Energy Fuels Resources (USA) Inc.
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August 10, 2016

Sent VIA OVERNIGHT DELIVERY

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

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

Dear Mr. Anderson:

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

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

Yours very truly,

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

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

Reclamation Plan

White Mesa Mill

Blanding, Utah

Radioactive Materials License No. UT1900479

Revision 5.1

August 2016

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

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INTRODUCTION

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

Summary of Plan

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

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

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

Plan Organization

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

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

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

Supporting documents include:

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

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

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

If Cell 4B is not used in the future for tailings disposal, Cell 4B can be reclaimed for clean closure. This design is not presented in this report.

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

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

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

1 SITE CHARACTERISTICS

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

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

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

Revision 3.0 of this Plan was submitted to and approved by NRC in 2000. A copy of Revision 3.0 of this Plan was also submitted to the DWMRC as part of the 2007 License Renewal Application. The most recently approved version of the Reclamation Plan is Revision 3.2b (Denison, 2011a). This version of the Reclamation Plan was approved by DRC under the Mill License on January 26, 2011. A copy of the White Mesa Mill Reclamation Plan, Revision 4.0 was previously submitted to the Director in November 2009 and is on file at the DRC. This version and previous versions of the Reclamation Plan presented design criteria for a multi-layered cover system. Revision 5.0 of this Plan were submitted to the DWMRC in September 2011. EFRI prepared Revision 5.0 of the Plan to incorporate changes since 2009 and to address interrogatories from the DWMRC (DRC, 2010 and 2011). EFRI prepared this Revision 5.1 of the Plan to incorporate changes since 2011 and include updates provided in EFRI response to interrogatories and review comments from DWMRC on Reclamation Plan, Revision 5.0 (Denison, 2012; EFRI, 2012a; EFRI, 2015).

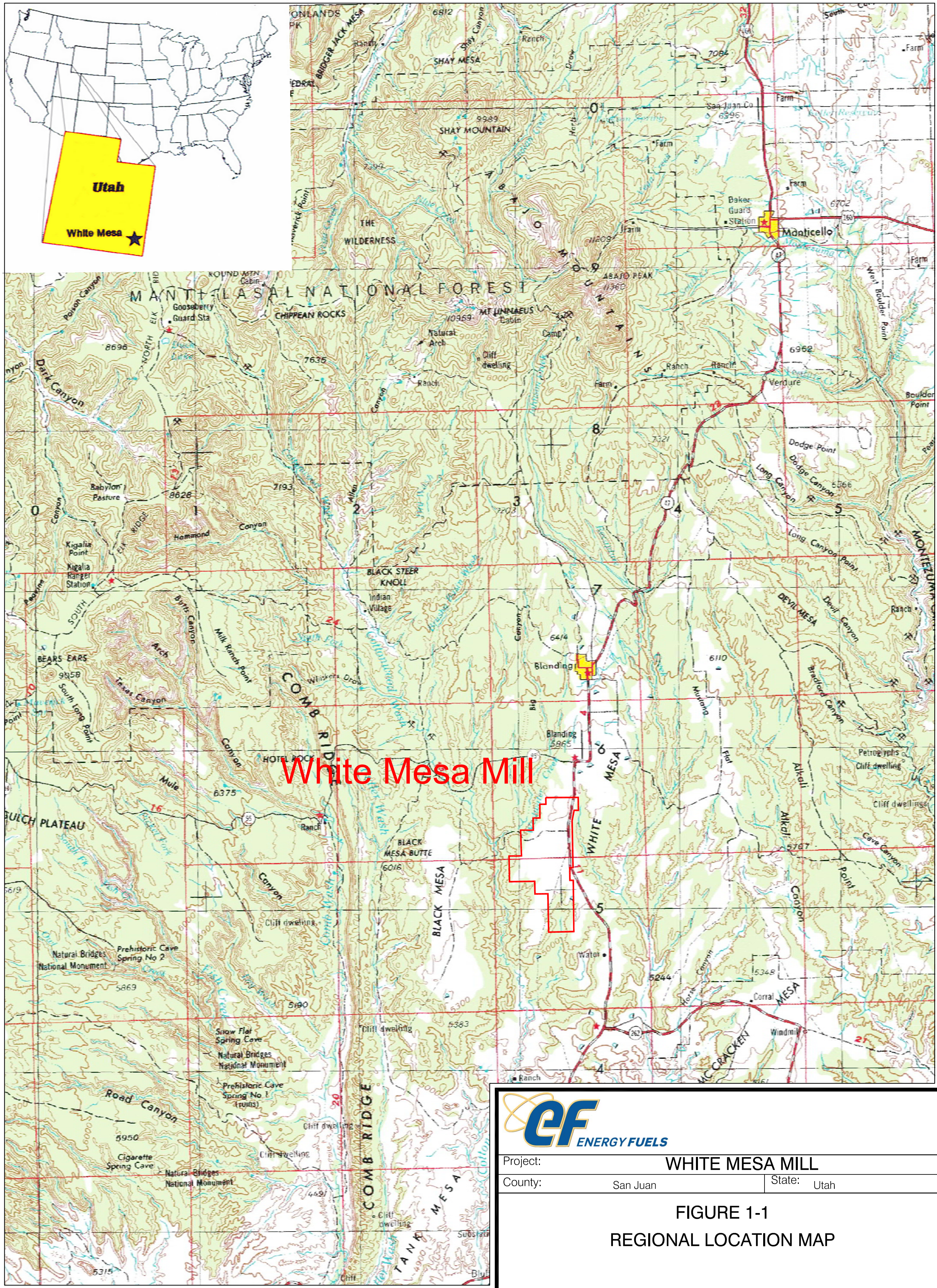
This Section 1.0 of the Plan incorporates by reference, updates or supplements, information previously submitted in previous environmental analyses performed at the Mill, as described below.

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

[3] The License was originally issued by the NRC as a source material license under 10 CFR Part 40 on March 31, 1980. It was renewed by NRC in 1987 and again in 1997. After the State of Utah became an Agreement State for uranium mills in August 2004, the License was re-issued by the DWMRC as a State of Utah Radioactive Materials License on February 16, 2005, but the remaining term of the License did not change.
[4] Prior to 2015, the DWMRC was two separate divisions of UDEQ, the Division of Radiation Control and the Division of Solid and Hazardous Waste.

addition, the following environmental evaluations and other reports have been performed for the Mill and are incorporated by reference into, updated or supplemented by this Section 1.0:

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



Scale 1"=5 miles

A portion of USGS Map No NJ12-9 Cortez, CO-UT

ENERGY FUELS

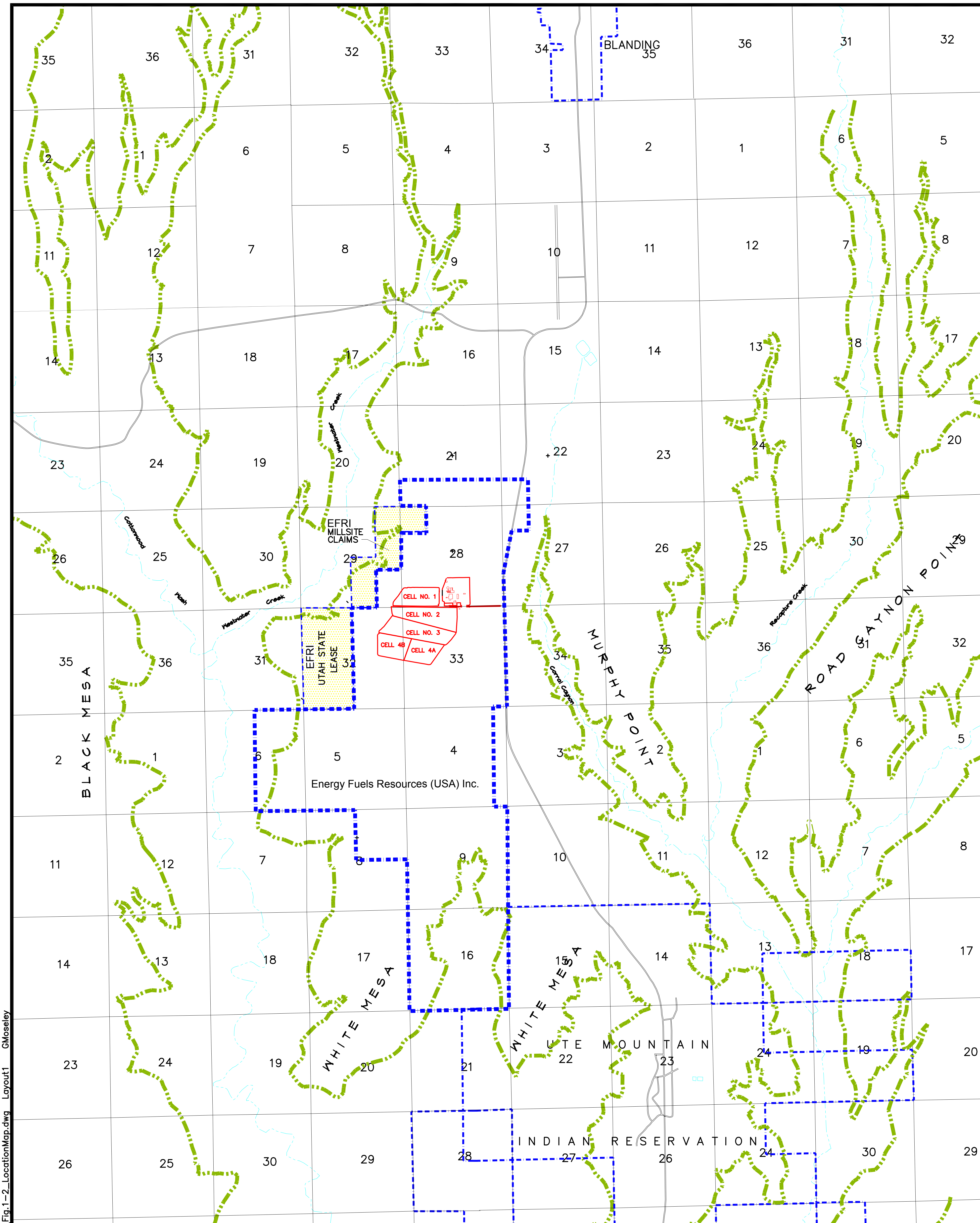
Project:	WHITE MESA MILL
County: San Juan	State: Utah

FIGURE 1-1

REGIONAL LOCATION MAP

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

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



N

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

SCALE: 1" = 5,000'

UT83-SF

ENERGY FUELS

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

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

1.1 Climate and Meteorology

1.1.1 Regional

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

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

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

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

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

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

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

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

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

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

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

1.1.2 Storms (FES Section 2.1.4, updated)

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

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

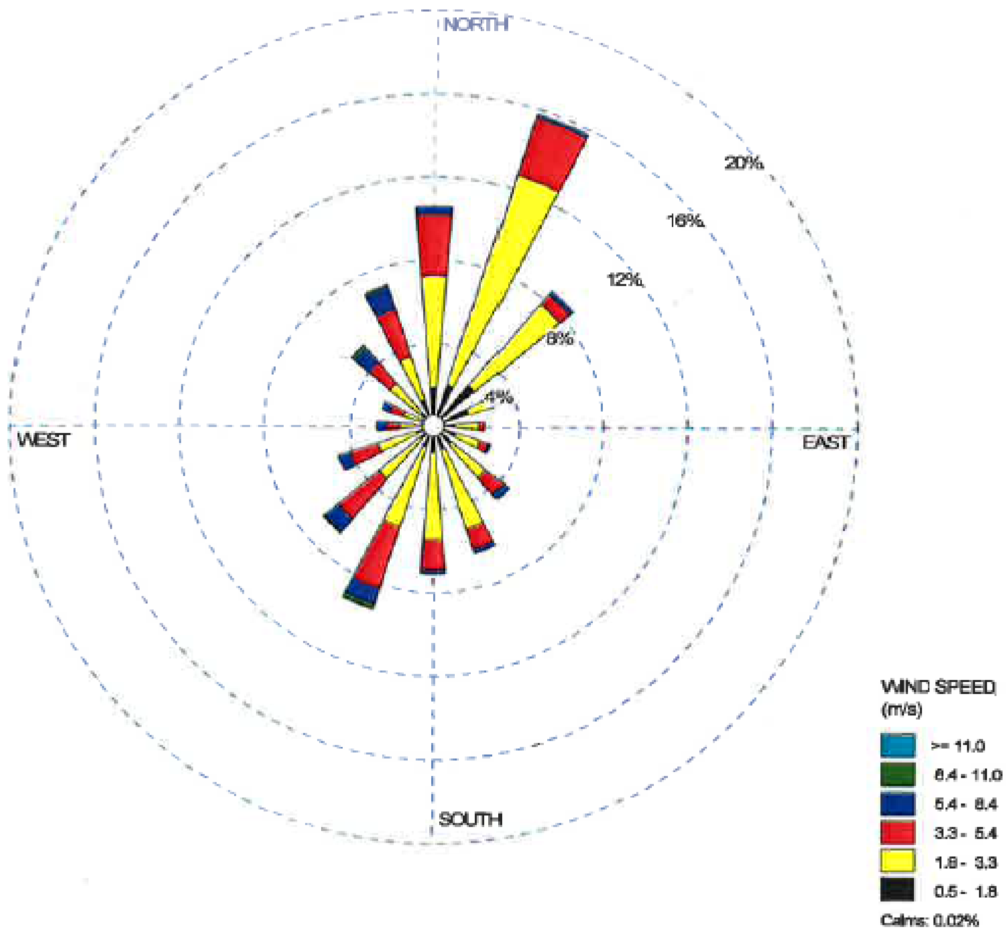
1.1.3 On Site

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

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

White Mesa Mill
Meteorological Data

Wind Speed
Direction (blowing from)



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

WRPLOT View - Lakes Environmental Software

ENERGY FUELS

REVISIONS		Project: White Mesa Mill	
Date	By	County: San Juan	State: UT
		Location:	

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

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

1.2 Topography

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

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

1.3 Archeological Resources

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

1.3.1 Archeological Sites

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

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

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

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

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

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

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

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

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

1.3.2 Current Status of Excavation

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

The sites reported as excavated are as follows:

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

Sites for which excavation has not been required are:

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

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

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

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

42Sa27732

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

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

1.4 Surface Water

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

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

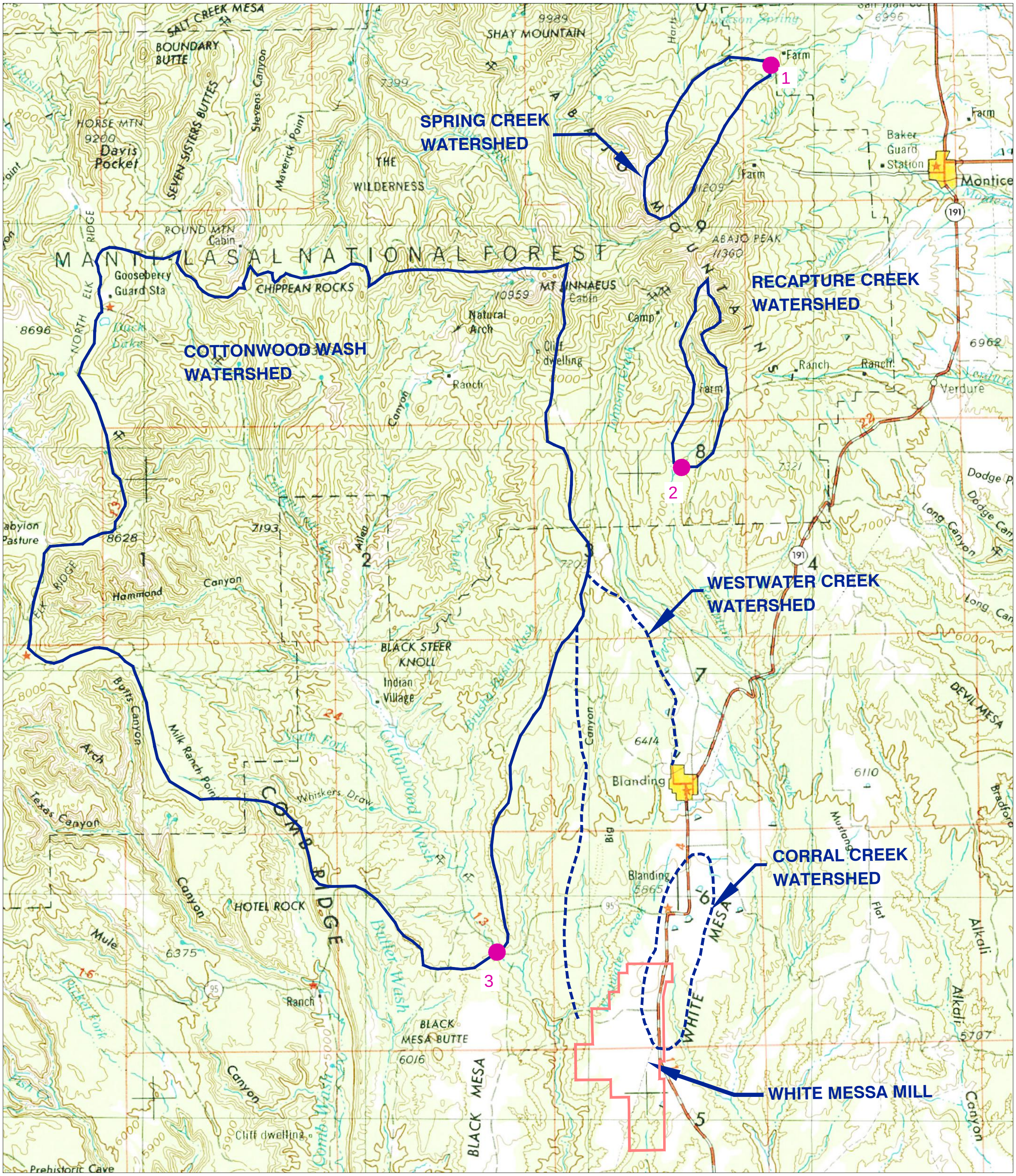
1.4.1 Surface Water Description (FES Section 2.6.1.1)

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

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

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

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



1 USGS GAUGE NO. 09376900

2 USGS GAUGE NO. 09378630

3 USGS GAUGE NO. 09378700

Energy Fuels

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

Drainage Map of the Vicinity of the White Mesa Mill

Figure 1.4-1

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

Table 1.4-1
Drainage Areas of Project Vicinity and Region

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

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

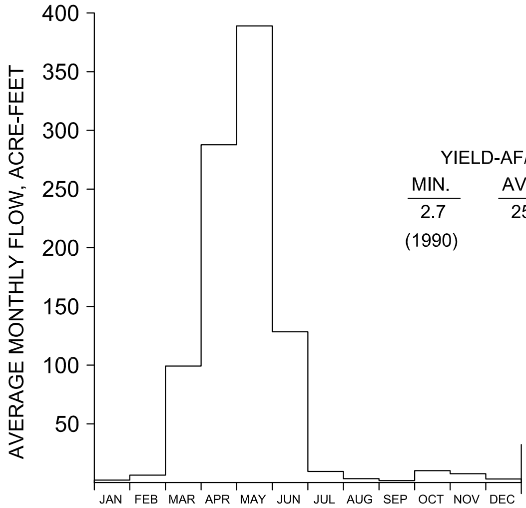
Storm runoff in these streams is characterized by a rapid rise in the flow rates, followed by rapid recession primarily due to the small storage capacity of the surface soils in the area. For example, on August 1, 1968, a flow of 20,500 cfs (581 m^3/sec) was recorded in Cottonwood Wash near Blanding.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

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

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

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

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

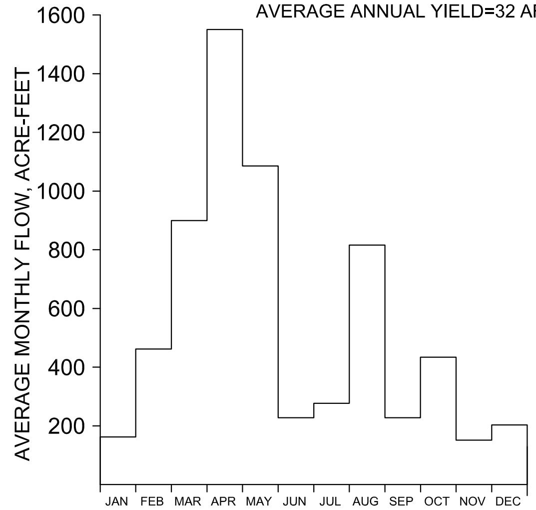


YIELD-AF/SQ. MI

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

MONTH
RECAPTURE CREEK NEAR BLANDING
USGS GAUGE 09378630

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

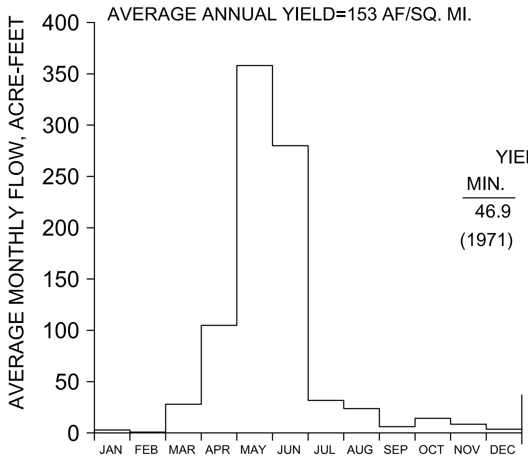


YIELD-AF/SQ. MI

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

MONTH
COTTONWOOD WASH NEAR BLANDING
USGS GAUGE 09378700

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



YIELD-AF/SQ. MI

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

MONTH
SPRING CREEK ABOVE DIVERSIONS,
USGS GAUGE 09376900

NOTES

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

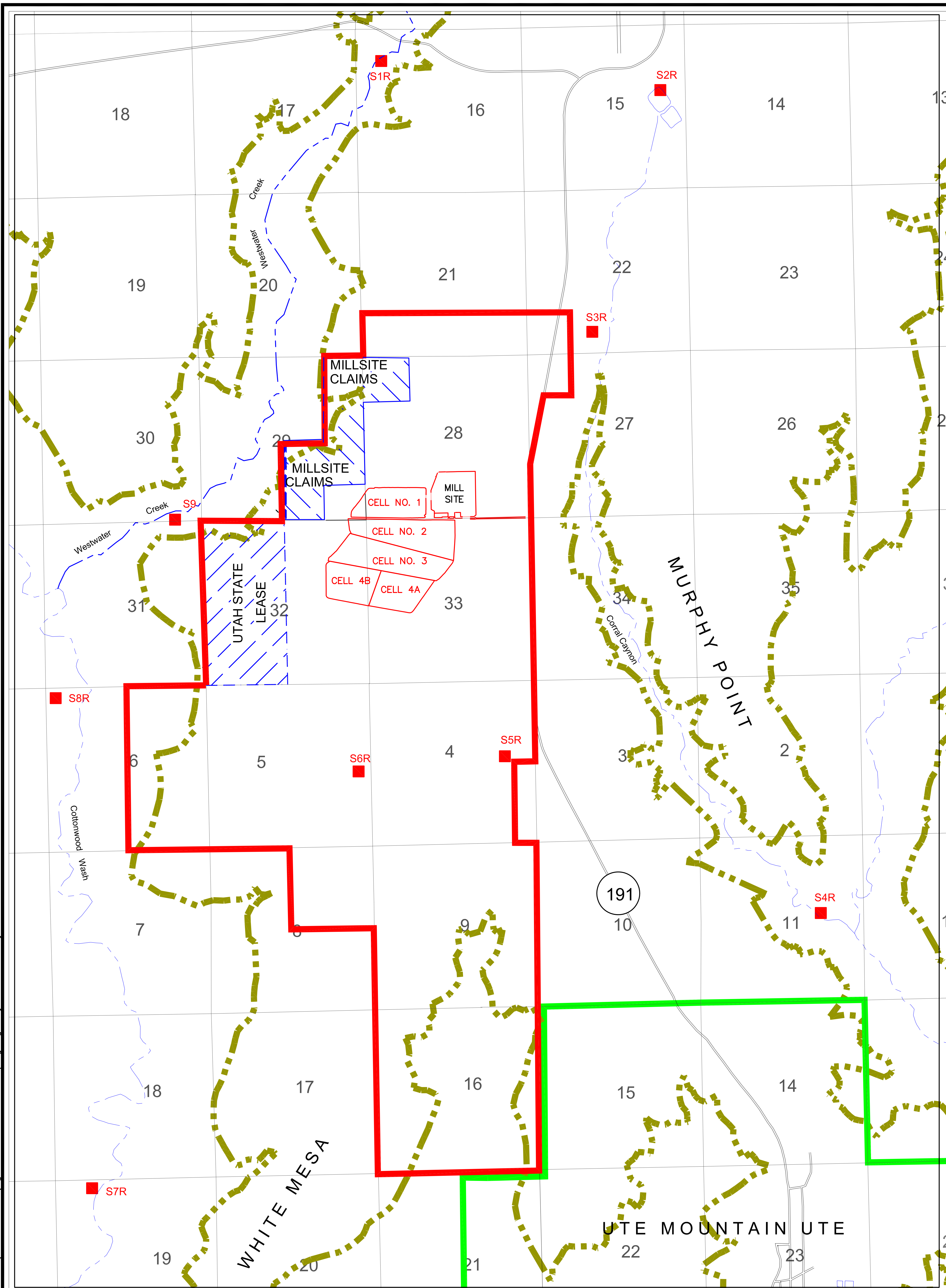
ENERGY FUELS

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

FIGURE 1.4-2

Streamflow Summary
Blanding, UT Vicinity

Date: Nov, 2009 Design: Drafted By: DLS



PROPERTY BOUNDARY

RESERVATION BOUNDARY

CANYON RIM

S SURFACE WATER SAMPLING LOCATION

N

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

SCALE: 1" = 3,000'

UT83-SF

ENERGY FUELS

REVISIONS		Project: White Mesa Mill	
Date	By	County: San Juan	State: UT
07-11	GM	Location:	

SURFACE WATER QUALITY SAMPLING STATIONS IN THE WHITE MESA VICINITY

FIGURE 1.4-3

Author: | Date: Nov 2009 | Drafted By: DLS

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

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

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

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

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

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

1.4.3 Surface Water Background Quality

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

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

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

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

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

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

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

Source: FES Table 2.22 and Mill Sample Data

*Data are from historical sampling events. All other data were collected during the 2009 annual Seeps and Springs and Semi-Annual Effluent Report (SAER) sampling events.

[2] Calculated by EFRI for activity comparison using the Specific Activity for U-nat (6.77E-7 Ci U-nat/g U-nat)

[3] Data are from the 2010 Seeps and Springs sampling event.

[4] Data are from 2010 SAER sampling events.

[5] Data are from 2011 Seeps and Springs sampling event.

[6] Data are from 2011 SAER quarterly sampling events.

[7] Data are from 2012 Seeps and Springs sampling event.

[8] Data are from 2012 SAER quarterly sampling events.

[9] Sediment samples are collected in the 4th quarter in lieu of surface water when Westwater Creek is dry throughout the year.

[10] Data are from 2013 Seeps and Springs sampling event.

[11] Data are from 2013 SAER quarterly sampling events.

[12] Data are from 2014 Seeps and Springs sampling event.

[13] Data are from 2014 SAER quarterly sampling events.

[14] Data are from 2015 Seeps and Springs sampling event.

[15] Data are from 2015 SAER quarterly sampling events.

1.5 Groundwater

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

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

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

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

1.5.1 Groundwater Characteristics

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

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

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

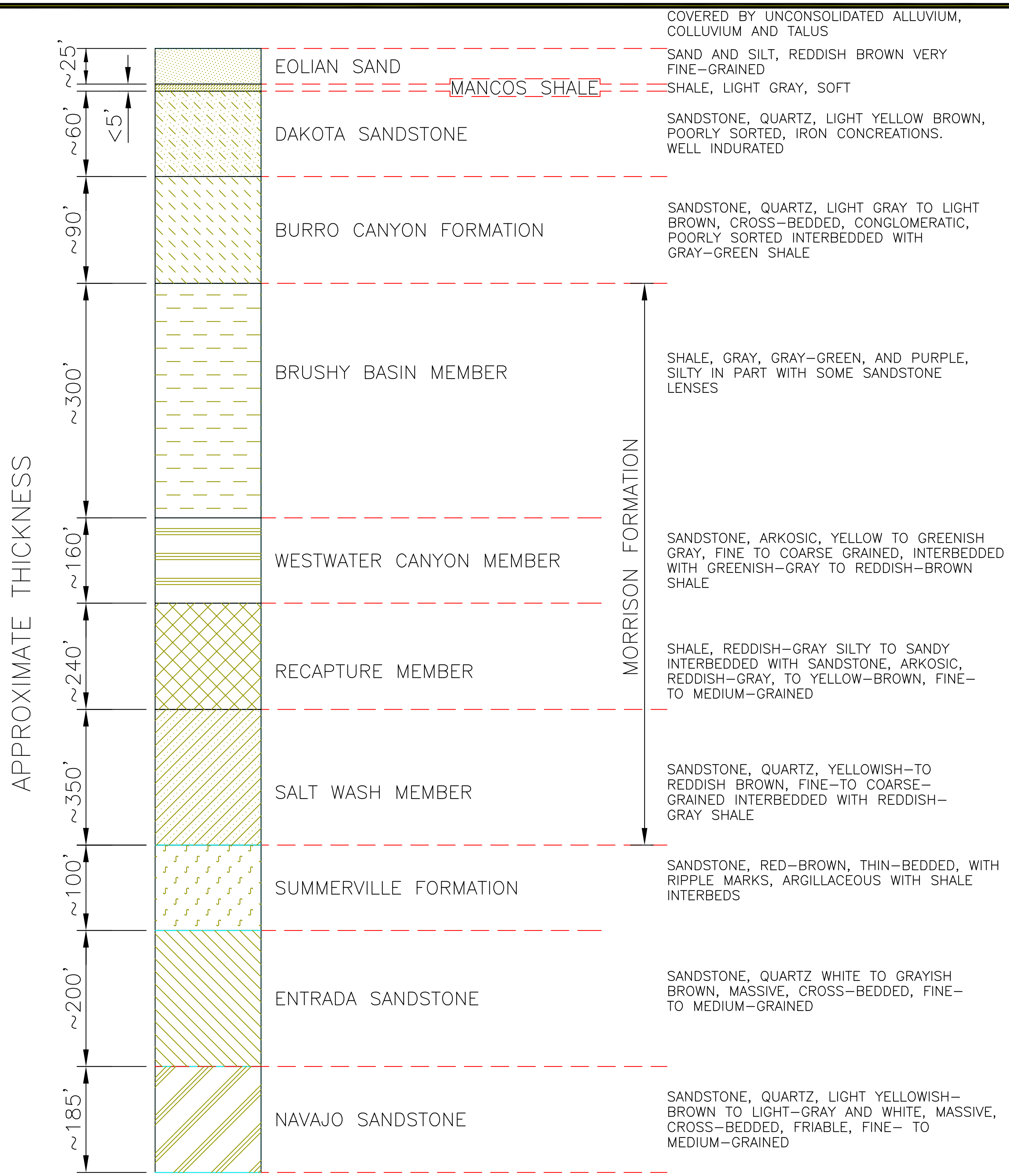
1.5.1.1 Geologic Setting

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

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

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

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



Taken from Stratigraphic Section near Water Well #3

ENERGY FUELS

Project: WHITE MESA MILL

REVISIONS		County:	State: UT
Date	By	Location:	

Figure 1.5-1

Generalized Stratigraphy of White Mesa Mill

Scale: N/A | Date: Aug 2009

Author: HRR | Drafted By: D.Sledd

1.5.1.2 Hydrogeologic Setting

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

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

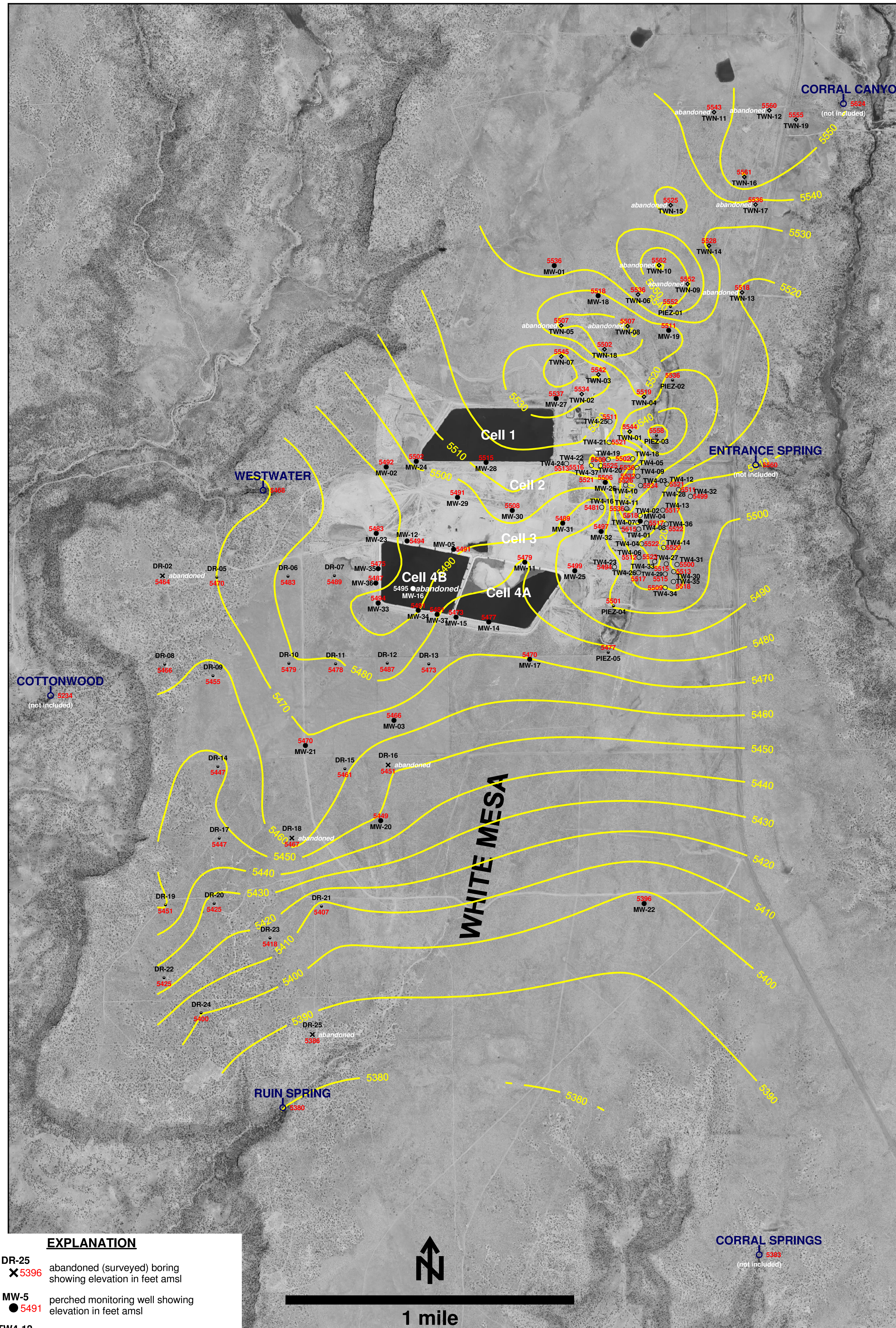
1.5.1.3 Perched Zone Hydrogeology

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

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

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

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



EXPLANATION

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

HYDRO
GEO
CHEM, INC.

KRIGED TOP OF BRUSHY BASIN MEMBER WHITE MESA SITE

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

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

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

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

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

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

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

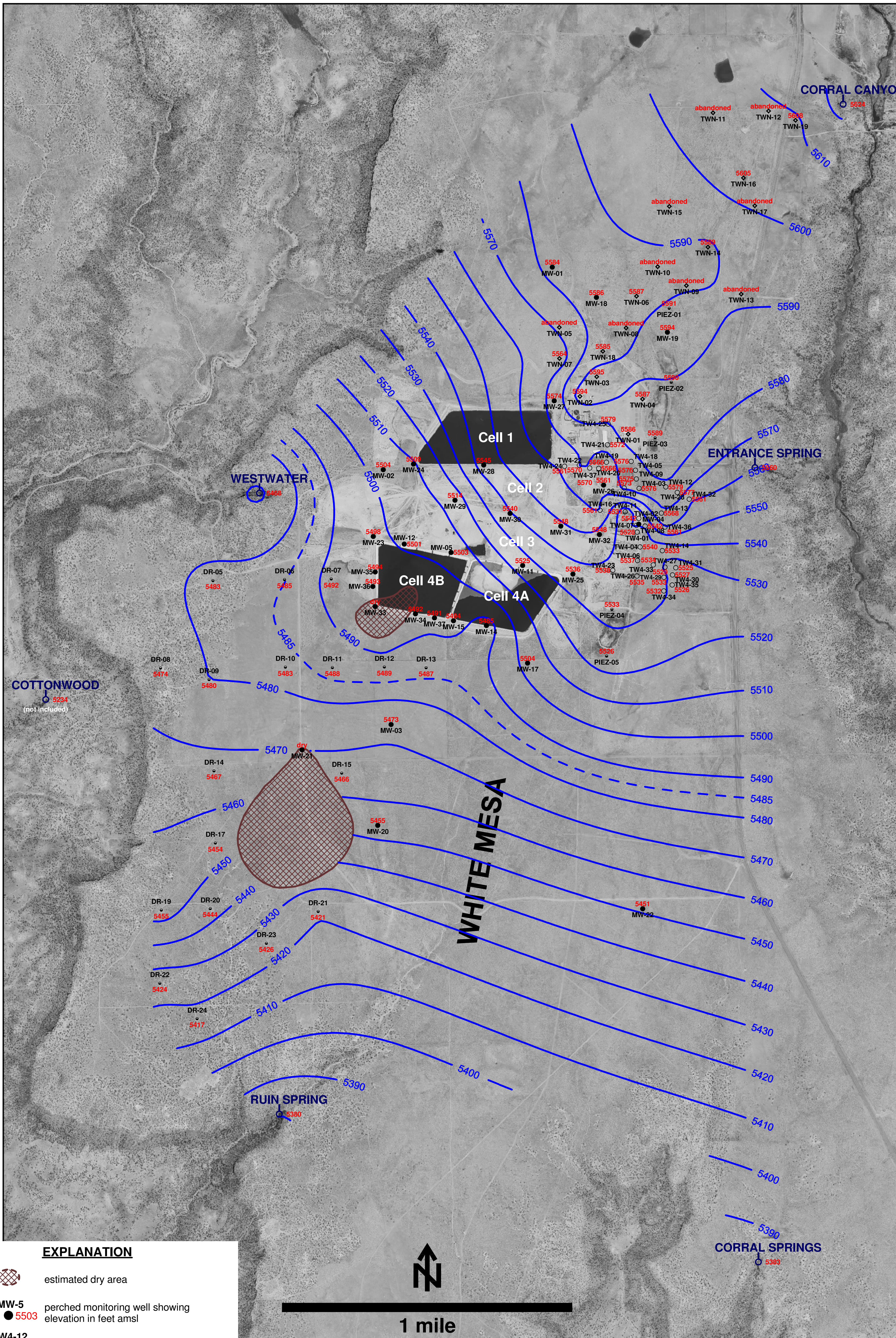
Because of the generally low permeability of the perched zone beneath the site, well yields are typically low (generally less than 0.5 gpm). Many of the perched monitoring wells purge dry and take several hours to more than a day to recover sufficiently for groundwater samples to be collected. Sufficient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

1.5.1.4 Perched Groundwater Flow

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

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

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



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

HYDRO GEO CHEM, INC.

KRIGED 1st QUARTER, 2016 WATER LEVELS WHITE MESA SITE

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

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

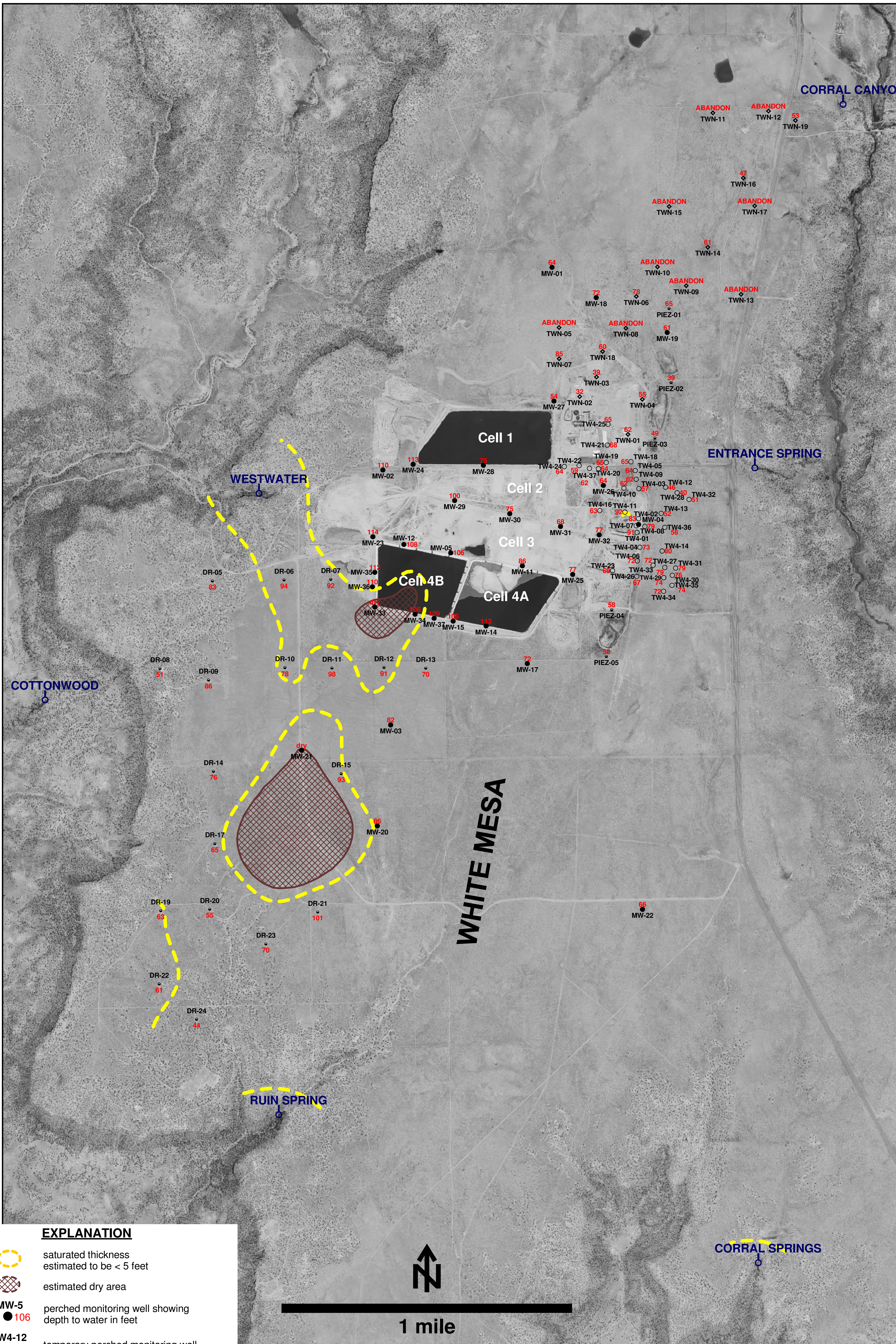
1.5.1.5 Perched Zone Hydrogeology Beneath and Downgradient of The Tailings Management Cells

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

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

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

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



EXPLANATION

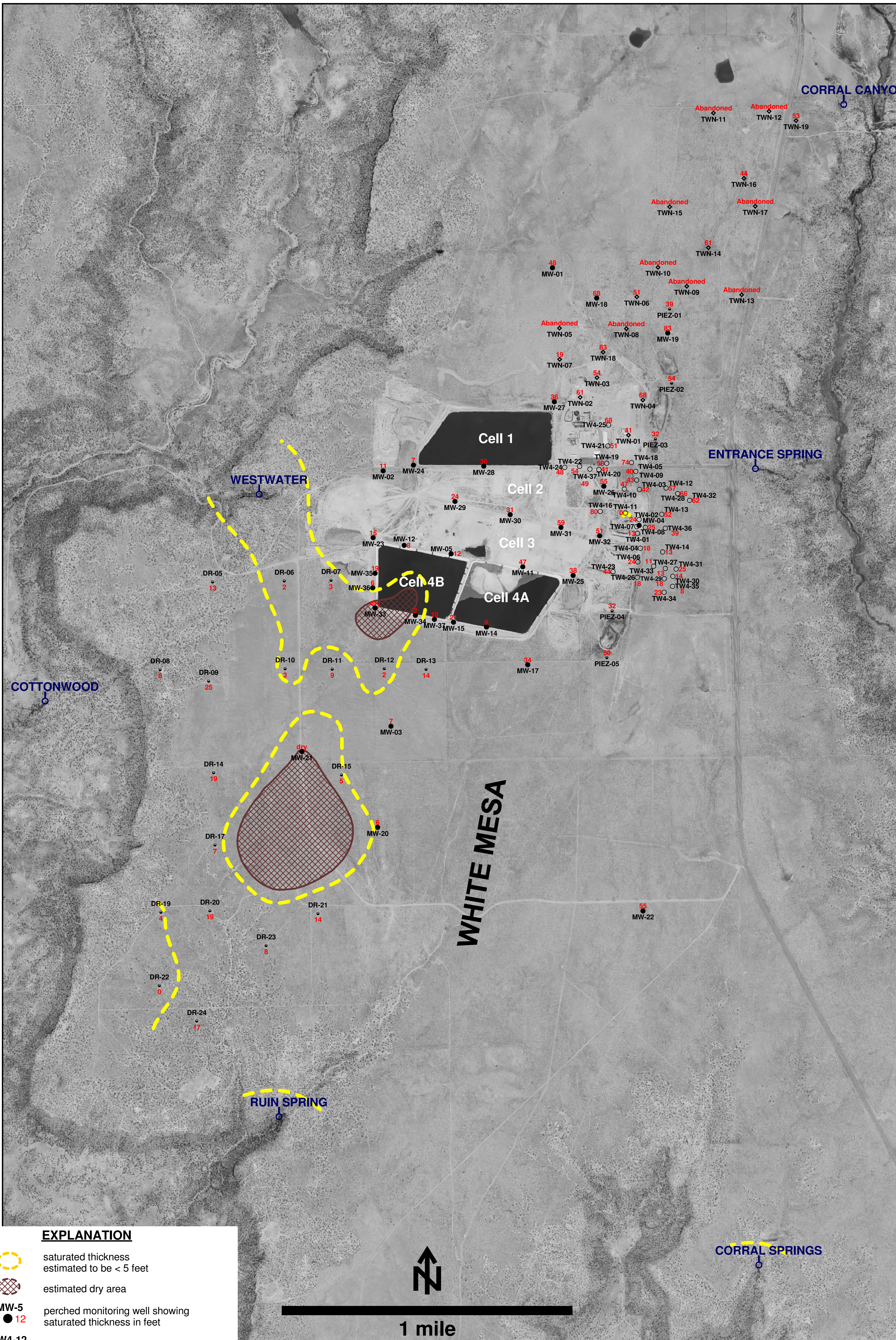
- saturated thickness estimated to be < 5 feet
- estimated dry area
- MW-5 ● 106 — perched monitoring well showing depth to water in feet
- TW4-12 ○ 46 — temporary perched monitoring well showing depth to water in feet
- TWN-7 ◆ 85 — temporary perched nitrate monitoring well showing depth to water in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

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

HYDRO GEO CHEM, INC.

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

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



EXPLANATION

saturated thickness estimated to be < 5 feet

estimated dry area

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

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

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

PIEZ-1 39 perched piezometer showing saturated thickness in feet

RUIN SPRING seep or spring

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

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

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

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

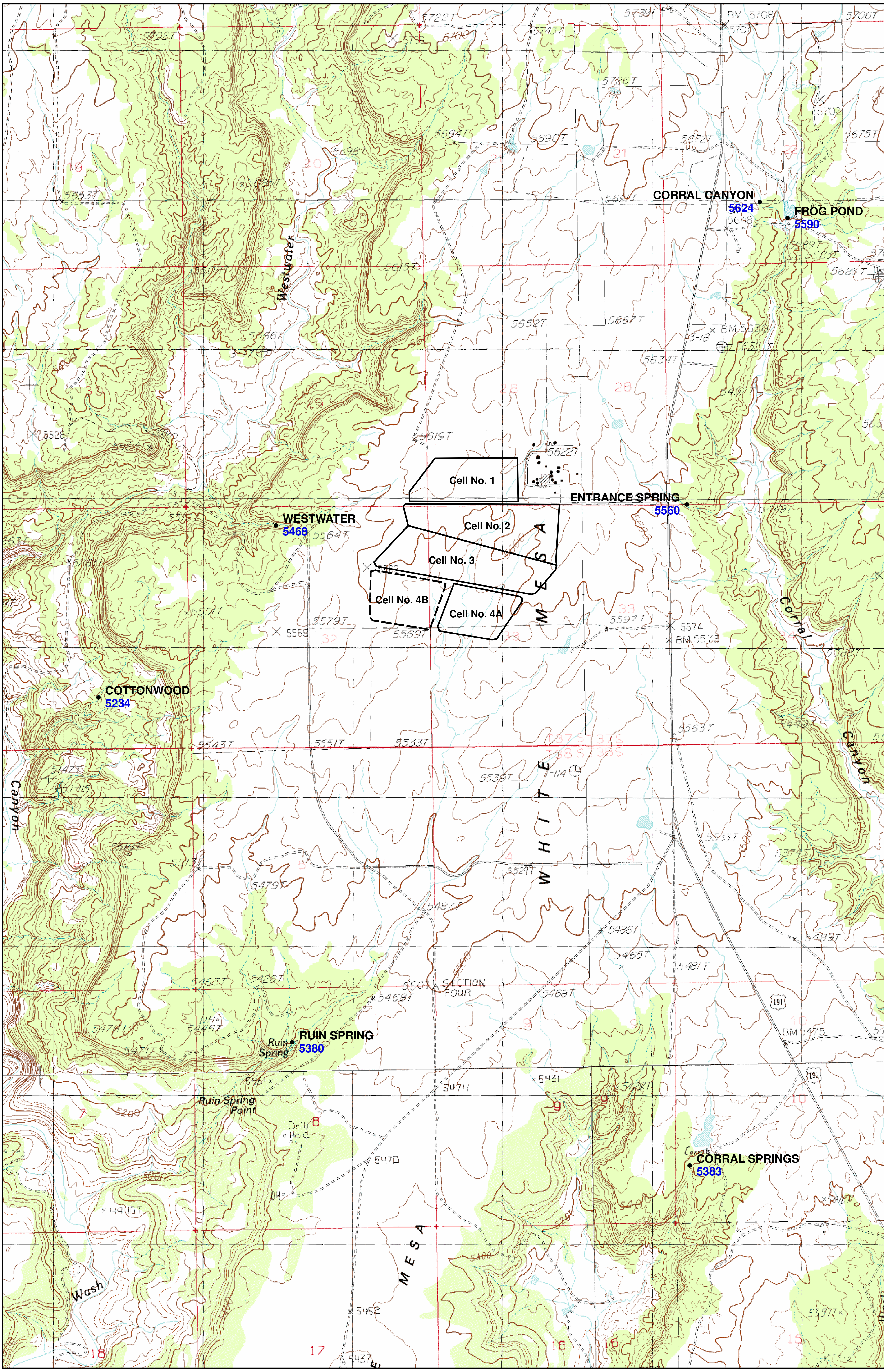
1.5.2 Seep and Spring Occurrence and Hydrogeology

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

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

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

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



0.5 0.25 0 0.5 1 Mile

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

NORTH

HYDRO GEO CHEM, INC.

SEEPS AND SPRINGS ON USGS TOPOGRAPHIC BASE WHITE MESA

Approved	Date	Author	Date	File Name	Figure
SJS	09/17/10	DRS	07/16/10	7180002G	7

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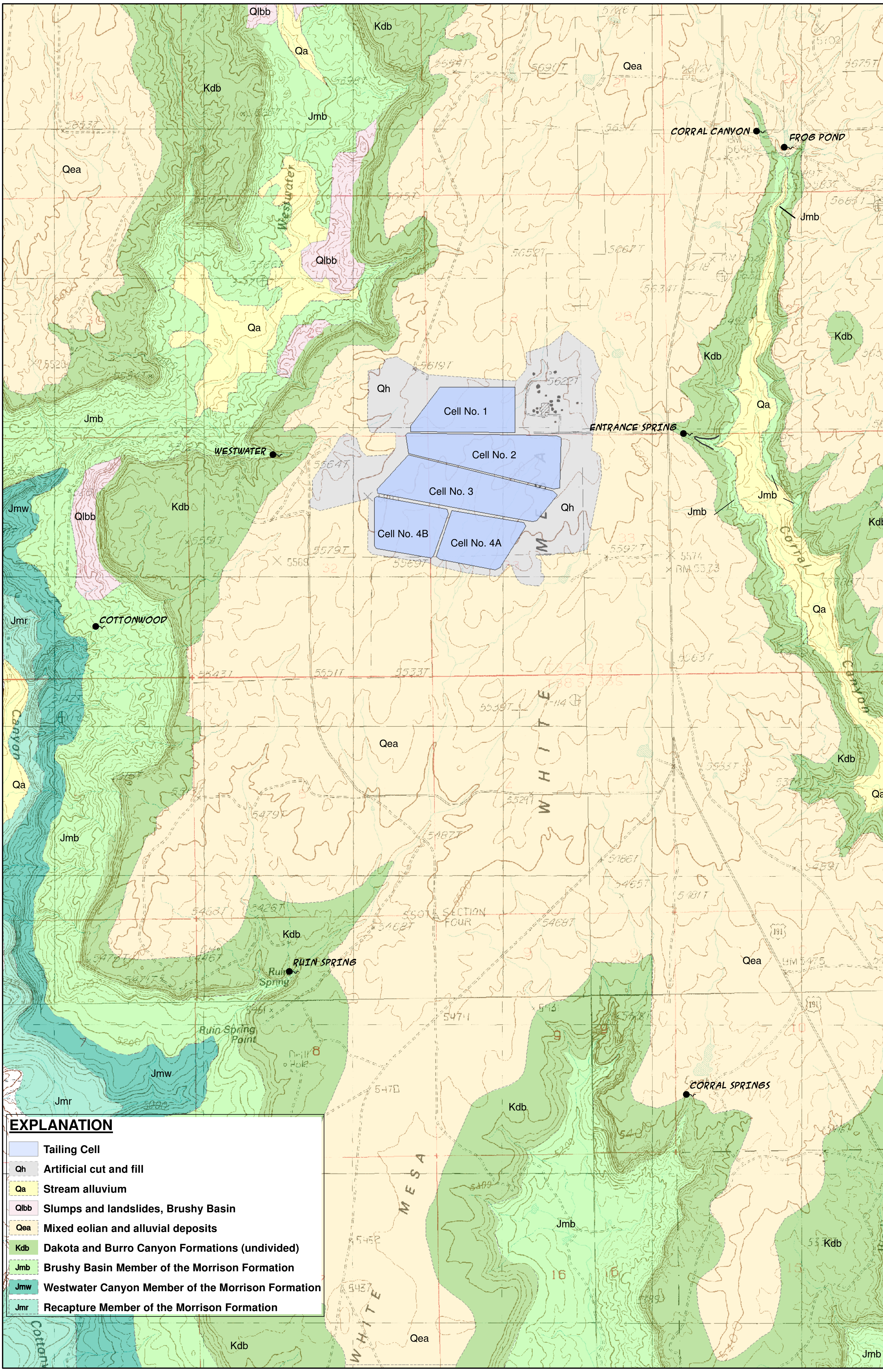
As discussed in Section 1.1.5.4, Figure 1.5-3 shows first quarter 2016 perched water level contours and the locations and elevations of seeps and springs. Perched water level contours are based on water levels measured in the perched groundwater monitoring wells shown on Figure 1.5-3, and include elevations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

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

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



0.5 0 1 Mile

N

Seep or Spring

Contact - dashed where uncertain

HYDRO GEO CHEM, INC.

GEOLOGIC MAP
WHITE MESA, UTAH

Approved	Date	File	Figure
SJS	12/28/11	K:\718000\GIS\Geology	

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

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

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

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

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

1.5.3 Groundwater Quality

1.5.3.1 Entrada/Navajo Aquifer

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

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

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

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

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

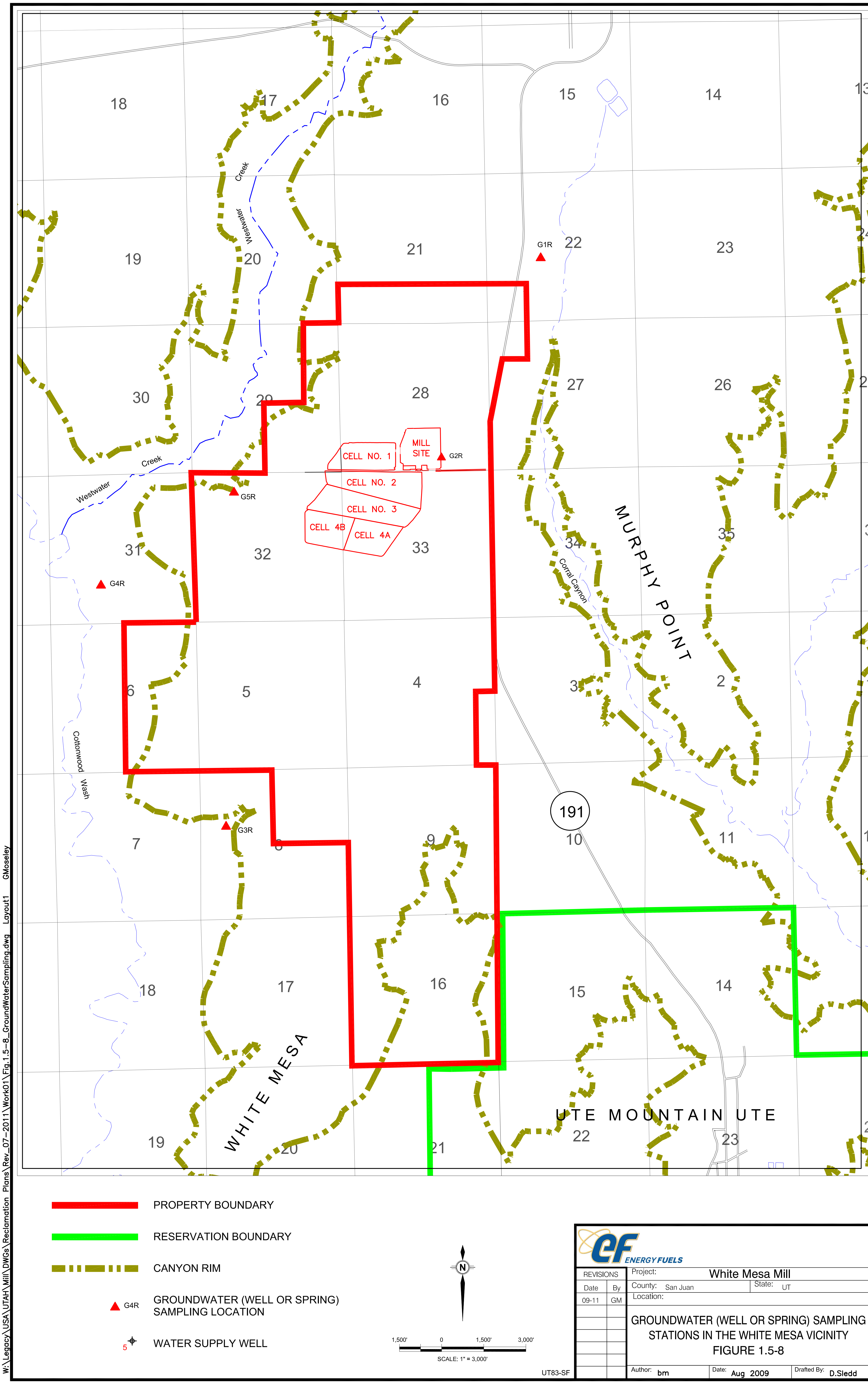
[1] Zero values (0.0) are below detection limits.

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

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

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

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



18
17
16
15
14
19
20
21
22
23
Westwater
Creek
G1R
30
29
28
27
26
CELL NO. 1
MILL SITE
G2R
CELL NO. 2
CELL NO. 3
CELL 4B
CELL 4A
Westwater
Creek
G5R
31
32
33
34
35
Corral Canyon
MURPHY POINT
G4R
6
5
4
3
2
Cottonwood Wash
191
7
G3R
8
9
10
11
18
17
16
15
14
WHITE MESA
UTE MOUNTAIN UTE
19
20
21
22
23
PROPERTY BOUNDARY
RESERVATION BOUNDARY
CANYON RIM
G4R
GROUNDWATER (WELL OR SPRING) SAMPLING LOCATION
5
WATER SUPPLY WELL
N
1,500'
0
1,500'
3,000'
SCALE: 1" = 3,000'
UT83-SF
ENERGY FUELS
REVISIONS
Date
By
09-11
GM
Project: White Mesa Mill
County: San Juan
State: UT
Location:
GROUNDWATER (WELL OR SPRING) SAMPLING STATIONS IN THE WHITE MESA VICINITY
FIGURE 1.5-8
Author: bm
Date: Aug 2009
Drafted By: D.Sledd
W:\Legacy\USA\UTAH\Mill\DWGs\Reclamation Plans\Rev_07-2011\Work01\Fig.1.5-8_GroundWaterSampling.dwg Layout1 GMoseley

1.5.3.2 Perched Groundwater Zone

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

1.5.4 Background Groundwater Quality in the Perched Aquifer

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1.5.5 Quality of Groundwater at the Compliance Monitoring Point

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

1.5.6 Springs and Seeps

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

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

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

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

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

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

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

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

Source: Table 3.7-9 of 2007 ER.

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

Table 1.5-4
Seeps and Springs Sampling

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

Table 1.5-4
Seeps and Springs Sampling (continued)

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

1.5.7 Groundwater Appropriations Within a Five Mile Radius

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

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

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

1.6 <u>Geology</u>

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

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

Table 1.5 - 4

Water Rights

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

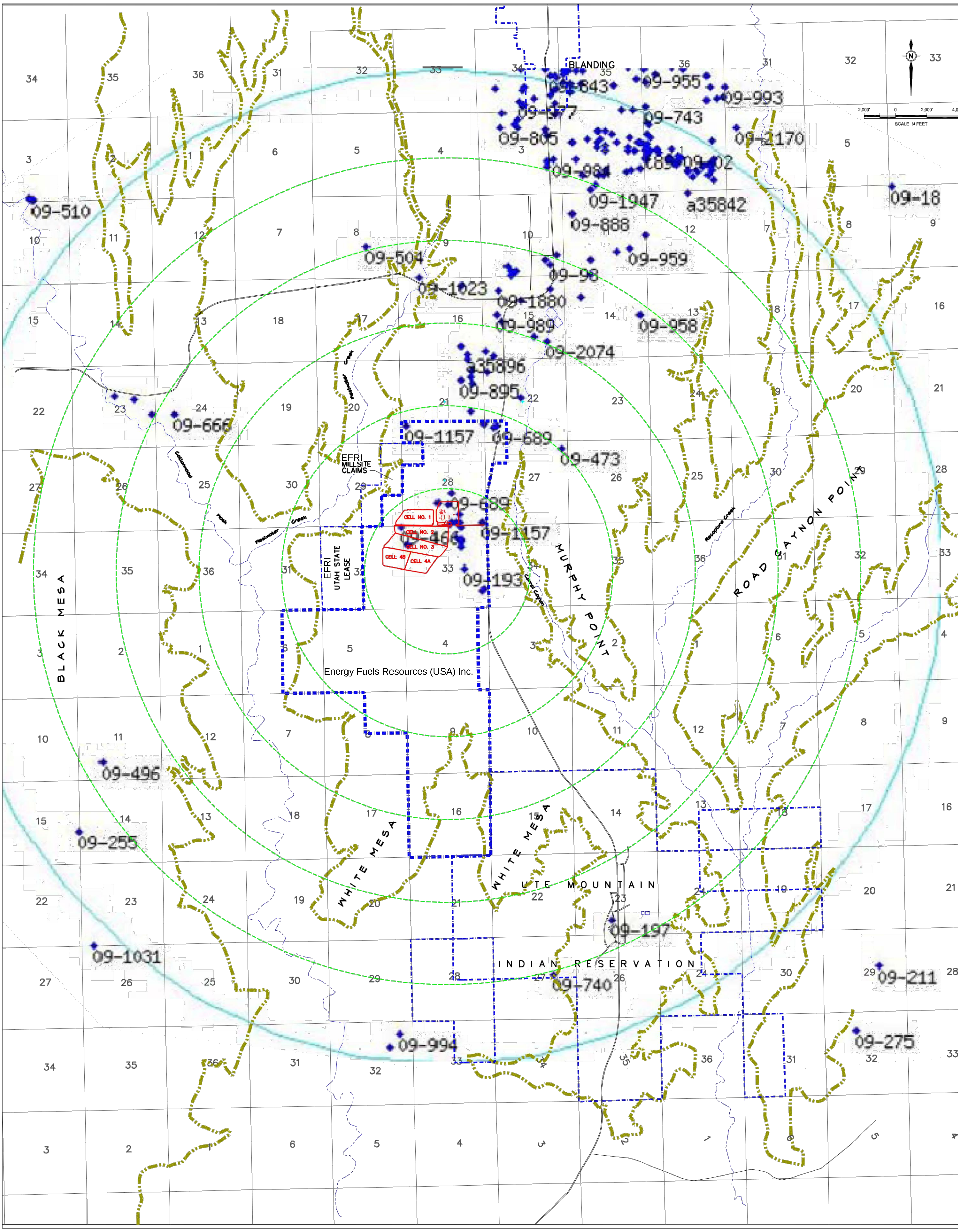
09-826	Underground		U	19770523	DIS	0.500	0.000	CLISBEE LYMAN
	N315 W450 S4 10 37S 22E SL							435 SOUTH 200 WEST 63-2
09-831	Underground		T	19800516	DIS	0.015	0.000	J. KEITH ROGERS
	N2306 E217 SW 35 36S 22E SL							3488 FOOTHILL DRIVE
09-832	Underground		T	19800516	DIS	0.015	0.000	J. KEITH ROGERS
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

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

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

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

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



ENERGY FUELS

REVISIONS	
Date	By
09-11	GM

Project: White Mesa Mill

County: San Juan State: UT

Location:

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

FIGURE 1.5-9

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

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1.6.1 Regional Geology

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

1.6.1.1 Physiography (1978 ER Section 2.4.1.1)

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

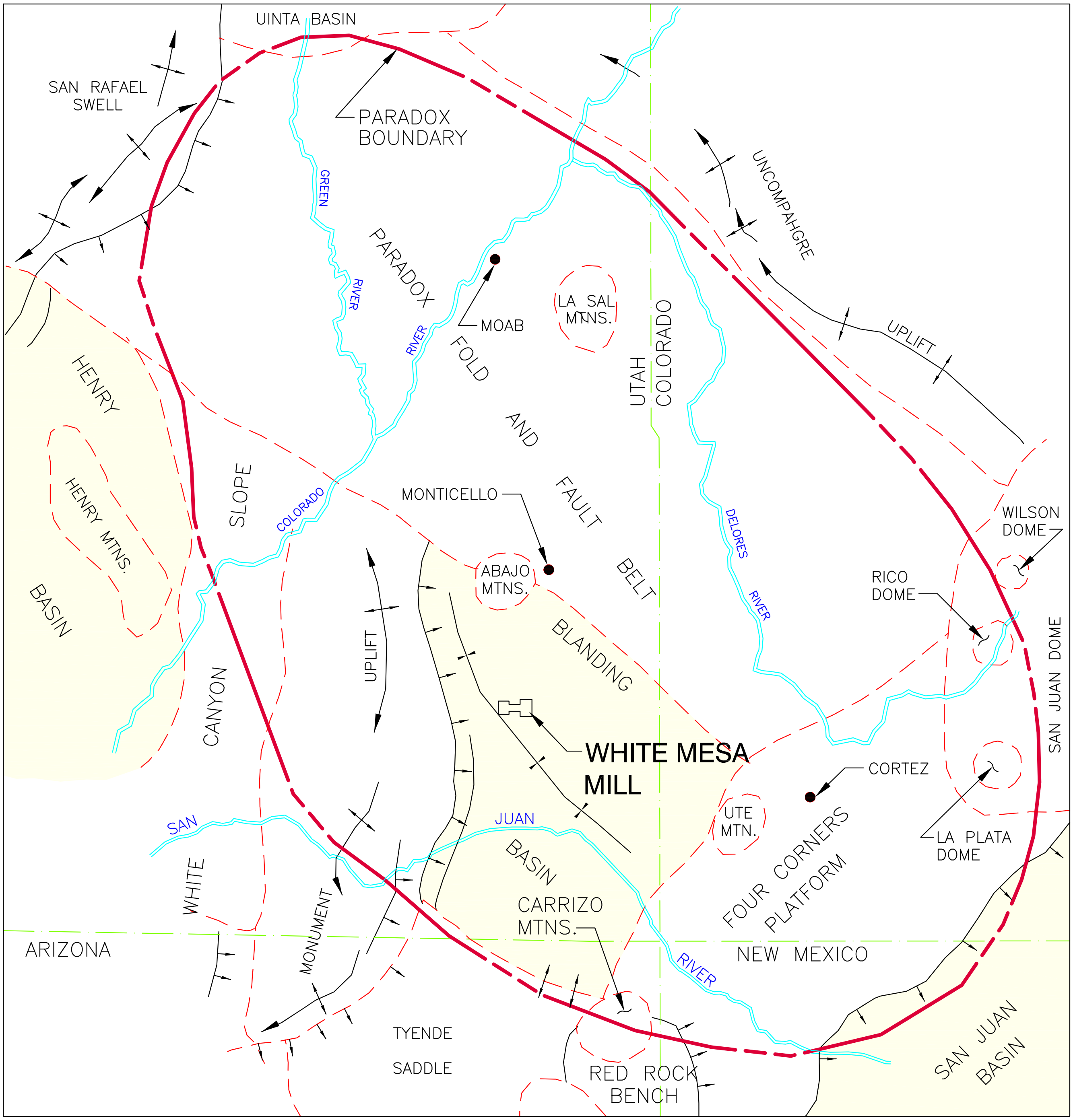
Canyon Lands has undergone epeirogenic uplift and subsequent major erosion has produced the region's characteristic angular topography reflected by high plateaus, mesas, buttes, structural benches, and deep canyons incised into flat-laying sedimentary rocks of pre-Tertiary age. Elevations range from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

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

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

1.6.1.2 Rock Units (1978 ER Section 2.4.1.1)

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



LEGEND

BOUNDARY OF TECTONIC DIVISION

MONOCLINE SHOWING TRACE OF AXIS AND DIRECTION OF DIP

ANTICLINE SHOWING TRACE OF AXIS AND DIRECTION OF PLUNGE

SYNCLINE SHOWING TRACE OF AXIS AND DIRECTION OF PLUNGE

Figure 1.6-1

Colorado Plateau Geologic Map

W:\USA\Utah\Mill\dwgs\Reclamation Plans\RecPlan4.0\Figure 1.6.1 Colo Plateau Geology.dwg Figure 1.6-1 23/11/2009 dsledd

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1.6.1.3 Structure and Tectonics (1978 ER Section 2.4.1.3)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

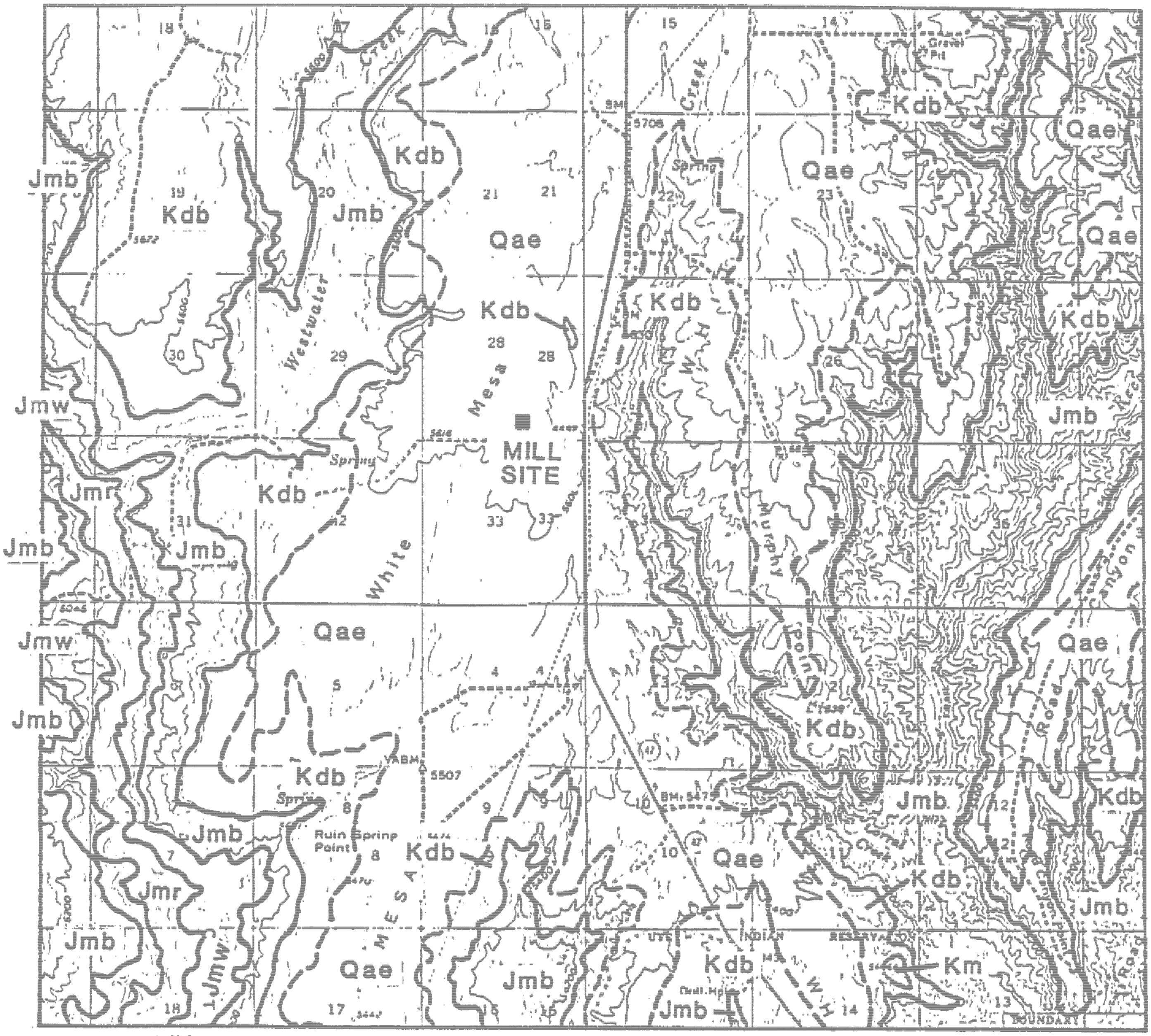
1.6.2 Blanding Site Geology

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

1.6.2.1 Physiography and Topography (1978 ER Section 2.4.2.1)

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

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



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

EXPLANATION

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

N.

3000 0 3000 6000

SCALE IN FEET

After Umetco, 1988

ENERGY FUELS

Project: WHITE MESA MILL

County: San Juan | State: Utah

FIGURE 1.6-2

WHITE MESA MILLSITE
GEOLOGY OF SURROUNDING AREA

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

W:\USA\Utah\Mill\dwgs\Reclamation Plans\RecPlan4.0\Figure 1.6-2 Geology.dwg Figure 23/11/2009 dsledd

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

1.6.2.2 Rock Units (1978 ER Section 2.4.2.2)

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

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

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

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

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

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

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

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

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

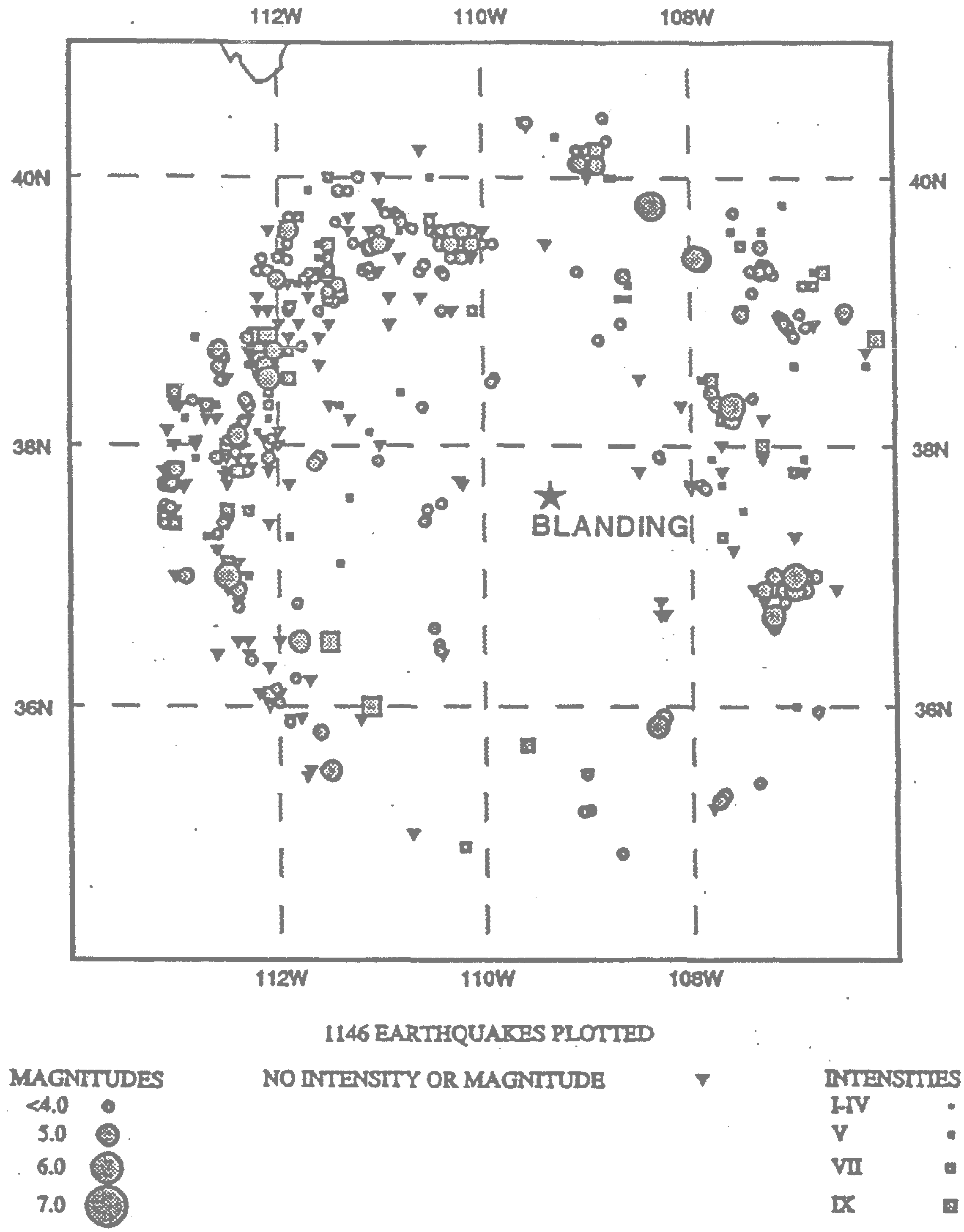
The Mancos shale is not exposed in the project vicinity. The nearest exposures are small isolated remnants resting conformably on Dakota Sandstone along the western rim above Recapture Creek 4.3 to 5.5 miles (6.9 to 8.9 kilometers) southeast of the Mill site. Additional exposures are found on the eastern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

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

1.6.2.3 Structure (1978 ER Section 2.4.2.3)

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

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



NATIONAL GEOPHYSICAL DATA CENTER / NOAA BOULDER, CO 80303

After Umetco 1988

ENERGY FUELS

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

FIGURE 1.6-3

SEISMICITY WITHIN 320 KM OF THE WHITE MESA MILL

Date: Nov. 2009	Design:	Drafted By: RAH

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

Table 1.6-3
Modified Mercalli Scale

Modified Mercalli Scale, 1956 Version[a]

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

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

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

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

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

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

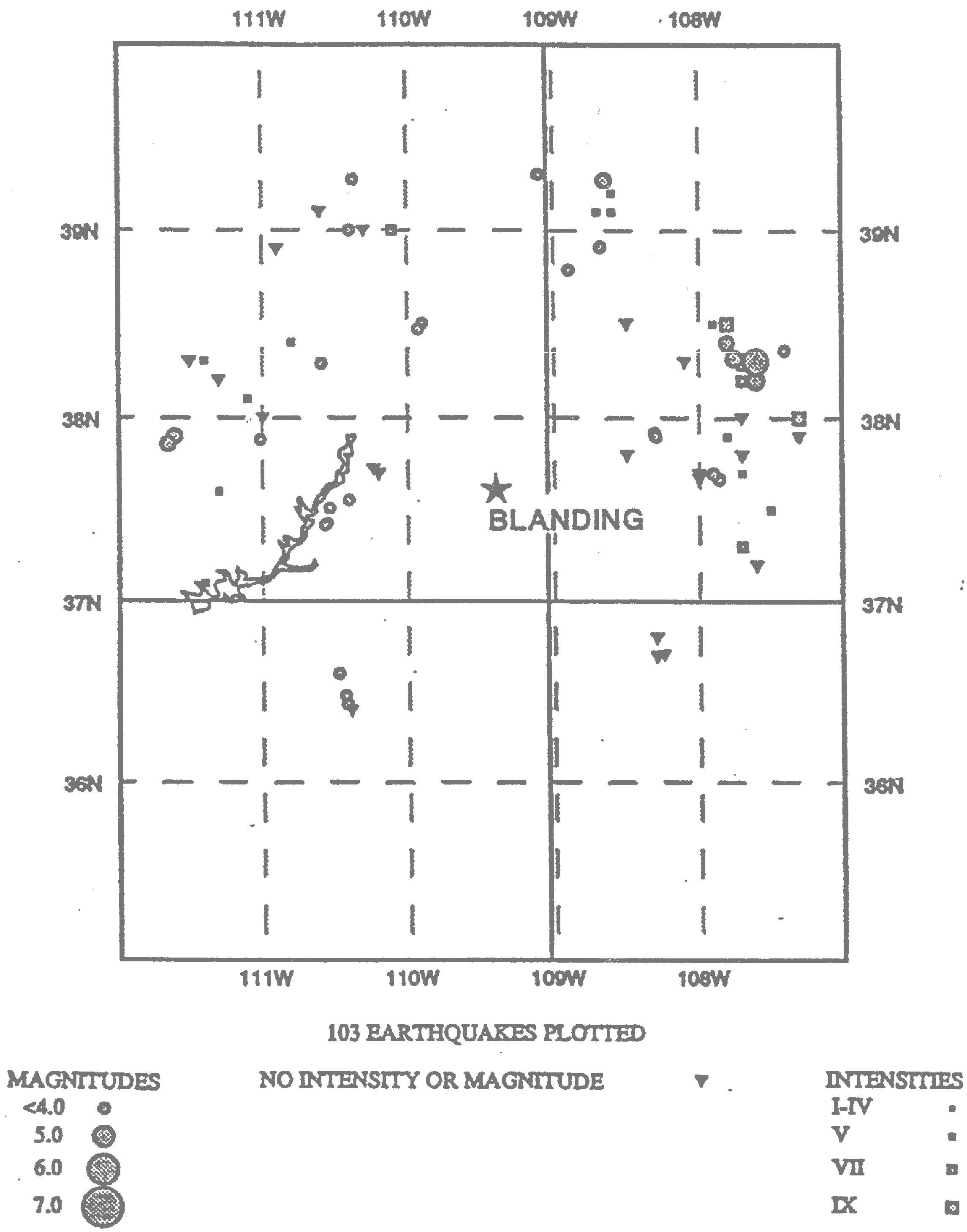
Three of the most damaging earthquakes associated with the seismic belt along the Colorado Plateau's western border have occurred in the Elsinore-Richfield are about 168 miles (270 km) northwest of the Mill site. All were of intensity VIII. On November 13, 1901, a strong shock caused extensive damage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

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

1.6.2.4 Relationship of Earthquakes to Tectonic Structures

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

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



NATIONAL GEOPHYSICAL DATA CENTER / NOAA BOULDER, CO 80303

After Umetco 1988

ENERGY FUELS

Project: WHITE MESA MILL

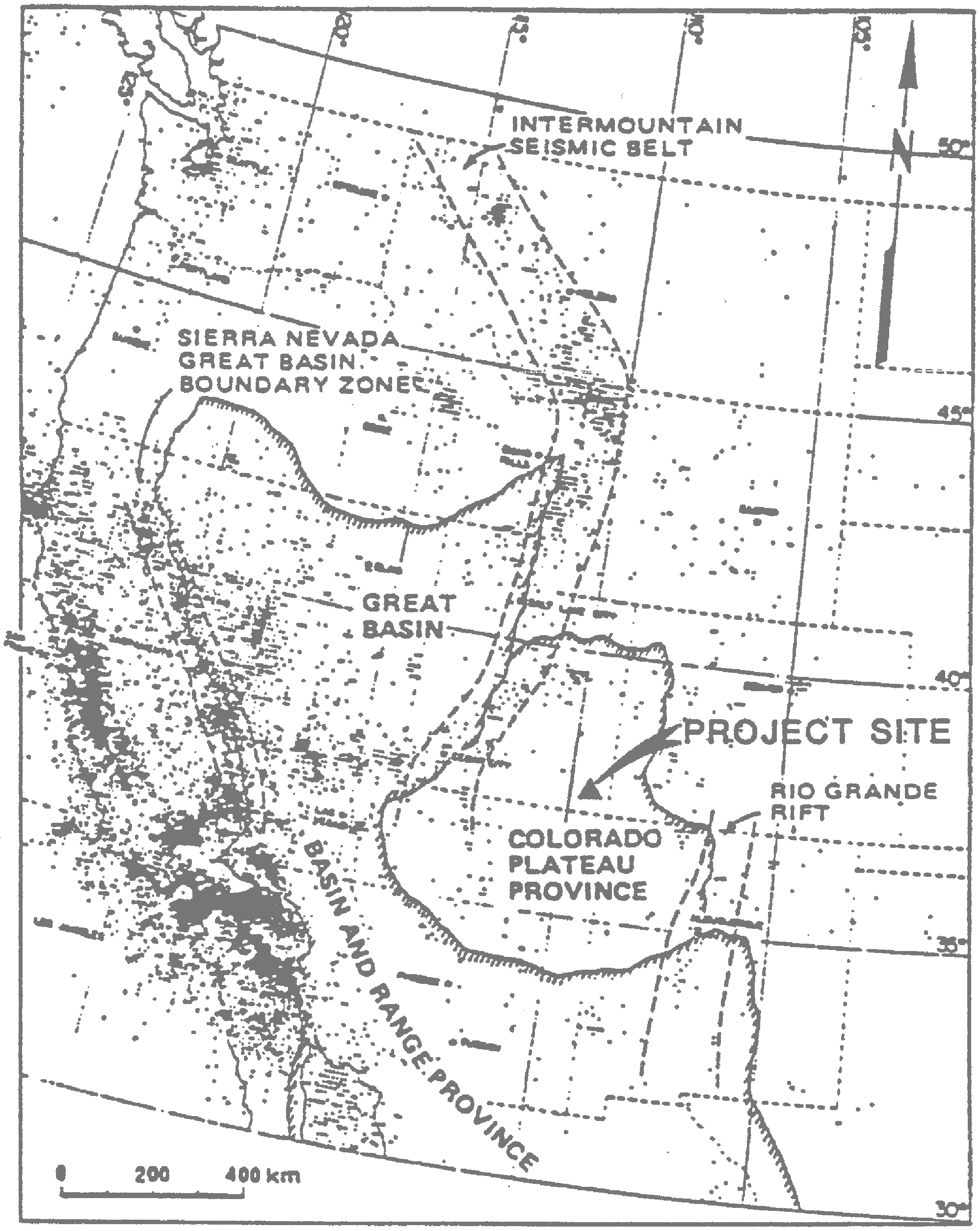
County: San Juan State: Utah

FIGURE 1.6-4

SEISMICITY WITHIN 200 KM
OF THE WHITE MESA MILL

Date: Nov. 2009 Design: Drafted By: RAH

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



Modified from Smith, 1978

SHOWS RELATIONSHIP OF THE COLORADO
PLATEAU PROVINCE TO MARCANAL BELTS

After Umetco. 1988

ENERGY FUELS

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

FIGURE 1.6-5

SEISMICITY OF THE WESTERN UNITED STATES
1950 TO 1976

Date:	Design:	Drafted By:
Nov. 2009		RAH

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

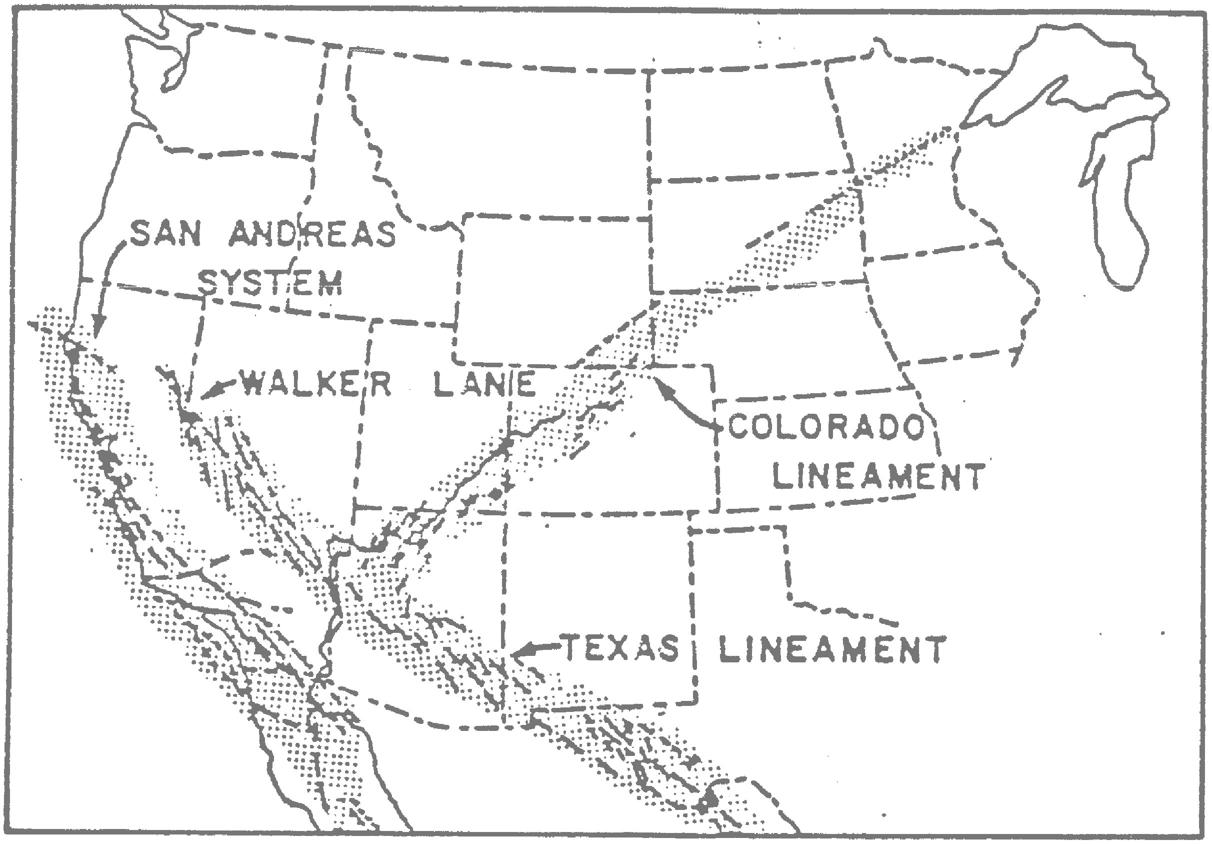
Another zone of seismic activity is in the vicinity of Dulce, New Mexico, near the Colorado border. This zone, which coincides with an extensive series of tertiary intrusives, may also be related to the northern end of the Rio Grande Rift. This rift is a series of fault-controlled structural depressions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

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

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

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

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



SOURCE: WARNER, 1978

After Umetco, 1988

Project: WHITE MESA MILL

County: San Juan State: Utah

FIGURE 1.6-6

COLORADO LINEAMENT

Date: Nov. 2009 Design: Drafted By: RAH

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

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

1.6.2.5 Potential Earthquake Hazards to Mill Area

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

1.6.3 Site-Specific Probabilistic Seismic Hazard Analysis

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

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

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

1.7 Biota (1978 ER Section 2.9)

1.7.1 Terrestrial (1978 ER Section 2.9.1)

1.7.1.1 Flora (1978 ER Section 2.9.1.1)

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

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

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

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

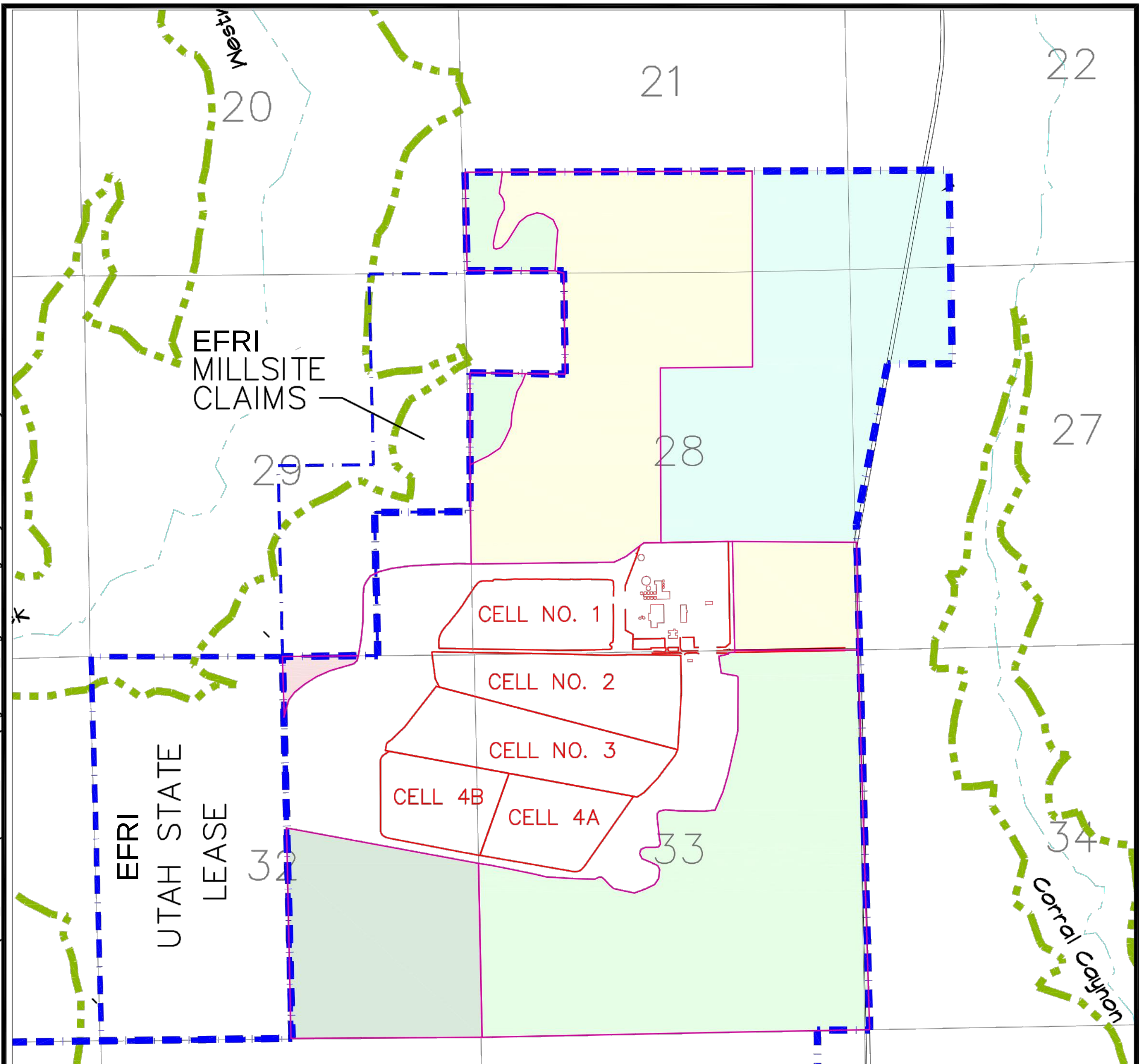
Table 1.7-1
Community Types and Expanse Within the Project site Boundary

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

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

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

[a]Rock covered 4.4% of the ground.



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

N

1,000' 0 1,000' 2,000'

SCALE: 1" = 2,000'

ENERGY FUELS

REVISIONS	
Date	By
11-09	DLS
07-11	GM

Project: White Mesa Mill

County: San Juan State: UT

Location:

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

Author: Date: May 1999 Drafted By: RAH

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

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

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

1.7.1.2 Fauna (1978 ER Section 2.9.1.2)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Source: 2002 EA (NRC, 2002)

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

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

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

Source: 2002 EA (NRC, 2002)

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

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

1.7.2 Aquatic Biota (*1978 ER Section 2.9.2*)

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

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

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

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

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

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

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

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

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

1.7.3.1 The World

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

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

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

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

1.7.3.2 United States

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

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

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

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

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

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

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

1.7.5 Current Monitoring Data

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

1.7.5.1 Environmental Radon

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

1.7.5.2 Environmental Gamma

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

1.7.5.3 Vegetation Samples

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

1.7.5.4 Environmental Air Monitoring and Stack Sampling

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

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

1.7.5.5 Surface Water

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

1.7.5.6 Meteorological Monitoring

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

2 EXISTING FACILITY

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

2.1 Facility Construction History

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

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

2.1.1 Mill and Mill Tailings System

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

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

2.2 Facility Operations

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

2.2.1 Operating Periods

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

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

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

2.2.2 Mill Circuit

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

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

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

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

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

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

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

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

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

2.2.3 Tailings Management Facilities

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

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

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

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

2.2.3.1 Tailings Management

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

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

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

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

2.2.3.2 Liquid Management

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

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

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

2.3 Monitoring Programs

2.3.1 Monitoring and Reporting Under the Mill's GWDP

2.3.1.1 Groundwater Monitoring

a) Plugged and Excluded Wells

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

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

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

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

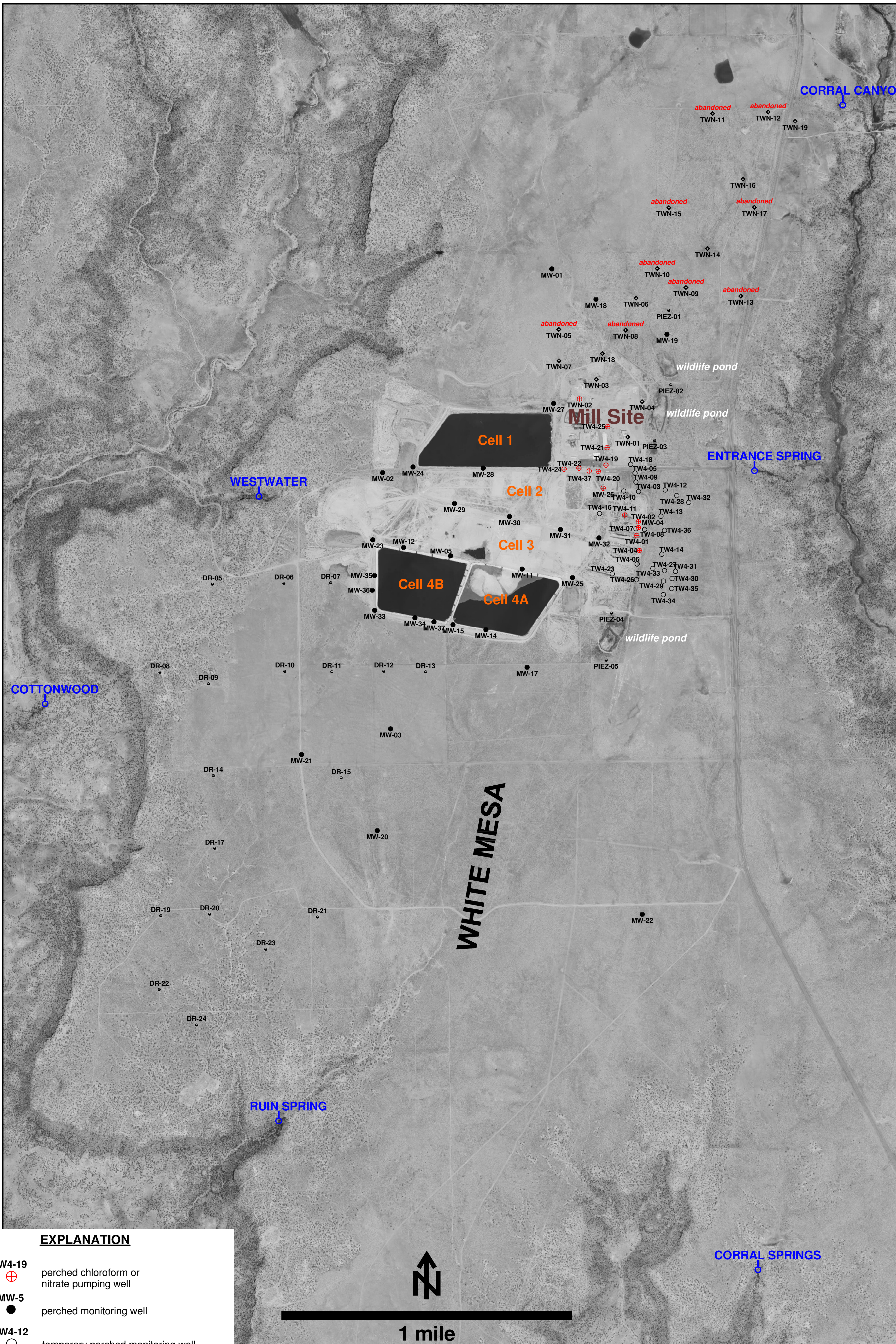
- The Mill and tailings system had produced no impacts to the perched zone or deep aquifer
- The most dependable indicators of water quality and potential cell failure were considered to be chloride, nickel, potassium and natural uranium

c) Issuance of the GWDP

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

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

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



EXPLANATION

TW4-19 ⊕	perched chloroform or nitrate pumping well
MW-5 ●	perched monitoring well
TW4-12 ○	temporary perched monitoring well
TWN-7 ◆	temporary perched nitrate monitoring well
PIEZ-1 ◒	perched piezometer
RUIN SPRING	seep or spring

HYDRO GEO CHEM, INC.

WHITE MESA SITE PLAN SHOWING LOCATIONS OF PERCHED WELLS AND PIEZOMETERS

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

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

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

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

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

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

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

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

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

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

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

2.3.1.2 Deep Aquifer

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

2.3.1.3 Seeps and Springs

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

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

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

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

2.3.1.4 Discharge Minimization Technology and Best Available Technology Standards and Monitoring

a) General

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

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

b) Tailings Cell Operation

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

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

c) Slimes Drain Monitoring

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

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

d) Maximum Tailings Waste Solids Elevation

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

e) Wastewater Elevation in Roberts Pond

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

f) Inspection of Feedstock Storage Area

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

g) Monitor and Maintain Inventory of Chemicals

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

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

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

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

2.3.1.5 BAT Performance Standards for Cell 4A

a) BAT Operations and Maintenance Plan

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

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

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

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

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

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

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

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

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

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

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

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

(ii) Slimes Drain Recovery Head Monitoring

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

2.3.1.6 Stormwater Management and Spill Control Requirements

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

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

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

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

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

2.3.1.7 Tailings and Slimes Drain Sampling

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

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

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

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

2.3.2 Monitoring and Inspections Required Under the License

2.3.2.1 Environmental Monitoring

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

c) Ambient Air Monitoring

(i) Ambient Particulate

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

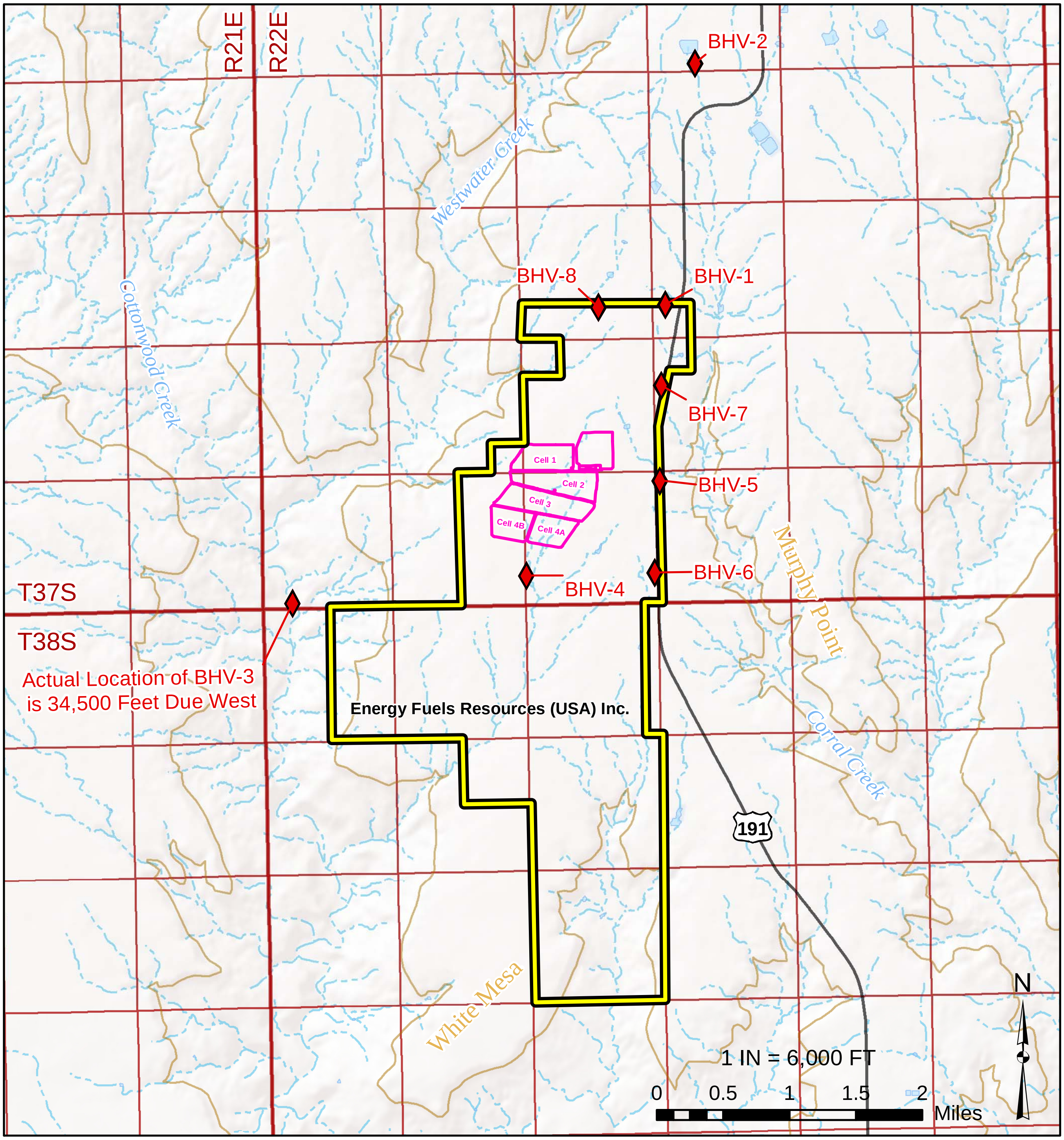
The present sampling system consists of high volume particulate samplers utilizing mass flow controllers to maintain an air flow rate of approximately 32 standard cubic feet per minute. Samplers are operated continuously with a goal for on-stream operating period at ninety percent. Filter replacement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

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

(ii) Ambient Radon

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

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



Legend

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

Coordinate System: NAD 1983 StatePlane Utah South FIPS 4303 Feet

ENERGY FUELS

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

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

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

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

d) External Radiation

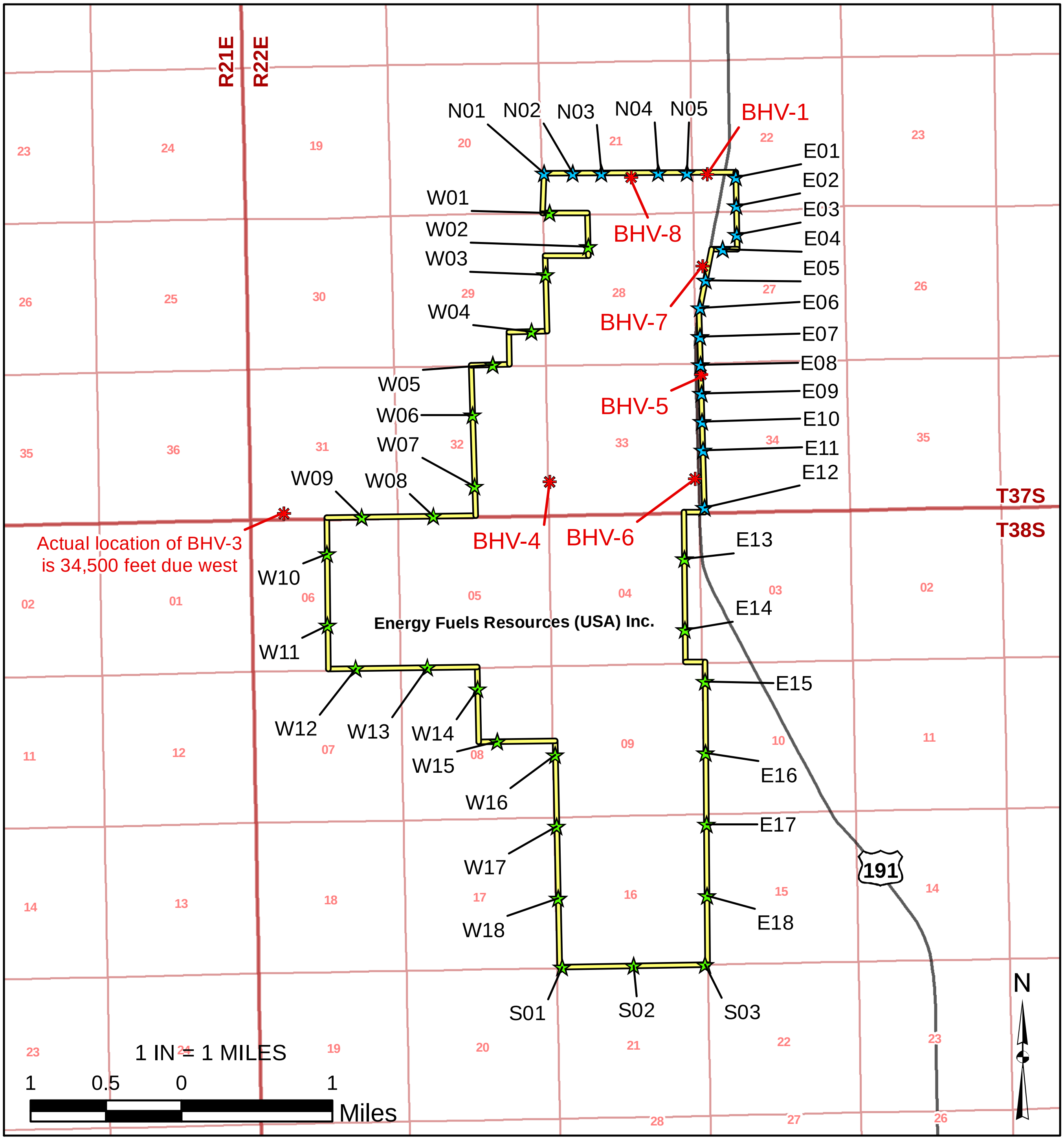
Optically Stimulated Luminescence ("OSL") badges, as supplied by Landauer, Inc., or equivalent, are utilized at all of the high volume air monitoring stations to determine ambient external gamma exposures (see Figure 2.3-2). System quality assurances are determined by placing a duplicate monitor at one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

e) Soil and Vegetation

(i) Soil Monitoring

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

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



Legend

Proposed Soil Monitoring Location

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

Coordinate System: NAD 1983 StatePlane Utah South FIPS 4303 Feet

ENERGY FUELS

REVISIONS		Project: WHITE MESA MILL	
Date:	By:	County: San Juan	State: Utah
		Location: -	

FIGURE 2.3-3

SOIL MONITORING LOCATIONS

Author: areither | Date: 2/16/2016 | Drafted By: areither

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(ii) Vegetation Monitoring

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

d) Meteorological

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

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

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

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

e) Point Emissions

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

Table 2.3-2
Stack Sampling Requirements

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

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

f) Surface Water Monitoring

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

Table 2.3-3
Operational Phase Surface Water Monitoring Program

Monitoring Sites

Westwater Creek and Cottonwood Creek

Field Requirements

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

Vendor Laboratory Requirements

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

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

2.3.2.2 Additional Monitoring and Inspections Required Under the License

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

a) Daily Inspections

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

(i) Radiation Staff Inspections

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

(ii) Operating Foreman Inspections

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

(iii) Daily Tailings Inspection

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

b) Weekly Inspections

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

(i) Weekly Inspection of the Mill Forms

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

(ii) Weekly Ore Storage Pad Inspection Forms

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

(iii) Weekly Tailings and DMT Inspection

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

c) Monthly Reports

Two types of monthly reports are prepared by Mill staff:

(i) Monthly Radiation Safety Reports

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

(ii) Monthly Tailings Inspection Reports

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

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

d) Quarterly Tailings Inspections

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

e) Annual Evaluations

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

(i) Annual Technical Evaluation

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

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

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

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

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

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

(ii) Annual Movement Monitor Survey

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

(iii) Annual Leak Detection Fluid Samples

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

3 TAILINGS RECLAMATION PLAN

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

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

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

3.1 Location and Property Description

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

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

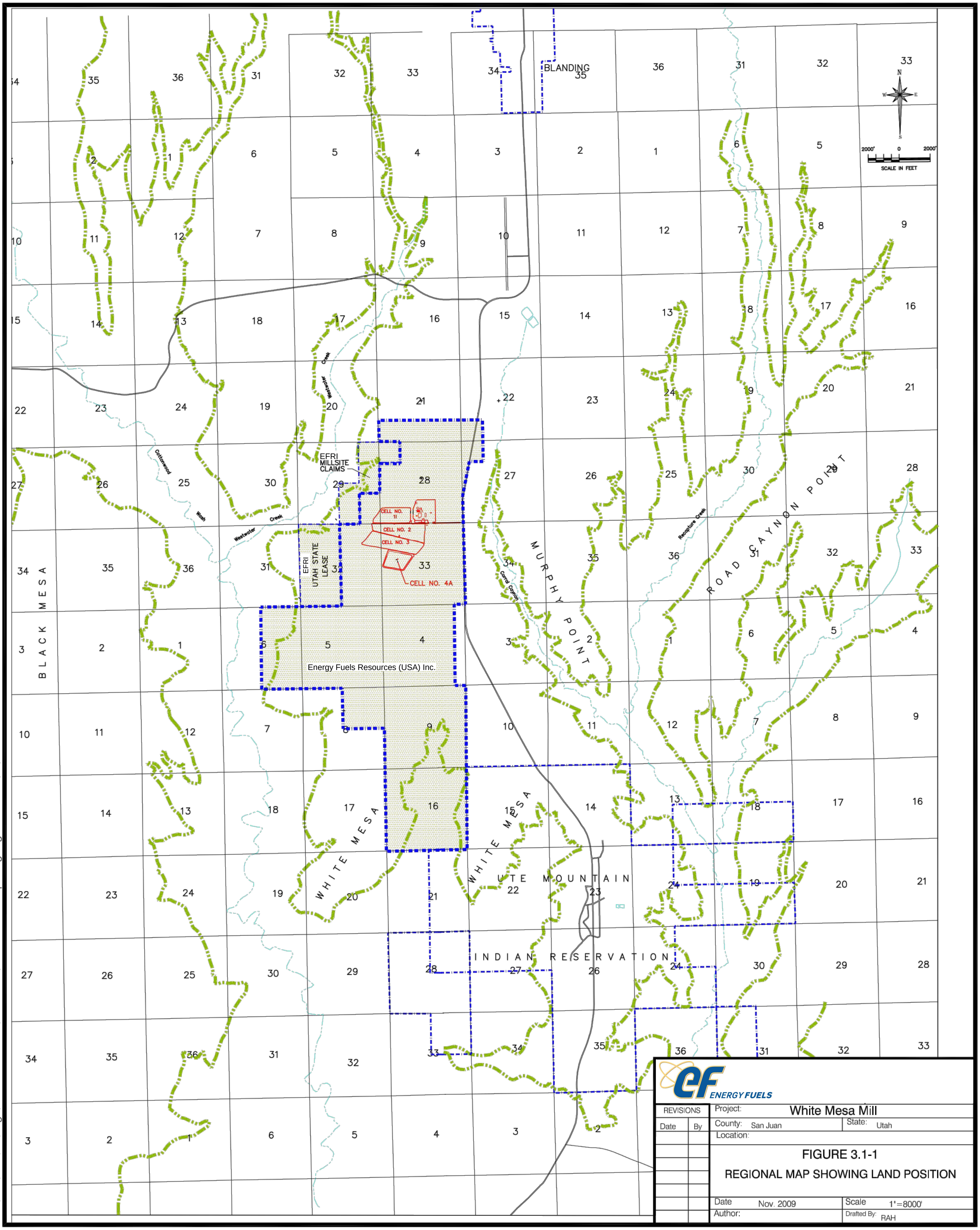

FIGURE 3.1-1

REGIONAL MAP SHOWING LAND POSITION

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

3.2 Facilities to be Reclaimed

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

3.2.1 Summary of Facilities to be Reclaimed

The facilities to be reclaimed include the following:

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

The reclamation of the above facilities will include the following:

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

3.2.2 Tailings and Evaporative Cells

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

Cell 2 final cover construction will take place before final cover construction on other cells at the White Mesa Mill. Cell 2 final cover construction will occur in two phases and a performance monitoring test section containing a lysimeter will be constructed in the southeast portion of Cell 2 concurrently with the Phase 1 cover placement. The plan for implementing final cover placement on Cell 2 and performance assessment and monitoring is presented in Appendix A. Cell 2 Phase 1 cover placement began in May 2016 and is expected to be completed in one construction season. Test section construction is planned to occur in 2016.

3.2.2.1 Soil Cover Design

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

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

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

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

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

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

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

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

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

3.2.2.2 Cell 1

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

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

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

A portion of Cell 1 (i.e., the Cell 1 Disposal Area), adjacent to and running parallel to the downstream cell dike, may be used for permanent disposal of contaminated materials and debris from the Mill site decommissioning and windblown cleanup. The actual area of the Cell 1 Disposal Area needed for storage of additional material will depend on the status of Cells 3, 4A, and 4B at the time of final Mill decommissioning. A portion of the Mill area decommissioning material may be placed in Cells 3, 4A or

4B if space is available, but for purposes of the reclamation design the entire quantity of contaminated materials from the Mill site decommissioning is assumed to be placed in the Cell 1 Disposal Area, which will subsequently be covered with the ET cover. This results in approximately 10 acres of the Cell 1 area constituting the Cell 1 Disposal Area and being utilized for permanent tailings storage. The remaining area of Cell 1 will then be breached and converted to a sedimentation basin. All runoff from the Cell 1 Disposal Area, the Mill area and the area immediately north of Cell 1 will be routed into the sedimentation basin and will discharge onto the natural ground via the channel located at the southwest corner of the basin. The channel is designed to accommodate the PMF flood. Hydraulic and erosional analyses are provided in Appendix A. The channel will be a bedrock channel with a 0.1 percent channel slope, 150-foot bottom width, and 3 horizontal: 1 vertical sideslopes.

3.2.2.3 Cell 2

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

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

3.2.2.4 Cell 3

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

3.2.2.5 Cells 4A and 4B

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

3.3 <u>Design Criteria</u>

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

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

3.3.1 Regulatory Criteria

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

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

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

- Minimize the infiltration of precipitation or other surface water into the tailings, including, but not limited to the radon barrier
- Prevent the accumulation of leachate head within the tailings waste layer that could rise above or over-top the maximum FML elevation internal to any disposal cell, i.e. create a “bathtub” effect

- Ensure that groundwater quality at the compliance monitoring wells does not exceed the GWQSs or GWCLs specified in Part I.C.1 and Table 2 of the GWDP

3.3.2 Radon Flux Attenuation

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

3.3.3 Infiltration Analysis

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

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

3.3.4 Freeze/Thaw Evaluation

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

The freeze/thaw calculations estimate the total depth of frost penetration for the cover system as 32 inches (2.67 ft). The frost penetration depth is not anticipated to exceed the depth of Layers 1 and 2 of the cover system (combined depth of 4 ft). The physical and hydraulic properties of these cover system layers after construction are expected to be close to long-term properties from pedogenic processes, such that post-construction changes due to freeze/thaw should be minimal. A complete description of the freeze/thaw analyses conducted for the proposed cover system is presented in the Updated Tailings Cover Design Report, attached as Appendix A to this Reclamation Plan.

3.3.5 Soil Cover Erosion Protection

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

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

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

3.3.6 Slope Stability Analysis

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

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

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

3.3.7 Tailings Dewatering

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

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

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

3.3.8 Settlement and Liquefaction Analyses

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

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

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

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

3.3.9 Vegetation and Biointrusion

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

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

3.3.10 Cover Material/Cover Material Volumes

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

Table 3.3-1. Reclamation Cover Material Quantity Summary

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

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

4 MILL DECOMMISSIONING PLAN

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

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

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

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

5 REVERSION TO EXISTING COVER DESIGN

5.1 Background

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

Per the Stipulated Consent Agreement (SCA) in development between EFRI and DWMRC, Cell 2 reclamation is planned to occur in 2 phases. Phase 1 is comprised of Layers 1 and 2 and 1.5 ft of Layer 3 of the Proposed Cover System, and will be placed on Cell 2 along with a test section that contains all of the Proposed Cover System, including the vegetative cover. The test section will be tested over a period of approximately 7 years.

Under the SCA, the Cell 2 cover performance test section will have to meet required performance criteria to verify the effectiveness of the Proposed Cover System and initiate Phase 2 cover placement. If the test section demonstrates that the Proposed Cover System meets all applicable regulatory criteria, then, assuming sufficient settlement of the tailings, Phase 2, comprised of the remainder of Layer 3, Layer 4 and the vegetative cover of the Proposed Cover System, will be placed on the Cell. Should the cover performance test section fail to meet the required performance criteria and follow up actions (to be identified in the SCA), then EFRI will complete Cell 2 Phase 2 cover placement in a manner that is functionally equivalent to the Existing Cover Design presented in Reclamation Plan Revision 3.2b (Denison, 2011b), as set out below. The Existing Cover Design will have a minimum thickness of 6 feet, and will consist of the following layers listed below from top to bottom:

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

5.2 Reverting to Existing Cover Design

If it is necessary to complete Cell 2 Phase 2 cover placement in a manner that is functionally equivalent to the Existing Cover Design, then:

a) the Cell 2 Phase 1 cover system (which includes the Proposed Cover System radon barrier) would remain in place;

b) The cover Layer 3 above the radon barrier for the Existing Cover Design would be placed on top of the Cell 2 Phase 1 cover;

c) The rock armor (Layer 4) would be placed on top of Layer 3 of the Existing Cover Design; and

d) The other tailings management cells would be reclaimed with the Existing Cover Design.

In the event that any other tailings impoundment is to be reclaimed during the test period for Cell 2, such tailings impoundment will be reclaimed by placing Phase 1 of the Proposed Cover System on the cell, and then waiting until the Cell 2 test is completed. Thereafter, reclamation of the cell will be completed in the same manner as Cell 2, in accordance with the SCA and, if applicable, this Section 5.0.

6 MILESTONES FOR RECLAMATION

6.1 Background

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

As the final radon barrier on an impoundment cannot be completed until the impoundment has been adequately dewatered and the tailings have stabilized, the timing of which depends on physical and technological factors beyond the control of the licensee, it is not possible to establish absolute deadlines or milestones for reclamation at the time of approval of this Plan.

In past reclamation plans for the Mill, the requirement to set milestones was satisfied by the requirement in the Plan to set a schedule in the future as conditions allow. Under Section 5.3.1 of the Company's Reclamation Plan Revision 3.2, placement of cover materials will be based on a schedule determined by analysis of settlement data, piezometer data and equipment mobility considerations. This gives the regulator authority to set deadlines and milestones as conditions allow, through the future approval of the schedule. The deadlines and milestones in the approved schedule would then serve as the deadlines and milestones for reclamation of the Mill, as contemplated by 10 CFR Part 40 Appendix A, Criterion 6A(1).

In an attempt to provide as much specificity as possible in this Plan, as contemplated by 10 CFR Part 40 Appendix A, Criterion 6A(1), this Section sets out the sequence of interim milestones and deadlines for reclamation of individual tailings impoundments at the Mill and for final Mill site closure, to the extent that they can be established at this time. A more detailed schedule, which incorporates the sequence of interim milestones and deadlines set out below, would be submitted to the Director for approval prior to final Mill site closure.

6.2 Milestones

6.2.1 General

a) Definition of "Operation"

"Operation" means that a tailings impoundment is being used for the continued placement of tailings sands or is on standby status for such placement. An impoundment is in operation from the day that tailings sands are first placed in the impoundment until the day final closure begins. Final closure means the activities following operations to reclaim the tailings impoundment.

b) When Final Closure of an Impoundment Begins

An impoundment shall be considered to have ceased operations, and final closure shall be deemed to have commenced, when the impoundment (A) is no longer being used for the continued placement of tailings sands and EFRI has advised the Director in writing that the impoundment is no longer being used for the continued placement of tailings sands and is not on standby status for such placement; or (B) is no longer being used for the continued placement of tailings sands, interim cover has been placed over the entire surface area of the impoundment, and dewatering activities have begun; or (C) the Mill facility as a whole has commenced final closure and a written notice to that effect has been provided to the Director in accordance with this Plan.

c) The Existing Tailings Management System at the Mill

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

d) The Proposed Cover Design and Existing Cover Design

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

The Stipulated Consent Agreement described in Section 6.2.1 (e) below will describe the circumstances under which the Final Cover Design will be the Proposed Cover Design or the Existing Cover Design. Section 5.0 of this Plan describes the manner in which EFRI will revert from the Proposed Cover Design to the Existing Cover Design if so required by the Stipulated Consent Agreement.

(i) <u>The Proposed Cover Design</u>

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

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

All the layers combined comprise the monolithic ET cover system.

(ii) *__The Existing Cover Design__*

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

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

(iii) __Interim and Final Cover Layers__

The "Interim Cover Layer" is, in the case of the Proposed Cover Design, Layer 1, and in the case of the Existing Cover Design, Layer 1. The "Final Cover Layers" are, in the case of the Proposed Cover Design, Layers 2, 3, and 4, and in the case of the Existing Cover Design, Layers 2, 3 and 4.

e) The Stipulated Consent Agreement

EFRI and the Director of the UDEQ DWMRC are developing a Stipulated Consent Agreement (the "SCA"), which, when finalized, will set out the terms on which the Mill will test the effectiveness of the Proposed Cover Design and the circumstances in which the approved Cover Design for reclamation of tailings impoundments will be the Proposed Cover Design, or a variation thereof, or the Existing Cover Design. If the Approved Cover Design is the Existing Cover Design, then the provisions of Section 5.0 of this Plan will apply.

6.2.2 Deadlines and Interim Milestones for Closure of Cell 2

The deadlines and interim milestones for closure of Cell 2 will be set out in the SCA. The requirements set out in the SCA, when finalized, will be incorporated by reference into this Plan as if set out in this Plan.

6.2.3 Milestones for Closure of an Individual Tailings Impoundment, other than Cell 2, that Ceases Operation While the Mill Facility as a Whole Remains in Operation

For each tailings impoundment, other than Cell 2, that ceases operation while the Mill facility as a whole remains in operation, final closure of the impoundment shall begin, and the final radon barrier for the impoundment shall be completed as expeditiously as practicable considering technological feasibility (including taking into consideration factors beyond the control of the licensee) in accordance with this Plan and the deadline and milestones set out below:

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

(i) __Removal of Freestanding Liquids__

Commencing on the date the impoundment ceases operations and final closure of the impoundment is deemed to commence in accordance with Section 6.2.1 b) above, the addition of liquids to the tailings impoundment, other than by natural precipitation, will be minimized, and free standing liquids will be allowed to dry out by natural evaporation. To the extent reasonably practicable, and excess evaporative capacity is available in other cells in the tailings management system without interfering with Mill operations, the Mill will transfer solutions out of the tailings impoundment and into other tailings impoundments and/or evaporation ponds in order to enhance evaporation and removal of solutions from the impoundment.

(ii) <u>Re-contouring</u>

Re-contouring of the tailings impoundment, in accordance with Drawings and Attachment A (Technical Specifications) of this Plan ("Re-contouring"), will commence within 180 days after removal of freestanding liquids from the impoundment and will be completed within 180 days thereafter, or such longer time as may be required if instability of the tailings sands restricts or hampers such activities, or as may be approved by the Director.

(iii) <u>Placement of Interim Cover Layers</u>

` Upon completion of Re-contouring of the impoundment, EFRI will complete placement of the Interim Cover Layers on the impoundment, in accordance with this Plan. If the Director has confirmed in writing prior to April 1 in any given year that the re-contouring of the impoundment has been completed, then placement of the Interim Cover Layers on the impoundment will be completed prior to December 31 of the following year, or such later date as may be approved by the Director.

(iv) <u>Dewatering</u>

Dewatering of the impoundment shall commence within 180 days after completion of Layer 1 (in the case of the Proposed Cover Design or the Existing Cover Design) over the entire surface area of the impoundment. Dewatering shall continue until the Settlement Monitoring Criteria described in paragraph 6.2.3 b) below are determined by the Director to be satisfied.

b) Placement of Final Cover Layers

After placement of the Interim Cover Layers on the impoundment in accordance with paragraph 6.2.3 a)(iii) above is complete, settlement monuments and piezometers in the impoundment will be monitored in accordance with this Plan.

Settlement and dewatering data will be evaluated to determine if sufficient settlement has occurred to facilitate placement of the Final Cover Layers on the impoundment and to minimize maintenance of the final cover surface. Decreasing trends in settlement followed by a maximum of 0.1 feet (30 mm) of cumulative settlement over 12 months (for at least 90 percent of the settlement monuments) will be considered acceptable (the "Settlement Monitoring Criteria") to proceed with placement of the Final Cover Layers on the impoundment.

Commencement of placement of the Final Cover Layers on the impoundment will commence after the Director has confirmed in writing that the Settlement Monitoring Criteria have been satisfied for the impoundment.

If the Director has confirmed in writing prior to April 1 in any given year that the Settlement Monitoring Criteria have been satisfied for the impoundment, then placement of the Final Cover Layers on the impoundment will be completed prior to December 31 of the following year, or such later date as may be approved by the Director.

c) The Placement of Erosion Protection Barriers or other Features Necessary for Long-term Control of the Tailings

(i) Vegetative Cover

If the Cover Design, as approved by the Director in accordance with the procedures described in the SCA, is the Proposed Cover Design or otherwise calls for vegetative cover on the impoundment, then revegetation of the cover will take place at the completion of placement of the Final Cover Layers on the impoundment, in accordance with the revegetation plan set out in Appendix J to the Updated Cover Design Report. All required seeding for re-vegetation will commence in the first available growing season after the completion of placement of the Final Cover Layers on the impoundment, as determined by the Director, and will be completed by the end of such growing season, or such later time as may be approved by the Director.

(ii) Rock Armor

If the Cover Design, as approved by the Director in accordance with the procedures described in the SCA, is the Existing Cover Design, then rock armor shall be placed on the tailings impoundment, in accordance with Reclamation Plan 3.2b (Denison, 2011b). Such placement, will commence within 180 days after completion of placement of the Final Cover Layers on the impoundment in accordance with Section 5.0 of this Plan, and will be completed within 180 days thereafter, or such or such later date as may be approved by the Director.

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

The License authorizes a portion of a specified impoundment to accept uranium byproduct material or such materials that are similar in physical, chemical, and radiological characteristics to the uranium mill tailings and associated wastes already in the pile or impoundment, from other sources, during the closure process, and on-site generated trash. Reclamation of the disposal area, as appropriate, must be completed in a timely manner after disposal operations cease in accordance with paragraph (1) of Criterion 6; however, these actions are not required to be completed as part of meeting the deadline for final radon barrier construction for the impoundment.

6.2.4 Milestones Applicable to Final Mill Closure

If the Mill facility as a whole has commenced final reclamation, as defined in this Plan, then the deadlines and interim milestones set out in this Section 6.2.4 shall apply.

EFRI shall submit a detailed decommissioning and reclamation schedule (the “Schedule”) to the Director for approval at least twelve (12) months prior to planned final shutdown of mill operations. The Schedule shall set out the steps required to complete the final radon barrier and shall be subject to and shall include the following deadlines and interim milestones:

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

Mill demolition and windblown tailings retrieval, as contemplated by Attachment A (Technical Specifications) of this Plan shall commence within the later of (1) 180 days after approval of both the Schedule and the decommissioning plan (the "Decommissioning Plan") required to be submitted under License Condition 12.2; and (2) 180 days after sufficient solutions have been evaporated from the tailings impoundment in which the materials are to be disposed of, and shall be completed within eighteen months thereafter, or such later date as may be approved by the Director.

b) *Reclamation of Individual Tailings Impoundments*

Each un-reclaimed tailings impoundment, other than the tailings impoundment used for the placement of mill demolition materials and windblown tailings pursuant to paragraph 6.2.4 (a) above, shall be reclaimed as expeditiously as practicable considering technological feasibility (including taking into consideration factors beyond the control of the licensee) in accordance with this Plan and the deadline and milestones set out Sections 6.2.3 (a) to (d) above. The first such tailings impoundment shall commence reclamation as soon as reasonably practicable after approval of the Schedule, or as otherwise set out in the Schedule, and each succeeding un-reclaimed tailings impoundment shall commence reclamation within 180 days after completion of reclamation of the previous tailings impoundment, or as otherwise set out in the Schedule.

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