deep aquifer
- The most dependable indicators of water quality and potential cell failure were considered to be chloride, nickel, potassium and natural uranium

c) Issuance of the GWDP

On March 8, 2005, the DWMRC issued the GWDP, which includes a groundwater monitoring program that supersedes and replaces the groundwater monitoring requirements set out in the License. Groundwater monitoring under the GWDP commenced in March 2005, the results of which are included in the Mill's *Quarterly Groundwater Monitoring Reports* that are submitted to the DWMRC.

d) Current Ground Water Monitoring Program at the Mill Under the GWDP

The current groundwater monitoring program at the Mill under the GWDP consists of monitoring at 25 point of compliance monitoring wells: MW-1, MW-2, MW-3, MW-3A, MW-5, MW-11, MW-12, MW-14, MW-15, MW-17, MW-18, MW-19, MW-23, MW-24, MW-25, MW-26, MW-27, MW-28, MW-29, MW-30, MW-31, MW-32 MW-35, MW-36, and MW-37. The locations of these wells are indicated on Figure 2.3-1.

Insert

Figure 2.3-1 Site Plan Showing Locations of Perched Wells and Piezometers

Part I.E.1.(c) of the GWDP requires that each point of compliance well must be sampled for the constituents listed in Table 2.3-1.

Table 2.3-1
Groundwater Monitoring Constituents Listed in Table 2 of the GWDP

Nutrients:		
Ammonia (as N)	Nitrate & Nitrite (as N)	
Heavy Metals:		
Arsenic	Lead	Thallium
Beryllium	Manganese	Tin
Cadmium	Mercury	Uranium
Chromium	Molybdenum	Vanadium
Cobalt	Nickel	Zinc
Copper	Selenium	
Iron	Silver	
Radiologics:		
Gross Alpha		
Volatile Organic Compounds:		
Acetone	Chloroform	Tetrahydrofuran
Benzene	Chloromethane	Toluene
2-Butanone (MEK)	Dichloromethane	Xylenes (total)
Carbon Tetrachloride	Naphthalene	
Others:		
Field pH (S.U.)	Chloride	TDS
Fluoride	Sulfate	

Further, Part I.E.1.(d) of the GWDP requires that, in addition to pH, the following field parameters must also be monitored:

- Depth to groundwater
- Temperature
- Specific conductance
- Redox potential

and that, in addition to chloride and sulfate, the following general organics must also be monitored:

- Carbonate, bicarbonate, sodium, potassium, magnesium, calcium, and total anions and cations

Sample frequency depends on the speed of ground water flow in the vicinity of each well. Parts I.E.1(b) and (c) of the GWDP provide that quarterly monitoring is required for all wells where local groundwater average linear velocity has been found by the DWMRC to be equal to or greater than 10 feet/year, and semi-annual monitoring is required where the local groundwater average linear velocity has been found by the DWMRC to be less than 10 feet/year.

Based on these criteria, MW-11, MW-14, MW-25, MW-26, MW-30, MW-31, MW-35, MW-36 and MW-37 are monitored quarterly. Semi-annual monitoring is required at MW-1, MW-2, MW-3, MW-3A, MW-5, MW-12, MW-15, MW-17, MW-18, MW-19, MW-23, MW-24, MW-27, MW-28, MW-29 and MW-32.

In addition MW-20 and MW-22, which have been classified as general monitoring wells are sampled semi-annually.

2.3.1.2 Deep Aquifer

The culinary well (one of the supply wells) is completed in the Navajo aquifer, at a depth of approximately 1,800 feet below the ground surface. Due to the fact that the deep confined aquifer at the site is hydraulically isolated from the shallow perched aquifer (see the discussion in Sections 1.5.1.1 and 1.5.1.2) no monitoring of the deep aquifer is required under the GWDP.

2.3.1.3 Seeps and Springs

Pursuant to Part I.E.6 of the GWDP, EFRI has a *Sampling Plan for Seeps and Springs in the Vicinity of the White Mesa Uranium Mill*, Revision: 0, March 17, 2009 (EFRI, 2009, the "SSSP") (and as modified on June 10, 2011, Revision 1 – submitted to UDEQ for review) that requires the Mill to perform groundwater sampling and analysis of all seeps and springs found downgradient or lateral gradient from the tailings management cells.

Under the SSSP, seeps and springs sampling is conducted on an annual basis between May 1 and July 15 of each year, to the extent sufficient water is available for sampling, at five identified seeps and springs near the Mill. The sampling locations were selected to correspond with those seeps and springs sampled for the initial Mill site characterization performed in the 1978 ER, plus additional sites located by EFRI, the BLM and Ute Mountain Ute Indian Tribe representatives.

Samples are analyzed for all groundwater monitoring parameters found in Table 2.3-1 and the general inorganic constituents specified for groundwater monitoring in Part I.E.1 (d). The laboratory procedures used to complete the analyses are those utilized for groundwater sampling. In addition to these laboratory parameters, the pH, temperature, redox potential, and conductivity of each sample will be measured and recorded in the field. Laboratories selected by EFRI to perform analyses of seeps and springs samples will be required to be certified by the State of Utah in accordance with UAC R317-6-6.12.A.

The seeps and springs sampling events are subject to the current Mill's QAP, unless otherwise specifically modified by the SSSP to meet the specific needs of this type of sampling.

2.3.1.4 Discharge Minimization Technology and Best Available Technology Standards and Monitoring

a) General

Part I.D. of the GWDP sets out a number of Discharge Minimization Technology ("DMT") and Best Available Technology ("BAT") standards that must be followed. Part I.E. of the GWDP sets out the Groundwater Compliance and Technology Performance Monitoring requirements, to ensure that the DMT and BAT standards are met. These provisions of the GWDP, along with the *White Mesa Mill Discharge Minimization Technology (DMT) Monitoring Plan*, 4/15 Revision: 12.3 (the "DMT Plan") (EFRI, 2015a), the *White Mesa Mill Tailings Management System* (EFRI, 2015b), the Cell 4A and 4B BAT Monitoring, Operations and Maintenance Plan and other plans and programs developed pursuant to such Parts of the GWDP, set out the methods and procedures for inspections of the facility operations and for detecting failure of the system.

In addition to the programs discussed above, the following additional DMT and BAT performance standards and associated monitoring are required under Parts I.D and I.E. of the GWDP.

b) Tailings Cell Operation

Part I.D.2 of the GWDP provides that authorized operation and maximum disposal capacity in each of the existing tailings cells shall not exceed the levels authorized by the License and that under no circumstances shall the freeboard be less than three feet, as measured from the top of the flexible membrane liner ("FML"). Part I.E.7(a) of the GWDP requires that the wastewater pool elevations in Cells 1 and 3 must be monitored weekly to ensure compliance with the maximum wastewater elevation criteria mandated by Condition 10.3 of the License. Parts I.E.8 (a)(4) and I.E.12.(a)(4) provide that authorized operation and maximum disposal capacity in Cells 4A and 4B shall not exceed the levels authorized GWDP (as noted in the DMT Plan) and that under no circumstances shall the freeboard be less than three feet, as measured from the top of the FML. The requirements to meet freeboard elevation limits in Cell 3 and Cell 4A were eliminated upon approval to use Cell 4B. The solution elevation measurements in Cell 4A are not required for compliance with freeboard limits but are required for the calculation of the daily allowable volume of fluids pumped from Cell 4A LDS and are collected for this purpose.

Part I.D.2 further provides that any modifications by EFRI to any approved engineering design parameter at these existing tailings cells requires prior Directorapproval, modification of the GWDP and issuance of a construction permit.

c) Slimes Drain Monitoring

Part I.D.3(b)(1) of the GWDP requires that EFRI must at all times maintain the average wastewater head in the slimes drain access pipe to be as low as reasonably achievable (ALARA) in each tailings disposal cell, in accordance with the approved DMT Plan. Compliance will be achieved when the average annual wastewater recovery elevation in the slimes drain access pipe, determined pursuant to the currently approved DMT Plan meets the conditions in Equation 1 specified in Part I.D.3(b)(1) of the GWDP.

Part I.E.7(b) of the GWDP requires that EFRI must monitor and record quarterly the depth to wastewater in the slimes drain access pipes as described in the currently approved DMT Plan at Cell 2, and upon commencement of de-watering activities, at Cell 3, in order to ensure compliance with Part I.D.3(b)(1) of the GWDP.

d) Maximum Tailings Waste Solids Elevation

Part I.D.3(c) of the GWDP requires that upon closure of any tailings cell, EFRI must ensure that the maximum elevation of the tailings waste solids does not exceed the top of the FML.

e) Wastewater Elevation in Roberts Pond

Roberts Pond has been permanently removed from service. Excavation activities have been completed and pursuant to DWMRC correspondence dated March 5, 2015, routine monitoring is no longer necessary.

f) Inspection of Feedstock Storage Area

Part I.D.3(f) of the GWDP requires that open-air or bulk storage of all feedstock materials at the Mill facility awaiting Mill processing must be limited to the eastern portion of the Mill site (the "ore pad") described by the coordinates set out in that Part of the GWDP, and that storage of feedstock materials at the facility outside of this defined area, must meet the requirements of Part I.D.11 of the GWDP. Part I.D.11 requires that EFRI must store and manage feedstock materials outside the defined ore storage pad in accordance with the following minimum performance requirements:

(i) Feedstock materials will be stored at all times in water-tight containers, and

(ii) Aisle ways will be provided at all times to allow visual inspection of each and every feedstock container, or

(iii) Each and every feedstock container will be placed inside a water-tight overpack prior to storage, or

(iv) Feedstock containers shall be stored on a hardened surface to prevent spillage onto subsurface soils, and that conforms with the following minimum physical requirements:

A. A storage area composed of a hardened engineered surface of asphalt or concrete, and

B. A storage area designed, constructed, and operated in accordance with engineering plans and specifications approved in advance by the Director. All such engineering plans or specifications submitted shall demonstrate compliance with Part I.D.4 of the GWDP, and

C. A storage area that provides containment berms to control stormwater run-on and run-off, and

D. Stormwater drainage works approved in advance by the Director, or

E. Other storage facilities and means approved in advance by the Director.

Part I.E.7(d) of the GWDP requires that EFRI conduct weekly inspections of all feedstock storage areas to:

(i) Confirm that the bulk feedstock materials are maintained within the approved feedstock storage area specified by Part I.D.3(f) of the GWDP; and

(ii) Verify that all alternate feedstock materials located outside the approved feedstock storage area are stored in accordance with the requirements found in Part I.D.11 of the GWDP.

Part I.E.7(e) further provides that EFRI must conduct weekly inspections to verify that each feed material container complies with the requirements of Part I.D.11 of the GWDP.

The Mill's procedures for weekly inspection of the ore pad is contained in Section 3.2 of the DMT Plan.

g) Monitor and Maintain Inventory of Chemicals

Part I.D.3(g) of the GWDP requires that for all chemical reagents stored at existing storage facilities and held for use in the milling process, EFRI must provide secondary containment to capture and contain all volumes of reagent(s) that might be released at any individual storage area. Response to spills, cleanup thereof, and required reporting must comply with the provisions of the Mill's *Emergency Response Plan*, as stipulated by Part I.D.10 of the GWDP. Part I.D.3(g) further provides that for any new construction of reagent storage facilities, such secondary containment and control must prevent any contact of the spilled or otherwise released reagent or product with the ground surface.

Part I.E.9 of the GWDP requires that EFRI must monitor and maintain a current inventory of all chemicals used at the facility at rates equal to or greater than 100 kg/yr. This inventory must be maintained on-site, and must include:

(iii) Identification of chemicals used in the milling process and the on-site laboratory; and

(iv) Determination of volume and mass of each raw chemical currently held in storage at the facility.

2.3.1.5 BAT Performance Standards for Cell 4A

a) BAT Operations and Maintenance Plan

Part I.D.6 and I.D.13 of the GWDP provides that EFRI must operate and maintain Cell 4A and Cell 4B respectively so as to prevent release of wastewater to groundwater and the environment in accordance with the Mill's Cell 4A BAT Monitoring, Operations and Maintenance Plan. The Mill's *Cell 4A and 4B BAT Monitoring, Operations and Maintenance Plan*, 07/11 Revision: EFRI 2.3 includes the following performance standards:

(i) The fluid head in the leak detection system shall not exceed 1 foot above the lowest point in the lower membrane liner

(ii) The leak detection system maximum allowable daily leak rate shall not exceed 24,160 gallons/day for Cell 4A and 26,145 gallons/day for Cell 4B

(iii) After EFRI initiates pumping conditions in the slimes drain layer in Cell 4A or Cell 4B, EFRI will provide continuous declining fluid heads in the slimes drain layer, in a manner equivalent to the requirements found in Part I.D.3(b) for Cells 2 and 3

(iv) Under no circumstances shall the freeboard be less than 3-feet in Cell 4B, as measured from the top of the FML

b) Implementation of Monitoring Requirements Under the BAT Operations and Maintenance Plan

The *Cell 4A and 4B BAT Monitoring, Operations and Maintenance Plan* also requires EFRI to perform the following monitoring and recordkeeping requirements:

(i) Weekly Leak Detection System (LDS) Monitoring - including:

A. EFRI must provide continuous operation of the leak detection system pumping and monitoring equipment, including, but not limited to, the submersible pump, pump controller, head monitoring, and flow meter equipment approved by the Director. Failure of any pumping or monitoring equipment not repaired and made fully operational within 24-hours of discovery shall constitute failure of BAT and a violation of the GWDP.

B. EFRI must measure the fluid head above the lowest point on the secondary FML by the use of procedures and equipment approved by the Director. Under no circumstance shall fluid head in the leak detection system sump exceed a 1-foot level above the lowest point in the lower FML, not including the sump.

C. EFRI must measure the volume of all fluids pumped from the leak detection system. Under no circumstances shall the average daily leak detection system flow volume exceed 24,160 gallons/day for Cell 4A or 26,145 for Cell 4B.

D. EFRI must operate and maintain wastewater levels to provide a 3-foot minimum of vertical freeboard in tailings Cell 4B. Such measurement must be made to the nearest 0.1 foot.

(ii) Slimes Drain Recovery Head Monitoring

Immediately after the Mill initiates pumping conditions in the Cell 4A or Cell 4B slimes drain system, quarterly recovery head tests and fluid level measurements will be made in accordance with the requirements of Parts I.D.3(b) and I.E.7(b) of the GWDP and any plan approved by the Director.

2.3.1.6 Stormwater Management and Spill Control Requirements

Part I.D.10 of the GWDP requires that EFRI will manage all contact and non-contact stormwater and control contaminant spills at the facility in accordance with the Mill's stormwater best management practices plan. The Mill's *Stormwater Best Management Practices Plan*, *Revision 1.5* (EFRI, 2016) includes the following provisions:

a) Protect groundwater quality or other waters of the state by design, construction, and/or active operational measures that meet the requirements of the Ground Water Quality Protection Regulations found in UAC R317-6-6.3(G) and R317-6-6.4(C)

b) Prevent, control and contain spills of stored reagents or other chemicals at the Mill site

c) Cleanup spills of stored reagents or other chemicals at the Mill site immediately upon discovery

d) Report reagent spills or other releases at the Mill site to the Director in accordance with UAC 19-5-114

2.3.1.7 Tailings and Slimes Drain Sampling

Part I.E.10 of the GWDP requires that, on an annual basis, EFRI must collect wastewater quality samples from each wastewater source at each tailings cell at the facility, including surface impounded wastewaters, and slimes drain wastewaters, pursuant to the Mill's *Sampling and Analysis Plan for Tailings Cells, Leak Detections Systems and Slimes Drains*, Revision 2.1, July 2012 (the "Tailings Management System SAP"). All such sampling must be conducted in August of each year.

The purpose of the Tailings Management System SAP is to characterize the source term quality of all Mill tailings system wastewaters, including impounded wastewaters or process waters in the Mill tailings system, and wastewater or leachates collected by internal slimes drains. The Tailings Management System SAP requires:

- Collection of samples of the liquid from the tailings management system cells and the slimes drain of each cell that has commenced de-watering activities.
- Samples of liquid and slimes drain material will be analyzed at an offsite contract laboratory and subjected to the analytical parameters included in Table 2 of the GWDP (see Table 2.3-1) and general inorganics listed in Part I.E.1(d)(2)(ii) of the GWDP, as well as semi-volatile organic compounds.
- A detailed description of all sampling methods and sample preservation techniques to be employed.
- The procedures used to analyze these samples will be standard analytical methods used for groundwater sampling as specified in the Mill's QAP.
- The contracted laboratory will be certified by the State of Utah in accordance with UAC R317-6-6.12A.
- 30-day advance notice of each annual sampling event must be given, to allow the DWMRC to collect split samples of all sources.

The tailings management and slimes drain sampling events are subject to the Mill's QAP, unless otherwise specifically modified by the Tailings Management System SAP to meet the specific needs of this type of sampling.

2.3.2 Monitoring and Inspections Required Under the License

2.3.2.1 Environmental Monitoring

The environmental monitoring program is designed to assess the effect of Mill process and disposal operations on the unrestricted environment. Delineation of specific equipment and procedures is presented in the most current version of the Mill's *Environmental Protection Manual*.

c) Ambient Air Monitoring

(i) Ambient Particulate

Airborne radionuclide particulate sampling is performed at seven locations, termed BHV-1, BHV-2, BHV-4, BHV-5, BHV-6, BHV-7, and BHV-8. With the approval of the NRC and effective November 1995, BHV-3 was removed from the active air particulate monitoring program. At that time, the Mill proposed (and NRC determined) that a sufficient air monitoring database had been compiled at station BHV-3 to establish a representative airborne particulate radionuclide background for the Mill. BHV-6 was installed by the Mill at the request of the White Mesa Ute Community. This station began operation in July 1999 and provides airborne particulate information in the southerly direction between the Mill and the White Mesa Ute Community. Figure 2.3-2 shows the locations of these air particulate monitoring stations.

The present sampling system consists of high volume particulate samplers utilizing mass flow controllers to maintain an air flow rate of approximately 32 standard cubic feet per minute. Samplers are operated continuously with a goal for on-stream operating period at ninety percent. Filter replacement is weekly with quarterly site composite for particulate radionuclide analysis. Analysis is done for U-natural, Th-230, Ra-226, Pb-210, and Th-232.

See the current Semi-Annual Effluent Monitoring Report for a summary of monitoring results for airborne particulate.

(ii) Ambient Radon

With the approval of the NRC, Radon-222 monitoring at the BHV stations was discontinued in 1995, due to the unreliability of monitoring equipment available at that time to detect the new 10 CFR standard of 0.1 pCi/l. From that time until the present, the Mill demonstrated compliance with the requirements of R313-15-301 by calculation authorized by the NRC in September 1995 and as contemplated by R313-15-302 (2) (a).

This calculation was performed by use of the MILDOS code for estimating environmental radiation doses for uranium recovery operations (Strenge and Bender 1981) in 1991 in support of the Mill's 1997 license renewal and more recently in 2007 in support of the 2007 License Renewal Application, by use of the updated MILDOS AREA code (Yuan et al., 1998). The analysis under both the MILDOS and MILDOS AREA codes assumed the Mill to be processing high grade Arizona Strip ores at full capacity, and calculated the concentrations of radioactive dust and radon at individual receptor locations around the Mill. Specifically, the modeling under these codes assumed the following conditions:

Insert

Figure 2.3-2 Particulate Monitoring Stations

- 730,000 tons of ore per year
- Average grade of 0.53 percent U_3O_8
- Yellowcake production of 4,380 tons of U_3O_8 per year (8.8 million pounds U_3O_8 per year).

Based on these conditions, the MILDOS and MILDOS AREA codes calculated the combined total effective dose equivalent from both air particulate and radon at the current nearest residence (approximately 1.2 miles north of the Mill), i.e., the individual member of the public likely to receive the highest dose from Mill operations, as well as at all other receptor locations, to be below the ALARA goal of 10 mrem/yr for air particulate alone as set out in R313-15-101(4). Mill operations are constantly monitored to ensure that operating conditions do not exceed the conditions assumed in the above calculations. If conditions are within those assumed above, radon has been calculated to be within regulatory limits. If conditions exceed those assumed above, then further evaluation will be performed in order to ensure that doses to the public continue to be within regulatory limits. Mill operations to date have never exceeded the License conditions assumed above.

In order to determine whether or not detection equipment has improved since 1995, EFRI voluntarily began ambient Radon-222 monitoring at the BHV stations in 2013. Radon-222 monitoring is completed using track etch detectors with an effective reporting limit of 0.06 pCi/L. The Radon-222 data collected from 2013 through present are presented in the Semi-Annual Effluent Monitoring Reports. Amendment 7 of the Mill Radioactive Materials License expanded the Mill's effluent monitoring programs in 2014. Amendment 7 included expanding the monitoring programs to require the collection of Radon-222 data at all of the BHV stations.

d) External Radiation

Optically Stimulated Luminescence ("OSL") badges, as supplied by Landauer, Inc., or equivalent, are utilized at all of the high volume air monitoring stations to determine ambient external gamma exposures (see Figure 2.3-2). System quality assurances are determined by placing a duplicate monitor at one site continuously. Exchanges of OSL badges are on a quarterly basis. Measurements obtained from location BHV-3 have been designated as background due to BHV-3's remoteness from the Mill site (BHV-3 is located approximately 3.5 miles west of the Mill site). For further procedural information see Section 4.3 of the most recent version of the Mill's *Environmental Protection Manual*. See the current Semi-Annual Effluent Monitoring Report for a summary monitoring results for external radiation.

e) Soil and Vegetation

(i) Soil Monitoring

As mentioned above, specific changes to the individual monitoring programs, including the soil sampling program, has been made as a result of Amendment 7 to the Radioactive Materials License.

Soil samples from the top 2 inches of surface soils are collected annually at each of the 52 locations (see Figure 2.3-3). and the soil samples are analyzed for U-natural, Ra-226, Pb-210, and Th-232. For further procedural information see Section 4.1 of the most current version of the Mill's *Environmental Protection Manual*. See Section 3.13.1.7.1 of the 2007 ER and the current Semi-Annual Effluent Monitoring Report for a summary of the historic results for soil monitoring. The 2007 ER concludes that the results of sampling are low, less than the unrestricted release limits.

Insert

Figure 2.3-3 Soil Monitoring Stations

(ii) Vegetation Monitoring

Forage vegetation samples are collected three times per year from animal grazing locations to the northeast (near BHV-l (the meteorological station)), northwest (to the immediate west of the site) and southwest (by BHV-4) of the Mill site. Samples are obtained during the grazing season, in the late fall, early spring, and in late spring. A minimum of three kilograms of vegetation are submitted from each site for analysis of U-natural, Ra-226, Pb-210, and Th-232. For further procedure information see Section 4.2 of the most current version of the Mill's *Environmental Protection Manual*. See Section 3.13.7(d) of the 2007 ER and the current Semi-Annual Effluent Monitoring Report for a summary of the historic results for vegetation monitoring. The most recent results indicate no increase in uptake of U-natural, Ra-226 Th-232, and Pb-210 in vegetation.

d) Meteorological

Meteorological monitoring is performed at a site near BHV-1. The sensor and recording equipment are capable of monitoring wind velocity and direction, from which the stability classification is calculated. Data integration duration is one-hour with hourly recording of mean speed, mean wind direction, and mean wind stability (as degrees sigma theta).

The data from the meteorological station is retrieved monthly by down loading onto a Campbell Scientific data module, or the equivalent. The data module is sent to an independent meteorological contractor where the module is downloaded to a computer record, and the data is correlated and presented in a Semi-Annual Meteorological Report.

Monitoring for precipitation consists of a daily log of precipitation using a standard NOAA rain gauge, or the equivalent, installed near the administrative office, consistent with NOAA specifications.

Windrose data is summarized in a format compatible with MILDOS and UDAD specifications for 40 CFR 190 compliance. For further procedural information see Section 1.3 of the most current version of the Mill's *Environmental Protection Manual*. A windrose for the site is set out in Figure 1.1-1.

e) Point Emissions

Stack emission monitoring from yellowcake facilities follows EPA Method 5 procedures and occurs on the following schedule shown in Table 2.3-2.

Table 2.3-2
Stack Sampling Requirements

Frequency	Grizzly Baghouse Stack	North and/or South Yellowcake Dryer Stacks	Yellowcake Packaging Baghouse Stack	Vanadium Dryer Stack	Vanadium Packaging Stack
Quarterly	If operating, U-nat, Th-230, Ra-226, Pb-210, Th-232, Ra-228, and Th-228.	If operating, U-nat, Th-230, Ra-226, Pb-210, Th-232, Ra-228, and Th-228.	If operating, U-nat, Th-230, Ra-226, Pb-210, Th-232, Ra-228, and Th-228.	If operating, U-nat, Th-230, Ra-226, Pb-210, Th-232, Ra-228, and Th-228.	If operating, U-nat, Th-230, Ra-226, Pb-210, Th-232, Ra-228, and Th-228.

Monitored data includes scrubber system operation levels, process feed levels, particulate emission concentrations, isokinetic conditions, and radionuclide emission concentrations. For further procedure information see Section 1.4 of the most current version of the Mill's *Environmental Protection Manual*. Stack emission data are summarized in the Semi-Annual Effluent Monitoring Report.

f) Surface Water Monitoring

Surface water monitoring is conducted at two locations adjacent to the Mill facility known as Westwater Canyon and Cottonwood Creek. Grab samples are obtained annually from Westwater and quarterly from Cottonwood. For Westwater Creek, samples of sediments will be collected if a water sample is not available. Field monitored parameters and laboratory monitored parameters are listed in Table 2.3-3. For further procedural information see Section 2.1 of the most current version of the Mill's *Environmental Protection Manual*. See the current Semi-Annual Effluent Monitoring Report for a summary monitoring results for surface water.

Table 2.3-3
Operational Phase Surface Water Monitoring Program

Monitoring Sites

Westwater Creek and Cottonwood Creek

Field Requirements

1. temperature C
2. Specific Conductivity umhos at 25 C
3. pH at 25 C
4. redox potential
5. sample date
6. sample ID Code

Vendor Laboratory Requirements

Semiannual*	Quarterly
One gallon Unfiltered and Raw	One gallon Unfiltered and Raw
One gallon Unfiltered, Raw and preserved to pH <2 with HNO_3	One gallon Unfiltered, Raw and Preserved to pH <2 with HNO_3
Total Dissolved Solids	Total Dissolved Solids
Total Suspended Solids	Total Suspended Solids
Gross Alpha	
Suspended Unat	
Dissolved Unat	
Suspended Ra-226	
Dissolved Ra-226	
Suspended Th-230	
Dissolved Th-230	

*Semiannual sample must be taken a minimum of four months apart. Annual Westwater Creek sample is analyzed for semi-annual parameters.
Radionuclides and LLDs reported in µCi/ml

2.3.2.2 Additional Monitoring and Inspections Required Under the License

Under the License daily, weekly, and monthly inspection reporting and monitoring are required by NRC Regulatory Guide 8.31, *Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Recovery Facilities will be As Low As is Reasonable Achievable*, Revision 1, May 2002 ("Reg

Guide 8.31"), by Section 2.3 of the Mill's ALARA Program and by the DMT Plan, over and above the inspections described above that are required under the GWDP. A copy of the Mill's ALARA Program is included as Appendix I to the 2007 License Renewal Application.

a) Daily Inspections

Three types of daily inspections are performed at the Mill under the License:

(i) Radiation Staff Inspections

Paragraph 2.3.1 of Reg. Guide 8.31 provides that the Mill's Radiation Safety Officer ("RSO") or designated health physics technician should conduct a daily walk-through (visual) inspection of all work and storage areas of the Mill to ensure proper implementation of good radiation safety procedures, including good housekeeping that would minimize unnecessary contamination. These inspections are required by Section 2.3.1 of the Mill's ALARA Program, and are documented and on file in the Mill's Radiation Protection Office.

(ii) Operating Foreman Inspections

30 CFR Section 56.18002 of the Mine Safety and Health Administration regulations requires that a competent person designated by the operator must examine each working place at least once each shift for conditions which may adversely affect safety or health. These daily inspections are documented and on file in the Mill's Radiation Protection Office.

(iii) Daily Tailings Inspection

Section 2 of the DMT Plan requires that during Mill operation, the Shift Foreman, or other person with the training specified in Appendix B of the Tailings Management System, designated by the RSO, will perform an inspection of the tailings line and tailings area at least once per shift, paying close attention for potential leaks and to the discharges from the pipelines. Observations by the Inspector are recorded on the appropriate line on the Mill's Daily Inspection Data form.

b) Weekly Inspections

Three types of weekly inspections are performed at the Mill under the License:

(i) Weekly Inspection of the Mill Forms

Paragraph 2.3.1 of Reg. Guide 8.31 provides that the RSO and the Mill foreman should, and Section 2.3.2 of the Mill's ALARA Program provides that the RSO and Mill foreman, or their respective designees, shall conduct a weekly inspection of all Mill areas to observe general radiation control practices and review required changes in procedures and equipment. Particular attention is to be focused on areas where potential exposures to personnel might exist and in areas of operation or locations where contamination is evident.

(ii) Weekly Ore Storage Pad Inspection Forms

Section 3 of the DMT Plan requires that weekly feedstock storage area inspections will be performed by the Radiation Safety Department, to confirm that the bulk feedstock materials are stored and maintained within the defined area of the ore pad and that all alternate feed materials located outside the defined ore pad area are maintained within water tight containers. The results of these inspections are recorded on the Mill's Ore Storage/Sample Plant Weekly Inspection Report.

(iii) Weekly Tailings and DMT Inspection

Section 3 of the DMT Plan require that weekly inspections of the tailings area and DMT requirements be performed by the radiation safety department.

c) Monthly Reports

Two types of monthly reports are prepared by Mill staff:

(i) Monthly Radiation Safety Reports

At least monthly, the RSO reviews the results of daily and weekly inspections, including a review of all monitoring and exposure data for the month and provides to the Mill Manager a monthly report containing a written summary of the month's significant worker protection activities (Section 2.3.4 of the Mill's ALARA Program).

(ii) Monthly Tailings Inspection Reports

The Tailings Management System Plan requires that a Monthly Inspection Data form be completed for the monthly tailings inspection. This inspection is typically performed in the fourth week of each month and is in lieu of the weekly tailings inspection for that week.

Mill staff also prepares a monthly summary of all daily, weekly, monthly and quarterly tailings inspections.

d) Quarterly Tailings Inspections

The Tailings Management System Plan requires that the RSO or his designee perform a quarterly tailings inspection.

e) Annual Evaluations

The following annual evaluations are performed under the License, as set out in Section 6 of the Tailings Management System Plan.

(i) Annual Technical Evaluation

An annual technical evaluation of the tailings management system must be performed by a registered professional engineer (PE), who has experience and training in the area of geotechnical aspects of retention structures. The technical evaluation includes an on-site inspection of the tailings management system and a thorough review of all tailings records for the past year. The Technical Evaluation also includes a review and summary of the annual movement monitor survey (see paragraph (ii) below).

All tailings management system components and corresponding dikes are inspected for signs of erosion, subsidence, shrinkage, and seepage. The drainage ditches are inspected to evaluate surface water control structures.

In the event tailings capacity evaluations were performed for the receipt of alternate feed material during the year, the capacity evaluation forms and associated calculation sheets will be reviewed to ensure that the maximum tailings capacity estimate is accurate. The amount of tailings added to the system since the last evaluation will also be calculated to determine the estimated capacity at the time of the evaluation.

As discussed above, tailings inspection records consist of daily, weekly, monthly, and quarterly tailings inspections. These inspection records are evaluated to determine if any freeboard limits are being approached. Records will also be reviewed to summarize observations of potential concern. The evaluation also involves discussion with the Environmental and/or Radiation Technician and the RSO regarding activities around the tailings area for the past year. During the annual inspection, photographs of the tailings area are taken. The training of individuals is also reviewed as a part of the Annual Technical Evaluation.

The registered engineer obtains copies of selected tailings inspections, along with the monthly and quarterly summaries of observations of concern and the corrective actions taken. These copies are then included in the *Annual Technical Evaluation Report*.

The *Annual Technical Evaluation Report* must be submitted by November 15th of every year to the Director and to the Directing Dam Safety Engineer, State of Utah, Natural Resources.

(ii) Annual Movement Monitor Survey

A movement monitor survey is conducted by a licensed surveyor semi-annually for the first three years, and annually thereafter during the second quarter of each year. The movement monitor survey consists of surveying monitors along dikes 4A-W, 4A-S and 4B-S to detect any possible settlement or movement of the dikes. The data generated from this survey is reviewed and incorporated into the *Annual Technical Evaluation Report* of the tailings management system.

(iii) Annual Leak Detection Fluid Samples

In the event solution has been detected in a leak detection system in Cells 1, 2 or 3, a sample will be collected on an annual basis. This sample will be analyzed according to the conditions set forth in License Condition 11.3.C. The results of the analysis will be reviewed to determine the origin of the solution.

3 TAILINGS RECLAMATION PLAN

This section provides an overview of the Mill location and property; details the facilities to be reclaimed; and describes the design criteria applied in this Plan. Drawings are presented as an attachment to this report. Technical specifications are presented in Attachment A. Attachment B presents the quality assurance and quality control plan for construction activities. Attachment C presents cost estimates for reclamation (based on the Existing Cover Design). Attachment D presents the most current Radiation Protection Manual for Reclamation Activities. Attachment E provides documents on the approved Existing Cover Design that was presented in Reclamation Plan Revision 3.2b (Denison, 2011b).

The Reclamation Plan is written assuming the tailings management system Cells 2, 3, 4A, and 4B will receive tailings to the maximum permitted tailings elevations. Cell 4B is used for evaporation of process solutions and has not been used for tailings storage. The Plan has been written assuming Cell 4B will be used in the future for tailings storage.

If Cell 4B is not used in the future for tailings storage, Cell 4B can be reclaimed for clean closure. Any remaining solutions would be pumped to the last active tailings Cell. The liner system would be removed and disposed in the last active tailings cell. The exterior embankments would then be regraded. This design is not presented in this report.

3.1 Location and Property Description

The Mill is located approximately six miles south of Blanding, Utah on US Highway 191 on a parcel of land encompassing all or part of Sections 21, 22, 27, 28, 29, 32, and 33 of T37S, R22E, and Sections 4, 5, 6, 8, 9, and 16 of T38S, R22E, Salt Lake Base and Meridian described as follows (Figure 3.1-1):

> The south half of the south half of Section 21; the southeast quarter of the southeast quarter of Section 22; the northwest quarter of the northwest quarter and lots 1 and 4 of Section 27 all that part of the southwest quarter of the northwest quarter and the northwest quarter southwest quarter of Section 27 lying west of Utah State Highway 163; the northeast quarter of the northwest quarter, the south half of the northwest quarter, the northeast quarter and the south half of Section 28; the southeast quarter of the southeast quarter of Section 29; the east half of Section 32 and all of Section 33, Township 37 South, Range 22 East, Salt Lake Base and Meridian. Lots 1 through 4, inclusive, the south half of the north half, the southwest quarter, the west half of the southeast quarter, the west half of the east half of the southeast quarter and the west half of the east half of the east half of the southeast quarter of Section 4; Lots 1 through 4, inclusive, the south half of the north half and the south half of Section 5 (all); Lots 1 and 2, the south half of

Insert

Figure 3.1-1 White Mesa Mill Regional Map Showing Land Position

the northeast quarter and the south half of Section 6 (E1/2); the northeast quarter of Section 8; all of Section 9 and all of Section 16, Township 38 South, Range 22 East, Salt Lake Base and Meridian. Additional land is controlled by 46 Mill site claims. Total land holdings are approximately 5,415 acres.

3.2 Facilities to be Reclaimed

See the Drawings for a general layout of the Mill yard and related facilities and the restricted area boundary.

3.2.1 Summary of Facilities to be Reclaimed

The facilities to be reclaimed include the following:

- Cell 1 (evaporation). Cell 1 was previously referred to as Cell 1-I.
- Cells 2, 3, and 4A (tailings).
- Cell 4B (This cell is currently used for evaporation. The reclamation design assumes this cell will be used for tailings in the future).
- Mill buildings and equipment.
- On-site contaminated areas.
- Off-site contaminated areas (i.e., potential areas affected by windblown tailings).

The reclamation of the above facilities will include the following:

- Placement of contaminated soils, crystals, and synthetic liner material and any contaminated underlying soils from Cell 1 into the last active tailings cell
- Placement of a ~~compacted clay liner~~liner system on a portion of the Cell 1 impoundment area to be used for disposal of contaminated materials and debris from the Mill site, if needed
- Decommissioning Cell 1
- Placement of materials and debris from Mill decommissioning into the last active tailings cell or Cell 1 Disposal Area
- Placement of an engineered multi-layer cover over the entire area of Cells 2, 3, 4A, 4B, and the Cell 1 Disposal Area
- Construction of runoff control and diversion channels as necessary
- Reclamation of Mill and ancillary areas
- Reclamation of borrow sources

3.2.2 Tailings and Evaporative Cells

The following subsections describe the cover design and reclamation procedures for Cells 1, 2, 3, 4A, and 4B. Complete engineering details and text are presented in the Updated Tailings Cover Design Report included as Appendix A to this Reclamation Plan.

Cell 2 final cover construction will take place before final cover construction on other cells at the White Mesa Mill. Cell 2 final cover construction will occur in two phases and includes a performance monitoring test section (Primary Test Section) containing a lysimeter constructed in the southeast portion of Cell 2 concurrently with the Phase 1 cover placement. A Supplemental Test Section ~~will be~~has been constructed north of the tailings management cells relating to vegetative cover and erosion control. The plan for implementing final cover placement on Cell 2 and performance assessment and monitoring is presented in Appendix A. Cell 2 Phase 1 cover placement began in May 2016 and ~~is expected to be~~was completed in ~~two construction seasons~~2017. The Primary Test Section was constructed in the fall of 2016. The Supplemental Test Section ~~is proposed to be~~was constructed in the fall of 2017.

3.2.2.1 Soil Cover Design

A conceptual ET cover design was proposed by EFRI for the White Mesa Mill tailings management cells in the Infiltration and Contaminant Transport Modeling (ICTM) reports (MWH 2007 and 2010) submitted to the DWMRC to fulfill the White Mesa Mill's Ground Water Discharge Permit No. UGW370004.

EFRI stated their intent to submit an ET cover design as part of their license renewal in a meeting with DWMRC on October 5, 2010 after review of the DWMRC Reclamation Plan, Version 4.0 Interrogatories – Round 1 (DRC, 2010). The proposed conceptual ET cover design was provided to DWMRC on October 7, 2010 and was essentially the same as presented in the 2010 Infiltration and Contaminant Transport Model report (MWH, 2010). The ET cover proposed and evaluated as described in the Updated Tailings Cover Design Report (Appendix A) is designed as 9.5 feet thick for Cells 1, 4A, and 4B, 10 feet thick for Cell 3, and 10.5 feet thick for Cell 2. The difference in cover thickensses is based on radon emanation analyses. The cover system consists of the following materials outlined below by individual layers and thicknesses from top to bottom:

- Layer 4 - 0.5 ft (15 cm) thick Erosion Protection Layer (gravel-admixture or topsoil)
- Layer 3 - 3.5 ft (107 cm) thick Growth Medium Layer acting as a Water Storage/Biointrusion/Frost Protection/Secondary Radon Attenuation Layer (loam to sandy clay)
- Layer 2 – 3.0 to 4.0 ft (91 to 122 cm) thick Compacted Cover acting as the Primary Radon Attenuation Layer (highly compacted loam to sandy clay)
- Layer 1 - 2.5 ft (76 cm) thick (minimum) Interim Fill Layer acting as a Secondary Radon Attenuation and Grading Layer (loam to sandy clay)

All the layers combined comprise the monolithic ET cover system. Layer 1 was placed in stages on Cell 2 and the majority of Cell 3 as interim cover. Layer 1 will be placed on the remaining area of Cell 3, all of the Cell 1 Disposal Area, and Cells 4A and 4B. It is assumed that this material was or will be dumped and minimally compacted by construction equipment to approximately 80 percent of standard Proctor density. Layer 1 will provide the platform for the remaining cover system and act as a secondary radon attenuation layer. Layer 2 will be compacted cover layer and act as the primary radon attenuation layer. It will be 3 - 4 feet thick (3 feet for Cells 1, 4A, and 4B, 3.5 feet for Cell 3, and 4 feet for Cell 2) and compacted to 95 percent of standard Proctor density. Layer 3 will be the growth medium layer. Layer 3 will also act as a secondary radon attenuation layer and a protection layer for the primary radon attenuation layer (Layer 2). Layer 3 will be 3.5 feet thick and placed at 85 percent of standard Proctor density to optimize water storage and rooting characteristics for plant growth. Layer 4 will be a 0.5-foot thick erosion protection layer. This layer will consist of topsoil in areas where the cover is sloped at 0.5 percent and topsoil-gravel admixture in areas where the cover is sloped at 1 percent. The topsoil-gravel admixture will consist of topsoil (75 percent) mixed with 1-inch minus gravel (25 percent).

The majority of the cover will be constructed from materials available from within the site boundaries. As a part of the soil cover, erosion protection will be placed as the top layer of the cover to stabilize slopes and provide long-term erosion resistance (see Appendix A for characterization of cover materials). The erosion protection materials will be obtained from off-site sources.

The key state and federal performance criteria for tailings cover design and reclamation include:

- Attenuate radon flux to a rate of 20 pCi/m2-s, averaged over each entire cell
- Minimize infiltration into the reclaimed tailings cells
- Maintain a design life of up to 1,000 years and at least 200 years
- Provide long-term isolation of the tailings, including slope stability and geomorphic durability to withstand erosional forces of wind and runoff (up to the probable maximum precipitation event) as well as design to accommodate seismic events (up to the peak ground acceleration from the maximum credible earthquake)
- Designs to accommodate minimum reliance on active maintenance

Several models/analyses were utilized in simulating the soil cover effectiveness: radon flux attenuation, infiltration, freeze/thaw effects, erosion protection, static and pseudostatic slope stability analyses, biointrusion, tailings dewatering, liquefaction, and settlement. These analyses and results are discussed in detail in Sections 3.3.2 through 3.3.10, and calculations are also shown in the Updated Tailings Cover Design Report (Appendix A).

The final grading plans are presented in the Drawings. As indicated in the Drawings, the drainage on the top surface of the ET cover at Cells 1, 2, and 3 is designed at a 0.5 percent slope, with portions of Cell 2 top surface at a 1 percent slope and portions of Cells 4A and 4B top surfaces at 0.8 percent slope. The external side slopes will be graded to five horizontal to one vertical (5H:1V).

3.2.2.2 Cell 1

Cell 1, used during Mill operations solely for evaporation of process liquids, is the northernmost existing cell and is located immediately west of the Mill. It is also the highest cell in elevation, as the natural topography slopes to the south. The drainage area above and including the cell is 216 acres. This includes drainage from the Mill site.

Cell 1 will be evaporated to dryness. The synthetic liner and raffinate crystals will then be removed and placed in the tailings cells. Any contaminated soils below the liner will be removed and also placed in the tailings cells. Based on current regulatory criteria, the current plan calls for excavation of the residual radioactive materials to be designed to ensure that the concentration of radium-226 in land averaged over any area of 100 square meters does not exceed the background level by more than:

- 5 pCi/g, averaged over the first 15 cm of soil below the surface
- 15 pCi/g, averaged over a 15 cm thick layer of soil more than 15 cm below the surface

A portion of Cell 1 (i.e., the Cell 1 Disposal Area), adjacent to and running parallel to the downstream cell dike, may be used for permanent disposal of contaminated materials and debris from the Mill site decommissioning and windblown cleanup. The actual area of the Cell 1 Disposal Area needed for storage of additional material will depend on the status of Cells 3, 4A, and 4B at the time of final Mill decommissioning. A portion of the Mill area decommissioning material may be placed in Cells 3, 4A or 4B if space is available, but for purposes of the reclamation design the entire quantity of contaminated materials from the Mill site decommissioning is assumed to be placed in the Cell 1 Disposal Area, which will subsequently be covered with the ET cover. This results in approximately 10 acres of the Cell 1 area constituting the Cell 1 Disposal Area and being utilized for permanent tailings storage. The remaining area of Cell 1 will then be breached and converted to a sedimentation basin. All runoff from the covered Cell 1 Disposal Area, the Mill area and the area immediately north of Cell 1 will be routed into the sedimentation basin and will discharge onto the natural ground via the channel located at the southwest corner of the basin. The channel is designed to accommodate the PMF flood. Hydraulic and erosional analyses are provided in Appendix A. The channel will be a bedrock channel with a 0.1 percent channel slope, 150-foot bottom width, and 3 horizontal: 1 vertical sideslopes.

3.2.2.3 Cell 2

Cell 2 has been filled with tailings and will be covered with the ET cover to a minimum cover thickness of 10.5 feet. The final cover will drain at a slope of 0.5 to 1 percent to the north and south as shown in the Drawings.

The cover will be as described in Section 3.2.2.1 above and will consist of a 2.5 feet of interim fill, followed by 4 feet of compacted cover, overlain by 3.5 feet of growth medium. Half a foot of topsoil or gravel-admixture will be utilized as armor against erosion at the surface of the cover. External side slopes will be graded to a 5:1 slope and will have 6 inches of angular riprap on the cover surface for erosion protection. A rock apron with dimensions as shown in the Drawings will be constructed at the transition areas of the toes of the side slopes of Cell 2.

3.2.2.4 Cell 3

Cell 3 will be filled with tailings, debris and contaminated soils and covered with the same ET cover system and erosion protection as Cell 2, except the total thickness will be 10 feet with a compacted cover layer of 3.5 feet.

3.2.2.5 Cells 4A and 4B

Cells 4A and 4B are designed to be filled with tailings, debris and contaminated soils and will be covered with the same ET cover system as Cell 2 and Cell 3, except the total thickness will be 9.5 feet with a compacted cover layer of 3 feet. The south external side slopes will be graded to 5H:1V and will have 8 inches of angular riprap on the cover surface for erosion protection. A rock apron with dimensions as shown on the drawings will be constructed at the south side slopes of Cells 4A and 4B. The east and west external side slopes will be graded to 5H:1V and have the same erosion protection as the east and west sides slopes of Cells 2 and 3.

3.3 Design Criteria

As required by Part I.H.11 of the GWDP, EFRI has completed an infiltration and contaminant transport model of the final tailings cover system to demonstrate the long-term ability of the ET cover to protect nearby groundwater quality. The ET cover design and basis presented in Appendix A will be used for this version of the Plan.

The design criteria summaries in this section are adapted from the Updated Tailings Cover Design Report. A copy of the Tailings Cover Design Report is included as Appendix A. It contains all of the calculations used in design and summarized in this section.

3.3.1 Regulatory Criteria

Information contained in 10 CFR Part 20, 10 CFR Part 40 and Appendix A to 10 CFR Part 40 (which are incorporated by reference into UAC R313-24-4), and 40 CFR Part 192 were used as criteria in final designs under this Plan. In addition, the following documents also provided guidance:

- Benson, C.H. W.H. Albright, D.O. Fratta, J.M. Tinjum, E. Kucukkirca, S.H. Lee, J. Scalia, P.D. Schlicht, and X. Wang, 2011. Engineered Covers for Waste Containment: Changes in Engineering Properties and Implications for Long-Term Performance Assessment (in four volumes). NUREG/CR-7028, Prepared for the U.S. Nuclear Regulatory Commission, Washington, D.C., December.
- Johnson, T.L., 2002. "Design of Erosion Protection for Long-Term Stabilization." U.S. Nuclear Regulatory Commission (NRC), *NUREG-1623*. September.
- Nelson, J.D. , S.R. Abt, R.L. Volpe, D. Van Zye, N.E. Hinkle, and W.P. Staub, 1986. Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments, NUREG/CR-4620. June.
- U. S. Department of Energy (DOE), 1988. Effect of Freezing and Thawing on UMTRA Covers, Albuquerque, New Mexico, October.
- U.S. Department of Energy (DOE), 1989. UMTRA-DOE Technical Approach Document, Revision II, UMTRA-DOE/AL 050425.0002. December.
- U.S. Nuclear Regulatory Commission (NRC), 1984. Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, NUREG/CR-3533
- U.S. Nuclear Regulatory Commission (NRC), 1989. Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers, Regulatory Guide 3.64.
- U.S. Nuclear Regulatory Commission (NRC), 1990. "Final Staff Technical Position, Design of Erosion Protective Covers for Stabilization of Uranium Mill Tailings Sites," August.

- U.S. Nuclear Regulatory Commission (NRC), 2003. Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites under Title II of the Uranium Mill Tailings Radiation Control Act of 1978. NUREG-1620, Revision 1, June.

As mentioned above, the requirements set out in Part I.D.8 of the GWDP require that the cover system for each tailings cell will be designed and constructed to meet the following minimum performance requirements for a period of not less than 200 years:

- Minimize the infiltration of precipitation or other surface water into the tailings, including, but not limited to the radon barrier
- Prevent the accumulation of leachate head within the tailings waste layer that could rise above or over-top the maximum FML elevation internal to any disposal cell, i.e. create a "bathtub" effect
- Ensure that groundwater quality at the compliance monitoring wells does not exceed the GWQSs or GWCLs specified in Part I.C.1 and Table 2 of the GWDP

3.3.2 Radon Flux Attenuation

Analyses of radon attenuation through the monolithic ET cover have been performed, and incorporate the current cover design, final grading plan, and results of geotechnical testing of material properties. Emanation of radon-222 from the top surface of the proposed cover system for the tailings cells was calculated using the NRC RADON model (NRC, 1989). The model was used to confirm that the designed cover system can achieve the State of Utah's long-term radon emanation standard for uranium mill tailings (Utah Administrative Code, Rule 313-24), 20 picocuries per square meter per second (pCi/m^2-s). The analyses were conducted following the guidance presented in NRC publications NUREG/CR-3533 (NRC, 1984) and Regulatory Guide 3.64 (NRC, 1989). Results of the analyses show that the proposed cover system can reduce the rate of radon-222 emanation to less than 20 pCi/m^2-s, averaged over the entire area of each tailings cell. A complete description of the radon attenuation analyses conducted for the ET cover system is included in Appendix A.

3.3.3 Infiltration Analysis

Infiltration modeling was conducted for the monolithic ET cover and a complete description of the analyses were provided in the ICTM Report (MWH, 2010). The modeling was updated to address DWMRC comments on the ICTM Report (DRC, 2012; 2013) and to incorporate additional geotechnical and hydrologic data collected in as part of field investigations conducted in 2010 and 2012 for cover borrow material and in 2013 for in situ tailings. The updated infiltration modeling results were presented in EFRI (2012b) and EFRI (2015c). The evaluation of infiltration of precipitation through the cover system was evaluated with the computer program HYDRUS-1D (Simunek et al., 2009). The modeling used historical daily meteorological data for precipitation and evapotranspiration over a 57-year climate period, as well as assumptions that were either conservative or based on anticipated conditions. Given the flat nature of the cover (less than 1 percent slope), no run-on- or runoff-based processes were assumed to occur. As a result, precipitation applied to the cover surface was removed through evaporation or transpiration, retained in the soil profile as storage, or transmitted downward as infiltration.

The model-predicted average long-term water flux rate through the cover system is 2.3 mm/yr. Additional model scenarios were analyzed to evaluate the sensitivity of the soil properties, climate, and reduced vegetation parameters. The range of average long-term water flux rates for these scenarios varied from 1.9 to 8.6 mm/yr. The model-predicted water flux rates through the monolithic ET cover indicate that the available cover storage capacity should be sufficient to significantly reduce infiltration through the cover system. A complete description of the infiltration analyses conducted for the monolithic ET cover is provided in MWH (2010) with updates provided in EFRI (2012b, 2015c), and is summarized in Appendix A to this Reclamation Plan.

3.3.4 Freeze/Thaw Evaluation

A freeze/thaw analysis was performed for the monolithic ET cover system, utilizing geotechnical properties of materials specified for use in construction of the cover. The calculations of frost penetration at the site were performed with the computer program ModBerg (CRREL), which uses a built-in weather database, as well as user-defined soil parameters.

The freeze/thaw calculations estimate the total depth of frost penetration for the cover system as 32 inches (2.67 ft). The frost penetration depth is not anticipated to exceed the depth of Layers 3 and 4 of the cover system (combined depth of 4 ft). The physical and hydraulic properties of these cover system layers after construction are expected to be close to long-term properties from pedogenic processes, such that post-construction changes due to freeze/thaw should be minimal. A complete description of the freeze/thaw analyses conducted for the proposed cover system is presented in the Updated Tailings Cover Design Report, attached as Appendix A to this Reclamation Plan.

3.3.5 Soil Cover Erosion Protection

The erosional stability of the reclaimed tailings cells was evaluated in terms of long-term water erosion under extreme storm conditions. The analyses were conducted in general accordance with NRC guidelines (NRC, 1990; Johnson, 2002). A description of the analyses performed is presented in Appendix A.

The components of erosion protection for the reclaimed tailings cells consist of the following:

- The cover on the top surface of Cells 1, 2, and 3, with slopes of 0.5 percent, would be constructed as a vegetated slope, with 6 inches of topsoil.
- The portions of Cell 2 with a top surface of 1 percent slope, and the portions of Cells 4A and 4B with 0.8 percent slope, would be constructed as a vegetated slope with 6 inches of topsoil mixed with 25 percent (by weight) gravel (maximum diameter of 1 inch).
- Erosion protection of external (5H:1V) side slopes would be provided by various sized angular and rounded riprap with layer thicknesses ranging from 6 to 8 inches and median particle sizes ranging from 1.7 to 5.3 inches. A 6-inch layer of filter material would be placed between the erosional protection layer and underlying soil layer in locations with riprap greater than 1.7 inches. A narrow zone of this filter will also be placed at the interface between the riprap (greater than 1.7 inches) on the external side slopes and the cover surface erosion protection layer.
- The toe of embankment slopes will have erosional protection and scour protection on the west and east sides of the cells provided by a rock apron measuring approximately 10 inches deep and 5 feet

wide, with a median particle size of 3.4 inches. On the south side of cells 4A and 4B, and east side of Cell 4A, the rock apron would be approximately 3 feet in depth, 13 feet in width, and have a median particle size of 10.6 inches. On the north side slope of the Cell 1 disposal area, the rock apron would be approximately 3 feet deep, 11 feet wide, and have a median particle size of 9 inches.

- The Sedimentation Basin area will be graded to 0.1 percent slope and constructed as a vegetated slope with 6 inches of topsoil.
- The Diversion Channel will be excavated into bedrock.

3.3.6 Slope Stability Analysis

Static (long-term) and pseudo-static slope stability analyses were performed for two critical cross sections through the tailings embankments. The analyses were performed using limit equilibrium methods with the computer program SLOPE/W (Geo-Slope, 2007). A complete description of the input parameters and assumptions used in the analyses is provided in Appendix A. Material strength parameters used for the analyses were based on historical laboratory testing on tailings and clay materials (Advanced Terra Testing, 1996; Chen and Associates, 1987; D'Appolonia, 1982; and Western Colorado Testing, 1999), laboratory testing conducted in 2010 and 2012 on potential cover borrow materials (see Attachment B of EFRI, 2012a), laboratory testing conducted in 2013 on tailings (MWH, 2015b) and typical published values.

The mean Peak Ground Acceleration (PGA) for reclaimed conditions is 0.15g based on the site specific PSHA (MWH, 2015a). This PGA represents the seismic loading from the Maximum Credible Earthquake (MCE). The seismic coefficient used for the pseudo static stability analysis was 0.10 g (equal to 2/3 of the PGA).

The calculated factors of safety range from 2.6 to 3.9 and 1.7 to 2.5 for static and pseudo-static loading conditions, respectively. The calculated factors of safety for both the long-term static condition and the pseudo-static condition exceed the required values of 1.5 and 1.1 respectively (NRC, 2003).

3.3.7 Tailings Dewatering

Cells 2, 3, 4A, and 4B are constructed to allow tailings dewatering. Dewatering analyses have been conducted for these tailings management cells assuming the cells receive tailings to the maximum permitted tailings elevation. Dewatering analyses for Cells 2 and 3 were conducted by MWH and are presented in Appendix A. Dewatering analyses for Cells 4A and 4B were conducted by Geosyntec (2007a, 2007b). The pertinent excerpts from MWH (2010), Geosyntec (2007a, 2007b), and DRC (2008) are included in Appendix A.

Water levels in Cells 2 and 3 were measured during the October 2013 tailings investigation (MWH, 2015b). Results of the investigation indicated migration of water towards the sump in Cell 2. This was expected since water has been pumped from the Cell 2 sump since 2008. Dewatering of Cell 3 has not yet started and the October 2013 investigation reflected this, with measured water levels a few feet below the tailings surface.

To monitor changes in water levels due to dewatering prior to and after final cover placement, installation of standpipe piezometers was recommended across the cells prior to the first phase of final cover placement and extension of the piezometers during final cover placement. These piezometers will provide information on the rate and extent of dewatering of the tailings. The piezometers are primarily located adjacent to the settlement monuments to minimize damage to the piezometers during cover construction, while providing sufficient locations to evaluate the water levels. Water levels are recommended to be monitored at the same frequency and duration as the settlement monuments. Piezometer locations for Cell 2 are shown in Appendix L of the Updated Tailings Cover Design Report.

3.3.8 Settlement and Liquefaction Analyses

Settlement analyses and evaluation of liquefaction potential for the tailings were performed for the tailings cells. A discussion of the analyses and results are provided in Appendix A.

One-dimensional settlement analyses were conducted to evaluate settlement due to placement of final cover, dewatering of the tailings cells, long-term static (creep) settlement, and seismically induced (seismic) settlement. The results of these analyses of specific locations were used to evaluate differential settlement and the potential for cover cracking. The CPT locations in Cell 2 and 3 from the October 2013 tailings investigation (MWH, 2015b) were selected as the locations for the settlement analyses. Parameters used for the settlement analyses are summarized in Appendix A. Tailings profiles and properties are based on results presented in MWH (2015a). Parameters for cover materials are based on cover material testing conducted in 2010 and 2012 (summarized in Appendix A). Evaluation of total settlement due to final cover placement and dewatering indicates potential future settlement during active maintenance ranging from 0.9 to 1.6 feet.

The majority of this settlement is expected occur after Phase 1 cover construction with the remaining settlement occurring soon after Phase 2 cover construction. During this time, additional fill may be placed in low areas to maintain positive drainage of the cover surface. The estimated total predicted future long-term settlement that could occur (due to creep and seismic settlement) after the maintenance period is complete ranges from approximately 0.3 to 0.7 feet. Estimates of total long-term settlement were calculated by summing the static creep and seismic settlement estimates. As such, these estimates are considered somewhat conservative, as they are not independent (i.e. as long-term static creep progresses, void ratio reduction will occur and the potential for seismic settlement will reduce over time as a result). The estimated differential settlement after completion of active maintenance is sufficiently low that slope reversal and ponding is not expected to occur on a cover slope of 0.5 to 1.0 percent. In addition, the results indicate that cracking of the highly-compacted radon barrier due to settlement-induced strains is not expected.

Liquefaction analyses were performed to evaluate the risk of earthquake-induced liquefaction of the tailings. Two methods (Idriss and Boulanger, 2008; Youd et al., 2001) were used for the analyses. Material properties were obtained from results of laboratory tests on tailings samples collected during the October 2013 tailings investigation of Cells 2 and 3 (MWH, 2015b). Other parameters used were based on CPT data measured during the October 2013 tailings investigation. Results of the site-specific PSHA (MWH, 2015a) were used in the analyses and include a PGA of 0.15g for an approximate 10,000-year return period, with the mean seismic source being a magnitude (Mw) 5.5 event occurring 20 km from the site. Computed factors of safety against liquefaction range from 2.0 to 2.8. Based on the calculated factors of safety, the tailings are not susceptible to earthquake-induced liquefaction.

3.3.9 Vegetation and Biointrusion

The plant species proposed for the cover system consist of native perennial grasses, forbs, and shrubs. The use of these species in reclamation of the tailing management cells provide a permanent or sustainable plant cover because of the highly adapted nature of these species to existing site conditions, their tolerance to environmental stresses such as drought, fire, and herbivory, and their ability to effectively reproduce over time. These species can coexist and fully utilize plant resources to minimize the establishment of invasive weeds and deep rooted woody species on the site. Once established, the proposed seed mixture produce a grass-forb-shrub community of highly adapted and productive species that can effectively compete with undesirable species. A complete discussion of cover vegetation is provided in Appendix A.

The proposed cover system is designed to minimize both plant root and burrowing animal intrusion through the use of thick layers of soil cover (total thickness 9.5 to 10.5 ft) in combination with a highly compacted layer placed at a depth that is below the expected rooting and burrowing depths of species that may inhabit the site. Root growth and animal burrowing into the highly compacted radon attenuation layer (beginning at a depth of 4 ft) will be restricted because of the high density of this material (compaction to 95 percent relative compaction based on the standard Proctor test). In addition, both root density and the size of roots decrease at a rapid rate with rooting depth, further limiting the potential for root growth into the compacted radon attenuation layer of the cover system. A complete discussion of the biointrusion evaluation through the ET cover is presented in Appendix A.

3.3.10 Cover Material/Cover Material Volumes

Material volumes required for construction of the interim cover, final cover, and erosion protection are provided in Table 3.3-1. The quantities of materials available for construction of the cover are also provided in Table 3.3-1. A summary of the volumes of borrow stockpiles was provided in Appendix A. Sufficient quantities are available from on-site sources for the topsoil and random fill materials. The bedding and gravel materials would be obtained from off-site commercial sources. Three commercial sources have been identified as potential sources for the bedding and gravel materials. The potential off-site sources were listed in Appendix A. Sufficient quantities of material are available from the off-site sources identified.

Table 3.3-1. Reclamation Cover Material Quantity Summary

Material	Quantity Required for Reclamation (cy)	Quantity Available (Identified Sources) (cy)
Topsoil (for Erosion Protection Layer)	195,000	284,100 (on-site stockpiles)
Gravel (1-inch minus for Erosion Protection Layer)	24,000	Sufficient quantity available (off-site commercial source)
Random Fill (total for additional Layer 1 material, Layer 2, and Layer 3)	3,500,000	3,596,621 (on-site stockpiles)
Riprap (for 5H:1V side slopes and rock aprons)	38,000	Sufficient quantity available (off-site commercial source)
Riprap Bedding/Filter Layer	16,000[1]	Sufficient quantity available (off-site commercial source)

Note: Based on 6-inch thick medium sand bedding/filter layer beneath riprap.

4 MILL DECOMMISSIONING PLAN

The preliminary plans for decommissioning of the Mill are presented in the plan included as Appendix B to this Reclamation Plan. This information has been updated since the previous Reclamation Plan, Revision 5.0 (Denison, 2011c). The Preliminary Decommissioning Plan attached as Appendix B includes a description of the following activities to be performed during the decommissioning process:

- Development and implementation of health and safety procedures
- Execution of pre-decommissioning activities
- Demolition of above-ground and under-ground facilities, and placement of these materials in the Cell 1 Disposal Area or the last active tailings cell
- Excavation of contaminated subsoils from the process area and placement in the Cell 1 Disposal Area or the last active tailings cell
- Clean-up of windblown contamination and placement in the Cell 1 Disposal Area or the last active tailings cell
- Regrading and revegetation

The Plan further describes the requirements prior to demolition and the procedures to be used for specific locations within the process area, as well as requirements for personnel training, environmental monitoring, and management of water and contaminants. The work should be conducted under the EFRI Radiation Protection Manual, as directed by the site Radiation Safety Officer.

The EFRI Radiation Protection Manual for Reclamation is included as Attachment D to this Reclamation Plan.

5 REVERSION TO EXISTING COVER DESIGN

5.1 Background

On November 11, 2015, the UDEQ Division of Waste Management and Radiation Control (DWMRC) recommended EFRI develop a plan to begin reclamation of the tailings management system cells. This plan would consist of placing the cover system presented in this Plan (the "Proposed Cover System") on Cell 2 and demonstrating acceptable cover performance via a performance monitoring program.

Per the Stipulation and Consent Agreement (SCA) in development between EFRI and DWMRC, Cell 2 reclamation is planned to occur in 2 phases. Phase 1 is comprised of Layers 1 and 2 of the Proposed Cover System, and will be placed on Cell 2 along with a Primary Test Section that contains all of the Proposed Cover System, including the vegetative cover. The Primary Test Section along with a Supplemental Test Section (located off of Cell 2, and relating only to vegetative cover and erosion control) will be tested over a period of approximately 7 years (the "Cell 2 Test Period").

Under the SCA, the Cell 2 Primary Test Section and Supplemental Test Section will have to meet required performance criteria to verify the effectiveness of the Proposed Cover System and initiate Phase 2 cover placement.

5.2 Proposed Cover Design Meets all Applicable Regulatory Criteria

If the Primary Test Section and Supplemental Test Section demonstrate that the Proposed Cover System meets all applicable regulatory criteria, then:

a) *Cell 2*

Phase 2, comprised of Layer 3, Layer 4 and the vegetative cover of the Proposed Cover System, will be placed on Cell 2, in accordance with the SCA and Section 6.0 below;

b) *Other Tailings Management System Cells being Reclaimed during Cell 2 Test Period*

In the event that any other tailings management system cells are to be reclaimed during the Cell 2 Test Period, such tailings impoundments will be reclaimed by placing Phase 1 of the Proposed Cover System on the cell, and then waiting until the Cell 2 test is completed. Thereafter, reclamation of the cells will be completed in the same manner as Cell 2, in accordance with the SCA and Section 6.0 below; and

c) *Other Tailings Management System Cells Being Reclaimed after Cell 2 Test Period*

Upon final reclamation in accordance with Section 6.0 below, the other tailings management system cells, which had not commenced reclamation during the Cell 2 test period, would be reclaimed with the Proposed Cover System.

5.3 Proposed Cover Design Does not Meet all Applicable Regulatory Criteria

If the Cell 2 Primary Test Section and Supplemental Test Section fail to meet the required performance criteria and follow up actions (to be identified in the SCA), then:

a) Cell 2

EFRI will complete Cell 2 Phase 2 cover placement by placing Layers 2, 3, and 4 of the Existing Cover System presented in Reclamation Plan Revision 3.2b (Denison, 2011b) (the "Existing Cover System") on top of the Phase 1 layers, as follows:

i. the Cell 2 Phase 1 cover system (which includes the Proposed Cover System Layers 1 and 2) would remain in place;

ii. the Existing Cover System Layer 2, comprised of 1 ft (30.5cm) Radon Barrier (compacted clay), would be placed on top of the Cell 2 Phase 1 cover;

iii. The Existing Cover System Layer 3 comprised of 2 ft (61 cm) Frost Barrier (random fill), would be placed on top of the Existing Cover System Layer 2; and

iv. the Existing Cover System Layer 4, comprised of 3 in (7.6 cm) Rock Armor would be placed on top of Existing Cover System Layer 3.

b) Other Tailings Management System Cells being Reclaimed during Cell 2 Test Period

In the event that any other tailings management system cells are to be reclaimed during the Cell 2 Test Period, such cells will be reclaimed by placing Phase 1 of the Proposed Cover System on the cells, and then waiting until the Cell 2 test is completed. Thereafter, reclamation of the cell will be completed in the same manner as Cell 2, in accordance with the SCA and Section 6.0 below. If Phase 1 of the Proposed Cover System is not completed during the Cell 2 Test Period for any such cells, then such cells may be reclaimed with the Existing Cover System; and

c) Other Tailings Management System Cells Being Reclaimed after Cell 2 Test Period

Upon final reclamation in accordance with Section 6.0 below, the other tailings management system cells which had not commenced reclamation during the Cell 2 Test Period, would be reclaimed with the Existing Cover System.

6 MILESTONES AND SCHEDULE COMMITMENTS FOR RECLAMATION

~~6.1~~6.1. Background

Utah Administrative Code R313-24-4, incorporating by reference 10 CFR Part 40 Appendix A Criterion 6A (**"Criterion 6A"**) paragraph (1), provides that: "For impoundments containing uranium byproduct materials, the final radon barrier must be completed as expeditiously as practicable considering technological feasibility after the pile or impoundment ceases operation in accordance with a written, Commission-approved reclamation plan. (The term as expeditiously as practicable considering technological feasibility as specifically defined in the Introduction of this appendix includes factors beyond the control of the licensee.) Deadlines for completion of the final radon barrier and, if applicable, the following interim milestones must be established as a condition of the individual license: windblown tailings retrieval and placement on the pile and interim stabilization (including dewatering or the removal of freestanding liquids and ~~recontouring~~re-contouring). The placement of erosion protection barriers or other features necessary for long-term control of the tailings must also be completed in a timely manner in accordance with a written, Commission-approved reclamation plan."

As ~~the final radon barrier on an impoundment cannot be completed until the impoundment has been adequately dewatered and the tailings have stabilized, the timing of which depends on physical and technological factors beyond the control of the licensee, it is not possible to establish absolute deadlines or milestones for reclamation at the time of approval of this Plan.~~

~~*In* past reclamation plans for the Mill, the requirement to set milestones was satisfied by the requirement in the Plan to set a schedule in the future as conditions allow. Under Section 5.3.1 of the Company's Reclamation Plan Revision 3.2, placement of cover materials will be based on a schedule determined by analysis of settlement data, piezometer data and equipment mobility considerations. This gives the regulator authority to set deadlines and milestones as conditions allow, through the future approval of the schedule. The deadlines and milestones in the approved schedule would then serve as the deadlines and milestones for reclamation of the Mill, as~~ contemplated by ~~10 CFR Part 40 Appendix A,~~ Criterion 6A~~(1).~~,

~~In an attempt to provide as much specificity as possible in this Plan, as contemplated by 10 CFR Part 40 Appendix A, Criterion 6A(1),~~ this Section sets out the ~~sequence of~~ interim milestones and deadlines for ~~reclamation of~~ completion of the final radon barrier for individual tailings impoundments ~~at the Mill and for~~ (referred to in this Section as "tailings impoundments" or "conventional impoundments") at the Mill after each such impoundment begins final closure. It also sets out milestones for the removal and disposal of non-conventional impoundments (referred to in this Section as "evaporation ponds" or "non-conventional impoundments") after each such impoundment begins final closure, as well as additional milestones applicable to final Mill site closure~~, to the extent~~. A table that ~~they can be established at this time. A more detailed schedule, which incorporates the sequence of interim milestones and deadlines set out below, would be submitted to the Director for approval prior to final Mill site closure~~summarizes all of these milestones is included in Section 6.2.6 below.

Also included below are schedule commitments for other events or actions which are not "milestones" required under Criterion 6A, but instead are schedule commitments to be achieved in order to ensure that those events or actions are completed in a timely manner. As these schedule commitments are not milestones they do not come under the specific provisions of paragraph (2) of Criterion 6A. However, a

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Formatted: Normal, Space Before: 0 pt general timeliness standard for completing those items is retained. The licensee must complete those actions in a timely way, and the Director has the authority to take action if necessary in this regard. As these schedule commitments are not milestones required under Criterion 6A(1), they are not included in the table set out in Section 6.2.5 below.

~~6.2~~6.2. Milestones and Schedule Commitments

~~6.2.1~~6.2.1. General

~~a)~~(a) Definition of "Operation"

"Operation" means that ~~a tailings~~an impoundment is being used for the continued placement of ~~tailings sands~~uranium byproduct material or tailings or is ~~on~~in standby status for such placement. An impoundment is in operation from the day that uranium byproduct material or tailings ~~sands~~ are first placed in the impoundment until the day that final closure begins. ~~Final closure means the activities following operations to reclaim the tailings impoundment.~~

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~~b)~~(b) *When Final Closure of an Impoundment Begins*

~~An~~ Final closure of an impoundment ~~shall be considered to have ceased operations, and final closure shall be deemed to have commenced,~~begins when the owner or operator provides written notice to the EPA and to the Director that:

i) In the case of a conventional impoundment (~~A)~~i.e., a tailings impoundment), the impoundment is no longer ~~being used for the continued placement of tailings sands and EFRI has advised the Director in writing that the impoundment~~receiving uranium byproduct material or tailings, is no longer ~~being used for the continued placement of tailings sands and is not~~ on standby status for such receipt and is being managed under an approved reclamation plan for that impoundment or facility closure plan; and

ii) In ~~placement; or (B)~~the case of a non-conventional impoundment (e.g., an evaporation pond), the impoundment is no longer required for evaporation or holding purposes, is no longer on standby for such purposes and is being ~~used for the continued placement of tailings sands, interim cover has been placed over the entire surface area of the~~managed under an approved reclamation plan for that impoundment~~, and dewatering activities have begun; or (C) the Mill~~ or facility ~~as a whole has commenced final~~ closure plan.

An approved reclamation plan prepared and ~~a written notice to that effect has been provided to the Director~~approved in accordance with 10 CFR part 40, Appendix A is considered a reclamation plan for purposes of this ~~Plan.~~paragraph 6.2.1(b).

~~c)~~(c) *The Existing Tailings Management System at the Mill*

The tailings management system at the Mill currently consists of three tailings impoundments: Cell 2, which is not in operation and is in final closure, and Cells 3 and 4A, which are in operation. Cell 1 is an evaporation pond. Cell 4B is currently being used as an evaporation pond and will continue to be used as an evaporation pond until it first starts to receive tailings sands or other byproduct material (other than solutions) for disposal. Future cells may commence as evaporation ponds, and will continue as evaporation ponds until they first receive tailings sands or other byproduct material (other than solutions) for disposal, at which time they will become tailings impoundments.

~~d)~~(d) *The Proposed Cover Design and Existing Cover Design*

This Plan presents a proposed evapotranspiration (ET) cover (the "**Proposed Cover Design**") as a component of the reclamation plan for the tailings ~~cells~~impoundments, to replace the rock armor cover design (the "**Existing Cover Design**") set out in Appendix D to the Reclamation Plan Version 3.2b (Denison, 2011b).

The Stipulation and Consent Agreement described in Section 6.2.1~~ ~~(e) below and Section 5.0 above describe ~~the~~a set of circumstances under which the Final Cover Design ~~will~~could be the Existing Cover Design rather than the Proposed Cover Design~~ or the Existing Cover Design.~~. Section 5.0 of this Plan describes the manner in which EFRI ~~will~~would revert from the Proposed Cover Design to the Existing Cover Design if so required by the Stipulation and Consent Agreement~~ and Section 5.0 of this Plan~~.

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~~(i)~~i) The Proposed Cover Design

The Proposed Cover Design will have a minimum thickness of 9.5 feet, and will consist of the following layers listed below from top to bottom:

- Layer 4 - 0.5 ft (15 cm) thick Erosion Protection Layer (topsoil-gravel admixture or topsoil) ~~(referred to herein as "Layer 4")~~
- Layer 3 - 3.5 ft (107 cm) thick Water Storage/Biointrusion/Frost Protection/Secondary Radon Attenuation Layer (loam to sandy clay) ~~(referred to herein as "Layer 3")~~
- Layer 2 – 3.0 - 4.0 ft (91 to 122 cm) thick Primary Radon Attenuation Layer (highly compacted loam to sandy clay) ~~(referred to herein as "Layer 2")~~
- Layer 1 - 2.5 ft (76 cm) thick (minimum) Secondary Radon Attenuation and Grading Layer (loam to sandy clay) ~~(referred to herein as "Layer 1")~~

All the layers combined comprise the monolithic ET cover system.

~~*(ii)*~~ii) The Existing Cover Design

The Existing Cover Design will have a minimum thickness of 6 feet, and will consist of the following layers listed below from top to bottom:

- Layer 4 -- 3 in (7.6 cm) Rock Armor
- Layer 3 -- 2 ft (61 cm) Frost Barrier Layer (random fill)
- Layer 2 -- 1 ft (30.5) Radon Barrier (compacted clay)
- Layer 1 -- Minimum 3 ft (91.4 cm) Platform Fill (random fill)

~~(iii) Interim and Final Cover Layers~~

~~The "Interim Cover Layer" is, in the case of the Proposed Cover Design, Layer 1, and in the case of the Existing Cover Design, Layer 1. The "Final Cover Layers" are, in the case of the Proposed Cover Design, Layers 3, and 4, and in the case of the Existing Cover Design, Layers 2, 3 and 4. In the case of the Proposed Cover Design only, Layer 2 will be added between placement of the Interim Cover Layer and the Final Cover Layers.~~

~~e)~~*(e)* *The Stipulation and Consent Agreement*

EFRI and the Director of the UDEQ DWMRC ~~are developing~~have entered into a Stipulation and Consent Agreement (the "**SCA**"), which~~, when finalized, will set~~ sets out the terms on which the Mill will test the effectiveness of the Proposed Cover Design and, together with Section 5.0 of this Plan, the circumstances in which the approved Cover Design for reclamation of tailings impoundments ~~will~~could be a variation of the Proposed Cover Design~~, or a variation thereof,~~ or the Existing Cover Design~~.~~ , rather than the Proposed Cover Design.

~~6.2.2~~6.2.2. Deadlines ~~and~~, Interim Milestones and Schedule Commitments for Closure of Cell 2

The deadlines and interim milestones and schedule commitment dates for closure of Cell 2 ~~will be~~are set out in the SCA. The requirements set out in the SCA~~, when finalized, will be~~ are incorporated by reference into this Plan as if set out in this Plan. The final radon barrier for Cell 2 (Layers 1 and 2 under the Proposed Cover Design) has been put in place. Radon flux measurements taken since the final radon barrier has been placed onto Cell 2 have been well below the 20 pCi/m^{2}s standard set out in Criterion 6A.

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~~6.2.3~~6.2.3. Milestones and Schedule Commitments for Closure of ~~an Individual~~ a Conventional Impoundment (i.e., a Tailings Impoundment~~,~~), other than Cell 2~~, that Ceases Operation While the Mill Facility as a Whole Remains in Operation~~

~~For each~~
A conventional impoundment (i.e., tailings impoundment~~,~~), other than Cell 2, ~~that ceases operation~~ may begin final closure at any time, including while the Mill facility as a whole remains in operation~~,~~ as well as during or after final Mill site decommissioning and closure. Once final closure of ~~the~~a conventional impoundment ~~shall begin, and~~begins as specified in Section 6.2.1 b) above, the final radon barrier for the impoundment shall be completed as expeditiously as practicable thereafter considering technological feasibility (including taking into consideration factors beyond the control of the licensee) in accordance with this Plan and the ~~deadline and~~deadlines, milestones and schedule commitments set out below:

~~a)~~(a) Interim Stabilization (Including Dewatering or the Removal of Freestanding Liquids and Re-contouring) of ~~each~~the Tailings Impoundment.

~~(i)~~i) Removal of Freestanding Liquids

Commencing on the date the impoundment ~~ceases operations and~~begins final closure ~~of the impoundment is deemed to commence~~ in accordance with Section 6.2.1 b) above, the addition of liquids to the tailings impoundment, other than by natural precipitation, will ~~be minimized~~cease, and free standing liquids will be allowed to dry out by natural evaporation. To the extent reasonably practicable, and if excess evaporative capacity is available in other cells in the tailings management system ~~without interfering with Mill operations~~, the Mill will transfer solutions out of the tailings impoundment and into other tailings impoundments and/or evaporation ponds in order to enhance evaporation and removal of solutions from the impoundment. This item must be completed within one year after the impoundment begins final closure. This deadline is a milestone as required by Criterion 6A(1), and is subject to the provisions of Criterion 6A(2).

~~(ii)~~ii) Re-contouring

Re-contouring of the tailings impoundment, in accordance with Drawings and Attachment A (Technical Specifications) of this Plan ("**Re-contouring**"), will commence ~~within 180 days after~~ upon removal of freestanding liquids from the impoundment and ~~will~~must be completed within ~~180 days thereafter, or such longer time~~two years after the impoundment begins final closure. This deadline is a milestone as ~~may be~~ required ~~if instability of the tailings sands restricts or hampers such activities, or as may be approved~~ by Criterion 6A(1), and is subject to the ~~Director.~~provisions of Criterion 6A(2).

iii) Commencement of Dewatering

Dewatering of the impoundment shall commence upon completion of re-contouring of the impoundment, and shall continue until the impoundment is dewatered as contemplated by item 6.2.3(a)(vii) below. This deadline is a milestone as required by Criterion 6A(1), and is subject to the provisions of Criterion 6A(2).

~~(iii)~~iv) Placement of ~~Interim Cover~~ Layer 1

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` Upon completion of Rere-contouring of the impoundment, EFRI will complete placement of the Interim Cover Layer 1 (Secondary Radon Attenuation and Grading Layer under the Proposed Cover Design or Platform Fill under the Existing Cover Design, as applicable) on the impoundment, in accordance with this Plan. If the Director has confirmed in writing prior to April 1 in any given year that the re-contouring of the impoundment has been completed, then placement of the Interim Cover Layer on the impoundment will This item must be completed within three years after the date the impoundment begins final closure. This deadline is a milestone as required by Criterion 6A(1), and is subject to the provisions of Criterion 6A(2).

v) Placement of Layer 2 (Final Radon Barrier)

Upon EFRI being satisfied that there have been decreasing trends in settlement followed by a maximum of 0.1 feet (30 mm) of cumulative settlement over 12 months (for at least 90 percent of the settlement monuments), or at such earlier time as EFRI may determine, EFRI shall commence placing Layer 2 (the Primary Radon Attenuation Layer under the Proposed Cover Design or the Radon Barrier under the Existing Cover Design, as applicable) on the impoundment. This item must be completed as expeditiously as practicable considering technological feasibility (including factors beyond the control of the licensee), but in any event within seven years after the impoundment begins final closure. This deadline is a milestone as required by Criterion 6A(1), and is subject to the provisions of Criterion 6A(2).

vi) Placement of Layer 3

After placement of prior to December 31 of the following yearLayer 2, EFRI will place Layer 3 (the Water Storage/Biointrusion/Frost Protection/Secondary Radon Attenuation Layer under the Proposed Cover Design or the Frost Barrier Layer under the Existing Cover Design, as applicable) on the impoundment. Timing of commencement of this item will be at the discretion of EFRI, and Layer 3 may be placed prior to or after completion of dewatering. The schedule commitment for this item is to have it completed within the later of (A) seven years after the impoundment begins final closure and (B) two years after completion of placement of Layer 2 on the impoundment, or such later date as may be approved by the Director. This item is not a milestone required under Criterion 6A(1) because it follows placement of the final radon barrier and is not required for that action, and because there is a separate milestone for dewatering. Instead, this item is included as a schedule commitment to be achieved in order to ensure that the activity is completed in a timely manner. As this schedule commitment is not a milestone it does not come under the specific provisions of paragraph (2) of Criterion 6A. However, a general timeliness standard for completing this activity is retained. EFRI must complete this activity in a timely way, and the Director has the authority to take action if necessary in this regard.

(iv)vii) Completion of Dewatering

Dewatering of the impoundment shall commence within 180 days after completion of placement of the Interim Cover Layer over the entire surface area of the impoundment. Dewatering shall continue until the Settlement Monitoring Criteria described in paragraph 6.2.3 b) below are determined by the Directorbe considered to be satisfied.

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After placement of the Interim Cover Layer on the impoundment in accordance with paragraph 6.2.3 a)(iii) above is complete, settlement monuments when, after the placement of Layer 2 and piezometers in the impoundment will be monitored in accordance with this Plan. In the case of the Proposed Cover Design (but not the Existing Cover Design), Layer 3 (if Layer 2 will be3 is placed on top of the Interim Cover Layer within two years after placement of the Interim Cover Layer on the impoundment (or such later date as determined by the Director).

Settlement and prior to completion of dewatering data will be evaluated to determine if sufficient settlement has occurred to facilitate placement of the Final Cover Layers on the impoundment and to minimize maintenance of the final cover surface. Decreasing) decreasing trends in settlement followed by a maximum of 0.1 feet (30 mm) of cumulative settlement over 12 months (for at least 90 percent of the settlement monuments) will be considered acceptable (the “Settlement Monitoring Criteria”) to proceed with placement of the Final Cover Layers on the impoundment. have occurred. This item must be completed within the later of (A) seven years after the impoundment begins final closure and (B) two years after completion of placement of Layer 2 on the impoundment. This deadline is a milestone as required by Criterion 6A(1), and is subject to the provisions of Criterion 6A(2).

Commencement

*viii)*Placement of placement ofLayer 4 Under the FinalProposed Cover LayersDesign

Placement of Layer 4 under the Proposed Cover Design (Erosion Protection Layer) on the impoundment will commence after the Director has confirmed in writing that the Settlement Monitoring Criteria have been satisfied for the impoundment.completion of dewatering (this item does not apply to the Existing Cover Design). The schedule commitment for this item is to have it completed within the later of (A) eight years after the impoundment begins final closure and (B) two years after completion of placement of Layer 3 on the impoundment, or such later time as may be approved by the Director. This item is not a milestone required under Criterion 6A(1), because it follows placement of the final radon barrier and is not required for that activity. Instead, this item is included as a schedule commitment to be achieved in order to ensure that the activity is completed in a timely manner. As this schedule commitment is not a milestone it does not come under the specific provisions of paragraph (2) of Criterion 6A. However, a general timeliness standard for completing this activity is retained. EFRI must complete this activity in a timely way, and the Director has the authority to take action if necessary in this regard.

If the Director has confirmed in writing prior to April 1 in any given year that the Settlement Monitoring Criteria have been satisfied for the impoundment, then placement of the Final Cover Layers on the impoundment will be completed prior to December 31 of the following year, or such later date as may be approved by the Director.

c) The Placement of Erosion Protection Barriers or other Features Necessary for Long-term Control of the Tailings

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(i)ix) Vegetative Cover

If the Cover Design, as approved by the Director in accordance with the procedures described in the SCA and Section 5.0 of this Plan, is the Proposed Cover Design or otherwise calls for vegetative cover on the impoundment, then revegetation of the cover will take place at the completion of placement of the Final Cover LayersLayer 4 (Erosion Protection Layer) on the impoundment, in accordance with the revegetation plan set out in Appendix J to the Updated Cover Design Report. All required seeding for re-vegetation will commence in the first available growing season after the completion of placement of the Final Cover LayersLayer 4 (Erosion Protection Layer) on the impoundment, as determined by the Director, and will be completed by the end of such growing season, or such later time as may be approved by the Director. This item is not a milestone required under Criterion 6A(1), because it follows placement of the final radon barrier and is not required for that activity. Instead, this item is included as a schedule commitment to be achieved in order to ensure that the activity is completed in a timely manner. As this schedule commitment is not a milestone it does not come under the specific provisions of paragraph (2) of Criterion 6A. However, a general timeliness standard for completing this activity is retained. EFRI must complete this activity in a timely way, and the Director has the authority to take action if necessary in this regard.

(ii)x) Rock Armor

If the Cover Design, as approved by the Director in accordance with the procedures described in the SCA and Section 5.0 of this Plan, is the Existing Cover Design or includes Layer 4 (Rock Armor) of the Existing Cover Design, then rock armor shall be placed on the tailings impoundment, in accordance with Reclamation Plan 3.2b (Denison, 2011b). In addition, rock armor is required for the exterior slopes of the impoundment under the Proposed Cover Design. Such placement, will commence within 180 daysone year after completion of placement of the Final Cover Layersdewatering on the impoundment in accordance with Section 5.0 of this Plan, and will be completed within 180 days thereafter, or such or such later date as may be approved by the Director.later date as may be approved by the Director. This item is not a milestone required under Criterion 6A(1), because it follows placement of the final radon barrier and is not required for that activity. Instead, this item is included as a schedule commitment to be achieved in order to ensure that the activity is completed in a timely manner. As this schedule commitment is not a milestone it does not come under the specific provisions of paragraph (2) of Criterion 6A. However, a general timeliness standard for completing this activity is retained. EFRI must complete this activity in a timely way, and the Director has the authority to take action if necessary in this regard.

d)(b) Leaving a Portion of an Impoundment Open for Disposal of On-site Generated Trash or 11e.(2) Byproduct Material from ISR Operations

The License authorizes a portion of a specified impoundment to accept uranium byproduct material or such materials that are similar in physical, chemical, and radiological characteristics to the uranium mill tailings and associated wastes already in the pile or impoundment, from other sources, during the closure process, and on-site generated trash., provided that this does not result in a delay or impediment to emplacement of the final radon barrier over the remainder of the impoundment in a manner that will achieve levels of radon-222 releases not exceeding 20 pCi/m^{2}s averaged over the entire impoundment. Reclamation of the disposal area, as appropriate, must be completed in a timely manner after disposal operations cease in accordance with paragraph (1) of Criterion 66A; however, these actions are not

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(c) Windblown Tailings Retrieval and Placement on the Impoundment

As the Mill facility as a whole may still be in operation at the time the impoundment is being reclaimed, there may not be a need to retrieve any windblown tailings for placement on the impoundment at the time of final closure of the impoundment. Those activities will be required during final decommissioning of the entire Mill facility. Accordingly, the milestones associated with those activities are set out in Section 6.2.5 below.

6.2.4. Milestones ~~Applicable to~~ and Schedule Commitments for Closure of a Non-Conventional Impoundment (e.g., an Evaporation Pond)

A non- conventional impoundment (e.g., an evaporation pond), may begin final closure at any time, including while the Mill facility as a whole remains in operation as well as during or after final Mill site decommissioning and closure. Once final closure of a non-conventional impoundment begins as specified in Section 6.2.1 b) above, final closure of the impoundment shall be accomplished in accordance with this Plan and the deadlines, milestones and schedule commitments set out below:

(a) Removal of Free-Standing Liquids from Evaporation Ponds

Commencing on the date the impoundment begins final closure in accordance with Section 6.2.1 b) above, the addition of liquids to the impoundment, other than by natural precipitation, will cease, and free standing liquids will be allowed to dry out by natural evaporation. To the extent reasonably practicable, and if excess evaporative capacity is available in other conventional or non-conventional impoundments in the tailings management system, the Mill will transfer solutions out of the impoundment and into other impoundments in order to enhance evaporation and removal of solutions from the impoundment. This item must be completed within five years after the impoundment begins final closure. Although this deadline is not a milestone required under Criterion 6A(1), because it is not linked to the placement of a final radon barrier in a non-operational tailings impoundment, EFRI agrees that for purposes of this Plan it shall be treated as a milestone as required by Criterion 6A(1), and as a result EFRI agrees that it will be subject to the provisions of Criterion 6A(2).

(b) Removal of Liners, Sediments and any Contaminated Soils from Evaporation Ponds

Upon removal of the free-standing liquids from the impoundment, the licensee shall commence removal of all liners, sediments and any contaminated soils from and under the impoundment and dispose of such materials into one or more conventional impoundments. This item must be completed within the earlier of (A) seven years after the impoundment begins final closure, and (B) three years after the removal of all free-standing liquids from the impoundment. Although this deadline is not a milestone required under Criterion 6A(1), because it is not linked to the placement of a final radon barrier in a non-operational tailings impoundment, EFRI agrees that for purposes of this Plan it shall be treated as a milestone as required by Criterion 6A(1), and as a result EFRI agrees that it will be subject to the provisions of Criterion 6A(2).

6.2.46.2.5.Additional Milestone for Final Mill Closure

If the Mill facility as a whole has commenced final reclamation, as defined in this Plan, then the deadlines and interim milestones set out in this Section 6.2.4following additional milestone shall apply. after that time:

EFRI shall submit a detailed decommissioning and reclamation schedule (the "Schedule") to the Director for approval at least twelve (12) months prior to planned final shutdown of mill operations. The Schedule shall set out the steps required to complete the final radon barrier and shall be subject to and shall include the following deadlines and interim milestones:

a)(a) Mill Demolition and Windblown Tailings Retrieval and Placement in a Tailings Impoundment

Mill demolition and windblown tailings retrieval, as contemplated by Attachment A (Technical Specifications) of this Plan shall commence within the later of (1) 180 days after approval of both the Schedule and the decommissioning plan (the "Decommissioning Plan") required to be submitted under License Condition 12.2; and (2) 180 days after sufficient solutions have been evaporated from the tailings impoundment in which the materials are to be disposed of, and shall be completed within eighteen months thereafter, or such later date as may be approved by the Director.and disposal into one or more tailings impoundments shall commence upon commencement of final closure of the entire Mill site ("Mill Final Closure"), and shall be completed within four years after commencement of Mill Final Closure. This deadline is a milestone as required by Criterion 6A(1), and is subject to the provisions of Criterion 6A(2).

b) Reclamation of Individual Tailings Impoundments

Each un-reclaimed tailings impoundment, other than the tailings impoundment used for the placement of mill demolition materials and windblown tailings pursuant to paragraph 6.2.4 (a) above, shall be reclaimed as expeditiously as practicable considering technological feasibility (including taking into consideration factors beyond the control of the licensee) in accordance with this Plan and the deadline and milestones set out Sections 6.2.3 (a) to (d) above. The first such tailings impoundment shall commence reclamation as soon as reasonably practicable after approval of the Schedule, or as otherwise set out in the Schedule, and each succeeding un-reclaimed tailings impoundment shall commence reclamation within 180 days after completion of reclamation of the previous tailings impoundment, or as otherwise set out in the Schedule. It should be noted that individual conventional and non-conventional impoundments may begin final closure before, during or after commencement or completion of Mill Final Closure, and the decision to begin final closure on any particular impoundment is not tied to Mill Final Closure. The milestones and schedule commitments in Sections 6.2.3 and 6.2.4 above apply to final closure of conventional and non-conventional impoundments once they begin final closure in accordance with Section 6.2.1(b) above, whether during Final Mill Closure or otherwise. Further, as a tailings impoundment will be considered to be in operation so long as it is receiving byproduct material, which includes Mill decommissioning materials, windblown, slimes drain dewatering solutions etc., and an evaporation pond will be considered to be in operation so long as it is required for evaporation or holding purposes, it is expected that one or more tailings impoundments and evaporation ponds will continue in operation during all or part of the Mill decommissioning process. One or more impoundments may also continue in operation for licensed activities, such as direct disposal of 11e.(2) byproduct material from In Situ Recovery uranium operations or other licensed activities, after completion of Mill Final Closure.

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6.2.6. Summary Table of Milestones

The following table summarizes all of the milestones required by Criterion 6A(1), all of which are described in more detail above.

As the schedule commitments described in detail above are not milestones required under Criterion 6A(1), they are not included in the following table.

	Milestone	**Reclamation Plan 5.1B Section Number**	**Start**	**End**
1. Milestones for Closure of an Individual Conventional Impoundment (Tailings Impoundment) at any Time				
1.1.	Removal of Free Standing Liquids	6.2.3(a)(i)	Date final closure of the impoundment begins in accordance with Section 6.2.1(b)	One year after impoundment begins final closure
1.2.	Re-contouring	6.2.3(a)(ii)	Upon removal of free standing liquids	Two years after impoundment begins final closure
1.3.	Commence Dewatering	6.2.3(a)(iii)	Upon completion of Re-contouring	NA
1.4.	Placement of Layer 1 (Secondary Radon Attenuation and Grading Layer under the Proposed Cover Design or Platform Fill under the Existing Cover Design, as applicable)	6.2.3(a)(iv)	Upon completion of re-contouring	Three years after impoundment begins final closure
1.5.	Placement of Layer 2 (Final Radon Barrier) (the Primary Radon Attenuation Layer under the Proposed Cover Design or the Radon Barrier under the Existing Cover Design, as applicable)	6.2.3(a)(v)	Upon EFRI being satisfied that there have been decreasing trends in settlement followed by a maximum of 0.1 feet (30 mm) of cumulative settlement over 12 months (for at least 90 percent of the settlement monuments), or at such earlier time as EFRI may determine	As expeditiously as practicable considering technological feasibility (including factors beyond the control of the licensee), but in any event within seven years after impoundment begins final closure
1.6.	Completion of Dewatering	6.2.3(a)(vii))	NA	Within later of (A) seven years after impoundment

	Milestone	Reclamation Plan 5.1B Section Number	Start	End
				begins final closure and (B) two years after completion of placement of Layer 2
2. Milestones for Closure of a Non-Conventional Impoundment (Evaporation Pond) at any Time				
2.1.	Removal of Free Standing Liquids	6.2.4(a)(i)	Date final closure of the impoundment begins in accordance with Section 6.2.1(b)	Five years after impoundment begins final closure
2.2.	Removal of Liners, Sediments and any Contaminated Soils from Impoundment	6.2.4(a)(ii)	Upon removal of the free-standing liquids from the impoundment	Earlier of (A) seven years after the impoundment begins final closure, and (B) three years after the removal of all free-standing liquids from the impoundment

	Milestone	Reclamation Plan 5.1B Section Number	Start	End
3. Additional Milestone Applicable to Mill Final Closure				
	Mill Demolition and Windblown Tailings Retrieval and Placement in a Tailings Impoundment	6.2.5(a)	Upon commencement of Mill Final Closure	Four years after Commencement of Mill Final Closure

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Additional Milestone Applicable to Mill Final Closure				
	Mill Demolition and Windblown Tailings Retrieval and Placement in a Tailings Impoundment	6.2.5(a)	Upon commencement of Mill Final Closure	Four years after Commencement of Mill Final Closure

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ATTACHMENT A

TECHNICAL SPECIFICATIONS FOR

RECLAMATION OF WHITE MESA MILL FACILITY

BLANDING, UTAH

TABLE OF CONTENTS

1.0 SPECIAL PROVISIONS

1.1 Scope of Document

The following technical specifications have been prepared for reclamation and decommissioning of the Energy Fuels Resources (USA) Inc. ("EFRI"), White Mesa Uranium Mill Facility ("Mill") in Blanding, Utah. These technical specifications have been prepared for review and approval by the Utah Department of Environment Quality ("DEQ"), Division of Waste Management and Radiation Control ("DWMRC") and are submitted as an attachment to the Reclamation Plan. The design drawings for reclamation are attached and are designated as the "Drawings". The Construction Quality Assurance/Quality Control Plan ("CQA/QC Plan") referenced in this document is provided as Attachment B to the Reclamation Plan. The Technical Specifications have been written assuming tailings management Cells 2, 3, 4A, and 4B will receive tailings to the maximum permitted tailings elevations. Cell 2 is full and partially reclaimed. Cell 3 was used for tailings storage, but is currently only receiving mill waste. Cell 3 is partially full and partially reclaimed. Cell 4A is the only cell currently receiving tailings and is partially full. Cell 4B is used for evaporation of process solutions and has not been used for storage of tailings. The Technical Specifications have been written assuming Cell 4B will be used in the future for tailings storage.

These technical specifications have been written assuming (a) a contractor will conduct tailings impoundment reclamation under contract with EFRI and under EFRI's direction (b) the work quality will be checked with independent (third-party) construction quality assurance, and (c) the tailings management system comprised of Cells 2, 3, 4A, and 4B will receive tailings to the maximum permitted tailings elevations.

1.2 Definitions and Roles

Construction Quality Assurance (CQA) – A planned and systematic pattern of means and actions designed to assure adequate confidence that the materials or services meet contractual and regulatory requirements and will perform satisfactorily in service. CQA refers to means and actions employed by the involved parties to assure conformity of the project work with the CQA/QC Plan, the Drawings, and the Technical Specifications.

Construction Quality Control (CQC) – Actions which provide a means to measure and regulate the characteristics of an item or service in relation to contractual and regulatory requirements. CQC refers to those actions taken by the Contractor, technicians, or other involved parties to verify that the materials and the workmanship meet the requirements of the CQA/QC Plan, the Drawings, and the Technical Specifications.

Technical Specifications – The document that prescribes the requirements and standards for the specific elements of the reclamation. The Technical Specifications will be prepared in final form prior to commencement of reclamation activities.

Drawings – The detailed project drawings to be used in conjunction with the Technical Specifications. The Drawings will be prepared in final form as construction drawings prior to reclamation.

Construction Project – The total authorized/approved reclamation project that requires several construction segments to complete.

Construction Segment – A portion of the total construction project involving a specific area or type of work. Several construction segments will likely take place simultaneously during reclamation.

Construction Task – A basic construction feature of a construction segment involving a specific construction activity.

ASTM Standards – The latest versions of the American Society for Testing and Materials specifications, procedures and methods.

For the Technical Specifications, EFRI is referred to as the **Owner**, with overall responsibility for closure, as well as site reclamation.

The on-site **Construction Manager** is responsible for the conduct, direction and supervision of all reclamation activities as detailed in the Drawings and Technical Specifications.

The **Design Engineer** is responsible for the design of the various elements of the reclamation project and for preparing the Drawings and Technical Specifications.

The **Contractor** is defined as the group (or groups) selected by the Owner and responsible for conducting the work tasks outlined in Section 1.3 under the direction of, and under contract with the Owner.

The **Surveyor** is a party, independent from the Owner or Contractor, who is responsible for surveying, documenting, and verifying the location of all significant components of the work.

The **CQA/QC Consultant** is a party, independent from the Owner or Contractor, who is responsible for observing, testing, and documenting the various activities comprising the Reclamation Project in accordance with the CQA/QC Plan, the Technical Specifications and the Drawings.

The **CQA Officer** will be responsible for overall implementation and management of the CQA/QC Plan for the reclamation project.

The **CQA Site Manager** will be appointed by the CQA Consultant to provide day-to-day, on-site oversight of the CQA/CQC activities. The CQA Site Manager could be an employee of the Owner or a third-party consultant.

The CQA Consultant will utilize various **QC Technicians** to assist the on-site CQA Site Manager to perform specific tasks throughout the project to verify the adequacy of construction materials and procedures.

The **Document Control Officer** will be appointed by the Construction Manager to assist with managing the various documents that will be produced throughout the project.

The **CQA Laboratory** is a party, independent from the Owner and Contractor, responsible for conducting tests of soils and other project materials in accordance with ASTM and other applicable standards in either an on-site or off-site laboratory.

The **DWMRC Project Manager** will represent the DWMRC's interests in the reclamation project.

The CQA/QC Plan (Attachment B of the Reclamation Plan) contains more detailed descriptions of the project roles.

1.3 Scope of Work

The work outlined in these Technical Specifications consists of execution of the following tasks associated with reclamation of the tailings management system and associated site reclamation.

- Preparation of borrow areas for material excavation by removal of vegetation; and stripping, salvaging, and stockpiling of topsoil;
- Preparation of material staging and stockpile areas by removal of vegetation; stripping, salvaging, and stockpiling of topsoil; and providing for storm water diversion and internal water collection;
- Removal of raffinates and PVC liner materials from Cell 1 and placement within the last active tailings cell;
- Construction of a clay-lined disposal cell (Cell 1 Disposal Area) along the Cell 1 containment dike for disposal of mill demolition debris and contaminated soils;
- Construction of a sedimentation basin in the location of Cell 1 (does not include the Cell 1 Disposal Area);
- Excavation of process area structure foundations, paved areas, concrete pads and roadways, and placement of these materials in the disposal cell;
- Excavation of contaminated subsoils from the process area, and placement in the last active tailings cell or the Cell 1 Disposal Area.
- Construction of the cover system over the tailings cells, with placement of topsoil and/or topsoil-gravel admixture over the disposal cell cover surface.
- Regrading and placement of topsoil over excavated areas, stockpile and staging areas, and other disturbed areas of the site.
- Establishment of vegetation on the disposal cell surface and surrounding reclaimed areas on site.

The Technical Specifications have been written assuming tailings management Cells 2, 3, 4A, and 4B will receive tailings to the maximum permitted tailings elevations. Cell 2 is full and partially reclaimed. Cell 3 was used for tailings storage, but is currently only receiving mill waste. Cell 3 is partially full and partially reclaimed. Cell 4A is the only cell currently receiving tailings and is partially full. Cell 4B is used for evaporation of process solutions and has not been used for storage of tailings. The Technical Specifications have been written assuming Cell 4B will be used in the future for tailings storage.

Work not included in these Technical Specifications consists of salvage of facility equipment, demolition of facility structures, groundwater monitoring and remediation, and post-reclamation performance monitoring.

1.4 Applicable Regulations and Standards

The work will be conducted to conform with applicable Federal, State, and County environmental and safety regulations, as well as applicable conditions in the Owner's radioactive materials license. Geotechnical testing procedures will follow applicable ASTM standards, as documented in the most current edition of standards in force at the start of work. Personnel safety procedures and monitoring will be conducted in accordance with the Owner's Radiation Protection Manual for Reclamation Activities and as directed by the Radiation Safety Officer ("RSO").

1.5 Permits

The work will be conducted under the Owner's existing radioactive materials license and State of Utah Air Quality Approval Order (DAQE-AN0112050018-11, issue date March 3, 2011). The Contractor will be responsible for applying for, and obtaining (permit fees included), all other necessary permits required to complete the work outlined in these Technical Specifications.

1.6 Inspection and Quality Assurance

In general, the QA/QC Plan details the Owner's organizational structure and responsibilities, qualifications of personnel, operating procedures and instructions, record keeping and document control, and quality control in the sampling procedure and outside laboratory. The Plan will adopt the existing quality assurance/quality control procedures utilized in compliance with the existing license.

The RSO (and approved assistants as needed) will conduct on-site training, and full-time personnel monitoring, and inspection of construction activities while the site reclamation work is in progress. The RSO (and assistants) will be independent representatives of and appointed by the Owner. The responsibilities and duties of the RSO shall be as outlined in the Owner's Protection Manual for Reclamation.

The CQA Site Manager (and approved assistants as needed) will provide on-site inspection of all construction activities and quality assurance testing outlined in these Technical Specifications and the CQA/QC Plan while the construction work is in progress. The CQA Site Manager and assistants will be independent representatives of and appointed by the Owner. The inspection and CQA testing conducted by the CQA Site Manager will be under the supervision of the Reclamation Project Manager. Inspection and CQA testing will include the tasks described in the CQA/QC Plan and listed below.

a. Observation of construction practices and procedures for conformance with the Technical Specifications.
b. Testing material characteristics to ensure that earthen materials used in the construction conform to the requirements in the Technical Specifications.
c. Documentation of construction activities, test locations, samples, and test results.
d. Notification of results from quality assurance testing to the Owner and the Contractor.
e. Documentation of field design modifications or approved construction work that deviates from the Technical Specifications.

The CQA Site Manager will record the documentation outlined above on a daily basis. The Reclamation Project Manager will approve deviations from the Technical Specifications (if necessary), with notification to the Owner and DWMRC or other appropriate Utah state regulatory agency personnel. Quality control procedures have been developed for reclamation and presented in Attachment B of this Reclamation Plan. Procedures will be used for testing, sampling, and inspection functions.

1.7 Construction Documentation

During construction, the CQA Site Manager will record documentation of construction inspection work on a daily basis. Documentation will include the following items.

a. Work performed by the Contractor.
b. CQA testing and surveying work conducted.
c. Discussions with the Owner and the Contractor.
d. Key decisions, important communications, or design modifications.
e. General comments including: weather conditions, work area surface conditions, and visitors to the site.

All earthwork test results will be documented on a daily basis, with a copy of the results given to the CQA Site Manager by the end of the following working day after the testing.

The CQA Site Manager or his representative will take photographs of key construction activities and critical items for documentation.

A final construction completion report, documenting the as-built conditions of the tailings impoundment reclamation components will be submitted to DWMRC at the end of construction. This report will include the following items.

a. All design modifications or changes to the Technical Specifications that were made during construction.

b. An as-built layout of the facility prior to, and at the completion of reclamation construction.

c. An as-built layout of other reclaimed areas of the site.

d. Documentation of soil cleanup verification work (soil radiation survey and soil sampling and analyses) in areas of contaminated soil excavation.

e. Documentation of the revegetation work (soil amendments, seed mix, and vegetation establishment).

1.8 Design Modifications

Design modifications (due to unanticipated site conditions or field improvements to the design) will be made following the protocol outlined below.

a. Communication of modification with the Reclamation Project Manager.
b. Submittal to, and review by, DWMRC for approval prior to implementation.
c. Documentation of modification(s) in the construction completion report.

1.9 Environmental Requirements

The Contractor shall store materials, confine equipment, and maintain construction operations according to applicable laws, ordinances, or permits for the project site. Fuel, lubricating oils, and chemicals shall be stored and dispensed in such a manner as to prevent or contain spills and prevent said liquids from reaching local streams or groundwater. If quantities of fuel, lubricating oils or chemicals exceed the threshold quantities specified in Utah regulations, the Contractor shall prepare and follow a Spill Prevention Control and Countermeasures Plan (SPCCP), as prescribed in applicable Utah regulations. The Owner will approve said plan. Used lubricating oils shall be disposed of or recycled at an appropriate facility. The Contractor shall be responsible for disposal of all waste associated with the project work.

1.10 Water Management

The Contractor shall construct and maintain all temporary diversion and protective works required to divert storm water from around work areas. The Contractor shall furnish, install, maintain, and operate all equipment required to keep excavations and other work areas free from water in order to construct the facilities as specified.

Water required by the Contractor for dust suppression or soil-moisture conditioning will be obtained from the Owner.

1.11 Historical and Archeological Considerations

The Contractor shall immediately notify the Owner if materials of potential historical or archeological significance are discovered or uncovered. The Owner may stop work in a specific area until the materials can be evaluated for historical, cultural, or archeological significance. All materials determined to be of significance will be protected during the work, as determined by appropriate regulatory agencies, including removal or adjustment of work areas.

1.12 Health and Safety Requirements

Work outlined in these Technical Specifications will be conducted under the Owner's Radiation Protection Manual for Reclamation Activities, as directed by the RSO.

The Contractor shall suspend construction or demolition operations or implement necessary precautions whenever (in the opinion of the Reclamation Project Manager or RSO) unsatisfactory conditions exist due to rain, snow, wind, cold temperatures, excessive water, or unacceptable traction or bearing capacity conditions. The CQA Site Manager, Reclamation Project Manager, and RSO each have the authority to stop Contractor work if unsafe conditions or deviations from Technical Specifications are observed.

1.13 Personnel Monitoring

Programs currently in place for monitoring of exposures to employees will remain in effect throughout the time period during which tailings cell reclamation, mill decommissioning and clean up of windblown contamination are conducted. These programs will include personnel monitoring and the ongoing bioassay program. Access control will be maintained at the Restricted Area boundary to ensure employees and equipment are released from the site in accordance with the current License conditions. In general, no changes to the existing programs are expected and reclamation activities are not expected to increase exposure potential beyond the current levels. The Owner will assign an employee to act as RSO responsible for assuring site workers comply with the Owner's Radiation Protection Manual for Reclamation Activities and the requirements set forth in the Owner's radioactive materials license.

1.14 Environmental Monitoring

Existing environmental monitoring programs will continue during the time period in which reclamation and decommissioning is conducted as applicable. This includes monitoring of surface and groundwater, airborne particulates, radon, soils and vegetation, according to the existing License conditions as applicable. As site features are reclaimed, monitoring programs for those features may cease. Any changes will be approved by DWMRC prior to the cessation of monitoring. In general, no changes to the extent of the existing programs are expected because reclamation activities are not expected to increase exposure potential beyond the current levels.

2.0 SITE CONDITIONS

2.1 Site Location

The White Mesa Mill site is located about 6 miles south of Blanding, Utah in San Juan County, along County Road 191.

2.2 Climate and Geology

The climate of southeastern Utah is classified as dry to arid continental. Although varying somewhat with elevation and terrain, the climate in the vicinity of the Mill can be considered as semi-arid with normal annual precipitation of about 13.3 inches. The mean annual relative humidity is about 44 percent and is normally highest in January and lowest in July. The average annual Class A pan evaporation rate is 68 inches (NOAA, 1977), with the largest evaporation rate typically occurring in July. (Denison, 2009)

The Mill is located within the Blanding Basin of the Colorado Plateau physiographic province. The average elevation of the site is approximately 5,600 ft (1,707 m) above mean sea level (amsl). Typical of large portions of the Colorado Plateau province, the rocks underlying the site are relatively undeformed. The site is underlain by unconsolidated alluvium and indurated sedimentary rocks consisting primarily of sandstone and shale. The alluvial materials consist mostly of aeolian silts and fine-grained aeolian sands with a thickness varying from a few feet to as much as 25 to 30 ft (7.6 to 9.1 m) across the site. The alluvium is underlain by the Dakota Sandstone and Burro Canyon Formation, which are sandstones having total thicknesses ranging from approximately 100 to 140 ft (31 to 43 m). (Denison, 2009)

2.3 Past Operations

The mill is a uranium/vanadium mill that was developed in the late 1970's by Energy Fuels Nuclear, Inc. (“EFN”) as an outlet for the many small mines located in the Colorado Plateau and for the possibility of milling Arizona strip ores. Construction on the tailings area began on August 1, 1978. The Mill was operated by EFN from the initial start-up date of May 6, 1980 until the cessation of operations in 1983 and then intermittently under different ownership through present-day. Denison (then named International Uranium (USA) Corporation), and its affiliates, purchased the assets of EFN in May 1997. Energy Fuels Resources (USA), Inc. purchased the facility in 2012 and is the current owner.

2.4 Facilities Demolition

Demolition of equipment, structures, and associated facilities at the Mill site will be conducted according to applicable conditions of the radioactive materials license, the demolition plan for the facility, and the Owner's Radiation Protection Manual for Reclamation Activities. Facilities demolition is not included in this document.

2.5 Disposed Materials

Materials to be placed in the disposal and tailings cells consists of process waste materials, structural debris, underlying liner materials, and subsoils from planned site cleanup activities. Additional detail on each material type is outlined later in the Technical Specifications. The four major types of materials are outlined below:

- Raffinate Crystals – located in Cell 1
- Synthetic Liner – PVC liner from Cell 1
- Contaminated Soils - soils located in and around the Mill site with concentrations exceeding prescribed unity rule concentrations (see Section 6)
- Mill Debris – all equipment and structures from the demolition of the mill

2.6 Construction Materials

Construction materials for the disposal cell liner, cover system, and for erosion protection of the cover and discharge channel will include soils and aggregates from on-site and off-site sources. These materials are outlined below.

2.6.1 Liner Materials

The disposal cell will be constructed, prior to the placement of contaminated soils and mill demolition debris, with a compacted clay liner. The soils will be obtained from suitable materials stockpiled on site during cell construction.

2.6.2 Random Fill

Random fill will be used within the disposal cell and tailings cells, placed on and around mill material and debris and placed for the components of the cover system. Fill materials will be obtained from soils stockpiled on site.

2.6.3 Topsoil

Topsoil for the surface of the disposal cell and surrounding areas to be revegetated will be obtained from on-site stockpile areas.

2.6.4 Topsoil-Gravel Admixture

A mixture of gravel and topsoil will be used in select areas on the cover. The sources of rock are nearby commercial sources of alluvial gravel. Topsoil-gravel admixture shall meet the particle-size distribution requirements outlined in Section 8.

2.6.5 Riprap

A layer of riprap will be placed on the side slopes and on the perimeter apron of the disposal cell as well as within the discharge channel. The sources of riprap are nearby commercial sources of alluvial gravel and cobbles. Riprap shall meet the particle-size distribution and durability requirements outlined in Section 8, and shall meet requirements for rock durability outlined in NRC (1990) and Johnson (1999, 2002).

2.6.6 Filter Materials

Filter layer materials will be obtained from an off-site local commercial source or from select on-site borrow areas.

2.6.7 Granular Materials

Granular materials will be used for filter material and may also be used for subsurface fill for the cell base. These materials will be obtained from off-site commercial sources of alluvial sand and gravel.

2.7 Staging and Stockpile Areas

Areas on site identified as staging areas or stockpile locations will be approved by the Owner. These areas will be constructed and used in a manner consistent with the Owner's plans for storm water management. The Contractor shall maintain proper erosion control measures for stockpiles and may be required to cover piles in situations where precipitation is anticipated.

2.8 Access and Security

Access to the site will be controlled at gated entrances in the existing restricted area fencing. All gated entrances and security for the Mill property will be maintained by the Owner.

2.9 Utilities

Utilities on site will be maintained by the Owner outside of work areas (areas to be demolished or reclaimed). Utilities inside of work areas will be provided and maintained by the Contractor.

2.10 Sanitation Facilities

The Contractor, in accordance with the Owner's Radiation Protection Manual for Reclamation Activities, will maintain sanitation facilities required during construction.

3.0 WORK AREA PREPARATION

3.1 General

This section describes the preparation of site areas for reclamation. This work will be conducted according to applicable sections of the Owner's Radiation Protection Manual for Reclamation Activities.

3.2 Water Management

Preparation for work in the site area will include water management tasks outlined below.

a. Removal of raffinate crystals from Cell 1.

Breaching of the Cell 1 dike for constructing the cell as a sedimentation basin. Re-routing runoff from the mill area and areas immediately north of the cell into the sedimentation basin for discharge onto the natural ground via the channel to be located at the southwest corner of the basin.

Diversion of clean area storm water runoff from work areas (where facilities demolition and material excavation will take place) and from the disposal cell footprint area.

Collection of storm water runoff from within the work areas and the disposal cell footprint for treatment and permitted discharge, or for disposed material compaction or dust control. The planned storage location for this affected storm water is the sedimentation pond.

Isolation of water used for processing operations associated with reclamation from storm water runoff. Water from processing operations or other contaminated water will not be used for disposal cell construction.

3.3 Cell Construction

A clay-lined disposal area will be constructed within Cell 1 (Cell 1 Disposal Area) for permanent disposal of contaminated material and debris from Mill site decommissioning. The disposal area will be located immediately north of the existing dike between Cells 1 and 2. The disposal footprint area will be lined with a compacted clay liner prior to placement of contaminated materials and installation of the final reclamation cover. If there is not sufficient debris, rubble and contaminated soil to fill the Cell 1 Disposal Area as designed, the footprint of the Cell 1 Disposal Area can be reduced to decrease the horizontal dimension extending out from Cell 2 and the lateral extent of the disposed materials, to be closer to the base of the Cell 2 dike. If a design modification is required for the Cell 1 Disposal Area, it will be submitted to DWMRC for review and approval, and these Technical Specifications will be revised accordingly.

3.4 Soil Borrow Areas

Fill cover and liner materials for the disposal cell will be excavated from suitable materials stockpiled in identified borrow areas on site. Specific soil borrow areas will be selected based on haul distance to the disposal cell, ease of excavation of cover material, geotechnical characteristics, uniformity of the borrow material, and acceptable radiological and geochemical characteristics.

Borrow area preparation will consist of setup for storm water management (Section 3.2) and clearing and stripping (Section 3.5).

3.5 Clearing and Stripping

In work areas with vegetation, preparation work will include tasks outlined below.

3.5.1 Clearing

Clearing of vegetation and grubbing of roots will be in identified work areas. Clearing and grubbing shall not extend beyond 20 feet from the edge of the work area, unless as shown on the Drawings or as approved by the Reclamation Project Manager.

Vegetation from clearing and grubbing may be shredded or chipped to form mulch. Alternative methods of on-site or off-site disposal or burning of stripped vegetation shall be conducted only as approved by the Reclamation Project Manager.

3.5.2 Stripping

Stripping of salvageable topsoil (if present) shall be done within the entire work area. Stripping of topsoil shall not extend beyond 10 feet from the edge of the work area, unless approved by the Reclamation Project Manager. The depth of stripping of reclamation soil shall be based on the presence of suitable topsoil and approved by the Reclamation Project Manager. Water shall be applied to the areas of excavation and soil salvage to minimize dust generation.

Topsoil shall be stockpiled in approved areas. The final stockpile surface shall be graded and smoothed to minimize erosion and facilitate interim revegetation of the stockpile surfaces.

4.0 CELL 1 DISPOSAL AREA BASE CONSTRUCTION

4.1 General

This section outlines work associated with construction of the disposal cell base (Cell 1 Disposal Area) for receipt of materials (as described in Section 7.0) within Cell 1. The ~~cell base~~Cell 1 Disposal Area will be constructed as shown on the Drawings and outlined in these Technical Specifications.

4.2 Materials Description

4.2.1 Subgrade Fill

The disposal cell footprint is likely to have an irregular surface from contaminated material excavation. Low areas of the excavated surface shall be filled with subgrade fill to form a smooth, competent foundation for clay liner construction (shown on the Drawings).

Subgrade fill will consist of off-site granular materials, or soils and weathered sedimentary rock from approved on-site excavation areas. Subgrade fill shall have a maximum size of 6 inches and shall be free from roots, branches, rubbish, and process area debris.

4.2.2 Clay Liner Material

Clay liner material shall have a maximum particle size of one inch, and shall be free from roots, branches, rubbish, and process area debris. Clay liner material shall have a minimum of 40 percent passing the No. 200 sieve and a minimum plasticity index (PI) of 15 percent.

4.3 Work Description

4.3.1 Foundation Preparation

The footprint of the disposal cell shall form a competent foundation for clay liner and cover construction. The surface of the disposal cell footprint shall be filled with subgrade fill (where required) in low areas to form a smooth, competent foundation for clay liner and cover construction. The final filled surface shall be compacted with approved construction equipment to provide a foundation surface with uniform density for clay liner placement.

4.3.2 Disposal Cell Foundation Area

The footprint of the disposal cell is established along the north side of the dike between Cells 1 and 2 (shown on the Drawings).

4.3.3 Subgrade Fill Placement

Subgrade fill (Section 4.2.1) shall be placed in lifts with a maximum loose thickness of 12 inches and compacted in excavated areas of the disposal cell footprint to meet desired grades and elevations for the disposal cell foundation.

4.3.4 Clay Liner Material Placement

Clay liner material (Section 4.2.2) shall be placed in lifts with a maximum loose thickness of 6 inches to form a continuous layer with a total minimum compacted layer thickness of 12 inches. Clay liner material shall be placed over the prepared subgrade surface of the disposal cell (Section 4.3.1).

Compaction of the clay liner material shall be done with a sheepsfoot or tamping-foot roller of sufficient weight to achieve the required compaction specifications. Compaction of the clay liner material shall not be achieved solely through the use of rubber-tired equipment.

If the moisture content of any layer of clay liner is outside of the allowable placement moisture content range specified (Section 4.4.2), the material shall be moistened and/or reworked with a harrow, scarifier, or other suitable equipment to a sufficient depth to provide relatively uniform moisture content and a satisfactory bonding surface before the next layer of clay material is placed. If the compacted surface of any layer of clay liner material is too wet (due to precipitation) for proper compaction of the fill material to be placed thereon, it shall be reworked with a harrow, scarifier or other suitable equipment to dry out the layer and reduce the moisture content to within the required limits, and re-compacted.

Clay liner construction shall minimize lenses, pockets, streaks or layers of material differing substantially in texture, gradation or moisture content from the surrounding material. Oversized material will be controlled through observation of placement by a qualified individual with authority to stop work and reject material being placed and by culling oversized material from the fill.

No clay liner material will be placed when either the materials, or the underlying material, is frozen or when ambient temperatures do not permit the placement or compaction of the materials to the specified density without developing frost lenses in the fill.

Any holes in the clay liner material resulting from testing shall be repaired by hand by filling with clay fill, or by filling with bentonite powder which is hydrated to fully seal the hole.

4.4 Performance Standards and Testing

Lifts of material with tested dry densities less than the specified values will be reworked by the Contractor as necessary and re-compacted until the specified dry density is attained. Material that is too dry or too wet to permit bonding of layers during compaction will be reworked by the Contractor until the moisture content is within the specified limits.

4.4.1 Subgrade Testing

Subgrade fill shall be placed in lifts not exceeding 8 inches in loose thickness. Each lift shall be compacted to a minimum of 90 percent of standard Proctor (ASTM D698) density and within 3 percent of the optimum moisture content for the material.

Where required, checking of compaction of compacted subgrade fill and the final subgrade surface will consist of a minimum of one field density test per 1,000 cubic yards of material compacted. A minimum of two tests will be taken for each day that more than 150 cubic yards of material is placed. A minimum of one test per lift and at least one test for every full shift of compaction operations will be taken.

Field density tests will be compared with standard Proctor tests (ASTM D698 Method A or C). Where required, standard Proctor or Maximum Index Density tests will be conducted at a frequency of at least one test per 10,000 cubic yards of material compacted, or when material characteristics show significant variation.

Field density testing will be conducted with the sand cone test (ASTM D1556) or a nuclear density gauge (ASTM D6938, or as modified by the CQA Site Manager). Correlation of nuclear density gauge results will be by comparison with results from sand cone test(s) and laboratory testing for water content(s) using the oven drying method (ASTM D2216) on similar material.

4.4.2 Clay Liner Testing

Each lift of clay liner material shall be compacted to at least 95 percent of the maximum dry density for the material, as determined by the standard Proctor test (ASTM D698). During compaction, the material shall be within 2 percent of the optimum moisture content for the material, as determined by the standard Proctor test. If water addition is required to achieve this range of moisture contents, the added water shall be thoroughly mixed into the material prior to compaction.

Material specifications for the clay liner material will be confirmed by gradation testing conducted by approved personnel. Testing will consist of No. 200 sieve wash and maximum particle size testing (ASTM D422), and Atterberg limits testing (ASTM D4318) on samples of clay liner materials, at a frequency of at least one test per 2,000 cubic yards of fill placed, or when material characteristics show a significant variation.

Compaction of the clay liner material will be checked with a minimum of one field density test per 500 cubic yards of material compacted. A minimum of two tests will be taken for each day that more than 150 cubic yards of material is placed. A minimum of one test per lift and at least one test for every full shift of compaction operations will be taken.

Field density tests will be compared with standard Proctor tests (ASTM D698 Method A or C) on the same material. Standard Proctor tests will be conducted at a frequency of at least one test

per 5,000 cubic yards of material compacted, or when material characteristics show significant variation.

Field density testing will be conducted with the sand cone test (ASTM D1556) or a nuclear density gauge (ASTM D6938, or as modified by the CQA Site Manager). Correlation of nuclear density gauge results will be by comparison with results from sand cone test(s) and laboratory testing for water content(s) using the oven drying method (ASTM D2216) on similar material.

4.4.3 Grading Tolerances

The completed grading for the clay liner shall be within 1.0 foot (horizontally) of the lines as designed, and within 0.1 foot (vertically) of the elevations as designed. The final surfaces shall be smoothed to avoid abrupt changes in surface grade or areas of runoff concentration. The layer thicknesses shall meet the required minimum thicknesses.

5.0 DISCHARGE CHANNEL GRADING

5.1 General

This section outlines specifications for the work associated with excavating the discharge channel from Cell 1. Portions of the grading for the sedimentation basin may be in soil, while other areas may require rock excavation. Although the rock may be rippable, the Contractor should prepare for non-rippable rock in some of the excavation areas.

5.2 Work Description

5.2.1 Discharge Channel Excavation

The discharge channel shall be excavated to the slopes and grades and channel widths shown on the Drawings. Discharge channel excavation will include breaching of the dike on the west side of Cell 1. Riprap will not be required to armor the discharge channel where the channel is excavated into competent sedimentary rock, as verified in the field by the CQA Site Manager.

5.2.2 Grading Tolerances

Completed grading in soil for the sedimentation basin shall be within 1.0 foot (horizontally) of the lines as designed, and within 0.1 foot (vertically) of the elevations as designed. Final surfaces shall be smoothed to avoid abrupt changes in surface grade or areas of runoff concentration.

The completed grading in rock for the discharge channel and portions of the sedimentation basin shall be within 2.0 foot (horizontally) of the lines as designed, and within 0.5 foot (vertically) of the elevations as designed. The final excavated rock surfaces of the discharge channel will be below design grades and shall not be filled to make grade.

6.0 MILL DECOMMISSIONING

The following subsections describe decommissioning plans for the mill buildings and equipment, the mill site, and associated windblown contamination.

6.1 Mill Buildings and Equipment

The uranium and vanadium processing areas of the Mill, including all equipment, structures and support facilities, will be decommissioned by demolition and disposed of in tailings or buried on site as appropriate. All equipment, including tankage and piping, agitation equipment, process control instrumentation and switchgear, and contaminated structures will be cut up, removed and buried in tailings prior to final cover placement. Concrete structures and foundations will be broken up and removed. Concrete foundations may be left in place and covered with soil as appropriate.

Decommissioned areas will include the following:

- Coarse ore bin and associated equipment, conveyors and structures
- Grind circuit including semi-autogeneous grind (SAG) mill, screens, pumps and cyclones
- Three pulp storage leach tanks to the east of the mill building, including all tankage, agitation equipment, pumps and piping
- Seven leach tanks inside the main mill building, including all agitation equipment, pumps and piping
- The counter-current decantation (CCD) circuit including all thickeners and equipment, pumps and piping
- Uranium precipitation circuit, including all thickeners, pumps and piping
- Two yellow cake dryers and all mechanical and electrical support equipment, including uranium packaging equipment
- Clarifiers to the west of the mill building including the preleach thickener (PLT), clarifier, and claricone area

- The boiler and all ancillary equipment and buildings
- The entire vanadium precipitation, drying and fusion circuit
- All external tankage not included in the previous list including reagent tanks for the storage of acid, ammonia, kerosene, water, dry chemicals, etc. and the vanadium oxidation circuit
- The ammonium sulfate pad
- The uranium and vanadium solvent extraction (SX) circuit including all SX and reagent tankage, mixers and settlers, pumps and piping
- The SX building
- The mill building
- The alternate feed processing circuit
- The decontamination pads
- The office building
- The shop and warehouse building
- The sample plant building
- The reagent storage building

The sequence of demolition will proceed so as to allow the maximum use of support areas of the facility such as the office and shop areas. It is anticipated that all major structures and large equipment will be demolished using hydraulic shears. This equipment will expedite the process, provide proper sizing of the materials for transport and placement, and reduce personnel exposure to radiation and other safety hazards during the demolition. Uncontaminated or decontaminated equipment to be considered for salvage and remediation equipment will be released in accordance with the terms of License Condition 9.10 and NUREG 1575 Supplement 1, Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual

(MARSAME) (NRC, 2009) as appropriate and applicable. Contaminated soils from the Mill area will be disposed of in the tailings cells in accordance with Section 7.0.

6.2 Mill Site and Windblown Contamination

Areas with contamination around the Mill site are expected to be primarily surficial, except for the claricone and ammonium sulfate pad areas, and include the ore storage area and limited surface contamination of roads. Ore and alternate feed materials will have been previously removed from the ore stockpile area. Contaminated materials at the Mill site will be excavated and be disposed in the Cell 1 Disposal Area in accordance with Section 7.0. The depth of excavation will vary depending on the extent of contamination and will be based on the criteria in Section 7.2.3, except for the claricone and ammonium pad areas which had removal depths and extents outlined in letters submitted by EFRI to the DWMRC on 10/26/12 and 12/23/13, respectively. All other 11e.(2) byproduct materials will be disposed in the tailings cells.

The Owner proposes to reclaim the Mill and surrounding land areas within the property boundary by excavating and placing wastes, demolition debris and contaminated soils into a fenced and controlled permanent disposal area. The permanent disposal area, the current restricted area, and the property boundary, are delineated in Drawing REC-1. The Owner proposes to survey and release all areas within the property boundary, excluding the Cell 1 Disposal Area and Cells 2, 3, 4A, and 4B, for unrestricted use.

Contaminants of concern are Ra-226, Th-230 and natural uranium (U-nat). The evaluation and remediation will be dictated by Ra-226, which is the contaminant with the most restrictive cleanup standard (based on the SENES Consultants, Inc. letter to EFRI dated August 15, 2012; this letter was provided as Attachment I to EFRI's Supporting Documentation for Response to Utah DWMRC Interrogatory 13/1 (SENES 2012)). The correlation between Ra-226 and the remaining two contaminants will be developed as outlined in subsequent sections of these Technical Specifications. Verification of the remediation will be established through a Wilcoxon Rank Sum (WRS) test between the study areas and local background areas. The procedure for verification will follow guidance from NUREG-1575 Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC, 2000). The procedure will include:

- Scoping and characterization surveys: soil samples will be collected to develop a correlation between gamma radiation levels and the unity rule.
- Classification of land areas: to (MARSSIM) Class 1 through Class 3.
- Remediation of land areas driven by correlation-based prediction equation between gamma radiation and the unity rule for multiple radionuclides.
- Final Status Survey using the Wilcoxon Rank Sum (WRS) test with local background areas.

The procedure also follows the Data Quality Objective (DQO) process defined in the MARSSIM Guidance, as discussed in Section 6.6, and NUREG-1757 Volume 2 Consolidated Decommissioning Guidance, Characterization, Survey, and Determination of Radiological Criteria (NRC, 2006).

6.3 Scoping and Characterization Surveys

Areas contaminated through process activities or windblown contamination from the tailings areas will be remediated to meet applicable cleanup criteria for Ra-226, Th-230, and U-nat. Contaminated areas will be remediated such that the residual radionuclides remaining on the site, which are distinguishable from background, will not result in a dose that is greater than that which would result from the Ra-226 soil standard, that is, 5 pCi/g above background for the surface 15 cm soil layer and 15 pCi/g for the subsurface 15 cm soil layer, respectively as discussed in Section 6.6.3.3 and hereafter referred to as “5/15”.

An initial scoping survey for windblown contamination will be conducted based on analysis of pertinent past radiometric and land use information. Operational surveys of the areas surrounding the Mill and tailings area have indicated potential windblown contamination only to the north and east of the ore storage area, and to the southwest of Cell 3. The initial scoping survey will be conducted using calibrated gamma radiation instruments on 15 meter (15 m) transects. Additional surveys will be conducted in a halo, or buffer zone, around the projected impact area. The survey in the halo will be conducted using 25 m transects. Areas where no readings exceed 75 percent of the gamma radiation guideline value, as developed per Section 6.3.2, will be classified as unaffected, and will not require remediation. Areas where one or more readings exceed the gamma radiation guideline value will be further investigated to determine whether or not remediation is required.

Prior to initiating cleanup of windblown contamination, a statistically-based soil sampling program will be conducted in an area within or outside the property boundary that is similar to the areas to be remediated, to determine the average background Ra-226 concentration, or concentrations, to be ultimately used for the cleanup. Similarity, or representativeness, will be determined based on geology, soil type and soil chemistry.

Soil cleanup verification will be accomplished by use of calibrated gamma radiation instruments. Multiple instruments will be maintained and calibrated to ensure availability and consistency during remediation efforts (Section 6.3.4).

6.3.1 Scoping and Characterization Survey for the Subsurface

The subsurface will only be investigated in areas where the historical site assessment (HSA) demonstrates the possibility of contamination below the 15 cm depth. This does not include areas of windblown contamination, or the ore storage area (unless also affected by an event demonstrated by the HSA). The method for the subsurface investigation will include boreholes where soil sampling and downhole gamma radiation investigations may occur. This method will be developed based on the HSA.

6.3.2 Gamma Radiation to Unity Rule Correlation

The Owner plans to use radiation measurement instrumentation for soil background analyses, unity rule – gamma radiation correlations, verification data, and sensitivity analyses. Soil background analyses will be completed using MARSSIM methods (NRC, 2000) for background reference areas.

Soil samples taken during characterization for correlation will be analyzed by a certified laboratory to determine the on-site correlation between the gamma radiation readings and the concentration of Ra-226, Th-230 and U-nat, in the samples. Samples will be taken from:

- Areas known to be contaminated with only processed uranium materials (i.e. tailings sand and windblown contamination)
- Areas in which it is suspected that unprocessed uranium materials (i.e. ore pad and windblown areas downwind of the ore pad) are present

The actual number of samples used will depend on the correlation of the results between gamma radiation readings and the unity rule as discussed below. Windblown contamination to the northeast of the Mill area is primarily associated with the unprocessed ore from the ore storage pad. The slightly larger windblown contamination area to the southwest of the Mill area is primarily associated with the processed tailings. A minimum of 35 samples of windblown tailings (to the southwest), and 15 samples of windblown unprocessed ore materials (to the northeast) will be collected.

Sufficient samples will be collected for developing prediction equations to calculate the linear regression lines and the corresponding upper and lower 95 percent confidence levels for each of the instruments. The upper one-sided 95 percent confidence limit will be used for the guideline value for correlation between gamma radiation readings and Ra-226 concentration. Because the unprocessed materials are expected to have proportionally higher values of uranium in relation to the Ra-226 and Th-230 content, the correlation to the gamma radiation readings are expected to be slightly different than readings from areas known to be contaminated with only processed materials. Areas expected to have contamination from both processed and unprocessed materials will be evaluated using the more conservative correlation, or will be excavated to the Ra-226 standard which should ensure that the uranium is removed.

The samples will be judgmentally selected with Ra-226 concentration at three different intervals related to the guideline value (5 pCi/g above background):

- 25 percent of the guideline value
- Approximately the guideline value
- Approximately twice the guideline value for the area of interest

This selection will maximize the precision of the correlation relationship at 5.0 pCi/g above background. Background Ra-226 concentrations have been gathered over a 16-year period at sample station BHV-3 located upwind and 5 miles west of the Mill. The Ra-226 background concentration from this sampling location is 0.93 pCi/g. This value and the concentrations of U-nat and Th-230 assumed in equilibrium with the Ra-226 will be used as an interim value for the background concentration used only in the initial planning for this project (e.g. use of historical knowledge for preliminary setting of verification sample sizes). Background locations for the verification test will have the three contaminants measured at multiple locations.

Because Ra-226 has short-lived radioactive decay products that are strong gamma radiation emitters (namely Pb-214 and Bi-214), gamma radiation surveys can be effective for characterizing soil Ra-226 distributions across large areas, including on relatively small spatial scales. The well-established, effective, and widely-used analytical approach for spatially comprehensive characterization of Ra-226 concentrations in surface soils involves spatially intensive gamma radiation surveys combined with the use of gamma radiation and soil Ra-226 concentration correlations.

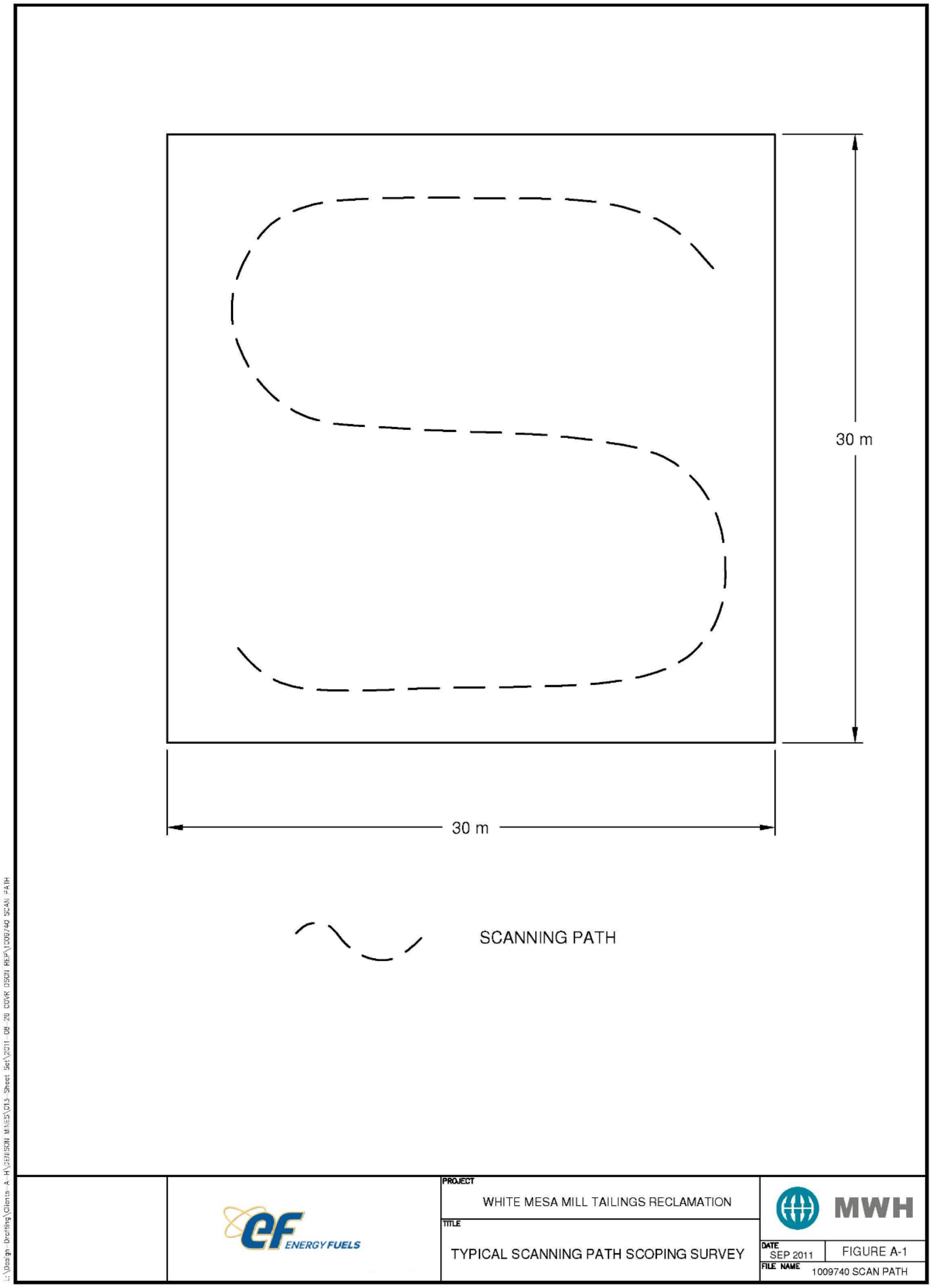
If a gamma radiation and Ra-226 concentration correlation is statistically significant, Ra-226 concentrations in surface soils can be predicted with reasonable accuracy based on gamma radiation readings collected at a high density of measurements across large areas. The same is true for other radionuclides, although correlative relationships tend to be less statistically significant and estimation uncertainty can be higher. The advantage of gamma radiation surveys is that a much higher density of measurements of terrestrial sources of gamma radiation is possible and when combined with gamma radiation/soil radionuclide correlation analysis, the approach produces a more comprehensive spatial characterization for comparisons against baseline conditions and evaluation of potential radiological contamination.

Fifteen soil samples will be collected in the restricted area to establish a correlation between the soil sampling analysis and the gamma radiation count. Additional measurement locations will be added, if necessary, to reach suitable precision, as defined in Section 6.6.3.7. The method that will be used in an effort to develop statistically significant gamma radiation/soil radionuclide correlations is as follows:

1. At each correlation plot, a 100 m^2 (10 m x 10 m) plot for correlation measurements and soil sampling will be established with pin flags. A gamma radiation scan will be performed across each correlation plot (5 m transects at a detector height of 18 inches). The average gamma radiation reading (e.g. cpm) from scan data across each correlation plot will be calculated and recorded in the field logbook, or developed using data collected from the gamma radiation scan. See Figure A-1 for the scan path.
2. Within each 10 m x 10 m correlation plot nine sub-samples of surface soils, one in the center, and eight against the edges of the plot, will be collected across the plot (at a depth of 15 cm) and composited into a single sample to represent average soil radionuclide characteristics across the correlation plot. Composite surface soil samples from each correlation plot will be submitted to a qualified commercial laboratory for analysis of U-nat, Ra-226, Th-230, Th-232 (by Ra-228), and K-40. The correlation plot scanning and sampling design for each location is illustrated in Figure A-1.
3. The laboratory chain of custody/analysis request form to be submitted with composite correlation plot soil samples will specify the following requirements:
    a. Thorough homogenization of each sample at the laboratory.
    b. Ra-226 analysis by EPA Method 901.1, modified for soil samples, with sample counting to be performed at least 21 days after sealing in the counting tin to ensure full ingrowth of Rn-222 and its decay products. Analysis of K-40 will also be conducted with EPA method 901.1, as will analysis of Ra-228 (to determine Th-232 concentrations under the assumption of radiological equilibrium).
    c. U-nat analysis by EPA Method 200.8 (ICP-MS) or equivalent, preferably with soil matrix digestion using EPA Method 3052 (microwave assisted acid digestion). EPA Method 3050B or equivalent digestive methods may alternatively be used; however, digestion will not be as complete.

d. Th-230 analysis by EPA Method 200.8 (ICP-MS) or equivalent, preferably with soil matrix digestion using EPA Method 3052 (microwave assisted acid digestion). Ten percent of the correlation plot samples will also be analyzed for Th-230 by alpha spectroscopy.

4. Upon receiving soil analysis results from the laboratory, regression analysis will be performed to determine, based on paired data from all correlation plots, if significant statistical correlations exists between average gamma radiation readings and soil Ra-226, U-nat, Th-230, Th-232 by Ra-228 and K-40 concentrations.


30 m
30 m
SCANNING PATH
PROJECT
WHITE MESA MILL TAILINGS RECLAMATION
TITLE
TYPICAL SCANNING PATH SCOPING SURVEY
ENERGY FUELS
MWH
DATE
SEP 2011
FIGURE A-1
FILE NAME
1009740 SCAN PATH

6.3.3 Area Classification

The characterization and scoping surveys will be used to classify areas as either non-impacted or impacted areas. The impacted areas will be further classified into Classes 1-3 (NUREG-1575; NRC, 2000). The classification of the areas will determine the rigor required to survey and release the areas.

- Class 1 areas are areas which have, or had prior to remediation, a potential for radioactive contamination based on Mill operating history, or known contamination based on previous radiological surveys. Areas containing contamination in excess of the release criterion, specifically the Derived Concentration Guideline Level (DCGL) associated with the Wilcoxon Rank Sum Test ($DCGL_W$), established by the radium benchmark dose (RBD) approach in Section 6.6.3.3 prior to remediation should be classified as Class 1 areas. The concentration terms "$DCGL_W$", "release criterion", and "unity rule", have been used interchangeably throughout the remainder of these Technical Specifications. However, where a gamma radiation-based level is meant, the term "gamma guideline level" is used specifically.

- Class 2 areas are areas which have, or had prior to remediation, a potential for radioactive contamination or known radioactive contamination, but are not expected to exceed the $DCGL_W$.

- Class 3 areas are any impacted areas not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the $DCGL_W$, based on Mill operating history and previous radiological surveys.

Table 6.1 - Final Status Survey Unit Classification for Land Areas

Survey Unit Classification		Statistical Test	Elevated Measurement Comparison	Sampling and/or Direct Measurements	Suggested Area (m^2)	Scanning
Impacted	Class 1	Yes	Yes	Systematic	2000	100% Coverage
	Class 2	Yes	Yes	Systematic	10,000	10-100% Systematic
	Class 3	Yes	Yes	Random	No limit	Judgmental
Non-Impacted		No	No	No	None	None

6.3.4 Remediation

Remediation will only occur in survey units that cannot pass the release criterion ($DCGL_W$). Remediation will consist of excavation of soils and placement in the tailing cells, as stated in Section 7.2.3. Remedial action support surveys will be conducted to guide the remediation. Remedial action support surveys will be conducted in a manner similar to the Final Status Surveys (FSSs), described in Sections 6.4 and 6.6, to ensure that the remedial action achieves the $DCGL_W$. Excavation will continue until the gamma radiation guideline value is achieved for surface soils.

Upon completion of remediation, gamma radiation surveys will be conducted on the excavated area and areas surrounding the excavation.

6.4 Final Status Surveys

Areas of the site will be released through the final status survey (FSS) process (see Section 6.6). Survey units will be released through FSS reports provided to DWMRC for each survey unit. Survey units that require remediation will undergo the FSS process after remediation. Survey units must meet the release criterion set forth in this section. Each survey unit that meets the release criterion will be released, pending DWMRC approval.

6.4.1 Release Criterion

Release criteria have been established and are discussed in more detail in Section 6.6.

6.4.2 Statistical Test

The WRS test will be performed using the background reference data set and the systematic sample data set from the survey unit under investigation. The background reference data set will be added to the unity rule (1) prior to the statistical test being completed. The two data sets will be derived using the weighted sum for multiple radionuclides set forth in MARSSIM (NRC, 2000):

For surface soils:

$$\frac{A\ (pCi/g\ Ra226)}{5\ (pCi/g)} + \frac{B\ (pCi/g\ \ Unat)}{545\ (pCi/g)} + \frac{C\ (pCi/g\ \ Th230)}{46\ (pCi/g)} + 1$$

For subsurface soils:

$$\frac{A\ (pCi/g\ \ Ra226)}{15\ (pCi/g)} + \frac{B\ (pCi/g\ \ Unat)}{2908\ (pCi/g)} + \frac{C\ (pCi/g\ \ Th230)}{142\ (pCi/g)} + 1$$

For instance, if the background reference area surface soil data set showed that one sample contained 2.2 pCi/g Ra-226, 2.2 pCi/g U-nat, and 2.0 pCi/g Th-230, the sample would be represented in the WRS data set as the following:

$$\frac{2.2\ (pCi/g\ \ Ra226)}{5\ (pCi/g)} + \frac{2.2\ (pCi/g\ \ Unat)}{545\ (pCi/g)} + \frac{2.0\ (pCi/g\ \ Th230)}{46\ (pCi/g)} + 1 = 1.49$$

Thus, 1.49 (unitless) for this particular background sample would be used in the WRS comparison data set for the background reference area to be compared to the survey unit data. If this sample were from the survey unit, the value would be 0.49 (unitless).

The WRS test will be performed on the survey unit and background reference area using the method in MARSSIM. For Class 1 to Class 3 survey units, the null hypothesis is that the survey unit exceeds the release criterion. If the null hypothesis is rejected, the mean for the survey unit does not exceed the $DCGL_W$, and no area exceeds the DCGL Elevated Measurement

Comparison ($DCGL_{EMC}$) then the survey unit is presumed to meet the release criterion and, pending DWMRC approval, released.

If an area in a survey unit exceeds the $DCGL_W$, the area of the contamination will be determined using a mixture of soil sampling and gamma radiation surveying.

A comparison to the EMC will be made to determine if the area presents a dose equal to, or lower than, the $DCGL_W$ scenario. This determination will be completed through the derivation of area factors based on the size of hypothetical areas of contamination. The area factor for a contaminated area will be multiplied by the $DCGL_W$ to determine the allowable contaminant concentration for that size of area, which still meets the unity rule. Area factors will be determined prior to FSS's and will be approved by DWMRC.

Areas of elevated activity that do not meet the $DCGL_{EMC}$ will be remediated.

6.5 Instrument Quality Assurance/Quality Control (QA/QC)

Field gamma radiation survey instrumentation will be sodium iodide (NaI) detectors. To the extent possible, the same instruments will be use throughout the characterization, remediation and final status survey. These instruments will be cross-calibrated to allow other identical instruments or similar instruments to be used. Individuals will be appropriately trained to use the selected instrumentation and the instrumentation will be suitable for its intended use. Instrumentation shall be operated in accordance with written procedures and manufacturers' manuals which will provide guidance to field personnel on the proper use and limitations of the instruments.

6.5.1 Calibration

The manufacturer's current calibration/maintenance records will be kept on site for review and inspection for all instruments used during the survey. Past calibration records will be retained for inclusion in the FSS report.

The records will include, at a minimum, the following:

- Equipment identification (name, model, and serial number)

- Manufacturer
- Date of calibration
- Calibration due date

Instrumentation must be maintained and calibrated to manufacturer's specifications to ensure that required traceability, sensitivity, accuracy, and precision of the equipment/instruments are maintained. Instruments will be maintained and calibrated in accordance with American National Standards Institute N323A (ANSI, 1997).

6.5.2 Source and Background Checks

Prior to and after daily use, instruments will be QC-checked by comparing the instrument's response to a designated gamma radiation source and to ambient background. Prior to commencement of field operations, a site reference location will be selected for the performance of these checks. Acceptable ranges (count rate) for each instrument will be established by performing a series of counts. The acceptable range will be ± 2 sigma of the mean of the series of counts. QC source checks will consist of one-minute integrated counts with the designated source position in a reproducible geometry, performed at the designated location. Background checks will be performed in an identical fashion with the source removed. Results of the background and QC checks will be recorded in a field logbook.

Instrument response to the designated QC check source will be plotted on control charts or in tabular form (spreadsheets) and evaluated against the average source and background readings established at the start of the field activities. A performance criterion of +/– 2 sigma of this average will be used as an investigation action level, and a repeat of the measurement will be performed. A performance criterion of +/– 3 sigma of this average will be used as a failure level requiring corrective action. Results exceeding this criterion will be investigated and appropriate corrections to instrument readings will be made if the response is affected by factors beyond personnel control, such as large humidity or temperature changes. The instrument(s) in question will be removed from service while investigations and corrective actions are in progress.

Instrument response to ambient background will be used to establish a mean background response for each instrument, to monitor gross fluctuations in background activity (e.g., from changes in barometric pressure and other, non-contaminant related causes), and to evaluate detector response. The background measurements are performed for the purpose of checking for detector contamination and electronic stability (especially cabling).

Instrument response to source checks are used to prove detector efficiency and electronics stability.

During QC checks, instruments shall be inspected for physical damage, current calibration and erroneous readings. The individual performing these tasks shall document the results in accordance with the instrument protocol within MARSSIM, as provided in Exhibit A-1. Instrumentation that does not meet the specified requirements of calibration, inspection, or response check will be removed from operation. If the instrument fails the QC response check, any data obtained to that point, but after the last successful QC check will be considered invalid due to potentially faulty instrumentation.

6.6 Data Quality Objectives

This plan was developed using guidance from MARSSIM to ensure surveys are conducted with the proper rigor, quality assurance, and statistical analysis to make proper decisions. A key step in the MARSSIM process is the development of DQOs. DQOs ensure collection of data of the right type, quality, and quantity to support decisions, the decommissioning process, and the achievement of the desired end state. The DQOs are outlined below, and include systematic processes to:

1) State the problem

2) Identify the goal of the characterization

3) Identify inputs to the decision

4) Define the study boundaries

5) Develop the decision rules/analytical approach

6) Define acceptable decision errors

7) Optimize the design

6.6.1 State the Problem

Ultimately, the mill will be decommissioned, the demolition and decommissioning waste disposed in the tailings cells, and the tailings system reclaimed as approved by DWMRC. The reclamation objective is to release the mill's land areas, other than the tailings area, for unrestricted use. Land areas may have radiological contamination from milling operations. The scanning procedure needs to identify and distinguish areas that can be released, from areas that must be remediated prior to being released. The data collected following excavation in remediation areas must also be suitable for use in the FSS to demonstrate that the clean-up criteria have been met.

6.6.2 Identify the Decisions

The decision process will be based on data from scoping and characterization surveys, gamma radiation correlation, remediation and final status surveys.

Survey and sampling data will be used to:

1) Assist in classification of survey units

2) Determine areas requiring remediation

3) Develop Final Status Surveys to verify that clean-up criterion has been met

6.6.3 Identify Inputs to the Decision

6.6.3.1 Characterization and Scoping

HSAs, scoping surveys, and characterization surveys will be used to determine the extent of the contamination as well as the presence of useable relationships/ratios between the radionuclides of background reference areas. The presence of useable relationships will be established in accordance with Section 4.5 of MARSSIM (NRC, 2000). Soil sampling will be conducted in the survey areas and samples will be analyzed for U-nat, Th-230 and Ra-226.

The background must be correctly characterized and a proper background reference area chosen to represent the background for the Mill soils. This will ensure that the soil will be cleaned up to the appropriate level. Goals of the characterization include selecting an appropriate background reference area(s) and appropriate background(s), and correctly comparing selected background(s) with the survey units. Multiple backgrounds may be selected for different survey units depending on the characterization and scoping surveys in conjunction with the HSA.

From MARSSIM Section 4.5, a site background reference area should have similar physical, chemical, geological, radiological, and biological characteristics as the survey unit being evaluated. Background reference areas are normally selected from non-impacted areas, but are not limited to natural areas undisturbed by human activities. In some situations, a reference area may be associated with the survey unit being evaluated, but cannot be potentially contaminated by site activities. For example, background measurements may be taken from core samples of a building or structure surface, pavement, or asphalt. The selected reference areas will be reviewed with DWMRC.

Systematic soil sampling will occur prior to the FSS, and samples will be analyzed for Ra-226, Th-230, and U-nat to determine background concentrations to be used for the cleanup. The soil sampling to determine the average background radionuclide concentrations to ultimately be used for the cleanup will be conducted prior to remediation. Background sampling will be conducted in a reference area within or outside of the property boundary that is similar to the area to be remediated.

Background reference areas will be chosen such that they are representative of the survey unit locations but are non-impacted from site operations. Representativeness shall be determined on the basis of geomorphology, geological, geochemical, and radiological, considerations.

6.6.3.2 Correlation

A correlation of the unity rule in the soil to the gamma radiation will be developed. This correlation will guide remediation and excavation. This correlation is explained in Section 6.3.2.

Remediation of the soil to meet the unity rule is described in Section 6.3.4. The final status survey reports will be the definitive source of information to describe the final impacts on the soil left by the Mill. The reports will detail how the cleanup met the Site Cleanup Criteria and show that each survey unit meets the cleanup criteria. The FSS reports will verify that the remediation has achieved the cleanup criteria.

6.6.3.3 Site Cleanup Criteria

The DCGLs for Ra-226 are set at 5 pCi/g for the surface 15 cm soil layer and 15 pCi/g for the subsurface 15 cm soil layer, respectively (hereafter referred to as "5/15") (See Attachment D for further discussion).

The DCGLs for radionuclides other than Ra-226 are derived from doses calculated for Ra-226 at 5/15 using the same exposure scenarios as were used to estimate the dose from Ra-226 at 5/15. This is referred to as the radium benchmark dose (RBD).

Generally, elevation of U-nat and Th-230 concentrations relative to Ra-226 is unexpected since the contaminated materials will either be ore (which are at or near secular equilibrium) or tailings where U-nat is reduced relative to the other uranium decay series radionuclides of interest. Possible exceptions are:

- Areas with raffinate crystals which may have higher Th-230 concentrations compared to Ra-226 concentrations
- Areas of spilled yellowcake product near the mill where U-nat may be elevated relative to Ra-226

The RBD approach was applied as described in Attachment D. The RESRAD (Version 6.5) code (Yu et al. 2001) was used to implement the RBD approach. As described in NUREG-1569 as Appendix E (NRC 2003, a Guidance document for NRC Commission Staff on the Radium Benchmark Dose Approach), NRC considers the RESRAD code as an acceptable code for application of the Ra-226 benchmark dose approach. In brief, radionuclides at their respective DCGLs result in the same benchmark dose as the Ra-226 DCGL.

The DCGLs for the radionuclides of interest for the surface and subsurface layers were calculated and are provided in Table 6.2. The scenario is for a rancher with the doses determined using the RESRAD Version 6.5 model. The default RESRAD dietary and inhalation data which apply for the adult are carefully selected from literature and are already considered to represent conservative parameter values. Details on the calculation of DCGL's are provided in Attachment D.

Table 6.2 - DCGL above background

DCGL (pCi/gram) above background		
Radionuclide	**Surface**	**Subsurface**
Ra-226	5	15
U-nat	545	2908
Th-230	46	142

Since there is more than one radionuclide of concern, the criteria for unrestricted use is applied using the unity rule such that the RBD is never exceeded.

In the equations below, the numerator is determined by subtracting the local background from the sample analysis following remediation. It is possible that the background may vary between survey units due to variation in soil types.

The unity rules are:

For surface soil:

$$\frac{A\ (pCi/g\ Ra226)}{5\ (pCi/g)} + \frac{B\ (pCi/g\ Unat)}{545\ (pCi/g)} + \frac{C\ (pCi/g\ \ Th230)}{46\ (pCi/g)} \leq 1$$

For subsurface soil:

$$\frac{A\ (pCi/g\ \ Ra226)}{15\ (pCi/g)} + \frac{B\ (pCi/g\ \ Unat)}{2908\ (pCi/g)} + \frac{C\ (pCi/g\ Th230)}{142\ (pCi/g)} \leq 1$$

MARSSIM requires that the median concentration in a survey unit be demonstrably lower than the $DCGL_W$ following remediation. This is accomplished with a WRS test between soil concentrations in the survey unit and appropriate background reference locations. For the WRS test, the actual concentrations are used for the survey unit rather than using the incremental concentrations, discussed previously in Section 6.4.2.

6.6.3.4 Gamma Radiation Surveys

Gamma radiation surveys will be conducted with a GPS-integrated system using 2-inch by 2-inch sodium iodide (NaI) detectors or the equivalent. Statistical correlations will be developed between the radiological soil sample analysis and the gamma radiation count rate. See Section 6.4.2 for the method for development and use of the gamma radiation correlation.

With the GPS-integrated method, high density gamma radiation scanning surveys will be done using the Ludlum 44-10 detectors at a height of 18 inches above the ground. The surveyor speed will be approximately 0.5 m/s.

For Class 1 survey units, transects will be 5 m apart and gamma radiation scanning surveys will continue up to 20 m outside the excavation with averages calculated on each 10-m by 10-m block. Class 1 survey units will scanned at a density to ensure that 95 percent of the 10-m by 10-m blocks have at least 20 gamma radiation measurements for blocks in and adjacent to the excavation areas with measurements in at least three of the four quadrants of the 10-m by 10-m block.

The remainder of the survey area outside the remediation area will be classified as Class 2 and will be surveyed at 10 m transects. The requirement for the remainder of the survey area, Class 2, will be that 95 percent of the blocks have at least 10 gamma radiation measurements.

The Class 3 area will include the buffer areas outside the area of contamination, and this area will be surveyed with planned transects of 50 m. Twenty percent or more of the 10-m by 10-m blocks will have at least 10 gamma radiation measurements.

The mean, median, and standard deviation of the 10-m by 10-m averages will be calculated by survey unit for data logged during the scanning surveys.

6.6.3.5 Gamma Radiation Guideline Level

The average gamma radiation count rate will be established over the 10-m by 10-m blocks. A correlation will be established between the gamma radiation level and the unity rule using co-located gamma radiation and soil concentration measurements. The gamma radiation guideline value will be the gamma radiation counts that equate to 0.8 (80 percent of unity rule) from the correlation equation. Locations where the gamma radiation guideline is exceeded will have additional gamma radiation surveys and potentially additional excavation before verification sampling.

6.6.3.6 Selection of Verification Samples

Following completion of excavation, if necessary, verification sampling will be carried out for each survey unit to allow a WRS test with background samples to confirm that the compliance criteria has been met. Ten sampling blocks will be determined from a random sampling approach for each survey unit. Following the final status gamma radiation survey, a minimum of 15 blocks in the survey unit will be measured to confirm the gamma radiation guideline level. For these 15 samples, the five 10- by 10-m blocks with the highest average gamma radiation will be sampled along with another 10 sample blocks randomly selected from the area.

The soil samples from the 10 randomly selected locations will be assessed to determine if the mean concentration in the survey unit is statistically below the unity rule with an alpha error of 0.05 using the MARSSIM WRS test.

The number of samples may be increased per Section 6.6.8.

6.6.3.7 Revision of Correlation

The verification sample measurements (soil analysis and mean gamma radiation counts) will be compared to the correlation to determine if the correlation is statistically valid. The correlation will be updated with the verification measurements if there is less than a 95 percent probability (p-value of 0.05) that the random verification data is less than $DCGL_W$. Verification measurements (soil sample and mean gamma radiation counts) will be taken with the same method as the correlation measurements.

6.6.3.7.1 Reporting

For each survey unit, the following will be reported:

1. Number of blocks remediated during remediation phase.
2. Number of blocks with subsequent remediation initiated by gamma radiation measurement.
3. Gamma radiation coverage compliance (i.e. percentage of blocks meeting number of measurement criteria).
4. Mean gamma radiation level averaged over the 10-m by 10-m blocks.
5. Mean and range of predicted unity rules based on gamma radiation survey.
6. Mean and range of measured unity rules based on verification sampling.

6.6.3.8 Field Data

The objectives of the survey and sampling activities are to identify the concentrations of residual radioactive material in the survey units so that the unity rule can be evaluated. This information will allow a determination of whether a survey unit is likely to be suitable for release. The average soil concentrations will be evaluated to verify that each radiological $DCGL_W$ is met.

6.6.4 Define the Study Boundaries

The soil in the restricted area will be surveyed for radiological contamination of U-nat, Th-230, and Ra-226. This does not include the tailings cells and unrestricted areas. Survey units will be established in the unrestricted area if, during the survey of the restricted area, contamination is found at the boundary of the restricted area or if there is reason to believe contamination is present in the unrestricted area.

6.6.5 Develop the Decision Rules/Analytical Approach

If soils exhibit widespread contamination above the $DCGL_W$, then removal of the soil will be necessary or the EMC process will need to be followed to ensure that areas of contamination will not exceed the $DCGL_W$ following excavation.

6.6.6 Define Acceptable Decision Errors

6.6.6.1 Statistical Tests

The WRS test will be used to compare background reference areas to survey units in the MARSSIM framework for the FSS reporting. The WRS test is a nonparametric test used to test for a difference in values between two populations; that is, one data population is hypothesized to consist of higher average values than the other data population.

MARSSIM suggests using the WRS test in cases where the contaminant is present in background at a significant fraction of the $DCGL_W$. Since the DCGL is 5 pCi/g for Ra-226 and the background is in the order of 1 pCi/g or more for Ra-226, the WRS test is the preferred test.

The soil concentrations from the 10 randomly selected locations as defined in Section 6.6.3.6 will be assessed with the WRS test to determine if the median concentration in the survey unit is statistically below the unity rule with an alpha error of 0.05 using the MARSSIM WRS test.

6.6.6.2 Hypothesis

The decisions necessary to determine compliance with the soil cleanup criteria are based on precise statistical statements called hypotheses, which are tested using the data from the survey unit.

Null Hypotheses - The situation that is presumed to exist is expressed as the null hypothesis (H_0), which states "*the median concentration in the survey unit exceeds the median concentration in the background reference area by more than the DCGL.*"

Alternative Hypotheses - For a given H_0, there is a specified alternative hypothesis (H_a), which is an expression of what is believed to be the situation if the null hypothesis is not true. The H_a

states "*the median concentration in the survey unit does not exceed the median concentration in the background reference area by more than the DCGL.*"

These hypotheses were chosen for the following two reasons: (1) the burden of proof is placed on the H_A and, (2) the survey unit will not be released until proven to meet the cleanup criterion. In order to pass the WRS using the above H_0, the median concentration of the systematic samples in the survey unit must be less than the $DCGL_W$ above background.

6.6.6.3 Error Types

Decision errors help to determine the number of samples required. Generally, more samples are required to generate lower decision errors (i.e., the fewer samples, the larger the uncertainty).

The statistical acceptability decisions are designed to avoid two kinds of errors:

- Releasing a survey unit which requires additional remediation
- Remediating a survey unit which is already below the $DCGL_W$

Two possible error types are associated with such decisions, Type I and Type II, which are described below.

Type I – which is also referred to as a false positive, occurs when H_0 is rejected when it is actually true. The probability of a Type I error is usually denoted by α. This error could result in higher potential doses to future site occupants than prescribed by the dose-based criterion. The maximum Type I error rate has been set at $\alpha = 0.05$ (there is less than 5 percent chance of error).

Type II - which is referred to as a false negative, occurs when H_0 is not rejected when it is actually false. The probability of a Type II error is usually denoted by β. Consequences of Type II errors include unnecessary remediation expense and project delays. The Type II error rate has been set at $\beta=0.10$ (there is less than 10 percent chance of error).

Statistical correlations will be developed between the unity rule and the gamma radiation measurements. The unity rule will be determined from measurement data for incremental concentrations at each sample location. The correlation between the unity rule and the gamma radiation measurement at the sample location will produce a prediction equation. MARSSIM requires that the mean concentration in a survey unit be demonstrably lower than criteria following remediation but does not require all sampling units, in this case the 10-m by 10-m areas, to be lower than the criteria. The precision goal for the relationship will be that the mean prediction uncertainty for the survey unit will be +/- 0.2 when the predicted unity rule is equal to "1".

Protocols will be in place to ensure decision errors are kept to a minimum. For example, instrument quality assurance checks will be required and minimum detectable concentrations (MDCs) will be met.

The gamma radiation survey will be limited by the MDC for the 2-inch x 2-inch sodium iodide (NaI) detector which is approximately 104 Bq/Kg (2.8 pCi/gram) for Ra-226, MARSSIM Table 6.7. This MDC is dependent on the background which may raise or lower the MDC (NRC, 2000).

Table 6.3. Reported MDC's from MARSSIM Table 6.7

Nuclide	MDC (Bq/kg)	MDC (pCi/gram)
U-Nat	2960	80
Th-230	78,400	2100
Ra-226 (with decay products in equilibrium)	104	2.8

6.6.7 Relative Shift and Number of Samples

The target decision errors are 0.05 and 0.10 for α and β, respectively. The major contributor to the unity rule is Ra-226 since the criterion is much lower for Ra-226 compared to U-nat and Th-230. The lower bound of the gray region (LBGR) has been set to 0.8 as Ra-226 has a typical concentration that is only about 25 percent of the LBGR and the uncertainty will likely be of this order.

The preliminary estimate is that a relative shift of 2.0 based on the LBGR of 0.8 and an uncertainty of twice the background concentration. Using Table 5.3 of MARSSIM (NRC, 2000), the required number of samples is 8.

Should any area exceed the $DCGL_{EMC}$ or large areas exceed the $DCGL_{W}$, remediation of the affected areas would be completed prior to resampling.

6.6.8 Optimize the Design

Initially, gamma radiation scans will be conducted in the restricted areas of the Mill site. The data from these scans will be reviewed to determine the location of any hotspots. These hotspot locations will be sampled to determine the activity concentrations of U-nat, Th-230, and Ra-226. A prediction equation of the unity rule will provide the basis for scanning large areas effectively to direct focused remediation and to ensure that the cleanup criterion is met.

The statistical test (WRS test) could fail to show that the mean is below the criterion due to the initial number of verification samples, since there may be insufficient samples to achieve the desired decision error rates given the characteristics of the survey unit. In cases where data suggest that the concentration is below the criterion (e.g., the mean bases), additional samples would reduce the decision error and potentially allow the survey unit to pass. In this case, the mean and variability of the 10 randomly selected measurements will be used to determine MARSSIM's relative shift with the lower bound of the gray region equal to 0.8 of the unity rule. The α error will be set to 5 percent and the β error set to 10 percent to determine the required total number of samples. These samples would be collected and the WRS repeated on the larger data set.

6.7 Soil Sampling

6.7.1 Laboratory Approval

All samples will be analyzed for radionuclide activity concentration (pCi/g). All analyses will be performed by a DWMRC-approved/certified laboratory and a DOE-certified, or National Environmental Laboratory Accreditation Program (NELAP)-certified laboratory. The laboratory will analyze method blanks, matrix spike samples, laboratory control samples and replicates**.** Typical required detection levels will be less than or equal to one tenth of the DCGL for each radionuclide.

6.7.2 Data Validation

Laboratory analytical results from the final status survey will be validated and will be reviewed by the data validator for the following:

- Data completeness/sample integrity
- Holding times
- Calibration
- Alpha spectroscopy tracer analysis
- Laboratory and field blanks
- Laboratory control samples
- Laboratory and field duplicates
- Alpha spectroscopy matrix spikes
- Quantitation and detection limits
- Alpha spectroscopy chemical separation specificity
- Gamma radiation spectroscopy target radionuclide list identification
- Secular equilibrium verification, and result verification

Review of these parameters checks the quality of the data with respect to:

- Precision – which is a measure of the reproducibility of an analysis under a given set of conditions. Precision will be evaluated through a review of field duplicate and laboratory duplicate samples.

- Accuracy – which is a measure of the bias that exists in a measurement system. Accuracy will be evaluated through a review of laboratory control samples, matrix spike samples, method blanks, and tracer recoveries.

- Representativeness – which is a measure of the degree to which the sampling data accurately and precisely represent site conditions. Representativeness will be evaluated through a review of raw data and through a comparison of whether the proposed scoping survey was implemented.

- Comparability – which is a measure of the degree of confidence with which two data sets can be compared to each other. Comparability will be evaluated through an assessment of whether appropriate and acceptable analytical methods were used.

- Completeness – which is a measure of the amount of valid data obtained.

6.8 Employee Health and Safety

Programs currently in place for monitoring of exposures to employees will remain in effect throughout the time period during which tailings cell reclamation, mill decommissioning and clean up of windblown contamination are conducted. This will include personal monitoring and the ongoing bioassay program. Access control will be maintained at the Restricted Area boundary to ensure employees and equipment are released from the site in accordance with the current License conditions. In general, no changes to the existing programs are expected and reclamation activities are not expected to increase exposure potential beyond current levels.

6.9 Environment Monitoring

Existing environmental monitoring programs will continue during the time period in which reclamation and decommissioning is conducted. This includes monitoring of surface and groundwater, airborne particulates, radon, soils and vegetation according to the existing License conditions. In general, no changes to the existing programs are expected and reclamation activities are not expected to increase exposure potential beyond current levels.

6.10 Quality Assurance

In general, the QA/QC Plan details the Owner's organizational structure and responsibilities, personnel qualifications, operating procedures and instructions, record keeping and document control, sampling procedures and outside laboratory testing.

7.0 MATERIAL DISPOSAL

7.1 General

This section outlines work associated with placement of materials in the disposal cell area within Cell 1 (Cell 1 Disposal Area) and tailings cells (Cells 2 through 4).

7.2 Materials Description

The types of materials to be disposed of are outlined below.

7.2.1 Raffinate Crystals

After the residual liquid in Cell 1 has been evaporated, the raffinate crystals from Cell 1 will be excavated and disposed in one of the tailings disposal cells. The crystals are likely to have granular consistency, with larger crystal masses that may require breaking down for loading and transport (using the loading equipment).

7.2.2 Synthetic Liner

The existing PVC liner in Cell 1 will be removed and disposed of in one of the tailings disposal cells.

7.2.3 Contaminated Soils

During remediation, soils located in and around the Mill site that exceed the soil cleanup guideline value will be placed in one of the tailings disposal cells. Soils excavated from Cell 1 to meet design grades or exceed the soil cleanup guideline value shall be placed in one of the tailings disposal cells.

7.2.4 Mill Debris

The Mill debris will include equipment, such as tankage and piping, agitation equipment, process control instrumentation and switchgear, and contaminated structures (including concrete structures and foundations). Mill debris will be placed in the ~~disposal area in Cell 1 (disposal cell)~~Cell 1 Disposal Area.

7.3 Work Description

Materials to be disposed in the cells will be spread over the working surface as much as possible to provide relatively uniform settlement and consolidation. In the disposal cell, a minimum of one foot of soil will be placed over the clay liner prior to placing any debris.

7.3.1 Raffinate Crystals

Raffinate crystals will be removed from Cell 1 and transported to the tailings cells. Placement of the crystals will be performed as a granular fill, with large-sized material broken to minus 6-inch size. Voids around large material will be filled with finer material. Actual placement procedures will be evaluated by the CQA Officer during construction as crystal materials are placed in the cells and modified with the agreement of the DWMRC.

7.3.2 Synthetic Liner

The PVC liner will be cut, folded (when necessary), removed from Cell 1, and transported to the tailings cells. The liner material will be spread as flat as practical over the designated area. After placement, the liner will be covered as soon as possible with at least one foot of soil, crystals or other materials for protection against wind uplift, as approved by the CQA Site Manager.

7.3.3 Contaminated Soils

The extent of contamination of the Mill site will be determined by gamma radiation scanning and the A correlation developed between gamma survey readings and the unity rule concentrations (Section 6). Gamma survey readings will be used to define cleanup areas and confirm cleanup. Soil sampling will be conducted to verify that the cleanup results meet soil cleanup guideline values.

Where surveys indicate the above criteria have not been achieved, the soil will be removed to meet the criteria. Soil excavated from Cell 1 will be transported to one of the tailings cells.

7.3.4 Mill Debris

Debris will be spread across the bottom of the disposal cell to avoid nesting and to reduce the volume of voids present in the disposed mass. Stockpiled soils and/or other approved materials will be placed over and into the debris in a sufficient lift thickness to fill the voids between the debris pieces. The CQA Site Manager will approve the use of materials other than stockpiled soils for filling voids.

7.3.5 Material Sizing and Preparation

Demolition debris to be placed in the ~~disposal area of Cell 1~~Cell 1 Disposal Area will consist of equipment and structural material from facilities demolition. Demolition procedures are outlined in the Appendix B to the Reclamation Plan (Preliminary Mill Decommissioning Plan). Because of the wide variety in shape and size of demolition debris, material of odd shapes will be cut or dismantled to facilitate handling, loading, transport, and placement in the disposal cell. The maximum size of dismantled or cut materials will not exceed 20 feet in the longest dimension and a maximum volume of 30 cubic feet. Smaller dimensions may be necessary for loading, handling, hauling, and placement of material.

7.3.6 Incompressible Debris

Material that is not compressible (steel columns and beams, concrete, and other solid material) will be reduced in size for loading, hauling, and placement in the disposal cell. Incompressible debris shall be placed, oriented, or spread in a manner that minimizes void spaces below, between, and above these materials. Incompressible debris shall be placed on and covered with soils or similar materials (Section 7.2.3). Incompressible debris such as steel members shall be placed in the disposal cell with the longest dimension oriented horizontally.

Thick-walled pipe, conduit, tanks, vats, pressure vessels, and other hollow materials that cannot be crushed or dismantled shall be transported to the planned location within the disposal cell and oriented for filling and burial. The voids on the inside of the item will be filled with contaminated soil, clean fill soil, or grout (controlled low-strength material or flowable fill). Contaminated soil (Section 7.2.3) or clean fill will be placed outside of the items and compacted with standard compaction equipment (where possible) or hand-operated equipment to the compaction requirements in Section 7.4. Several lifts of compacted contaminated soil or clean fill may be necessary to fill around and cover these items.

For debris where internal voids cannot practically be filled with soil, a grouting program will be initiated to pump controlled low strength material (CLSM, flowable fill) into the voids. Debris will be grouped together and characterized as materials that will require grouting, so that a significant volume of debris can be grouted in a single action, rather than grouting individual lengths of pipe. Pipe sections could be stacked horizontally, or cut short enough to stand vertically in a safe manner. Grout will fill the voids within the grouped debris with a soil berm or trench used to contain the grout laterally around the perimeter of the selected debris.

If CLSM is required for the grouting of voids that cannot be filled with soil, the mix design for the grout will mimic, as closely as possible, the strength and hydraulic properties of the contaminated soil that will also be used for filling voids within the debris. The unconfined compressive strength of the CLSM will be between 30 and 150 psi, and unit weights will be approximately 100 to 120 pcf.

7.3.7 Compressible Debris

Materials that are compressible (such as thin-walled piping and thin-walled tanks) will be flattened or crushed in a designated staging area or in the disposal cell. Flattening or crushing will be done with a hydraulic excavator bucket or other attachments, or with a dozer or other steel-tracked equipment.

These materials shall be placed in the disposal cell and spread to form a lift with a maximum thickness of two feet. Placement shall be done in a manner resulting in materials lying flat and minimizing void spaces. Pipe shall be cut into lengths of approximately 10 feet or less for disposal. Pipe larger than 12 inches in diameter shall be longitudinally split or cut, or filled with grout.

7.3.8 Organic Debris

Organic materials (such as wood and paper) will be placed in the disposal cell in maximum lifts of 12 inches and mixed with the soil and other incompressible debris during placement to prevent pockets of organic material from being created. Organics mixed with soil for spreading will be limited to 30 percent by volume of the mixture.

7.3.9 Soils and Similar Materials

Soils and soil-like materials to be placed in the disposal cell will be from on-site areas identified by the Owner for excavation. Soil or soil-like material will be placed and compacted over each lift of debris (Section 7.2.4) or other materials in lifts not to exceed 2 feet in loose thickness and compacted prior to placement of additional lifts. Soils will also be used for interim soil cover to minimize exposure of demolition materials and other materials to air and meteoric water.

7.4 Performance Standards and Testing

7.4.1 Material Compaction – Debris Lifts

During construction, the compaction requirements for the raffinate crystals will be evaluated based on field conditions, material quantities, and compaction equipment. The compaction requirements will be determined by the CQA Site Manager and the Construction Manager or a designated representative, with the agreement of the Owner.

Each lift of debris (up to 2 feet thick) will be covered with soil (Section 7.3.9) (up to 2 feet in loose thickness). Each lift of soil or similar material will be compacted with a minimum of 6 passes with vibratory compaction equipment. The number of passes shall be confirmed with the actual compaction equipment on site with a field test section to establish a correlation between the field compaction method and 80 percent of maximum dry density for the soil, as determined by the standard Proctor test (ASTM D698).

The CQA Technicians will monitor and approve debris placement. In areas where voids are observed during placement, the Contractor shall re-excavate the area, fill any voids encountered with soil and recompact the materials, or grout the voids. The CQA Site Manager will recommend implementation of a grouting program where voids, either within a debris mass, or within a vessel, cannot be properly filled with soil using conventional equipment.

7.4.2 Material Compaction – Final Disposed Material Surface

The upper 12 inches of the final disposed material surface shall be compacted to 90 percent of the maximum dry density for the material, as determined by the standard Proctor test (ASTM D698).

7.4.3 Testing Frequency

Field density tests shall be compared with standard Proctor tests (ASTM D698 Method A or C) on the same material. Standard Proctor tests shall be conducted at a frequency of at least one test per 5,000 cubic yards of material compacted, or when material characteristics show significant variation.

Field density testing may be conducted with the sand cone test (ASTM D1556) or a nuclear density gauge (ASTM D6938, or as modified by the CQA Site Manager). Correlation of nuclear density gauge results shall be by comparison with results from sand cone test(s) and laboratory testing for water content(s) using the oven drying method (ASTM D2216) on similar material.

The frequency of the field density and moisture tests will be not less than one test per 2,000 cubic yards of compacted soil. A minimum of two tests will be taken for each day that more than 150 cubic yards of material is placed. A minimum of one test per lift and at least one test for every full shift of compaction operations will be taken.

7.4.4 Final Slope and Grades

The final disposed material surface shall have maximum side slopes of 5:1 (H:V) and a top surface sloping in the directions and grades shown on the Drawings. The side slopes and top surface shall be free from abrupt changes in grade or areas of runoff concentration. The final disposed material surface shall be compacted with approved construction equipment to form a smooth surface with uniform density for subsequent cover placement.

8.0 COVER CONSTRUCTION

8.1 General

This section outlines work associated with construction of the cell cover system. A multi-layered earthen cover will be placed over tailings Cells 2, 3 and 4A and a portion of Cell 1 used for disposal of contaminated materials (the Cell 1 Disposal Area).

8.2 Materials Description

8.2.1 Random Fill

The random fill for the interim fill, compacted cover, and growth medium layers will consist of on-site stockpiled soils from areas designated by the Owner. Random fill, except for the interim fill, shall have a maximum particle size of 6 inches, and a minimum of 10 percent passing the No. 200 sieve. Oversized material will be controlled through selective excavation at the stockpiles and through the utilization of a grader, bulldozer or other equipment to cull or break down oversized materials.

The source of these materials will be on-site stockpiles from previous cell construction activities. On-site stockpiles shall be approved for specific use by the Construction Manager and Design Engineer prior to use.

8.2.2 Organic Matter Amendment

Composted biosolids will be used to amend the physical and chemical properties of the random fill used to construct the growth medium layer (Section 8.3.7). Composted biosolids will be added to the upper 6 inches of the growth medium layer at a rate of 10 tons/acre.

8.2.3 Topsoil-Gravel Admixture

Gravel will be mixed with topsoil and placed on portions of the cover on Cells 2, 3, 4A, and 4B top surfaces (as shown on the Drawings) as the erosion protection layer. Topsoil-gravel admixture material shall be shall be free from roots, branches, rubbish, and debris.

The gravel portion of the topsoil-gravel admixture will consist of granular materials from approved off-site areas. The gravel portion of the topsoil-gravel admixture shall have a maximum particle size of 1 inch.

The topsoil portion of the topsoil-gravel admixture will consist of select material from the on-site topsoil borrow area (Section 3.4). The mixture shall be 25 percent gravel by weight.

8.2.4 Riprap

Riprap will be placed along the toe of the disposal cell and the tailings cells (as shown on the Drawings). Riprap will consist of granular materials from approved off-site sources. Riprap shall be shall be a screened product, free from roots, branches, rubbish, and debris.

Riprap shall meet NRC long-term durability requirements (a rock quality designation of 65 or more; Johnson, 2002). For a rock quality designation of 70 or higher, the particle-size specifications below shall be used. If actual rock quality designation is between 65 and 69, oversizing will be required.

Designated gradations for the riprap will be as specified on the Drawings. Riprap will be imported from off-site.

- Side Slope riprap shall have a minimum D_{50} as listed below and a minimum layer thickness of 1.5 times the D_{50} or the D_{100} of the riprap, whichever is greater:
  - 1.7 in. for non-accumulating flow side slopes
  - 5.3 in. for Cell 4A and Cell 4B southern side slopes
  - 5.3 in. for Cell 1 Disposal Area side slope
- Riprap used in the rock aprons shall have a minimum D_{50} as listed below and a minimum layer thickness of 1.5 times the D_{50} or the D_{100} of the riprap, whichever is greater
  - 3.4 in. for Rock Apron A

- 10.6 in. for Rock Apron B
- 9.0 in. for Rock Apron C

8.2.5 Filter Material

Filter material shall be shall be free from roots, branches, rubbish, and debris. The filter material shall meet the gradation specifications in Table 8.1.

Table 8.1 – Filter Material Gradation

Sieve Size	Percent Passing, By Weight
3-inch	100
No. 4	70-100
No. 20	40-60
No. 200	0-5

8.2.6 Topsoil

Topsoil will consist of select material from the designated, on-site topsoil borrow area (Section 3.4).

8.3 Work Description

The Contractor will place cover materials based on a schedule determined by the Owner and the Owner's analysis of settlement data, piezometer data and equipment mobility considerations. Settlement monitoring points will be established and monitored in accordance with Sections 8.3.1 to 8.3.3 and the Settlement Monitoring Plan approved by DWMRC for the site.

Cover construction shall minimize lenses, pockets, or layers of material differing substantially in texture, gradation or moisture content from the surrounding material. Oversized material will be controlled through selective excavation of stockpiled material, observation of placement by a qualified individual with authority to stop work and reject material being placed and by culling oversized material from the fill.

If the compacted surface of any layer of fill is too dry or smooth to bond properly with the layer of material to be placed thereon, it will be moistened and/or reworked with suitable equipment to a sufficient depth to provide relatively uniform moisture content and a satisfactory bonding surface before the next succeeding layer of fill is placed. If the compacted surface of any layer of fill in-place is too wet, due to precipitation, for proper compaction of the fill material to be placed thereon, the material will be reworked to reduce the moisture content to the specified range and recompacted.

No material will be placed when either the material being compacted, or the underlying material, is frozen or when ambient temperatures do not permit the placement or compaction of the materials to the specified density, without developing frost lenses in the fill.

8.3.1 Monitoring Interim Cover Settlement

The existing settlement monitoring points located within tailings disposal cells will be maintained by extending them through additional fill placement. For areas without settlement monitoring points, settlement monitoring points will be installed to monitor settlement of the interim cover surface and will be constructed as specified in the DWMRC approved Settlement Monitoring Plan. Settlement data will be collected and analyzed; and the reclamation techniques and schedule will be adjusted accordingly.

8.3.2 Monitoring Final Cover Settlement

After placement of final cover material, settlement plates will be extended or will be installed to monitor settlement of the final cover surface. The settlement plates will be constructed as specified in the DWMRC approved Settlement Monitoring Plan.

8.3.3 Monitoring Settlement Points

Settlement monument placement and data collection will be made in accordance with the DWMRC approved Settlement Monitoring Plan.

8.3.4 Interim Fill Layer

The interim fill layer will have a minimum thickness of 2.5 feet and will be placed over the tailings surface to form a stable working platform for subsequent controlled fill placement. This interim fill layer will be placed by pushing random fill material across the tailings such that the underlying tailings are displaced as little as possible. Interim fill will be placed in lifts of 12-inch maximum loose thickness to form a uniform subsoil layer for the cover system. A rough surface will be maintained on the surface of each lift.

8.3.5 Compacted Cover Layer

The compacted cover layer shall be constructed of random fill placed in lifts with a maximum loose thickness of 12 inches to form a continuous layer with a total minimum compacted layer thickness of 36 to 48 inches, as indicated in the Drawings. A rough surface will be maintained on the surface of each lift.

8.3.6 Growth Medium Layer

The growth medium layer shall be constructed of random fill placed to a minimum of 42 inches thick, above the compacted cover layer in lifts of 18-inch maximum loose thickness. If oversized material is observed during the excavation of fill material, it will be removed, as far as practicable, before it is placed in the fill. A rough surface will be maintained on the surface of all but the uppermost lift.

8.3.7 Organic Matter Amendment

Composted biosolids will be applied prior to the placement of the erosion protection layer (topsoil or the topsoil-gravel admixture). Composted biosolids will be uniformly spread over the surface of the growth medium layer and mixed to a depth of 6 inches.

8.3.8 Erosion Protection Layer: Topsoil-Gravel Admixture

The topsoil and the gravel admixture shall be 75 percent topsoil - 25 percent gravel admixture (by weight). The mixture shall be prepared (mixed) prior to transport to the placement areas. Gradation samples will be collected at the point of placement to verify the mixture’s content.

The CQA Site manager will approve the Contractor's proposed method of mixing based on the gradation results during initial placement.

The mixture shall be placed in one loose lift to form a uniform layer with a final thickness of 6 inches on the slope surfaces of the disposal cell (shown on the Drawings). The topsoil-gravel admixture shall be spread with tracked equipment.

The erosion protection layer will not be amended for organic matter or nutrients to avoid the stimulation of undesirable weedy species.

Following placement of the topsoil-gravel admixture erosion protection layer, the area shall be harrowed to reduce any compaction that may have occurred during placement of the cover and to create an uneven surface for optimum seedbed conditions.

8.3.9 Erosion Protection Layer: Topsoil

Topsoil (Section 8.2.6) shall be placed in one loose lift to form a uniform layer with a final thickness of 6 inches on the top and side slope surfaces of the disposal cell (shown on the Drawings). The topsoil shall be spread with tracked equipment.

The erosion protection layer will not be amended for organic matter or nutrients to avoid the stimulation of undesirable weedy species.

Following placement of the topsoil layer, the area will be harrowed to reduce any compaction that may have occurred during placement of the cover and to create an uneven surface for optimum seedbed conditions.

8.3.10 Riprap and Filter Material Placement

The side slopes of the reclaimed cover will be protected by rock surfacing. Riprap (Section 8.2.4) and filter material (Section 8.2.5) shall be placed in one or more lifts to the depths outlined in the Drawings and using the methods outlined below. The Drawings show the location of riprap with the size and thickness requirements for the various side slopes and aprons.

Filter material and riprap shall be handled, loaded, transported, stockpiled, and placed in a manner that minimizes segregation. Riprap and filter material shall be placed in or near its final location by dumping, then spread with a small dozer, the bucket of a trackhoe, or other suitable equipment. Riprap and filter material shall be placed and spread in a manner that minimizes displacement of underlying cover soils, natural soils, or filter material. Each layer of riprap and filter material shall be track-walked with a small dozer, tamped with the bucket of a trackhoe, or densified by other approved methods.

Placement of the riprap will avoid accumulation of riprap sizes less than the minimum D_{50} size and nesting of the larger sized rock. The riprap layer will be compacted by at least two passes by a dozer, tamping with the bucket of a trackhoe, or equivalent methods in order to key in the rock particles for stability. The completed layer of filter material shall be well-graded in particle-size distribution and free from pockets of smaller material and free from large voids or loose areas.

8.4 Performance Standard and Testing

8.4.1 Compacted Cover Layer Testing

Each lift of the compacted cover layer shall be compacted to at least 95 percent of the maximum dry density for the material, as determined by the standard Proctor test (ASTM D698). Water contents shall be adjusted, as needed, to meet the density requirements.

Material specifications for the random fill material shall be confirmed by gradation testing conducted by approved personnel. Testing shall consist of No. 200 sieve wash and particle-size distribution testing (ASTM D422) at a frequency of at least one test per 2,000 cubic yards of fill placed, or when material characteristics show a significant variation.

Checking of compaction shall consist of a minimum of one field density test per 500 cubic yards of material compacted. A minimum of two tests shall be taken for each day that more than 150 cubic yards of material is placed. A minimum of one test per lift and at least one test for every full shift of compaction operations will be taken.

Field density tests shall be compared with standard Proctor tests (ASTM D698 Method A or C) on the same material. Standard Proctor tests shall be conducted at a frequency of at least one test

per 5,000 cubic yards of material compacted, or when material characteristics show significant variation.

Field density testing may be conducted with the sand cone test (ASTM D1556) or a nuclear density gauge (ASTM D6938, or as modified by the CQA Site Manager). Correlation of nuclear density gauge results shall be by comparison with results from sand cone test(s) and laboratory testing for water content(s) using the oven drying method (ASTM D2216) on similar material.

8.4.2 Growth Medium Layer Testing

Each lift of the growth medium layer shall be compacted to at least 85 percent of the maximum dry density for the material, as determined by the standard Proctor test (ASTM D698). Water contents shall be adjusted, as needed, to meet the density requirements.

Material specifications for the random fill for water storage layer shall be confirmed by gradation testing conducted by approved personnel. Testing shall consist of No. 200 sieve wash and particle-size distribution testing (ASTM D422) at a frequency of at least one test per 2,000 cubic yards of fill placed, or when material characteristics show a significant variation.

The frequency of the field density tests will be not less than one test per 2,000 cubic yards of compacted fill. A minimum of two tests will be taken for each day that more than 150 cubic yards of material is placed. A minimum of one test per lift and at least one test for every full shift of compaction operations will be taken.

Field density tests shall be compared with standard Proctor tests (ASTM D698 Method A or C) on the same material. Standard Proctor tests shall be conducted at a frequency of at least one test per 10,000 cubic yards of material compacted, or when material characteristics show significant variation.

Field density testing may be conducted with the sand cone test (ASTM D1556) or a nuclear density gauge (ASTM D6938, or as modified by the CQA Site Manager). Correlation of nuclear density gauge results shall be by comparison with results from sand cone test(s) and laboratory testing for water content(s) using the oven drying method (ASTM D2216) on similar material.

8.4.3 Topsoil-Gravel Admixture Testing

The gradation specifications for the topsoil-gravel admixture (Section 8.2.3) shall be confirmed by gradation testing, on samples collected from the point of placement (on the topdeck). Testing shall consist of particle-size distribution testing (ASTM D422) at a frequency of at least one test per 2,000 cubic yards of mixture placed, or when the characteristics of the mixture show a significant variation. The CQA Site Manager may choose to increase the frequency of testing at the beginning of placement to evaluate the mixing method proposed by the Contractor.

Topsoil-gravel admixture thickness will be controlled through the establishment of grade stakes placed on a 200 x 200 foot grid on the top of the cells and by a 100 x 100 foot grid on the cell slopes. Physical checks of topsoil-gravel admixture depth will be accomplished through the use of hand dug test pits at the center of each grid in addition to monitoring the depth indicated on the grade stakes.

8.4.4 Riprap Testing

Material specifications for the riprap shall be confirmed by gradation testing conducted by the CQA Technician. Testing shall consist of particle-size distribution testing (ASTM D422) at a frequency of at least one test per 2,000 cubic yards of rock delivered to the site, or when rock characteristics show a significant variation.

Rock layer thickness will be controlled through the establishment of grade stakes placed on a 200 x 200 foot grid on the top of the cells and by a 100 x 100 foot grid on the cell slopes. Physical checks of riprap depth will be accomplished through the use of hand dug test pits at the center of each grid in addition to monitoring the depth indicated on the grade stakes.

The durability of the riprap shall be verified by durability tests outlined in Section 8.4.7.

8.4.5 Filter Material Testing

Material specifications for filter material (Section 8.2.5) shall be confirmed by gradation testing conducted by CQA Technician. Testing shall consist of No. 200 sieve wash and maximum particle size testing (ASTM D422) at a frequency of at least one test per 10,000 cubic yards of fill placed, or when material characteristics show a significant variation.

Filter layer thickness will be established during construction with grade stakes placed on a grid or centerline and offset pattern and layer thickness marks on each grade stake. The minimum thickness of the layer will be verified by spot checking of layer thickness by hand excavation in selected locations.

8.4.6 Rock Durability Testing

For riprap materials, each load of material will be visually checked against standard piles for gradation prior to transport to the tailings piles. Prior to delivery of any riprap materials to the site, rock durability tests will be performed for each gradation to be used. Test series for riprap durability will include specific gravity, absorption, sodium soundness and LA abrasion. During construction, additional test series and gradations will be performed for each type of riprap when approximately one-third (1/3) and two-thirds (2/3) of the total volume of each type have been produced or delivered. For any type of riprap where the volume is greater than 30,000 cubic yards, a test series and gradations will be performed for each additional 10,000 cubic yards of riprap produced or delivered.

8.5 Surface Slopes and Grades

The final cover surface shall have maximum side slopes of 5:1 (H:V) and a top surface sloping in the direction and grade shown on the Drawings. The side slopes and top surface shall be free from abrupt changes in grade or areas of runoff concentration. The perimeter apron at the toe of the side slopes shall have the dimensions as shown on the Drawings.

8.6 Grading Tolerances

The completed cover surface shall be constructed to within 1.0 foot (horizontally) of the lines as designed, and within 0.1 foot (vertically) of the elevations as designed. The final surface of the subsoil zone shall be smoothed to avoid abrupt changes in surface grade. The layer thicknesses shall meet the required minimum thicknesses.

The completed riprap shall be placed to within 5.0 foot (horizontally) of the layout as designed, and within 0.5 foot (vertically) of the elevations as designed. The rock layer thicknesses shall meet the minimum requirements.

9.0 REVEGETATION

9.1 General

Following topsoil placement, the cover surface and other areas disturbed during reclamation work will be revegetated. This section outlines the requirements for vegetation establishment where required. This section may be revised as necessary based on field requirements and soil nutrient analyses at the time of revegetation.

9.2 Materials Description

The soil amendments, seed mixture, and erosion control materials for revegetation are outlined below. Submittals for each of the following products shall be provided to the Owner for approval prior to use of such products.

9.2.1 Soil Amendments

The proposed application rate may be adjusted up or down based on soil chemical analysis that is conducted prior to placement of the water storage layer.

Composted biosolids shall be added at a rate of 10 tons/acre and uniformly spread over the surface of the water storage layer and mixed to a depth of 15 cm. This treatment will be applied after the water storage layer is in-place and before placement of the erosion protection layer.

9.2.2 Seed Mix

Species selection for the seed mixture was based on native vegetation found in the area as well as soil and climatic conditions of the Mill site. Changes to the seed mixture will be as approved by the Owner. The seed mixture in Table 9.1 shall be used on all seeded areas.

Table 9.1. Species and seeding rates proposed for Mill site.

Scientific Name	Common Name	Varietal Name	Native/ Introduced	Seeding Rate (lbs PLS/acre)†	Seeding Rate (# seeds/ft²)
Grasses					
Pascopyrum smithii	Western wheatgrass	Arriba	Native	3.0	7.9
Pseudoroegneria spicata	Bluebunch wheatgrass	Goldar	Native	3.0	9.6
Elymus trachycaulus	Slender wheatgrass	San Luis	Native	2.0	6.2
Elymus lanceolatus	Streambank wheatgrass	Sodar	Native	2.0	7.3
Elymus elymoides	Squirreltail bottlebrush	Toe Jam	Native	2.0	8.8
Thinopyrum intermedium	Pubescent wheatgrass	Luna	Introduced‡	1.0	1.8
Achnatherum hymenoides	Indian ricegrass	Paloma	Native	4.0	14.7
Poa secunda	Sandberg bluegrass	Canbar	Native	0.5	11.4
Festuca ovina	Sheep fescue	Covar	Introduced‡	1.0	11.5
Bouteloua gracilis	Blue grama	Hachita	Native	1.0	16.5
Hilaria jamesii	Galleta	Viva	Native	2.0	7.3
Forbs					
Achillea millefolium, variety *occidentalis*	Common yarrow	VNS*	Native	0.5	32
Artemisia ludoviciana	White sage	VNS	Native	0.5	45
Shrubs					
Atriplex canescens	Fourwing saltbush	Wytana	Native	3.0	3.4
Ericameria nauseosa	Rubber rabbitbrush	VNS	Native	0.5	4.6
Total				26.5	188

†Seeding rate is for broadcast seed and presented as pounds of pure live seed per acre (lbs PLS/acre).
‡Introduced refers to species that have been 'introduced' from another geographic region, typically outside of North America. Also referred to as 'exotic' species.
*VNS=Variety Not Specified and seed source will be from sites that are climatically similar to White Mesa.

Seed shall be purchased as pounds of pure live seed and will be certified by the Utah State Department of Agriculture and Food. Certification will verify that the seed is correctly identified and genetically pure. Once the seed is obtained, seed labels will be checked to determine the percent PLS and the date that the seed was tested for percent purity and percent germination. If the test date is greater than 6 months old, the seed will be tested again before being accepted.

9.2.3 Erosion Control Materials

Wood fiber mulch will consist of specially prepared wood fibers and will not be produced from recycled material such as sawdust, paper, cardboard, or residue from pulp and paper plants. The fibers will be dyed an appropriate color, with non-toxic, water-soluble dye to facilitate visual metering during application. Wood-fiber mulch will be supplied in packages and each package will be marked by the manufacturer to show the air-dry weight.

A tackifier will be used with the wood-fiber mulch to improve adhesion. The tackifier will be a biodegradable organic formulation processed specifically for the adhesive binding of mulch. In addition, the tackifier will uniformly disperse when mixed with water and will not be detrimental to the homogeneous properties of the mulch slurry.

9.3 Work Description

Revegetation efforts shall be directed at all reclaimed and disturbed areas. The goal of the revegetation plan is to ensure that a self-sustaining vegetative community is established.

9.4 Soil Amendment Application

Following final placement and grading of the frost barrier layer, amendments will be applied as discussed in Section 9.2.1. Inorganic sources of nitrogen, phosphorus, and potassium will not be applied to the soil because composted biosolids will provide all the macronutrients required for long-term sustainability.

9.5 Growth Zone Preparation

A favorable seedbed shall be prepared on the topsoil layer or topsoil-rock mixture, prior to seeding operations. The soil shall be loose and friable so as to maximize contact with the seed. The soil will be tilled, following site contours with a disc or harrow (or similar approved equipment) to a maximum depth of 6 inches. The depth of valleys and the height of ridges caused by the final tillage operations are not to exceed 3 inches.

9.6 Seed Application

Seeding will follow the application of soil amendments and seedbed preparation, by broadcast spreading method. This procedure will use a centrifugal type broadcaster (or similar implement), also called an end gate seeder. The broadcasters will have a minimum effective spreading width of 20 feet. Seed will be applied in two separate passes. One-half of the seed will be spread in one direction and the other half of seed will be spread in a perpendicular direction. This will ensure that seed distribution across the site is highly uniform and also provide the opportunity to adjust the seeding rate if the specified rate is not being achieved. Seeding will not occur if wind speeds exceed 10 mph.

Immediately following seeding, the area will be lightly harrowed to provide seed coverage and to maximize seed-soil contact. Broadcast seed shall be harrowed into the soil to a depth of 0.25 to 0.75 inches.

Seeding will take place as soon as practical after the cover system is in place. Successful seeding in southeastern Utah can occur either in late fall (e.g. October) as a dormant seeding, with germination and establishment occurring the following spring or can be conducted in June, prior to the summer monsoon season. Timing for seeding will depend upon the construction schedule for the cover system.

9.7 Erosion Control Material Application

Mulch will be applied immediately following seeding. A weed-free, wood-fiber mulch shall be applied to the seeded area at a minimum rate of 1.5 tons/acre. The wood-fiber mulch will be applied by means of hydraulic equipment that utilizes water as the carrying agent. A continuous agitator action, that keeps the mulching material and approved additives in uniform suspension, will be maintained throughout the distribution cycle.

The pump pressure will be capable of maintaining a continuous non-fluctuating stream of slurry. The slurry distribution lines will be large enough to prevent stoppage and the discharge line will be equipped with a set of hydraulic spray nozzles that will provide even distribution of the mulch slurry to the seedbed. Mulching will not be done in the presence of free surface water resulting from rains, melting snow, or other causes. Tackifier may be added either during the manufacturing of the mulch or incorporated during mulch application.

9.8 Performance Standard and Testing

The following section describes performance-based criteria for successful revegetation.

9.8.1 Seeding Rates

Prior to seeding, a known area will be covered with a tarp and seed will be distributed using the broadcaster and simulating conditions that would exist under actual seeding conditions. Seed will then be collected and weighed to determine actual seeding rate in terms of pounds per acre. This process will be repeated until the specified seeding rate is obtained.

During the seeding process, the seeding rate will be verified at least once by comparing pounds of seed applied to the size of the area seeded.

9.8.2 Erosion Control

The cover shall be inspected two times per year for eroded areas. Any area that has experienced erosion shall be backfilled and reseeded. Erosion control materials shall also be reapplied over reseeded areas.

9.8.3 Weed Control

Weed management will be conducted on the Mill site by identifying the presence of any noxious weeds during annual vegetation surveys and developing a weed control plan that is specific to the species that are present (Table 9.2). Noxious weed control is species-dependent and both method and timing will vary from species to species.

Table 9.2. Noxious weed species.

Scientific Name	Common Name
Utah State—Listed Noxious Weeds	
Acroptilon repens	Russian knapweed
Cardaria spp.	Whitetop (all species)
Carduus nutans	Musk thistle
Centaurea diffusa	Diffuse knapweed
Centaurea solstitialis	Yellow star thistle
Centaurea stoebe ssp. micranthos	Spotted knapweed
Centaurea virgate ssp. Squarrosa	Squarrose knapweed
Cirsium arvense	Canada thistle
Convolvulus spp.	Bindweed (all species)
Cynodon dactylon	Bermuda grass
Elymus repens	Quackgrass
Euphorbia esula	Leafy spurge
Isatis tinctoria	Dyer’s woad
Lepidium latifolium	Broadleaf pepperweed
Lythrum salicaria	Purple loosestrife
Onopordum acanthium	Scotch thistle
Sorghum almum	Perennial sorghum (all species)
Taeniatherum caput-medusae	Medusahead
San Juan County—Listed Noxious Weeds	
Aegilops cylindrical	Jointed goatgrass
Alhagi maurorum	Camelthorn
Asclepias subverticillata	Western whorled milkweed
Solanum elaeegnifolium	Silverleaf nightshade
Solanum rostratum	Buffalobur

Each survey will identify noxious weed populations and locate these populations on a map using a set of symbols to identify species, size of the infestation, and density of the population. The effectiveness of control methods will be documented in each annual survey. In addition, immediately adjacent off-site properties will be visually surveyed to a distance of 100 feet. Inspections will be conducted by personnel familiar with the identification of noxious weeds in the area and based on Utah’s Noxious Weed List.

The selected control methods will be based on the type, size, and location of the mapped noxious weeds. The treated area(s) will be monitored and re-inspected annually for new weed introductions and to evaluate the success of the control methods. Prevention is the highest priority weed management practice on non-infested lands; therefore protecting weed-free plant communities is the most economical and efficient land management practice. Prevention is best accomplished by ensuring that new weed species seed or vegetative reproductive plant parts of weeds are not introduced into new areas, and by early detection of any new weed species before they begin to spread.

Control methods may include chemical or mechanical approaches. The optimum method or methods for weed management vary depending on a number of site-specific variables such as associated vegetation, weed type, stage of growth, and severity of the weed infestation.

Chemical Control

Chemical control consists mostly of selective and non-selective herbicides. Considerations for chemical controls include: herbicide selection, timing of application, target weed, desirable plant species being grown or that will be planted, number of applications per year and number of years a particular species will need to be treated for desired control. Also important are the health and safety factors involved, and the need to consider undesirable impacts. The use of herbicides will be in compliance with all Federal and State laws on proper use, storage, and disposal. The chemical application will be done by a licensed contractor in accordance with all applicable laws and regulations and all label instructions will be strictly followed. Applications of herbicides will not be permitted when the instructions on the herbicide label indicate conditions that are not optimal.

Mechanical Control

Mechanical control is the physical removal of weeds from the soil and includes tilling, mowing, and pulling undesirable plant species. Tillage is most effective prior to seeding and establishment of desirable vegetation. The tillage method of weed control can be effective in eliminating noxious perennial weeds when repeated at short intervals (every 1-2 weeks) throughout the growing season. Tillage has the drawback of indiscriminately impacting all vegetation interspersed with weeds in established areas and can eliminate competitive, desirable vegetation leaving behind a prime seedbed for weeds to reinvade. Mowing can be an effective method for controlling the spread of an infestation and preventing the formation and dispersal of seeds. Mowing is most effective on weeds which spread solely or primarily by seed. In order to achieve this, mowing must be repeated at least twice during the growing season prior to, or shortly after bloom. Also, even the most intense mowing treatment will not kill hardy perennial weeds. Additional considerations will be made when selecting control treatments when specific situations arise regarding type, size, and location of weed infestations. Examples of this are perennial versus biennial, broadleaf versus grasses, noxious weeds interspersed with desirable vegetation, large monoculture patches, or small patches requiring spot treatment.

Treatment windows schedules, based on the control methods chosen and the noxious weeds present, will be established for each treatment area. The best time to treat perennial noxious weeds is in the spring or fall during their active growth phase. Different species will have different optimum treatment times even with the same type of control. Perennial weeds usually grow vegetatively in the spring, flower and seed in late spring and early summer, enter dormancy during the summer and actively grow again in the fall. The treatment windows selected will depend on the species present and control methods selected.

The final preparatory step is to determine the priority for areas to be treated. Prioritization ensures that the most important areas are dealt with at the most effective times. Important areas of concern include areas that may transport weed seeds. These areas include ditches, roadsides, and land equipment storage sites. Large monoculture patches are of concern wherever they occur and will always be high priority. Also, small patches of weeds will be treated to prevent expansion of weed populations.

Once the treatment plan is implemented, detailed records will be kept, and success or failure of treatment will be recorded so as to eliminate unsuccessful treatments.

9.8.4 Vegetation Establishment Performance

The following Revegetation Acceptance Goals/Criteria have been adapted from the Monticello Site and will be used at the Mill site to determine reclamation success.

Revegetation Acceptance Goal/Criteria:

Criterion 1 Species Composition

a. The vegetative cover (the percentage of ground surface covered by live plants) shall be composed of a minimum of five perennial grass species (at least four listed as native), one perennial forb species, and two shrub species listed in Table 9.1.

Criterion 2 Vegetative Cover

a. Attain a minimum vegetative cover percentage of 40 percent.

b. Individual grass and forb species listed in Table 9.1 that are used to achieve the cover criteria shall have a minimum relative cover (the cover of a plant species expressed as a percentage of total vegetative cover) of 4 percent and a maximum relative cover of 40 percent.

c. Individual species not listed in Table 9.1 may be accepted as part of the cover criteria if it is demonstrated that the species is native or adapted to the area and is a desirable component of the reclaimed project site.

d. Species not listed in Table 9.1, including annual weeds or other undesirable species such as those listed in Table 9.2, shall not count toward the minimum vegetative cover requirement. Every attempt shall be made to minimize establishment of all noxious weeds.

e. Reclaimed areas shall be free of state- and county-listed noxious weeds (Table 9.2).

f. The vegetative cover shall be self-regenerating and permanent. Self-regeneration shall be demonstrated by evidence of reproduction, such as tillers and seed production.

Criterion 3 Shrub Density

a. A minimum shrub density of 500 stems per acre.

b. Shrubs shall be healthy and have survived at least two complete growing seasons before being evaluated against success criteria.

Plant cover will be measured annually on the tailing cells for a minimum of ten years or until the revegetation goals stated above are achieved. Cover will be measured by the point method, using a vegetation sighting scope mounted on an adjustable tripod with a level. Cover will be measured for each species encountered, as well as litter, rock, and bareground. Cover measurements will be made along a minimum of ten randomly placed transects on each tailing cell that are 100 feet long. A total of 100 points will be sited at one-foot intervals along each transect to collect cover data in the categories of live vegetation, litter, rock, and bareground. Sample adequacy will be determined for each tailing cell using the following formula that identifies the minimum number of samples that are necessary to estimate the population mean at a 90 percent level of confidence. Total live vegetation cover will be used to calculate sample adequacy.

$$n = \frac{t^2 s^2}{(.10x)^2}$$

Where: n = minimum number of samples required to meet sample adequacy requirements

s^2 = variance

t^2 = 1.64 for 90% confidence

x = sample mean

Shrub density will be measured in belt transects placed on either side of the cover transects. All shrubs will be counted within a three-foot wide strip or belt transect along each side of the transect used for point cover measurements, resulting in a belt transect that is six-feet wide and 100 feet long.

In addition to the above cover sampling, annual observations will be made of overall plant community health and sustainability. Overall health will be based on plant vigor, presence of annual weeds, and signs of plant deficiencies or toxicities. Plant community sustainability will be based on observations of reproduction, including both vegetative reproduction, such as tillering, and seed production.

If revegetated areas are not making satisfactory progress in meeting revegetation goals outlined above, then remedial actions will be implemented as needed. These actions may include fertilization/soil amendments, reseeding, weed control, and/or erosion control depending upon the cause of the problem that may exist and the best remediation approach to ensure plant community success.

10.0REFERENCES

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Exhibit A-1:
Daily QA/QC Checks

August 2016

1.0 INTRODUCTION

A background count rate and reliability check using a check source shall be performed daily, prior to use, when the detector/scaler is used for counting. Background count rates and source checks shall be input on a control chart after developing of the mean and standard deviation (sigma) as discussed below.

2.0 QC CONTROL CHARTING

Select a background location such as an office or other location where background gamma radiation gamma values are not expected to vary. Take ten 30-second count readings and record them on Form 1. Using the ten readings, calculate the mean, sigma, and 2 sigma). These results shall also be recorded on Form 1.

Daily, prior to use, and at the end of surveys, perform a 30-second background and source count at the same location and in the same configuration as the acceptable ranges were developed. If the background or source check result exceeds a difference of two standard deviations, (2s or 2 sigma) from the mean, as shown on Figure 2, the Instrument Control Chart, re-count the background or source, log the results, and enter the new data on the Instrument Control Chart. Two successive background or source check counts outside the 2s Instrument Control Chart range indicates possible problems with the detector/electronics.

Values between ± 2s of the mean net counts generally indicate normal operation of the instrument. Values outside the mean ± 2s will occur with a frequency of less than 5 percent. Values greater than 3s from the mean will occur with a frequency of less than one percent and should be investigated. Two consecutive measurements outside 3s indicate problems with equipment and require adjustments and/or repairs as necessary. The scaler shall be removed from service and immediate notification shall be made to the RSO or designee prior to counting any samples.

Calibrations shall be checked whenever a significant change or repair is made to the measurement system, or when changes are detected as a result of check source measurements.

Control charts shall be maintained to indicate instrument operability and/or malfunction problems on a daily basis when instruments are in use. Use the attached control chart. Control charts should be kept for both background counts and counts with a check source, such as a 5 μCi Cs-137 source.

FORM 1: CALCULATION OF INSTRUMENT STANDARD DEVIATION							
Date of 1st Instrument Use	**Count 1**	**Count 2**	**Count 3**	**Count 4**	**Count 5**	**Count 6**	**Count 7**
	Count 8	**Count 9**	**Count 10**	**Sample Mean (λ)**	**Sample Standard Deviation (σ)**	**Lower Control Limit (λ-2s)**	**Upper Control Limit (λ+2s)**

$$\lambda = \frac{1}{10}\sum_{i=1}^{10} n_i$$

Where λ is the mean of the counts, and n is the 30 second count rate

$$s = \sqrt{\frac{\sum_{i=1}^{m}(n_i - \lambda)}{9}}$$

Where σ is the standard deviation, λ is the mean of the counts, and n is the 30 second count rate

FORM 2: INSTRUMENT CONTROL CHART

Initials	Date	Count	Sample Mean (λ)	Sample Standard Deviation (s)	Lower Control Limit (λ-2s)	Upper Control Limit (λ+2s)	Pass?
							Y or N
							Y or N
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