---------- Forwarded message ---------
From: **Vern C. Rogers** <vcrogers@energysolutions.com>
Date: Mon, Jan 27, 2020 at 2:50 PM
Subject: REQUEST FOR PRELIMINARY REVIEW: Federal Cell Facility Radioactive Material License Application
To: Helge Gabert (hgabert@utah.gov) <hgabert@utah.gov>
Cc: Don Verbica (dverbica@utah.gov) <dverbica@utah.gov>, Bret Randall (bfrandall@agutah.gov) <bfrandall@agutah.gov>, Karen Kirkwood <kxkirkwood@energysolutions.com>

Helge

In accordance with the Director's Letter (dated January 16, 2020) concurring with EnergySolutions' request to pre-file a license application, attached is marked as a "PRELIMINARY REVIEW DRAFT" and is a radioactive material license application for a new federal cell facility for the disposal of concentrated depleted uranium from the U.S. Department of Energy. The attached is preliminary and EnergySolutions understands that any comments provided by the Director or the Director's contractor (SC&A) will not trigger a formal regulatory process or that the matters upon which the Director offers comments are to be considered as receiving approval. As proposed in my email of 20 January 2020, it is my understanding that review or comment by the Director's contractor will primarily focus on those sections of the application dramatically different from those already accepted by the Director via EnergySolutions' other Radioactive Material Licenses and not already under separate review (such as the depleted uranium performance assessment).

Having executed the second amendment to the Memorandum of Agreement (dated 22 Jan 2020), it is my understanding that prior to commencing any preliminary review, a budget and expected schedule will be prepared by SC&A and the Director and submitted to EnergySolutions for prerequisite concurrence. It is also my understanding that preliminary license review activities will not detract or delay SC&A's parallel review of EnergySolutions' Concentrated Depleted Uranium Performance Assessment.

Please let me know if you have any questions.

Thank you,

Vern C. Rogers | ENERGYSOLUTIONS
299 South Main Street, Suite 1700
Salt Lake City, UT 84111

PHONE: 801.649.2000
DIRECT: 801.649.2253
MOBILE: 801.557.9840
FACSIMILE: 801.880.2879
EMAIL: vcrogers@energysolutions.com

CONFIDENTIALITY NOTICE: This electronic message transmission contains information from the firm of **ENERGY*SOLUTIONS***, which is confidential and privileged, in accordance with Utah Code 63G-2-309. The information is intended to be for the use of the individual or entity named above. If you are not the intended recipient, be aware that any disclosure, copying, distribution or use of the contents of this information is prohibited. If you have received this electronic transmission in error, please notify me by telephone (801.649.2253) or by electronic mail (vcrogers@energysolutions.com) immediately. Nothing herein or in the message above is intended to create a contractual relationship.

PDF 01272020 - Feder…

STATE OF UTAH RADIOACTIVE MATERIAL LICENSE APPLICATION FOR THE FEDERAL CELL FACILITY

January 27, 2020

By
Energy*Solutions*, LLC
299 South Main Street, Suite 1700
Salt Lake City, UT 84111

For
Utah Division of Waste Management and Radiation Control
Post Office Box 144880
195 North 1950 West
Salt Lake City, UT 84114-4880

PRELIMINARY REVIEW DRAFT

TABLE OF CONTENTS

Section	Title	Page
SECTION 1.	**GENERAL INFORMATION**	**1-1**
1.1	INTRODUCTION	1-2
1.2	GENERAL FACILITY DESCRIPTION	1-3
1.3	SCHEDULES	1-20
1.3.1	*Construction*	*1-20*
1.3.2	*Receipt of Waste*	*1-21*
1.3.3	*First Waste Placement*	*1-21*
1.3.4	*Operations*	*1-21*
1.3.5	*Closure*	*1-21*
1.4	INSTITUTIONAL INFORMATION	1-21
1.5	MATERIAL INCORPORATED BY REFERENCE	1-22
1.6	CONFORMANCE TO REGULATORY GUIDES	1-22
1.7	SUMMARY OF PRINCIPLE REVIEW MATTERS	1-23
SECTION 2.	**SITE CHARACTERISTICS**	**2-1**
2.1	GEOGRAPHY, DEMOGRAPHY, AND FUTURE DEVELOPMENTS	2-1
2.1.1	*Site Location and Description*	*2-1*
2.1.2	*Population Distribution*	*2-2*
2.2	METEOROLOGY AND CLIMATOLOGY	2-2
2.3	GEOLOGY AND SEISMOLOGY	2-7
2.3.1	*Geologic Site Characteristics*	*2-8*
2.3.2	*Seismology*	*2-9*
2.4	HYDROLOGY	2-14
2.4.1	*Surface Water Hydrology*	*2-14*
2.4.2	*Groundwater Characterization*	*2-15*
2.5	GEOTECHNICAL CHARACTERISTICS	2-19
2.6	GEOCHEMICAL CHARACTERISTICS	2-21
2.7	NATURAL RESOURCES	2-25
2.7.1	*Geological Resources*	*2-25*
2.7.2	*Water Resources*	*2-25*
2.8	BIOTIC FEATURES	2-25
2.9	SITE CHARACTERISTIC PREOPERATIONAL MONITORING	2-29
SECTION 3.	**DESIGN AND CONSTRUCTION**	**3-31**
3.1	PRINCIPAL DESIGN FEATURES	3-32
3.2	DESIGN CONSIDERATIONS FOR NORMAL/ABNORMAL/ACCIDENT CONDITIONS	3-
3.3	CONSTRUCTION CONSIDERATIONS	3-44
3.4	DESIGN OF AUXILIARY SYSTEMS AND FACILITIES	3-46
3.4.1	*Utility Systems*	*3-46*
3.4.2	*Auxiliary Facilities*	*3-47*
3.4.3	*Fire Protection System*	*3-48*
3.4.4	*Erosion and Flood Control Systems*	*3-49*
3.5	DRAWINGS	3-49
SECTION 4.	**FACILITY OPERATIONS**	**4-1**
4.1	RECEIPT AND INSPECTION OF WASTE	4-1
4.2	WASTE HANDLING AND INTERIM STORAGE	4-5

PRELIMINARY REVIEW DRAFT

4.3 WASTE DISPOSAL OPERATIONS 4-5
4.3.1 Waste Emplacement 4-5
4.3.2 Filling of Void Spaces 4-6
4.3.3 Waste Covering 4-7
4.3.4 Disposal Unit Stabilization 4-7
4.3.5 Federal Cell Facility Marking 4-7
4.3.6 Buffer Zone 4-8
4.4 OPERATIONAL ENVIRONMENTAL MONITORING AND SURVEILLANCE 4-8

SECTION 5. FEDERAL CELL FACILITY CLOSURE PLAN AND CONTROL 5-1

5.1 SITE STABILIZATION 5-1
5.1.1 Surface Drainage and Erosion Protection 5-1
5.1.2 Geotechnical Stability 5-3
5.2 DECONTAMINATION AND DECOMMISSIONING 5-4
5.3 POST-OPERATIONAL ENVIRONMENTAL MONITORING AND SURVEILLANCE 5-5

SECTION 6. SAFETY ASSESSMENT 6-1

SECTION 7. OCCUPATIONAL RADIATION PROTECTION 7-1

7.1 OCCUPATIONAL RADIATION EXPOSURES 7-1
7.2 RADIATION SOURCES 7-1
7.3 RADIATION PROTECTION DESIGN FEATURES 7-4
7.4 RADIATION PROTECTION PROGRAM 7-5

SECTION 8. CONDUCT OF OPERATIONS 8-1

8.1 ORGANIZATIONAL STRUCTURE 8-1
8.2 QUALIFICATIONS OF APPLICANT 8-1
8.3 TRAINING PROGRAM 8-1
8.4 EMERGENCY PLANNING 8-2
8.5 REVIEW AND AUDIT 8-4
8.6 FACILITY ADMINISTRATIVE AND STANDARD OPERATING PROCEDURES 8-4
8.7 PHYSICAL SECURITY 8-4

SECTION 9. QUALITY ASSURANCE 9-1

9.1 DESIGN CONTROL 9-2
9.2 PROCUREMENT DOCUMENT CONTROL 9-2
9.3 INSTRUCTIONS, PROCEDURES, AND DRAWINGS 9-2
9.4 DOCUMENT CONTROL 9-2
9.5 CONTROL OF PURCHASED ITEMS AND SERVICES 9-3
9.6 IDENTIFICATION AND CONTROL OF ITEMS 9-4
9.7 CONTROL OF PROCESSES 9-4
9.8 INSPECTION 9-4
9.9 TEST CONTROL 9-5
9.10 CONTROL OF MEASURING AND TEST EQUIPMENT 9-5
9.11 HANDLING, STORAGE, AND SHIPPING 9-6
9.12 INSPECTION, TEST, AND OPERATING STATUS 9-6
9.13 CONTROL OF NONCONFORMING ITEMS 9-7
9.14 CORRECTIVE ACTION 9-7
9.15 QUALITY ASSURANCE RECORDS 9-8
9.16 AUDITS 9-8
9.17 QUALITY ASSURANCE IMPLEMENTATION 9-8

PRELIMINARY REVIEW DRAFT

SECTION 10. FINANCIAL ASSURANCE **10-1**

10.1 PREMATURE CLOSURE 10-1
10.2 SITE TRANSITION 10-17
10.2.1 Authorities and Accountabilities will be Assigned and Documented 10-17
10.2.2 Site Conditions will be Accurately and Comprehensively Documented 10-18
10.2.3 Engineered Controls, Operation and Maintenance Requirements and Emergency / Contingency Planning will be Documented 10-18
10.2.4 Institutional Controls, Real and Personal Property and Enforecement Authorities will be Identified 10-18
10.2.5 Regulatory Requirements and Authorities will be Identified 10-19
10.2.6 Long-Term Surveillance and Maintenance Budget, Funding and Personnel Requirements will be Identified 10-20
10.2.7 Information and Records Management Requirements will be Satisfied 10-21
10.2.8 Public Education, Outreach, Information and Notice Requirements will be Documented and Satisfied 10-21
10.2.9 Natural, Cultural and Historical Resource Management Requirements will be Satisfied 10-23
10.2.10 Business Closure Functions, Pension and Benefits, Contract Closeout or Transfer and Other Administrative Requirements are Satisifed 10-23
10.2.11 Real Property Requirements 10-23
10.2.12 Post-Closure Benefit Information and Data Needs 10-23
10.3 PERPETUAL CARE 10-17
10.3.1 Performance Objectives (UAC R313-25-20) 10-17
10.3.2 Waste Characteristics Requirements (UAC R313-15-1008(2)(a)) 10-18
10.3.3 Technical Analyses (UAC R313-25-9) 10-18
10.3.4 Siting Requirements (UAC R313-25-24) 10-18
10.3.5 Design Requirements (UAC R313-25-25) 10-19
10.3.6 Operating and Closure Requirements (UAC R313-25-26) 10-20
10.3.7 Environmental Monitoring Requirements (UAC R313-25-27) 10-21
10.3.8 Funding for Routine Perpetual Care Activities 10-21
10.3.9 Impact of Highly Unlikely Catastrophic Events 10-23
10.4 ANNUAL ADJUSTMENTS 10-26

SECTION 11. REFERENCES **11-1**

PRELIMINARY REVIEW DRAFT

LIST OF APPENDICES

Appendix	Title
A	Proposed Radioactive Material License for the Federal Cell Facility
B	Engineering and Construction Drawings
C	Long-Term Stewardship Agreement for the Federal Cell Facility
D	Drainage Ditch Calculations
E	Cover/Liner Construction Estimates
F	Depleted Uranium Performance Assessment (digital copy)
G	Financial Surety Calculations

PRELIMINARY REVIEW DRAFT

LIST OF FIGURES

Figure	Title	Page
1-1	Energy*Solutions* Site Location	1-12
1-2	Energy*Solutions* Property Ownership	1-13
1-3	Tooele County Hazardous Industrial District Zoning	1-14
1-4	Energy*Solutions'* Clive Facility General Site Plan	1-16
2-1	Energy*Solutions* Wind Rose January 1993 – 2018 (MSI, 2019)	2-6
2-2	Energy*Solutions* Fault and Seismicity Map (AMEC, 2012a)	2-11

PRELIMINARY REVIEW DRAFT

LIST OF TABLES

Table	Title	Page
1-1	Utah Radiation Control Rules Compliance Matrix	1-4
1-2	NUREG-1199 Compliance Matrix	1-8
2-1	12-Kilometer Population Wheel	2-3
2-2	Tooele County Growth Projection: 2010-2030	2-4
2-3	Selected data from 26 earthquakes within 100 km of the Clive site. Data from catalogs maintained by the University of Utah and the University of Nevada-Reno.	2-13
2-4	Federal Cell Facility Construction Material Estimate	2-22
2-5	Geotechnical Properties of Clive Site Surface Soils	2-23
2-6	Preoperational Radioactivity Concentrations in Soil	2-30
6-1	Peak TEDE: Statistical Summary	6-6
6-2	Peak Groundwater Activity Concentrations within 500 yr, Compared to GWPLs	6-8
6-3	Cumulative Population TEDE: Statistical Summary	6-9
6-4	Statistical Summary of Lake Water Concentrations at Peak Lake Occurrence	6-10
6-5	Statistical summary of Sediment Concentrations at Peak Lake Occurrence	6-11
6-6	Quantitative Assessment Results for Model Analyses	6-13
7-1	Energy*Solutions* Employee Annual Dose Summary	7-7
10-1	Combined Clive Disposal Complex Surety Matrix	10-2
10-2	Similarities in DOE Long-Term Stewardship at the Clive Disposal Facility	10-22
10-3	Summary of Inexact Ranges of Probabilities of Unplanned and Unanticipated Future Events	10-22

PRELIMINARY REVIEW DRAFT

SECTION 1. GENERAL INFORMATION

The proposed Federal Cell Facility will be used for the disposal of federally-generated or otherwise owned radioactive waste and materials. The Director of the Utah Division of Waste Management and Radiation Control is responsible for regulating activities in the State of Utah that involve radioactive materials, some types of radioactive waste, and radiation. As part of this responsibility, the Director enforces requirements promulgated by the State of Utah in Utah Code 19-3, "*Radiation Control Act.*" Requirements applying to land disposal of radioactive waste are contained in Utah Administrative Code (UAC), Rule R313-25, "*License Requirements for Land Disposal of Radioactive Waste – General Provisions*." Additional applicable rules are contained in UAC Rule R313-15 "*Standards for Protection Against Radiation*," which defines requirements for protecting individuals from the effects of radiation and UAC Rule R313-22, "*Specific Licenses*," which identify licensing requirements, many of which are met by compliance with or superseded by the provisions of UAC Rule R313-25. Additional chapters of the UAC are also applicable.

In accordance with requirements, the Director has issued other licenses to Energy*Solutions* to receive, store, and dispose, by land burial, the following categories of radioactive materials and waste:

- Naturally-occurring and accelerator produced radioactive material (NORM) waste,
- Low-activity radioactive waste (LARW),
- Class A low-level radioactive waste (LLRW),
- Special nuclear material (SNM),
- 11e.(2) waste,
- Radioactive waste that is also determined to be hazardous (mixed waste), and
- Naturally occurring radioactive material (NORM).

Energy*Solutions* holds the following licenses and permits:

- State of Utah Radioactive Material License UT2300249, Amendment 25, under timely renewal;
- State of Utah Radioactive Material License, 11(e).2 Byproduct Material License UT2300478, Amendment 2;
- State of Utah Part B Permit, U.S. Environmental Protection Agency (EPA) Identification Number UTD982598898, under timely renewal; and
- State of Utah Ground Water Quality Discharge Permit (GWQDP) Number UGW450005, under timely renewal.

The Radiation Control Act includes specific requirements prerequisite to receiving license authority to dispose of concentrated depleted uranium. In order to be licensed to dispose of concentrated depleted uranium, Utah Code §19-3-103.7(3) requires that the Director (a) approve a depleted uranium performance assessment; (b) agree to a Federal Cell Facility designation and (c) enter into an agreement wherein the U.S. Department of Energy (DOE) accepts perpetual management of the Federal Cell Facility, title to the land on which the Federal Cell Facility is located, title to the waste in the Federal Cell Facility, and financial stewardship for the Federal Cell Facility and waste in the Federal Cell Facility.

PRELIMINARY REVIEW DRAFT

Under authority of the Utah Radiation Control Act, the Waste Management and Radiation Control Board established requirements and criteria in UAC Rule R313-25, "*License Requirements for Land Disposal of Radioactive Waste – General Provisions*" for licensing radioactive waste disposal facilities. Under provisions of UAC Section R313-25-4, no person may receive, possess, or dispose of waste, at a land disposal facility, unless authorized by a license issued by the Director, an Agreement State, or the U.S. Nuclear Regulatory Commission (NRC) pursuant to UAC Rules R313-22 and R313-25 or equivalent requirements.

The requirements of UAC Rule R313-25 address such topics as: Performance Objectives, Site Suitability Requirements, Facility Design, Construction, Operating, Closure, and Post-closure Requirements, Waste Characteristic Requirements, Environmental Monitoring Requirements, Financial Assurance and Financial Qualifications Requirements and Administrative Requirements.

1.1 INTRODUCTION

The framework for the technical analysis of the disposal of radioactive waste was developed in the 1980s with the NRC's issuance of Title 10 of the Code of Federal Regulations (10 CFR) Part 61, "*Licensing Requirements for Land Disposal of Radioactive Waste*." Part 61 establishes a waste classification scheme based on the role that radionuclide concentrations and waste forms play in the long-term performance of disposal facilities. When initially suggested for 10 CFR 61.55, concentrated depleted uranium was considered Class A low-level radioactive waste (LLRW). Although included in the draft analysis, depleted uranium was removed from the final Part 61 rule because the nominal amounts of depleted uranium in need of disposal were not found to create elevated risk to human health and the environment. Additionally, there were no commercial facilities producing large quantities of depleted uranium at that time and depleted uranium in store at Federal facilities was not regulated by the NRC; instead, it was controlled and managed by DOE as a potential future resource. Because Utah is an Agreement State with the U.S. Nuclear Regulatory Commission (NRC), the Utah regulations for the issuance of licenses for the land disposal of radioactive wastes, as discussed within UAC R313-25, closely follow the NRC's Part 61 regulations.

On February 28, 1988, Energy*Solutions*, LLC, a Utah Limited Liability Corporation, (known then as Envirocare of Utah, Inc.) was first issued a license by the Utah Bureau of Radiation Control to dispose of naturally-occurring radioactive material (NORM). On March 21, 1991, the Utah Bureau of Radiation Control granted Energy*Solutions* a license to dispose of LARW. The license authorized receipt and disposal of a select group of 44 radionuclides (including depleted uranium) with specific concentration limits less than the Class A limits promulgated in UAC R313-15-1009. On October 5, 2000, Energy*Solutions*, was issued Radioactive Material License UT2300249 by the Utah Division of Radiation Control to manage and dispose of LLRW (including depleted uranium) up to the Class A limits promulgated in UAC R313-15-1009. The Radioactive Material License UT 2300249 was later renewed by the Director on January 25, 2005 and is currently under timely renewal.

On January 31, 2005, Envirocare of Utah, Inc. was sold and became Envirocare of Utah, LLC. On February 2, 2006, Envirocare of Utah, LLC became Energy*Solutions*, LLC, which is a subsidiary of Energy*Solutions*, Inc., a publicly held corporation. On January 7, 2013, Energy*Solutions*, LLC announced it had entered into agreement to be acquired by Energy Capital Partners II, LLC. Energy*Solutions*, LLC is a privately held Utah limited liability corporation with Corporate Headquarters at 299 South Main Street, Suite 1700, Salt Lake City, UT 84111. All references, attachments, and appendices to this Application that were performed for, or

PRELIMINARY REVIEW DRAFT

in support of, Envirocare of Utah, Inc. or Envirocare of Utah, LLC, are pertinent to this Energy*Solutions* Application.

In October 2008, 5,408 drums of depleted uranium were sent to the Energy*Solutions* facility at Clive from DOE's Savannah River Site (SRS) for disposal (out of a total inventory of 33,000 drums needing final disposition). Energy*Solutions* was also informed that DOE further intended to dispose of the large quantity of depleted uranium expected to be generated in facilities in Ohio and Kentucky [~700,000 megagrams (Mg) or 700,000 metric tons; Neptune 2015]. Because depleted uranium concentration limits were excluded when the final Part 61 rules were promulgated, the State of Utah initiated formal rulemaking on March 2, 2010 to amend UAC R313-25 and impose Condition 35 on Energy*Solutions'* Radioactive Material License UT2300249 to significantly limit further disposal of concentrated depleted uranium until a site-specific depleted uranium performance assessment ("DU PA") could be completed. In 2011, Energy*Solutions* submitted a DU PA to meet Condition 35 and requested approval of the DU PA from the Director. Energy*Solutions* and the Director have worked in good faith on the DU PA in the ensuing years. Since its initial submission, Energy*Solutions* and the Director have determined the preferred disposal method requires Energy*Solutions* to segregate the concentrated depleted uranium from its other waste streams and dispose of it in a dedicated Federal Cell. Therefore, Energy*Solutions* now proposes to dispose of the concentrated depleted uranium in a dedicated Federal Cell, as reflected in this Federal Cell Radioactive Material License Application. This Application is governed by Utah Administrative Code R313-25-9(5)(a), the applicable sections of Utah Administrative Code R313-22, et seq., and Utah Code section 19-3-103.7 (among other applicable law)—but not Condition 35 of License UT2300249.

To the extent practicable, the information presented in this Application was prepared in accordance with UAC R313-25-13 and conforms to the format and outline suggested by NRC (NRC, 1991). Table 1-1 provides a compliance matrix relating requirements found in the Utah regulations for the issuance of licenses for the land disposal of radioactive wastes (UAC R313-25) to the location of this information in the Application. Similarly, Table 1-2 provides a matrix relating this Application's information to guidelines set forth by NRC (1991), "**Standard Format and Content of a License Application For a Low-Level Radioactive Waste Disposal Facility**." A complete list of NRC Regulatory Guides relevant to the Application is included in Section 1.6. Proposed Radioactive Material License for the Federal Cell Facility is provided in Appendix A.

1.2 GENERAL FACILITY DESCRIPTION

The Clive site is on the eastern edge of the Great Salt Lake Desert, three miles west of the Cedar Mountains, 2.5 miles south of Interstate 80, and 1 mile south of a switch point called Clive on the tracks of the Union Pacific system. Figure 1-1 shows the location of the site in relation to Salt Lake City and surrounding towns. The disposal site is a parcel of land, consisting of one square mile in Tooele County, Utah. The land was owned by the State of Utah, and, with the exception of approximately 100 acres used in the Vitro Remedial Action project, has been purchased by Energy*Solutions*. DOE owns the 100 acres used in the Vitro Remedial Action project. The licensed property owned by Energy*Solutions*, is Utah SLB&M, Section 32, Township 1 South, Range 11 West, Tooele County, Utah.

PRELIMINARY REVIEW DRAFT

Table 1-1

Utah Radiation Control Rules Compliance Matrix

Rule	Definition	Application References
R313-25-1	**Purpose and Scope**	
R313-25-2	**Definitions**	
R313-25-3	**Pre-licensing Plan Approval Criteria for Siting of Commercial Radioactive Waste Disposal Facilities.**	
(1)	Persons proposing to construct or operate commercial radioactive waste disposal facilities shall obtain plan approval from the Director before applying for a license.	1.1
(2)	The siting criteria and plan approval requirements in R313-25-3 apply to pre-licensing plan approval applications.	1.1
(3)	This license requirement delineates where treatment facilities, including commercial radioactive incinerators cannot be located. It specifies the hydrogeologic, seismic, archeological, and federal criteria that would prevent the licensing of a disposal facility.	2.1-2.9
(5)	Facilities may not be located within a distance to existing drinking water wells and watersheds for public water supplies of one year ground water travel time plus 1,000 feet for incinerators and of five years groundwater travel time plus 1,000 feet for land disposal facilities.	2.4
(6)	The plan approval application shall include hydraulic conductivity and other information necessary to estimate adequately the groundwater travel distance.	2.6
(7)	The plan approval application shall include the results of studies adequate to identify the presence of ground water aquifers in the area of the proposed site and to assess the quality of the ground water of all aquifers identified in the area of the proposed site.	2.5, 2.6, 2.7, 2.9

PRELIMINARY REVIEW DRAFT

Rule	Definition	Application References
(9)	This license requirement specifies plan approval requirements pertinent to emergency response and safety during operations at the disposal facility.	4.5
R313-25-4	**License Required**	1.1
(1)	Persons shall not receive, possess, or dispose of waste at a land disposal facility unless authorized by a license issued by the Director pursuant to R313-25 and R313-22.	1.1
(2)	Persons shall file an application with the Director pursuant to R313-22-32 and obtain a license as provided in R313-25 before commencement of construction of a land disposal facility. Failure to comply with this requirement may be grounds for denial of a license and other penalties established by law and rules.	1.1
R313-25-5	**Content of Application**	
(1)	In addition to the requirements set forth in R313-22-33, an application to receive from others, possess, and dispose of waste shall consist of general information, specific technical information, institutional information, and financial information, as set forth by R313-25-6 through R313-25-10.	Section 1, Section 2, Section 3, Section 5, Section 10
R313-25-7	**General Information**	
(1)	Identity of the applicant.	1.1
(2)	Applicant qualifications.	1.1
(3)	Description of site location, waste and technical abilities.	1.1, 1.2, 2.1, 2.3 - 2.10, 6.1, 6.2
(4)	Proposed schedules for construction, receipt, and waste emplacement.	1.3, 4.2, 4.3
R313-25-8	**Specific Technical Information**	
(1)	A description of the natural and demographic disposal site characteristics shall be based on and determined by disposal site selection and characterization activities. The description shall include geologic, geochemical, geotechnical, hydrologic, ecologic, archeological, meteorological, climatologic, and biotic features of the disposal site and vicinity.	1.2, 2.1 - 2.9

PRELIMINARY REVIEW DRAFT

Rule	Definition	Application References
(2)	Design feature descriptions, including: water infiltration; cover integrity; structural stability; contact water management; disposal site drainage, closure, and stabilization; elimination to the extent practicable of long-term disposal site maintenance; inadvertent intrusion; occupational exposures; disposal site monitoring; and adequacy of buffer zone size.	1.2, Section 2, 3.1, 3.2, 3.3, 3.4, Section 5, Section 7
(3)	Description of principal design criteria.	Section 3
(4)	Description of natural events or phenomena on which the design is based and their relationship to the principal design criteria.	1.2, 2.1-2.9
(5)	Description of codes and standards which the applicant has applied to the design, and will apply to the construction of the land disposal facility.	1.1, 1.5, 1.6, Section 3, 6.2, 6.3, 4.8
(6)	Description of construction and operation of land disposal facility, including: disposal unit construction methods, waste emplacement and segregation methods, types of intruder barriers, onsite traffic and drainage systems, survey control program, methods and areas of waste storage, surface and groundwater waste access control, and methods to be employed in handling chelating agents or other non-radiological substances which might affect meeting the performance objectives.	1.2, Section 2, Section 3, Section 5, Section 7, 4.1-4.9
(7)	Description of site closure plan, including those design features which will facilitate disposal site closure and eliminate the need for active maintenance after closure.	Section 5
(8)	Identification of natural resources that could lead to inadvertent intrusion.	2.9
(9)	Description of radioactive waste (kind, amount, classification, and specifications).	6.2
(10)	Description of QA program.	Section 9
(11)	Description of radiation safety program.	4.4, Section 7
(12)	Description of environmental monitoring program.	2.11, 4.9

PRELIMINARY REVIEW DRAFT

Rule	Definition	Application References
(13)	Description of administrative procedures.	4.8, 9.5
(14)	Description of the facility electronic recordkeeping system as required in R313-25-33.	4.2
R313-25-9	**Technical Analyses**	
(1)	Air, soil, groundwater, surface water, animal burrowing will be considered in general population protection. Analysis will differentiate between roles performed by the natural site characteristics and roles performed by design features.	1.2, 2.1, 6.4, 4.7
(2)	Inadvertent intruder protection.	1.2, 6.4, 4.7
(3)	Expected exposure to workers during operation.	4.4, 6.3, 7.2
(4)	Long term stability. Analysis based on natural processes including erosion, mass wasting, slope failure, settlement, infiltration, and surface drainage.	Section 3, 6.4
(5)	Performance Assessment that demonstrates that the performance standards will be met for the total quantities of concentrated depleted uranium for 10,000 years.	Appendix F
R313-25-10	**Institutional Information**	1.4, 5.4, 10.3
(1)	A certification from the agency which owns the disposal site that the agency is prepared to accept transfer of the license when the provisions of R313-25-16 are met and will assume responsibility for institutional control after site closure and for post-closure observation and maintenance.	1.4
(2)	Evidence, if the proposed disposal site is on land not owned by the federal or state government that arrangements were made for assumption of ownership in fee by the federal or state agency.	1.4
R313-25-11	**Financial Information**	1.4, 5.4, 10.1-10.3
R313-25-12	**Requirements for Issuance of a License by the Director**	
(1)	Won't cause unreasonable risk to public safety or health.	2.1, 2.4, 2.7
(2)	Applicant is qualified.	1.1

PRELIMINARY REVIEW DRAFT

Rule	Definition	Application References
(3)	Disposal site is adequate: to protect the public health and safety.	5.1, 6.3, 4.4, 4.6-4.9
(4)	Disposal site is adequate: to protect from inadvertent intrusion.	1.2, 4.7
(5)	Disposal site is adequate: to protect public post-closure.	1.2, 2.1, 2.4 - 2.8, 4.7
(6)	Disposal site is adequate: long-term stability.	2.1-2.10, 3.1, 4.3, 5.1, 6.4
(7)	Applicant provides reasonable assurance that the requirements of R313-25 will be met.	
(8)	Demonstrate adequacy of institutional controls.	4.6, 5.4, 9, 10.3
R313-25-13	**Conditions of License**	
(5)	Requirement to confine waste and waste handling equipment to approved areas only.	4.1-4.3
R313-25-14	**Application for Renewal or Closure**	
(1)	An application for renewal or an application for closure shall be filled at least 90 days prior to license expiration.	1.1
(2)	Application requirements.	1.1
(3)	If a licensee has filed an application in proper form for renewal of a license, the license shall not expire unless and until the Director has taken final action to deny application for renewal.	1.1
(4)	In evaluating an application for license renewal, the Director will apply the criteria set forth in R313-25-11.	1.1
R313-25-15	**Contents of Application for Site Closure and Stabilization**	
R313-25-16	**Post-Closure Observation and Maintenance**	4.9, 6.4
R313-25-17	**Transfer of License: Following closure and the period of post-closure observation**	
R313-25-18	**Termination of License**	
R313-25-19	**General Requirement: Land Disposal Facilities shall be sited, designed, operated, closed, and controlled after closure so that reasonable assurance exists that exposure to individuals do not exceed the limits stated in R313-25-19 and 25-22.**	Section 2, Section 3, Section 7

PRELIMINARY REVIEW DRAFT

Rule	Definition	Application References
R313-25-20	**Protection of the General Population from Releases of Radioactivity.**	6.3, 6.4, 7.3
R313-25-21	**Protection of Individuals from Inadvertent Intrusion**	1.2, 4.7, 6.4, 7.3
R313-25-22	**Protection of Individuals During Operations**	6.3, 4.4, 7.3, 7.4
R313-25-23	**Stability of the Disposal Site After Closure**	2.1, 2.3
R313-25-24	**Disposal Site Suitability Requirements for Land Disposal-Near-Surface Disposal**	
(1)	Primary emphasis: Isolation of wastes and disposal site features that ensure that the long-term performance objectives are met.	2.1-2.10, 3.1-3.3
(2)	The disposal site shall be capable of being characterized, modeled, analyzed, and monitored.	1.2, Section 2, 5.1, 5.3
(3)	Future population growth considerations.	1.2, 2.1
(4)	Natural resource considerations.	1.2, 2.9
(5)	Flooding considerations.	2.5, 6.3
(6)	Minimization of upstream drainage areas.	2.5
(7)	The disposal site shall provide sufficient depth to the water table that groundwater intrusion, perennial or otherwise, into the waste will not occur.	2.6, 2.7
(8)	The hydrogeologic unit used for disposal shall not discharge groundwater to the surface within the disposal site.	2.5-2.8
(9)	Seismic considerations.	2.4, 5.1
(10)	Geologic process considerations.	2.4, 5.1
(11)	Environmental considerations.	1.2, 2.10, 2.11, 4.9
R313-25-25	**Disposal Site Design for Near-Surface Land Disposal**	
(1)	Primary emphasis: Long-term isolation.	2.1, 2.3-2.8, 5.1
(2)	Design compatible with closure plan.	5.1
(3)	Disposal site design requirements.	6.4, 4.3
(4)	Cover requirements.	1.2, 3.1, 3.2, 3.3, 5.1, 5.1
(5)	Ditch requirements.	
(6)	Water and waste contact issues.	2.5, 2.6, 5.1
R313-25-26	**Near Surface Land Disposal Facility Operation and Disposal Site Closure**	
(1)	Segregation of Class A wastes.	1.2
(3)	Waste acceptance requirements.	Section 6, Section 7
(4)	Waste emplacement requirements.	4.3

PRELIMINARY REVIEW DRAFT

Rule	Definition	Application References
(5)	Void space minimization requirements.	4.3
(6)	Radiation dose minimization requirements.	4.4
(7)	Boundary marking requirements.	1.2, 2.1, 6.3
(8)	Buffer zone requirements.	4.3
(9)	Closer and stabilization requirements.	Section 5
(10)	Disposal operation requirements.	4.3
(11)	Waste specifications.	
(12)	Director authority.	1.1
R313-25-27	**Environmental Monitoring**	
(1)	Requirement for pre-operational monitoring.	2.11, Section 2
(2)	Maintenance of an environmental monitoring program.	4.9
(3)	Post operational monitoring.	5.3
(4)	Emergency cleanup plans.	4.5
R313-25-29	**Institutional Requirements**	Section 4, Section 6, 5.4, 10.1-10.3
R313-25-30	**Applicant Qualifications and Assurances**	1.1, 9, 10.3
R313-25-31	**Funding for Disposal Site Closure and Stabilization**	10.1-10.3
R313-25-32	**Financial Assurances for Institutional Controls**	1.1, 5.4, 10.1-10.3
R313-25-33	**Maintenance of Records, Reports, and Transfers**	1.1, 1.2, 5.4, 9.4-9.6
R313-25-34	**Tests on Land Disposal Facilities**	5.1

PRELIMINARY REVIEW DRAFT

Table 1-2

NUREG-1199 Compliance Matrix

Rule	Definition	Application References
1.0	**General Information**	
1.1	Introduction	1.1
1.2	General Facility Description	1.2
1.3	Schedules	1.3
1.4	Institutional Information	1.4, 5.4
1.5	Material Incorporated by Reference	1.5
1.6	Conformance to Regulatory Guides	1.6
1.7	Summary of Principle Review Matters	1.7
2.0	**Site Characteristics**	
2.1	Geography, Demography, and Future Developments	2.1
2.1.1	Site Location and Description	2.1.1
2.1.2	Population Distribution	2.1.2
2.2	Meteorology and Climatology	2.2
2.3	Geology and Seismology	2.3
2.3.1	Geologic Site Characterization	2.3.1
2.3.2	Seismic Investigation	2.3.2
2.4	Hydrology	2.4
2.4.1	Surface Water Hydrology	2.4.1
2.4.2	Groundwater Characterization	2.4.2
2.5	Geotechnical Characteristics	2.5
2.6	Geochemical Characteristics	2.6
2.7	Natural Resources	2.7
2.7.1	Geologic Resources	2.7.1
2.7.2	Water Resources	2.7.2
2.8	Biotic Features	2.8
2.9	Site Characterization Monitoring	2.9
3.0	**Design and Construction**	
3.1	Principle Design Features	3.1
3.2	Design Considerations for Normal and Abnormal/Accident Conditions	3.2
3.3	Construction Considerations	3.3
3.4	Design of Auxiliary Systems and Features	3.4
3.4.1	Utility Systems	3.4.1
3.4.2	Auxiliary Facilities	3.4.2
3.4.3	Fire Protection System	3.4.3
3.4.4	Erosion and Flood Control System	3.4.4

PRELIMINARY REVIEW DRAFT

Rule	Definition	Application References
4.0	**Facility Operations**	
4.1	Receipt and Inspection of Waste	4.1
4.2	Waste Handling and Interim Storage	4.2
4.3	Waste Disposal Operations	4.3
4.4	Operational Environmental Monitoring and Surveillance	4.9
5.0	**Site Closure Plan and Institutional Controls**	
5.1	Site Stabilization	5.1
5.1.1	Surface Drainage and Erosion Protection	5.1.1
5.1.2	Geotechnical Stability	5.1.2
5.2	Decontamination and Decommissioning	5.2
5.3	Post Operational Environmental Monitoring and Surveillance	5.3
6.0	**Safety Assessment**	
6.1	Release of Radioactivity	6
6.1.1	Determination of Types, Kinds, and Quantities of Waste	6
6.1.2	Infiltration	6
6.1.3	Radionuclide Release - Normal Conditions	6
6.1.4	Radionuclide Release - Accidents or Unusual Operating Conditions	6
6.1.5	Radionuclide Transfer to Human Access Location	6
6.1.5.1	Transfer Mechanism - Groundwater	6
6.1.5.2	Transfer Mechanism - Air	6
6.1.5.3	Transfer Mechanism - Surface Water	6
6.1.5.4	Other Transfer Mechanisms	6
6.1.6	Assessment of Impacts and Regulatory Compliance	6
6.2	Intruder Protection	6
6.3	Long-Term Stability	6
6.3.1	Surface Drainage and Erosion Protection	6
6.3.2	Stability of Slopes	6
6.3.3	Settlement and Subsidence	6
7.0	**Occupational Radiation Protection**	
7.1	Occupational Radiation Exposures	7.1
7.2	Radiation Sources	7.2
7.3	Radiation Protection Design Features	7.3
7.4	Radiation Protection Program	7.4

PRELIMINARY REVIEW DRAFT

Rule	Definition	Application References
8.0	**Conduct of Operations**	
8.1	Organizational Structure	8.1
8.2	Qualifications of Applicant	8.2
8.3	Training Program	8.3
8.4	Emergency Planning	8.4
8.5	Review and Audit	8.5
8.6	Facility Administrative and Operating Procedures	8.6
8.7	Physical Security	8.7
9.0	**Quality Assurance**	
9.1	Quality Assurance During the Design and Construction Phase	Section 9
9.2	Quality Assurance During the Operations Phase	Section 9
10.0	**Financial Assurance**	Section 10
11.0	**References**	Section 11

PRELIMINARY REVIEW DRAFT

Most of the land within a 10-mile radius of the site is predominantly within the public domain, as administered by the U.S. Bureau of Land Management (BLM). As is illustrated in Figures 1-2 and 1-3, the non-federally owned lands around the Clive facility have been designated as a Hazardous Industrial District MG-H by Tooele County. This designation limits, through zoning, the future uses of land in the area of the disposal facility to heavy industrial processes (General Industrial District M-G type uses) and to industries dealing with hazardous wastes, by the issuance of conditional use permits. Because the Hazardous Industrial District MG-H designation does not authorize any other types of land-use, it also reduces the potential for population encroachment near Energy*Solutions*' Clive facility. In fact, previous to the Vitro project, there were no industrial, residential, or municipal activities near the site. Since that time, three hazardous waste facilities have located in the Clive area:

- Clean Harbors' Grassy Mountain facility, a commercial, hazardous waste, treatment, storage and disposal facility located greater than ten miles north-northwest of Energy*Solutions'* Clive facility;

- Clean Harbors' Aragonite facility a 140 million Btu slagging rotary kiln with a vertical afterburner chamber located approximately 8 miles east-northeast of Energy*Solutions'* Clive facility; and,

- Clean Harbors Clive facility, a defunct incinerator site currently permitted for transfer and storage of hazardous waste located one mile west of Energy*Solutions'* Clive facility.

No new industrial facilities have been established in this area of Tooele County's West Desert since June 30, 1988. Individuals who work at these facilities do not live on site, nor do they represent permanent residential population centers.

The remoteness of the site from the urbanized areas of Tooele County makes the surrounding area an improbable location for any other significant industrial use which might be impacted by the disposal project. BLM has seasonal sheep and cattle grazing allotments near Clive. Additionally, the low precipitation and high evaporation rates are not conducive to any sustainable crop yields.

The groundwater at Clive is classified as Class IV, *saline ground water* according to UAC R317-6-3 Ground Water Classes, with total dissolved solids (TDS) concentrations ranging from 30,000 mg/L to 100,000 mg/L. Because of the naturally poor quality and high salinity, the underlying groundwater in the vicinity of the Clive site is not suitable for most human uses or potable for humans (Lundberg, 2014). Because of this, residential population cannot be centered in this area as the groundwater dramatically exceeds the Utah Division of Drinking Water primary and secondary drinking water standards.

Energy*Solutions* operates an LLRW disposal facility west of the Cedar Mountains in Clive, Utah. Clive is located along Interstate-80, approximately 3 miles south of the highway, in Tooele County. The facility is approximately 50 miles east of Wendover, Utah, and approximately 60 miles west of Salt Lake City, Utah. The facility sits at an elevation of approximately 4,275 feet above mean sea level (amsl) and is accessed by both road and rail transportation.

PRELIMINARY REVIEW DRAFT

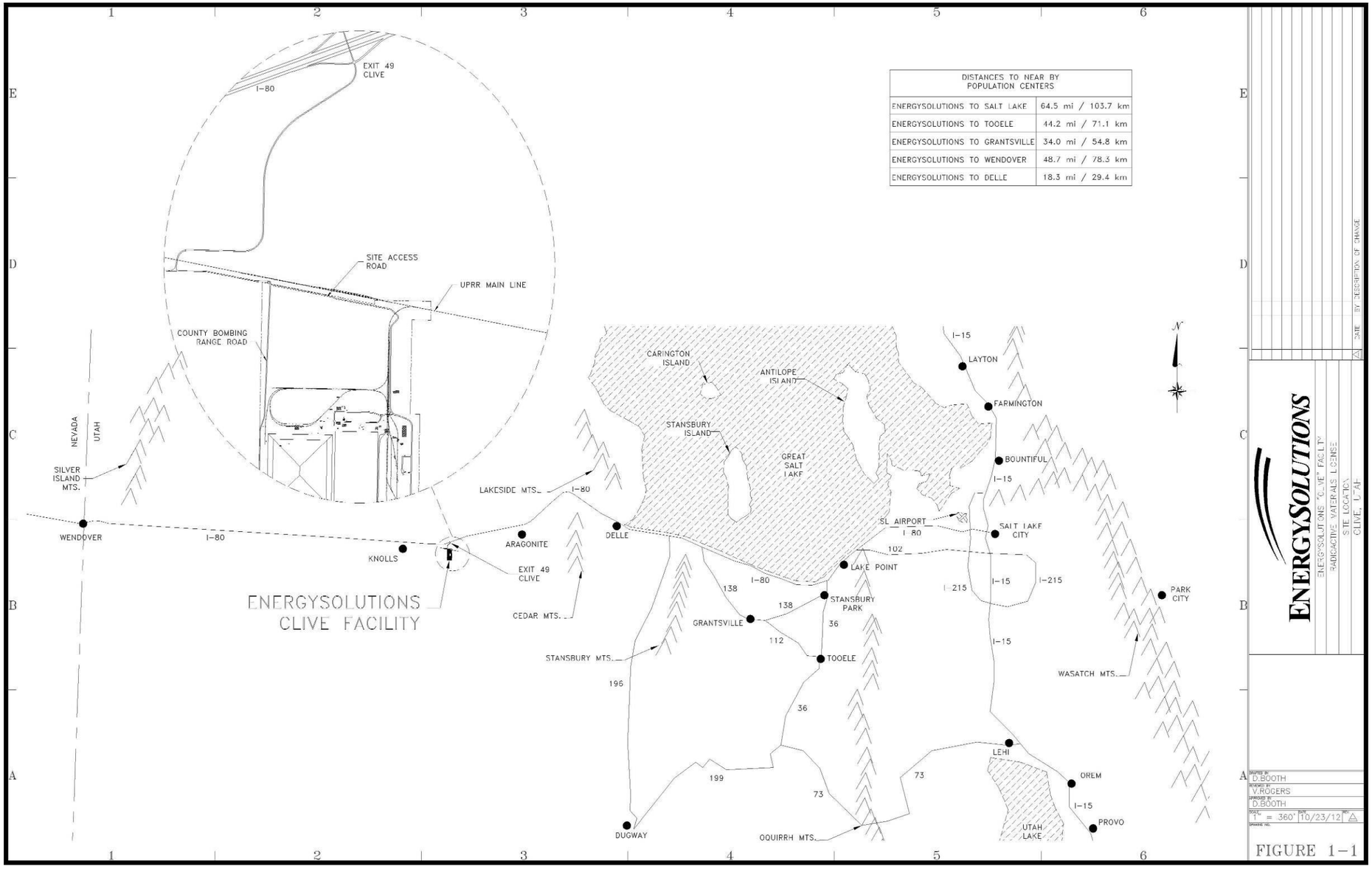


Figure 1-1. Energy*Solutions* Site Location

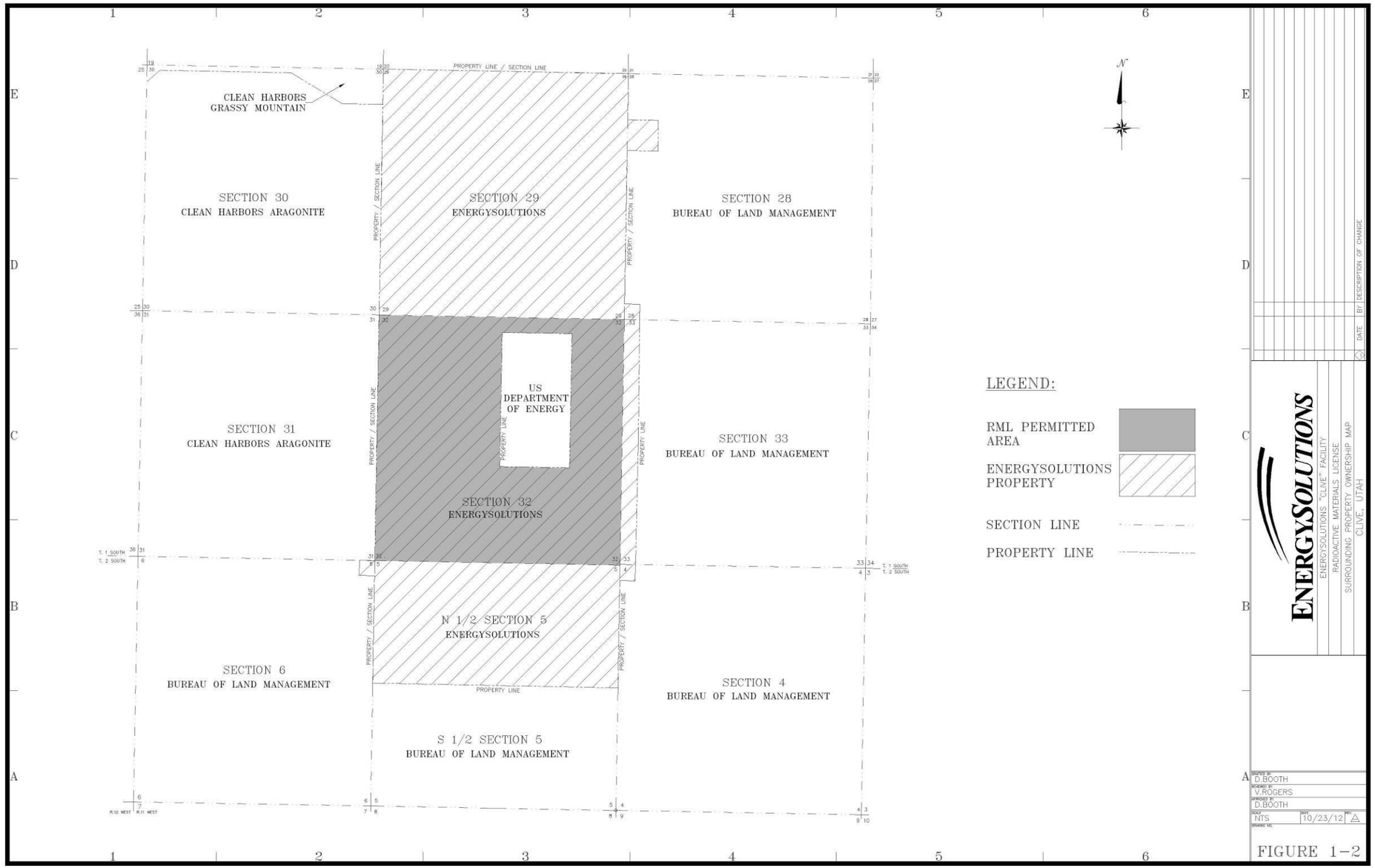


Figure 1-2. Energy*Solutions* Property Ownership

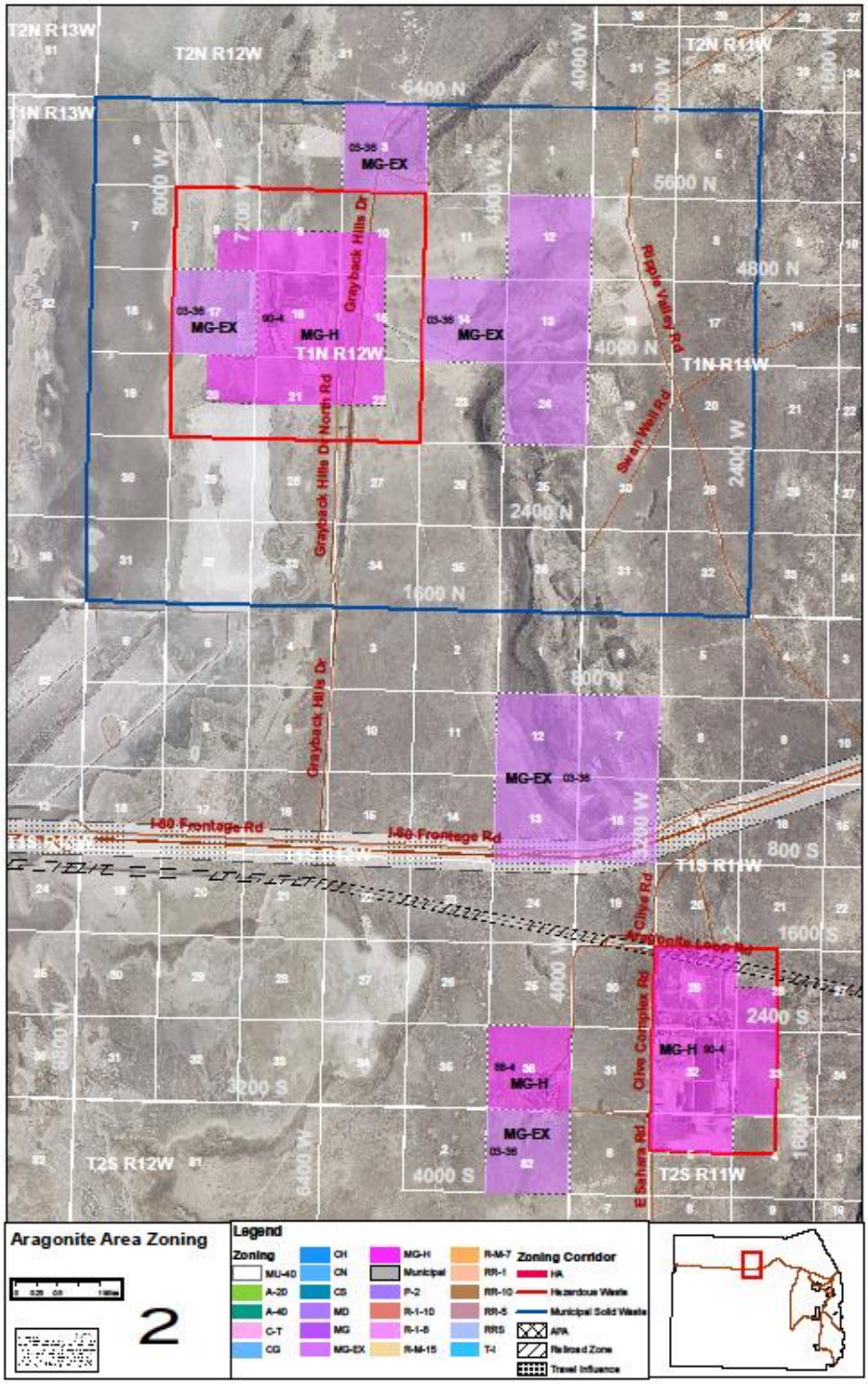


Figure 1-3. Tooele County Hazardous Industrial District Zoning.

The disposal cell in the southern part of Section 32 has been defined as the "11e.(2) Cell," which was initially authorized by the NRC in 1995, before Utah became an Agreement State. The currently approved 11e.(2) Cell occupies a footprint of about 2,254 feet (751 yards) by 1,767 feet (589 yards), which is about 3.98 million square feet and is licensed with a waste disposal capacity of about 5.04 million cubic yards.

On January 4, 2008, Energy*Solutions* requested a design change to the 11e.(2) Cell that would allow LLRW to be disposed of in the western portion of the 11e.(2) Cell, which was and still is unused. That configuration was known as the Class A South (CAS) Cell proposal. This LLRW disposal area was to be 1,472 feet by 1,860 feet in size. Energy*Solutions* herein proposes that a Federal Cell Facility be licensed in the area originally considered for the CAS cell and be physically separated from the 11e.(2) Cell.

The general aspect of the proposed Federal Cell Facility is that of a hipped cap, with relatively steeper sloping sides nearer the edges. The upper part of the Federal Cell Facility, known as the top slope, has a moderate slope, while the side slope is markedly steeper (20 percent as opposed to 2.4 percent). Energy*Solutions* requests authorization to only dispose of depleted uranium beneath the top slope areas of the Federal Cell Facility, with no depleted uranium beneath the side slopes. All depleted uranium waste will be disposed below current grade level. Depleted uranium waste placement will progress from the eastern boundary of the top slope of the Federal Cell Facility to the west.

Energy*Solutions* has licensed four disposal Federal Cell Facility. In addition, DOE constructed and owns the Vitro Federal Disposal Facility located adjacent to Energy*Solutions'* facilities. A current site layout is provided on Figure 1-4, including the location of the Federal Cell Facility in relation to other site facilities.

Vitro Federal Disposal Facility: The Vitro Federal Disposal Facility was constructed and is owned by DOE between 1984 and 1988. It contains waste generated by the cleanup of the Vitro Chemical Company site in South Salt Lake City, Utah. This plant had processed uranium and vanadium ore from 1951 through 1968. Total capacity of the Vitro Federal Disposal Facility is approximately 2.5 million cubic yards.

LARW Disposal Facility: The LARW Facility was Energy*Solutions*' first disposal facility at the Clive Disposal Complex. Disposal operations began in 1988 as a Naturally-Occurring Radioactive Materials (NORM) Disposal Facility, with Low-Activity Radioactive Waste later included for disposal. The LARW Disposal Facility is completed and covered, with final waste placed on May 26, 2004 and final cover completed June 12, 2006. Environmental monitoring activities continue, as described in this Application. Total capacity of the LARW Disposal Facility is approximately 2.2 million cubic yards.

Mixed Waste Disposal Facility: Disposal operations in the Mixed Waste Disposal Facility began in early 1992, as authorized by a state-issued Part B Permit (EPA ID Number UTD982598898), originally issued to Energy*Solutions* by the Utah Division of Solid and Hazardous Waste on November 30, 1990. Mixed wastes contain both hazardous and radioactive constituents. Energy*Solutions* also disposes of select non-hazardous radioactive wastes in the Mixed Waste Disposal Facility. Total capacity of the Mixed Waste Disposal Facility is approximately 1.3 million cubic yards.

PRELIMINARY REVIEW DRAFT

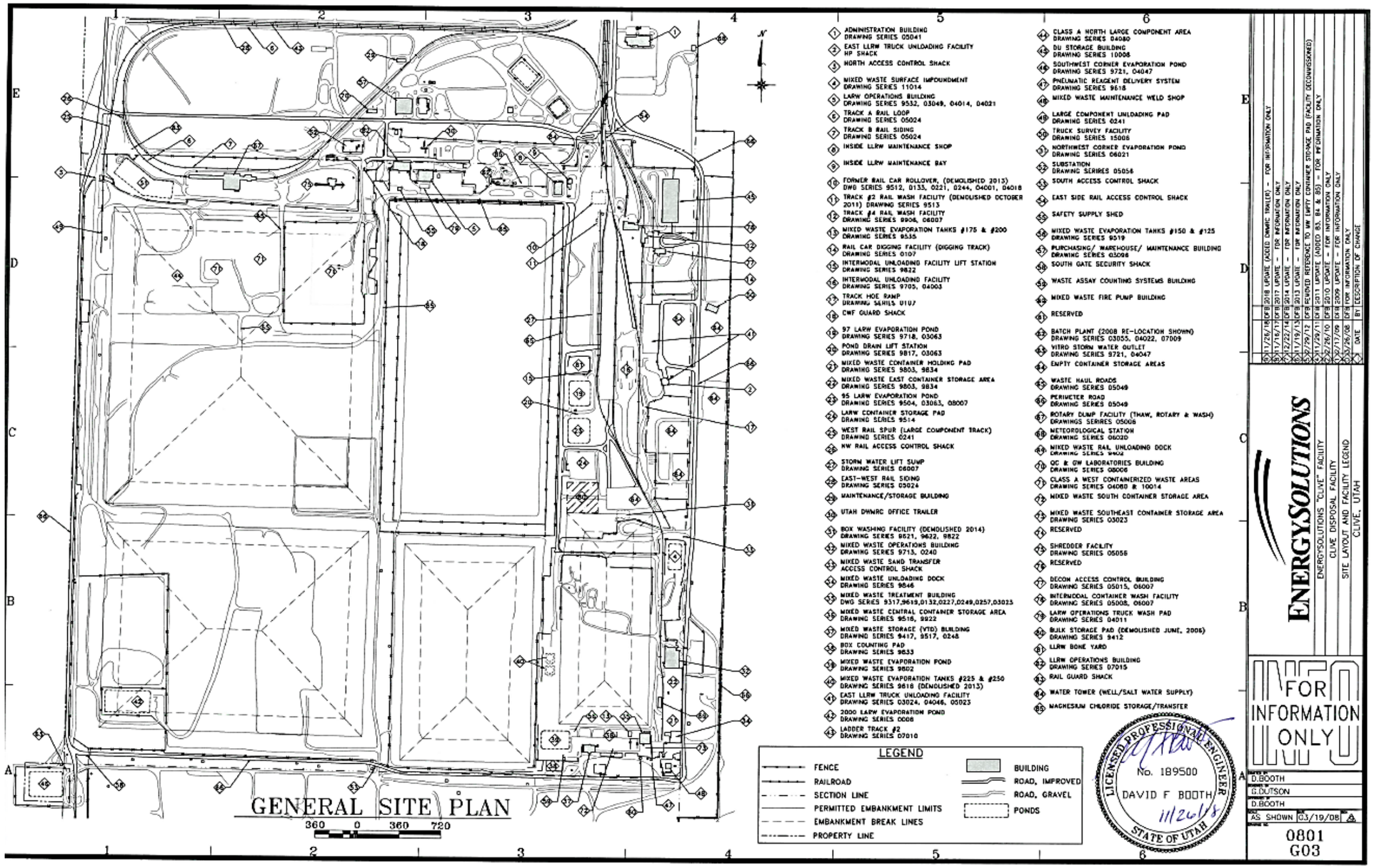


Figure 1-4. General Clive Disposal Complex Layout

PRELIMINARY REVIEW DRAFT

11e.(2) Federal Byproduct Facility: Disposal operations in the 11e.(2) Federal Byproduct Facility began in fall 1994 and are restricted to the disposal of 11e.(2) byproduct material (uranium and thorium wastes), as authorized by Byproduct Material License (UT 2300478) issued to Energy*Solutions* by the Director on November 30, 2003. Total capacity of the 11e.(2) Federal Byproduct Facility is approximately 5.0 million cubic yards.

Class A West Facility: Disposal operations in the Class A Facility (a predecessor to the Class A West Facility) began in summer 2000. A second LLRW Disposal Facility was initially licensed in 2005 (the Class A North Disposal Facility). The Class A and Class A North disposal facilities were combined into the Class A West Disposal Facility in late 2012. Energy*Solutions* also licensed the Clive Containerized Waste (CWF) disposal concept to manage radioactive waste shipments with higher contact radioactivity (but with relatively low volumes) in contrast to the LLRW typically disposed at Clive (higher volumes of low activity waste). The CWF is wholly contained within the Class A West Disposal Facility. In addition to the CWF, a footprint has been designated as a clean restricted area reserved for disposal of large components. Total capacity of the Class A West Disposal Facility is approximately 8.7 million cubic yards.

The facility is served by Rocky Mountain Power for electric power. Electric service includes three-phase 440-volt service. Additionally, Energy*Solutions* has installed a telephone cable. Energy*Solutions* does not have a public supply of water, and transports potable water to site storage tanks from Grantsville, Utah. Non-potable groundwater (provided by a well owned by Energy*Solutions* north of Interstate 80) and collected storm water are used for decontamination and dust suppression. Sanitary sewage is handled via septic tank drainage fields.

Many of the Clive facilities, buildings, and infrastructure are common to the operating areas of the facility and will support Energy*Solutions*' Federal Cell Facility disposal operations. Key facilities and buildings (with building numbers from Figure 1-4 parenthetically noted) that will be utilized to support Federal Cell Facility disposal operations include:

- **Track #4 Rail Wash Facility (12)**: A railcar decontamination facility within the Clive Facility Restricted Area.

- **Intermodal Unloading Facility (16)**: This facility is used for unloading bulk intermodal containers.

- **1997 Evaporation Pond (19), 1995 Evaporation Pond (23), 2000 Evaporation Pond (42) and Northwest Corner Evaporation Pond (51)**: Storm water collected from non-hazardous waste management and disposal facilities is contained and evaporated in these ponds.

- **LARW Container Storage Pad (24)**: This facility is used for the short term storage of waste filled containers (boxes, drums, etc.).

- **East LLRW Truck Unloading Facility (41)**: Trucks carrying containers of waste can be unloaded without bringing the truck into the restricted area. Large equipment reaches over the Restricted Area boundary to transfer the containers of waste from the trucks into the Restricted Area.

PRELIMINARY REVIEW DRAFT

- **Batch Plant (62)**: The batch plant produces concrete for construction and waste disposal operations.

- **Waste Haul Roads (65)**: Waste haul roads are used to haul waste from receiving areas to final placement within the Federal Cell Facility. Also used for general operations within the facility.

- **Perimeter Road (66)**: The perimeter road provides general site access.

- **Rotary Dump Facility (Thaw, Rotary & Wash) (67)**: This facility is used to thaw and offload bulk rail shipments received in gondola type railcars. It is also used for the decontamination of railcars after waste is offloaded.

- **Meteorological Station (68)**: Weather station equipment is used to gather wind, temperature, evaporation, and precipitation data.

- **QC & GW Laboratories Building (70)**: Offices and laboratories for quality control (QC) and groundwater/environmental monitoring.

- **Outside Maintenance Building (57)**: Maintenance facilities for equipment not used in the Restricted Area. Offices for quality control (QC) and groundwater and environmental monitoring.

- **Shredder Facility (75)**: The shredder facility is utilized to size reduce waste debris.

- **Intermodal Container Wash Facility (78)**: Supports decontamination of waste shipping containers.

- **Administration Building (1)**: The Administration Building houses office space for Security, Shipping and Receiving, Health Physics, Engineering and Quality Assurance.

- **LLRW Operations Building (82)**: This building houses administrative offices, laboratories, and locker rooms; as well as the principal access control point to the Restricted Area.

The storage and concentrated depleted uranium handling areas will include, but are not limited to, the LARW storage pad (24), the Truck Unloading Facility (41), and the Federal Cell Facility. Additionally, the Shredder Facility (75), the Rotary Dump Facility (67), and other storage and waste handling areas have been permitted, constructed, and placed into operation. Design and continued operation of these facilities will be unaffected this Application.

Decontamination of workers, if needed, takes place at the Operations Building (5). Railcars are decontaminated at the Railcar Decontamination Facilities (12). Containers, other than railcars, transported via rail are decontaminated at the Intermodal Container Wash Facility (78). Vehicle maintenance inside the Restricted Area is performed at the Inside Maintenance Shed (8), or in the north bay of the Mixed Waste Operations Building (32). Decontamination and wastewater management facilities also include the Intermodal Container Wash Building (78), East Side Drainage and Gray Water System, and Northwest Corner Evaporation Pond (51). Design and operation of these facilities will be unaffected by this Application. No new support facilities are proposed in this Application to specifically serve the Federal Cell Facility.

PRELIMINARY REVIEW DRAFT

Site security procedures for the Clive facility are provided in the Site Radiological Security Plan referenced in Condition 54 of Radioactive Material License UT2300249. The Site Radiological Security Plan requires that personnel enter the Restricted Area through designated access control points in the LLRW Operations Building. Traffic is allowed to enter the site through one of the approved access gates.

The entire controlled area of the Clive Facility is fenced to ensure that intruders do not gain access to the site inadvertently. The fences are posted with appropriate warning signs, and all entrances into the work areas are locked or guarded by personnel when unlocked. All fences are of the chain link type. Temporary fencing is constructed with "T" posts located at least every 12 feet. Permanent fencing is built with permanent posts cemented in concrete and topped with 3 strands of barbed wire. In order to assist security personnel in identifying material or equipment that has been removed from the Restricted Area without authorization, the Site Radiological Security Plan requires vegetation to be removed.

The Site Radiological Security Plan requires that signs be present to guide visitors to the Administration Building. Because some visitors to the Clive facility remain within the Administration Building or are required to always be accompanied by an authorized escort, visitors desiring unescorted access beyond the Administration Building are briefed on radiation posting, security measures and general risks found at the Clive Facility.

Standard heavy construction equipment will be used for the operation of the Federal Cell Facility. The actual equipment will vary, but it will normally consist of rock trucks, bulldozers, track mounted backhoes, front-end loaders, water trucks, and other equipment as required. Daily service and maintenance of the equipment is performed in the Restricted Area. If required, major service may be performed outside of the Restricted Area. Equipment serviced outside of the Restricted Area is decontaminated and surveyed to applicable release standards prior to release from the Restricted Area.

Excavated materials will be used in the construction of the Federal Cell Facility. Clays and other soil materials are excavated from Sections 5 and 29, for use in disposal facility liner and cover construction, as required. Other borrow materials are excavated from publically-available sources nearby. Excavated materials are often stockpiled on Energy*Solutions* property to the north and south of the facility.

1.3 SCHEDULES

A schedule for construction, placement of depleted uranium and eventual closure of the Federal Cell Facility is subject to receipt of a Radioactive Material License, execution of the prerequisite long-term stewardship agreements, successful construction, and rate of generation and shipment by DOE of depleted uranium.

1.3.1 Construction

Much of the necessary excavation for the Federal Cell Facility has already been completed in support of clay and sand material excavation activities supporting construction of other Energy*Solutions* Clive disposal facilities. Upon awarding of a License for the Federal Cell Facility, liner construction is anticipated to commence during the next available construction season (anticipated to be 2020). As is already required in Energy*Solutions'* LLRW and 11e.(2) Construction Quality Assurance and Quality Control Manual (CQA/QC Manual), referenced in Condition 44 of Radioactive Material License UT2300249, the Director will be

PRELIMINARY REVIEW DRAFT

notified prior to liner construction activities in order to facilitate inspection. Additionally, Energy*Solutions* will continue to provide the Director with detailed weekly construction schedules during clay liner construction projects (also as required by the CQA/QC Manual). Energy*Solutions'* Annual As-Built Reports will provide detailed information regarding each year's progress in Federal Cell Facility construction activities.

1.3.2 Receipt of Waste

Energy*Solutions* projects receipt of approximately 50% of DOE's projected volume of depleted uranium over a 20-year period (i.e., 50% of 700,000 metric tons). While not included in this Application, Energy*Solutions* also anticipates seeking further amendment of its Federal Cell Facility Radioactive Material License to authorize disposal of other Class A LLRW generated by federal agencies in the Federal Cell Facility's available capacity. Energy*Solutions* estimates that waste receipt and disposal operations in the Federal Cell Facility to continue for approximately 40 years. The Federal Cell Facility's waste volume and nuclide-specific disposed activities will be reported annually to the Director.

1.3.3 First Waste Placement

Immediate placement of the 5,408 drums of SRS depleted uranium already in storage at the Clive Disposal Complex is expected in the Federal Cell Facility in 2020 (following construction of sufficient clay liner).

1.3.4 Operations

Energy*Solutions* estimates that disposal operations in the Federal Cell Facility will begin in 2020 and continue for a minimum of 40 years.

1.3.5 Closure

As is Energy*Solutions'* common practice for disposal facilities in the Clive Disposal Complex, closure of the Federal Cell Facility will take place during normal operations. As fill and waste are placed in the Federal Cell Facility Director-approved design height, these areas will be covered to meet final design specifications before being closed. Prior to final cover construction, closure activities will include settlement monitoring, as required by the CQA/QC Manual. Settlement monitoring includes a requirement that temporary cover be placed and monitored for at least one year prior to final cover construction, with evaluation of differential settlement. If differential settlement exceeds or is projected to exceed the established criteria, surcharging of affected areas is required. Timing for final cover construction and closure will ultimately be driven by the open cell time limit required by Part I.E.6 of Energy*Solutions'* GWQDP. Upon final closure of the all of the Clive Disposal Complex disposal facilities, the site will be decommissioned and long-term surveillance initiated.

1.4 INSTITUTIONAL INFORMATION

Energy*Solutions* has 30 years of experience with the design, construction, management, engineering, and operation of radioactive waste disposal at the Clive site. Since receiving its first radioactive material license in 1988, Energy*Solutions* has constructed a low-activity radioactive waste (LARW) Facility, a RCRA mixed radioactive and hazardous waste (Mixed Waste) Disposal Facility, the Class A and Class A North Disposal

PRELIMINARY REVIEW DRAFT

facilities (which have now been combined into the Class A West Disposal Facility), and a uranium- and thorium-mill radioactive tailings 11e.(2) Byproduct Disposal Facility.

Division regulations UAC R313-25-3(8) and UAC R313-25-9(2) require that "*that if the proposed disposal site is on land not owned by state or federal government, that arrangements have been made for assumption of ownership in fee by a state or federal agency.*" Energy*Solutions* and DOE entered into an Agreement that establishes covenants and restrictions related to DOE long-term stewardship of the Federal Cell Facility (see Appendix C). This Agreement transfers ownership of the Federal Cell Facility (including land and disposed waste) from Energy*Solutions* to DOE for long-term maintenance and monitoring. In support of this transfer, Energy*Solutions* has escrowed funds, designated for use at the Federal Cell Facility, to allow the complete decontamination, decommissioning, closure and other reasonably expected activities perpetually following closure.

Funds for the closure, remediation and long-term surveillance of the facility will be made available through a Surety Bond, established by Energy*Solutions* and a Standby Trust Agreement established with Zions First National Bank. As is already required for its other disposal facilities, Energy*Solutions* will annually review and revise the amount of funds required to fully close the Federal Cell Facility and evaluate perpetual care requirements. Results of this annual review and any adjustments in funding conducted will be reported to the Director by March 1 of each year.

Finally, Energy*Solutions* will establish funds with Zions First National Bank for the perpetual care of the closed and stable Federal Cell Facility. Following closure, perpetual care monies will be released to address costs required for long-term stewardship of the closed Federal Cell Facility. Perpetual Care funds will be comprised by annual payments of 2% of the revenue collected by Energy*Solutions* for authorized disposal of waste in the Federal Cell Facility and earnings accrued to the fund cash balance with a Surety Bond bringing the present value to 3,153,677 million. Energy*Solutions* will include the basis for the necessary perpetual care funds in its annual review of the post-closure costs. Results of this annual review and any adjustments in perpetual care funding cash balance and the associated Surety Bond will be included in the report to the Director by March 1 of each year.

1.5 MATERIAL INCORPORATED BY REFERENCE

Section 11 of this Application lists the references incorporated by reference.

1.6 CONFORMANCE TO REGULATORY GUIDES

To the extent practicable, the information presented in this Application was prepared in accordance with UAC R313-25-13. Additionally, Energy*Solutions* strives to meet and exceed all requirements applicable to its operations, including

- NUREG-0902, "Site Suitability, Selection and Characterization;"
- NUREG-1199, "Standard Format and Content of a License Application for a Low-Level Radioactive Waste Disposal Facility;"

PRELIMINARY REVIEW DRAFT

- NUREG-1200, "Standard Review Plan for the Review of a License Application for a Low-Level Radioactive Waste Disposal Facility;"
- NUREG-1293, "Quality Assurance Guidance for a Low-Level Radioactive Waste Proposal Facility;"
- NUREG-1300, "Environmental Standard Review Plan for the Review of a License Application for a Low-Level Radioactive Waste Disposal Facility;"
- NUREG-1623, "Design of Long-Term Erosion Protection Covers for Reclamation of Uranium Mill Sites;"
- NUREG/CR-2700, "Parameters for Characterizing Sites for Disposal of Low-Level Radioactive Waste;"
- Regulatory Guide 1.8, "Personnel Selecting and Training;"
- Regulatory Guide 1.28, "Quality Assurance Program Requirements (Design and Construction);"
- Regulatory Guide 1.33, "Quality Assurance Program Requirements (Operational);"
- Regulatory Guide 1.74, "Quality Assurance Terms and Definitions;"
- Regulatory Guide 4.14, Revision 1, "Radiological Effluent and Environmental Monitoring at Uranium Mills".
- Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment;"
- Regulatory Guide 4.18, "Standard Format and Content of Environmental Reports for Near-Surface Disposal of Radioactive Waste;"
- Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposure As Low As Is Reasonably Achievable;"
- Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection;"
- NRC's "Final Standard Review Plan for Review and Remedial Action of Inactive Mill Tailings Sites under Title I of the Uranium Mill Tailings Radiation Control Act, Revision 1;" and
- NRC's 1982 "Technical Position on Near-Surface Disposal Facility Design and Operation."

1.7 SUMMARY OF PRINCIPLE REVIEW MATTERS

Energy*Solutions* requests the Director issue a new Radioactive Material License to authorize management and disposal of concentrated depleted uranium and NORM in a Federal Cell Facility.

PRELIMINARY REVIEW DRAFT

PRELIMINARY REVIEW DRAFT

SECTION 2. SITE CHARACTERISTICS

Energy*Solutions'* overarching objective for its Federal Cell Facility siting and design decision focuses on the permanent isolation of the depleted uranium. These decisions target minimizing disturbance and dispersion by natural forces, without the need of ongoing maintenance. For practical reasons, specific siting decisions and design standards involve finite times [a compliance period of 10,000 years for depleted uranium has been promulgated in UAC R313-25-9(5)]. The following site features are considered in judging the adequacy of the Federal Cell Facility:

a. Remoteness from populated areas;

b. Hydrologic and other natural conditions as they contribute to continued immobilization and isolation of contaminants from groundwater sources; and

c. Potential for minimizing erosion, disturbance, and dispersion by natural forces over the long term.

2.1 GEOGRAPHY, DEMOGRAPHY AND FUTURE DEVELOPMENTS

The Federal Cell Facility will be situated in a remote area of Tooele County in the western portion of Utah. The nearest resident is a person acting as caretaker at a rest stop along I-80, roughly 7 miles to the Northeast, with the nearest community being approximately 35 miles from the site. Strict access control and security provide additional assurance of protection to the public. The Federal Cell Facility will be designed to minimize dispersion of the waste by resisting water erosion, wind erosion, geotechnical instability and other natural events. All features are designed to promote Federal Cell Facility stability.

2.1.1 Site Location and Description

The Clive site is on the eastern edge of the Great Salt Lake Desert, three miles west of the Cedar Mountains, 2.5 miles south of Interstate 80, and 1 mile south of a switch point called Clive on the tracks of the Union Pacific system. The Clive Disposal Complex is located on a parcel of land, consisting of one square mile in Tooele County, Utah. The land is owned by Energy*Solutions*, with the exception of approximately 100 acres owned by DOE for the Vitro Remedial Action project. The licensed property owned by Energy*Solutions*, is Utah SLB&M, Section 32, Township 1 South, Range 11 West, Tooele County, Utah, except for the following legal description of the Vitro site:

> *Beginning at a point located 1120.32 feet N 89 degrees 56' W., along the section line, and 329.49 feet South from the Northeast corner of Section 32, Township 1 South, Range 11 West, Salt Lake Base and Meridian and running thence: N 89 degrees 56' 32" W 1503.72 feet, thence S 0 degrees 03' 28" W 2880.50 feet, thence S 89 degrees 56' 32" E 1503.72 feet, N 0 degrees 03' 28" E 2880.50 feet to the point of the beginning.*

Operations are conducted in Sections 5, 29, and 32 (Township 1 South, Range 11 West, SLB&M), of Tooele County, Utah. These locations are known as Clive, Utah. Most of the land within a 10-mile radius of the Site is public domain administered by BLM. Land use in the immediate vicinity of the Site will not affected by

PRELIMINARY REVIEW DRAFT

granting of the License, since the Federal Cell Facility and associated licensed actions are located entirely within the licensed area of Section 32.

While Energy*Solutions* also owns property adjacent to the licensed area, properties outside of Section 32 are not licensed for active LLRW management. The south portion of the site contains Energy*Solutions'* Class A West Federal Cell Facility, LARW Federal Cell Facility, Mixed Waste landfill cell, and the 11e.(2) Federal Cell Facility. Energy*Solutions*' Federal Cell Facility will be located to the west of the 11e.(2) Federal Cell Facility and south of the Class A West Facility.

The low precipitation and high evaporation rates are not conducive to sustainable crop yields. Further, because the groundwater is saline with high TDS, it is impossible to support a permanent, residential population center in the site area.

2.1.2 Population Distribution

While 58,501 people resided within 50 miles of the Clive site at the time of the 2010 Census, most of the immediate area is uninhabited (Census, 2012). The closest resident lives roughly seven miles to the northeast of the site, and acts as a caretaker for the rest stop just off I-80. As is illustrated in Table 2-1, the largest group of people lives 48 - 80.5 miles to the east and southeast of the site in the Tooele-Grantsville area.

Table 2-2 summarizes a study projecting that Tooele County will continue to increase its population at the annual average rate of 3.74 percent until the year 2030 (most recent three year average). It is projected that Tooele and Grantsville Cities will continue to be the areas of greatest growth, with growth rates of 3.74 percent through the year 2030 (Census, 2019).

The remoteness of the site from the urbanized area of Tooele County makes the surrounding area an improbable location for any other significant industrial use. This was one of the chief reasons for its selection as a disposal site in the Vitro project.

The Tooele County Commission has designated the Clive site and surrounding areas as hazardous industries zones. This designation prohibits all residential housing in the vicinity of the Clive site. Also, NRC identified the absence of any culinary water sources at the Clive Facility as a major deterrent to any potential population growth within a 12-kilometer radius (NRC, 1993c).

2.2 METEOROLOGY AND CLIMATOLOGY

Energy*Solutions* has operated a weather station at Clive since April 1992. The station monitors wind speed and direction, 2-m and 9-m temperatures, precipitation, pan evaporation and solar radiation. Annual meteorological reports are submitted to the Director for Clive data collected from July 1992 to the most recent December, (MSI, 2019). Since the Federal Cell Facility is located entirely within Section 32, this information adequately characterizes the site.

PRELIMINARY REVIEW DRAFT

Table 2-1

12-Kilometer Population Wheel

Direction	Distance (km)					
	0 - 2	2 - 4	4 - 6	6 - 8	8 - 10	10 - 12
N - 0.0						
NNE - 22.5						
NE - 45.0						
ENE - 67.5						1
E - 90.0						
ESE - 112.5						
SE - 135.0						
SSE - 157.5						
S - 180.0						
SSW - 202.5						
SW - 225.0						
WSW - 247.5						
W - 270.0						
WNW - 292.5						
NW - 315.0						
NNW - 337.5						
Total	**0**	**0**	**0**	**0**	**0**	**1**

PRELIMINARY REVIEW DRAFT

Table 2-2

Tooele County Growth Projection: 2010-2030

Year	County Population*	Annual Growth Rate+
2030	108,611	3.74%
2029	104,696	3.74%
2028	100,921	3.74%
2027	97,283	3.74%
2026	93,776	3.74%
2025	90,395	3.74%
2024	87,136	3.74%
2023	83,995	3.74%
2022	80,967	3.74%
2021	78,048	3.74%
2020	75,234	3.74%
2019	72,522	3.74%
2018	69,907	3.69%
2017	67,418	4.47%
2016	64,535	3.06%
2015	62,617	1.91%
2014	61,446	1.34%
2013	60,633	1.41%
2012	59,788	1.02%
2011	59,182	1.16%
2010	58,501	1.09%

* from the 2010 U.S. Census

\+ Forward growth rate computed as average of that from recent three years available (2016 – 2018 - Information as reported by the U.S. Census Bureau, 2019.

PRELIMINARY REVIEW DRAFT

The site region is in the Intermountain Plateau climatic zone that extends between the Cascade-Sierra Nevada Ranges and the Rocky Mountains and is classified as a middle-latitude dry climate or steppe. The climate is characterized by hot dry summers, cool springs and falls, moderately cold winters, and a general year-round lack of precipitation.

While neighboring mountain ranges generally restrict the movement of weather systems into the area, there are occasional well-developed storms in the prevailing regional westerlies. The mountains act also as a barrier to frequent invasions of cold continental air. Precipitation is generally light during the summer and early fall and reaches a maximum in spring when storms from the Pacific Ocean are strong enough to move over the mountains. During the late fall and winter months, high pressure systems tend to settle in the area for as long as several weeks at a time.

In the 26-year period of time (July 1992 through December 2018) the most frequent (and predominant) winds were from the south-southwest direction, with the second most frequent direction being the east-northeast, followed by the south. Wind Rose data summarized in Figure 2-1 has been obtained from the on-site weather station and checked for accuracy by a certified meteorologist (MSI, 2019). Temperatures at Clive range from an hourly minimum of -31.5 ^{o}C to an hourly maximum of 41.3 ^{o}C.

The Clive site receives an average of 8.37 inches of precipitation per year. Measurements taken at the Clive site showed that the lowest monthly precipitation recorded was 0 inches, during several distinct months. The highest recorded monthly precipitation was 4.28 inches, in May 2011.

Pan evaporation measurements are taken from April through October when ambient temperatures remain above freezing. Maximum hourly evaporation values usually occur in July. The 24-year average annual evaporation at the Clive site is 53.4 inches (excluding 2 years of reported instrument malfunction).

Historically, a severe weather phenomenon in the west desert-region of Utah has taken one of four forms: tornadoes, severe thunderstorms, damaging hail, or dust devils. Tornadoes are rare in the State of Utah primarily due to the lack of atmospheric moisture and the presence of mountainous terrain. Utah tornadoes tend to be much weaker and smaller than their central U.S. counterparts. Utah tornadoes stay on the ground for an average of only a few minutes and their path widths are usually one-eighth of a mile or less. Five tornadoes were observed in Tooele County for the period 1847–2017 (Lietz, 2017). Based on this historic record, the probability of a tornado strike at any one point in Tooele County is extremely low. Although tornadoes are very rare and not statistically likely to strike the Clive site, they are amongst weather phenomena that can occur in the State of Utah.

While thunderstorms are fairly common over Utah, especially in the late summer months, these storms are typically not severe. The Dugway, Utah station records an average of 20 thunderstorm-days per year. Historic records suggest than approximately 10% of these thunderstorms develop into the severe category, equating to two annual high-speed wind events (50 knots or greater) at the Clive site.

PRELIMINARY REVIEW DRAFT

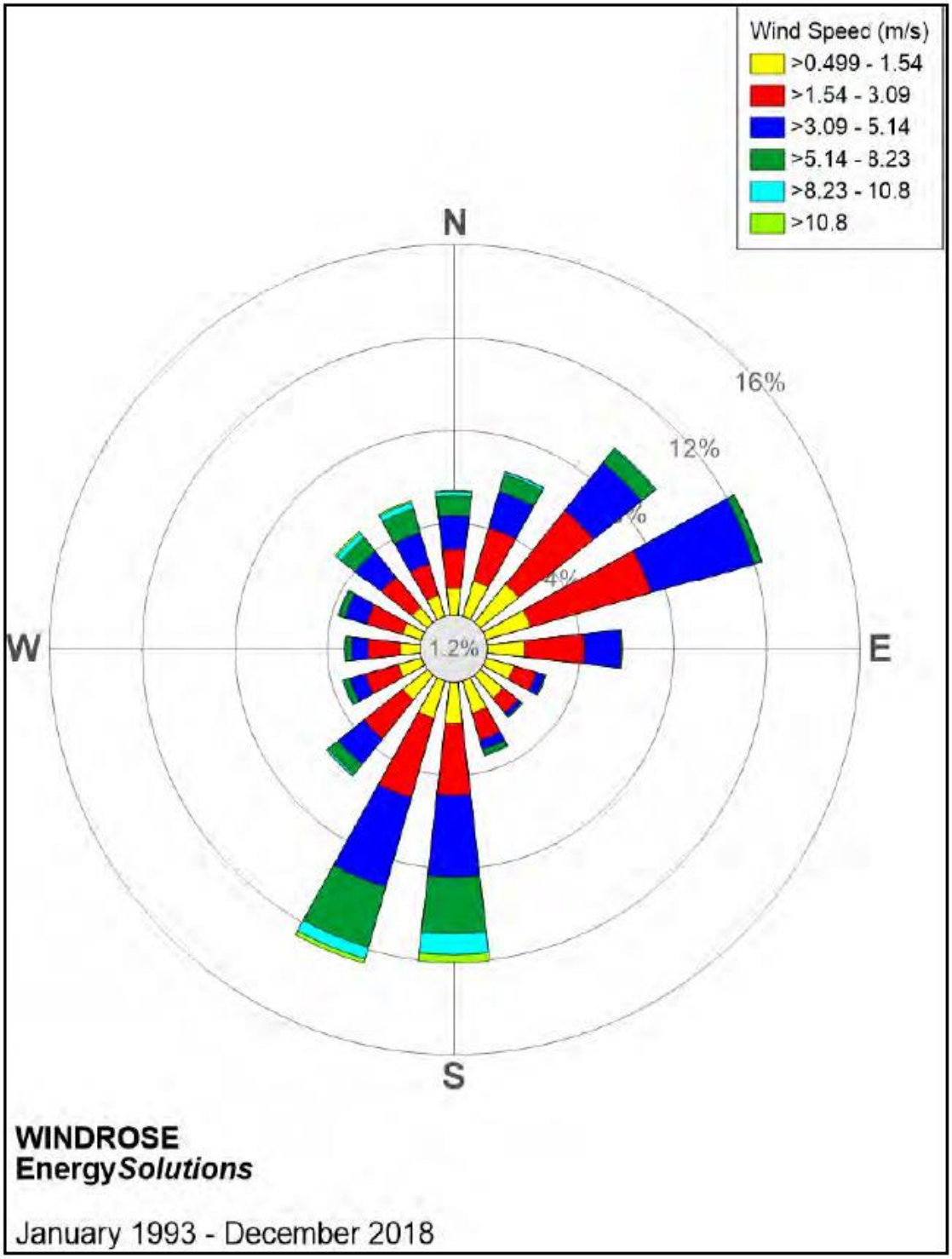


Figure 2-1. Energy*Solutions* Wind Rose January 1993 – December 2018 (MSI, 2019).

Large damaging hail is another rare phenomenon in the State of Utah, primarily due to the lack of atmospheric moisture needed to develop strong thunderstorms and related hail. During the last 60 years there have been four severe thunderstorm events in Tooele County with reported hail damage (Brough, et.al; 2010). Two of these reports indicated hail with a diameter of one inch or greater. These reports also suggest a return interval of 10–15 years for such storms with potential damaging hail for the Energy*Solutions* site.

Dust devils are quite common throughout the west desert of Utah. They are caused by local thermally-induced updrafts and do little more than stir up dust and other light objects. Wind speeds associated with dust devils are normally less than 50 miles per hour and are short-lived. The highest recorded wind speed for a west desert dust devil is 60 miles per hour.

2.3 GEOLOGY AND SEISMOLOGY

The Federal Cell Facility will be located on the eastern fringe of the Great Salt Lake Desert. Geophysical surveys performed in the surrounding region included (1) a regional gravity survey conducted over a study area that included the eastern half of the Great Salt Lake Desert - performed by the University of Utah Geophysics Department between 1957 and 1961 (Cook et. al, 1964); and (2) an earth resistivity survey (Bisdorf and Zohdy, 1980) conducted in the Fish Springs area, about 50 miles south of the site to delineate faults and their influence on springs in the area. Many basin and range faults, grabens and horsts are indicated in Cook's report on the Great Salt Lake Desert study area. The gravity data was used to determine regional geologic conditions (Cook et. al, 1964). In addition to these regional surveys, the Utah Department of Natural Resources has prepared two hydrologic reports for the Great Salt Lake West Desert area (Stephens, 1974; UDNR, 1981). These reports provide a description of physiographic conditions, regional characteristics, groundwater aquifers, flow characteristics and water quality. The U.S. Geological Survey has also prepared geologic and surface water resources maps for the same areas (Moore, 1979; Bucknam, 1977). These historic surveys and studies have been combined with characterization of the site geology and hydrogeology, in the Revised Hydrogeologic Report prepared by Energy*Solutions* (Energy*Solutions*, 2019).

The Energy*Solutions* Clive facility is located in the extreme eastern margin of the Great Salt Lake Desert, which is part of the Basin and Range Province of North America. The Basin and Range topography is typified by block-faulted (normal fault) mountain ranges that generally trend north to south. This predominant geologic structural feature with alluvial filled basins is discontinuous and was created by extensional normal faulting. The basins consist primarily of sediments originating from Quaternary lacustrine Lake Bonneville deposits and Quaternary and Tertiary colluvial and alluvial materials eroded from adjacent mountains. The unconsolidated to semi-consolidated valley fill is generally about 800 to 1,000 feet thick throughout the central portions of the valleys in the Great Salt Lake Desert.

The block-faulted mountains mainly consist of Paleozoic limestones, dolomites, shales, quartzites, and sandstones. Tertiary extrusive igneous rocks of basaltic lava flows and pyroclastics are also found in isolated areas of the Great Salt Lake Desert. The valley sediments are composed of alluvial fans, evaporites and unconsolidated and semi-consolidated valley fill (Stephens, 1974). These sediments consist of intercalated colluvium, alluvium, lacustrine, and fluvial deposits with some basalt flows, pyroclastics and deposits of eolian material. Generally, the colluvial and coarse alluvial deposits are near the mountain ranges where they contain a wide range of grain sizes, varying from boulders to clay. Extending to the center of the valleys, the deposits grade into well sorted beds of sand and gravel interlayered with alluvial and lacustrine silt and clay. Thick beds of alluvial fans generally fringe the mountains ranges. The alluvial fans grade laterally into fine-

PRELIMINARY REVIEW DRAFT

grained alluvium and thin toward the center of the valleys where it is present as a veneer overlying and adjacent to fine-grained Lake Bonneville lakebed deposits.

The ranges are affected by mass-wasting and fluvial erosion where ephemeral streams that enter the desert basins deposit their load as they evaporate or infiltrate. The desert mountain perimeters of the basins are therefore impacted by the deposition and erosional processes of alluvial fans. The central portions of the basins, which typically demonstrate relatively flat topographic relief, are unaffected by surface fluvial activities, and therefore mechanical and chemical weathering processes advance at very slow rates. These geomorphic processes are typical of the proposed Federal Cell Facility's semiarid to arid desert setting.

Natural resources in Tooele County include limestone, metallic minerals, potassium salts, tungsten, salt, clays, and sand and gravel. Gravel quarries have been located in the alluvial fans that flank the Cedar Mountains (DOE, 1984). Mineral extraction by evaporation of brine occurs near Knolls, about 10 miles northwest of the site. Limestone is quarried in the Cedar Mountains about five miles east of the site. Presently no oil and gas production takes place in the area. The classification of the area as prospectively valuable for oil and gas is based solely on general criteria. Even so, there has been little interest in the western desert for oil and gas exploration. Previous exploration near the west side of the Great Salt Lake revealed a low-grade product with little or no yield. There is no coal production in the area or geologic formations with coal resources. No active or pending mining claims or mineral leases are located on the site.

2.3.1 Geologic Site Characteristics

The proposed Federal Cell Facility is located in the eastern margin of the Great Salt Lake Desert, part of the Basin and Range Province. This province is characterized by north-south trending mountain ranges with discontinuous alluvium-filled valleys found between the ranges. The mountains are composed of mainly Paleozoic-age sedimentary rocks, but can also be composed of volcanic rocks. Metamorphic rocks do not outcrop in the vicinity of the facility, with the closest occurring in the Granite Peak area, approximately 40 miles south of Clive. The intermountain troughs are filled primarily with unconsolidated alluvial, lacustrine, fluvial, and evaporite deposits; but pyroclastics, aeolian sediments, and basalt flows also occur (Bingham Environmental, 1996 and Stephens, 1974). Sediments near the mountains are predominately colluvial and alluvial, and are generally coarser grained than the lacustrine deposits found in the center of the valleys. The proposed Federal Cell Facility is situated on Quaternary-age lacustrine lake bed deposits associated with the former Lake Bonneville. These surficial lacustrine deposits are generally comprised of low-permeability silty clay. Surficial sand and gravel outcrops are mapped in the sections adjacent to the facility.

Beneath the proposed Federal Cell Facility, the sediments consist predominantly of interbedded silt, sand, and clay with occasional gravel lenses. The depth of the valley fill beneath the facility is unknown; a 2019 exploratory investigation confirmed their presence at the Clive Facility down to 620 feet below ground surface (bgts); with estimates ranging from 250 to 3,000 feet bgs. The deepest borehole within Section 32 (well I-1-700) was drilled to a depth of 620 feet bgs without encountering bedrock. An exploratory borehole for a potential water-supply well on Section 29 north of the Energy*Solutions* facility did not encounter bedrock at a depth of 700 feet bgs. Up to 3,000 feet of basin fill sediment are present in the Ripple Valley (the basin immediately north of Interstate-80, east of the Grayback Hills).

The Grayback Hills are located approximately four miles north of the proposed Federal Cell Facility and are outcrops of extrusive igneous and sedimentary rocks. Igneous extrusive rocks (trachyandesite lava flows) form a resistant cap on the Grayback Hills, and volcaniclastic rocks are mapped in the area. The lava flows

PRELIMINARY REVIEW DRAFT

and volcaniclastics have been dated as latest Eocene to earliest Oligocene (38-35 million years before present). Exposed sedimentary rocks in the Grayback Hills are Permian and Triassic Grandeur, Murdock Mountain, Gerster, Dinwoody, and Thaynes Formations consisting of predominantly carbonate units. Lake Bonneville cycle lakes have inundated and modified the outcropping rocks of the Grayback Hills. Lacustrine deposits are present, including sands and gravels associated with bars, splits, and beaches. Petrographic examination of gravel from the Grayback Hills determined the gravel is composed almost entirely of acidic to intermediate volcanic rock. Rock types were identified as trachyandesite, dacite/andesite with a scoriaceous texture, pyroclastic, rhyolite, and a small volume of limestone. Many of the gravel particles are partially or completely coated in caliche (Energy*Solutions*, 2019).

2.3.2 Seismology

The Clive site does not have any known active faults in its vicinity. NRC (1993c) indicates that the nearest faulting is located 29 km (18 miles) to the north, having occurred between 1 million to 25 million years ago. Although the site is not located near any active faults, isostatic rebound is suspected to be the cause of any recent seismic activity in the Lake Bonneville area.

NRC (1993c) cites two seismic investigations that were conducted for the Vitro tailings disposal facility and a proposed site for a supercollider that was to encompass a 15-mile elliptical ring around the Clive site. Based on these studies, NRC (1993c) indicated that nearby structures and seismogenic areas that could pose a hazard include the fault zones within a 45-mile radius of the site. These include the eastern flank of the Cedar Mountains, western flank of the Lakeside Mountains, Northwest Puddle Valley, eastern flank of the Newfoundland mountains, and the western flank of the Stansbury Mountains. However, NRC (1993c) concluded that no active fault zones lie beneath the Clive site, and there is no macroseismic evidence of a capable fault in the vicinity of the site.

The lack of Quaternary and/or capable faults in the vicinity of the Clive site is not sufficient evidence to dismiss seismic activity as a potential issue of concern. While the absence of surface faults in the site is consistent with a low probability of surface-fault rupture, ground shaking associated with background earthquakes require assessments (i.e. moderate-size earthquakes (M5.5 – 6.5) that do not cause surface rupture, (Wong, 2013).

Seismic hazard assessments have been evaluated previously for the Clive site including assessments of active or potentially active faults in the region and background earthquakes. The peak ground accelerations for both seismic sources is 0.24 g. The peak ground accelerations for the Clive site are within the range of estimated ground accelerations for two DOE regulated and approved low-level waste disposal sites (Area G, Los Alamos, New Mexico (LANL, 2008). Performance assessments for these sites conclude that the impacts of ground shaking on waste disposal systems are minor and are overshadowed by the longer-term effects of subsidence.

The negligible effects of the peak ground accelerations on the long-term stability of Clive's embankments has previously been demonstrated and found acceptable by the Division. No new information on seismic hazards has been identified that would change or require revisions of the previous work.

PRELIMINARY REVIEW DRAFT

The seismic hazard for the faults near the proposed Federal Cell Facility (as illustrated in Figure 2-2) was evaluated using methodology consistent with the requirements of UAC R313-25-8(5) (AMEC, 2012a). The seismic hazard assessment included analysis of the peak ground acceleration (PGA) associated with the Maximum Credible Earthquake (MCE) for known active or potentially active faults in the proposed Federal Cell Facility region. The PGA was obtained from a probabilistic seismic hazard analysis (PSHA) to assess the seismic hazard for earthquakes that may occur on unknown faults in the area surrounding the proposed Federal Cell Facility (i.e., background seismicity). For fault sources, the PGA was based on the maximum rupture length and rupture area for each fault. The return period for ground motions resulting from a background earthquake was estimated at 5,000 years (i.e., equal to a one percent probability of exceedance in 50 years).

The approach of selecting a MCE PGA from the larger of the values associated with the deterministic MCE for faults or the PSHA result for background earthquakes at a 5,000 year return period is consistent with recommendations of the Utah Seismic Safety Commission (2003) and requirements promulgated by the Utah Division of Water Rights (Dam Safety Section) for assessment of dams (AMEC, 2012a).

The maximum PGA value that was calculated for the maximum events on neighboring fault sources was projected as 0.28 g, (which is the largest PGA from the deterministic assessment of fault-specific sources and the probabilistic assessment of the background earthquake). The maximum magnitude of the MCE varies from 7.0 to 7.3 for the sources that result in the maximum PGA. The largest value of 7.3 is considered conservatively appropriate for use in the seismic stability analyses for the proposed Federal Cell Facility.

The liquefaction/cyclic softening potential of the subsurface soil profiles below the proposed Federal Cell Facility have also been evaluated (AMEC, 2012a). The potential for liquefaction of sand-like soil has been determined to be low and the potential for seismic settlement to be on the order of one to two inches. The potential for cyclic-softening was also found to be low.

Historical_Earthquake catalogs for the site region were obtained from the seismological observatories at the University of Utah and the University of Nevada. The Utah catalog begins in 1850, whereas the Nevada catalog begins in 1852. The two catalogs combined contain 1277 epicenters within 100 km of the proposed Federal Cell Facility. The earliest earthquake occurred in 1915 and the latest in September 2005. The smallest was M 0.0 and the largest M 5.2. The closest was 9.9 km from the site and the farthest was 99.9 km. Selected Data for 26 Earthquakes are presented in Table 2-3 which is sorted by increasing distance from the site. These 26 earthquakes are located within 100km of the site, but a magnitude and distance filter was applied to the catalogs to produce the data shown in Table 2-3 because most of the epicenters represent small earthquakes more than 50 km form the site.

Most of the faults in the site region that cut deposits of Quarternary age were identified a number of years ago. Most of them had not been studied in detail by the time the USGS was conducting their 1996 seismic hazard mapping project, and the USGS omitted them as line sources because key parameters (maximum magnitude and recurrence or slip rate) were not available. Subsequently, a systematic inventory of Quaternary faults was completed in the Western United States, and more complete information was available for the 2002 USGS update. In addition, faults in the Skull Valley were discovered and characterized. Ten Quaternary faults are included in the USGS database within about 70km of the proposed Federal Cell Facility. The closest Quarternary fault to the site is the Cedar Mountains fault at a distance of 23km to the east.

PRELIMINARY REVIEW DRAFT

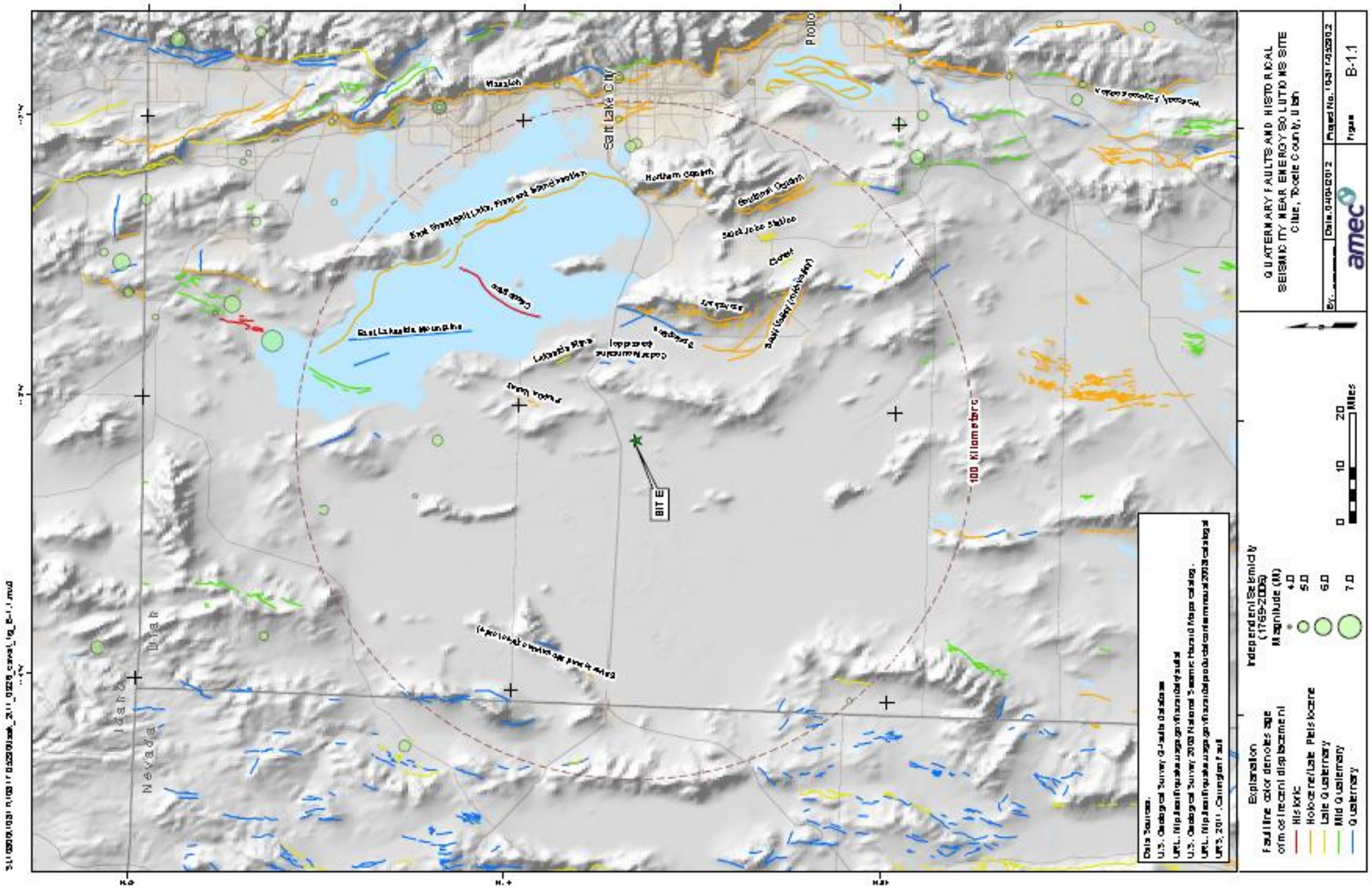


Figure 2-2. Energy*Solutions* Fault and Seismicity Map (AMEC, 2012a)

PRELIMINARY REVIEW DRAFT

Table 2-3

Selected data from 26 earthquakes within 100 km of the Clive site. Data from Catalogs Maintained by the University of Utah and the University of Nevada-Reno.

Month/Day/Year	North Latitude	West Longitude	Earthquake Magnitude	Site Distance (km)
April 03, 1998	40.7568	-113.1897	2.0	9.87
October 23, 1976	40.6723	-112.8315	1.30	23.81
March 29, 1979	40.4807	-113.2092	2.20	24.69
November 15, 1979	40.8668	-112.9173	2.00	25.58
June 10, 1975	40.5408	-112.8650	1.20	26.71
July 11, 1981	40.4573	-113.1952	1.70	26.82
April 26, 2004	40.4685	-113.2412	1.07	26.95
December 06, 1996	40.4627	-113.2773	2.32	28.89
January 04, 1975	40.6602	-112.7690	1.20	29.20
August 05, 1988	40.9568	-113.0798	1.90	29.71
August 11, 1915	40.5000	-112.6500	4.30	44.46
October 23, 1987	41.1963	-113.1693	4.20	56.39
September 25, 1987	41.1957	-113.2137	4.30	56.77
October 26, 1987	41.2008	-113.1777	4.70	56.95
September 25, 1987	41.2068	-113.1357	4.10	57.38
September 26, 1987	41.2090	-113.1500	4.00	57.68
September 25, 1987	41.2135	-113.1318	4.80	58.12
September 28, 1987	41.2267	-113.1808	4.00	59.84
February 16, 1967	41.2733	-113.3338	4.00	67.37
September 05, 1962	40.7153	-112.0888	5.20	86.52
February 22, 1943	40.7000	-112.0800	5.00	87.23
April 10, 1992	40.7000	-112.0800	4.30	87.23
March 16, 1992	40.4702	-112.0448	4.20	93.60
November 04, 1992	41.5098	-113.3878	4.80	93.91
September 08, 1983	40.7480	-111.9927	4.30	94.78
October 05, 1915	40.1000	-114.0000	4.30	99.91

PRELIMINARY REVIEW DRAFT

2.4 HYDROLOGY

The proposed Federal Cell Facility is located in the semi-arid desert of western Utah. The area containing the site lies within the Great Basin drainage, a closed basin having no outlet. The proposed Federal Cell Facility drains into the normally-dry Ripple Valley depression on the eastern fringe of the Great Salt Lake Desert. The nearest usable body of water east of the Clive site is 28.1 miles away. At this location, a perennial stream flows from Big Spring (1,000 feet south of I-80) to the Timpie Springs Waterfowl Management Area, about 2,000 feet north of I-80. Stream flows from higher elevations evaporate and infiltrate into the ground before reaching lower, flatter land. The watershed up-gradient of the site covers approximately 46 square miles. There are no perennial surface-water systems associated with the proposed Federal Cell Facility. Activities at the proposed Federal Cell Facility will have no effect on surface-water quantities or quality at the Clive Disposal Complex. Water necessary for construction is provided by existing wells in the vicinity, or impounded water.

2.4.1 Surface Water Hydrology

The proposed Federal Cell Facility is located in the eastern margin of the Great Salt Lake Desert, part of the Basin and Range Province. This province is characterized by north-south trending mountain ranges with discontinuous alluvium-filled valleys found between the ranges. The mountains are composed of mainly Paleozoic-age sedimentary rocks, but can also be composed of volcanic rocks. Metamorphic rocks do not outcrop in the vicinity of the facility, with the closest occurring in the Granite Peak area, approximately 40 miles south of Clive. The intermountain troughs are filled primarily with unconsolidated alluvial, lacustrine, fluvial, and evaporite deposits; but pyroclastics, aeolian sediments, and basalt flows also occur (Bingham Environmental, 1996 and Stephens, 1974). Sediments near the mountains are predominately colluvial and alluvial, and are generally coarser grained than the lacustrine deposits found in the center of the valleys.

The lack of surface water bodies, the sparse precipitation and the high evaporation rate make it unlikely that any condition creating a permanent body of standing water will occur. Standing water at the Clive Site is managed during the operational life of the facility according to Condition I.E.7 of GWQDP UGW450005,"*Run-on and Run-off Control Requirements*" and "*Waste Water, Runoff, and Storm Water Management Requirements*." Standing water in depressions outside waste management areas is not actively managed. UAC R313-25-23(5) states: "*The disposal site shall be generally well drained and free of areas of flooding or frequent ponding*." Federal Cell Facility areas will be managed to remove standing water, when necessary. Energy*Solutions* uses a mobile pumping truck to access and remove water from disposal site areas which are not designed to free-drain into an evaporation pond or equipped with permanent pumps. Other areas of the property are channeled to the southwest. The site has also been designed to drain any water that may accumulate during flooding.

There is no data indicating that historical floods have impacted the Clive site. Analyses prepared in support of Radioactive Material License UT2300249 modeled the Probable Maximum Precipitation (PMP) and Probable Maximum Flood (PMF) for the Clive Disposal Complex. The largest "instantaneous" value of runoff from the watershed was 29,800 cubic feet per second (cfs) and was associated with the six-hour PMP. Modeling shows a PMP of 10.10 inches for the six-hour storm and 6.1 in. for a 1-hour storm. The Probable Maximum Flood expected at the site from a six-hour Probable Maximum Precipitation event is 13,100 cfs, as compared to an estimated 100-year flood of 1,300 cfs. Additionally, Energy*Solutions* Federal Cell Facility disposal operations will not take place in a 100-year flood plain (UGS, 1999).

PRELIMINARY REVIEW DRAFT

The Probable Maximum Flood would most likely flow into the south and east borders of the site with the fringes of the flow encroaching on Energy*Solutions*' Clive Disposal Complex. The maximum depth of flow at the site was calculated to be between 2 and 4 feet and last for 6 hours. Thus, the Probable Maximum Flood would not infiltrate into groundwater beneath the proposed Federal Cell Facility. These events demonstrate that for post-closure, a short-term flood of any depth is likely to have no impact on the Federal Cell Facility's performance. Additionally, short-term flooding of any depth on the order of days or even weeks can intuitively be seen to have minimal impact on long-term performance.

Runoff from such a hypothetical event as the Probable Maximum Flood will be diverted from encroaching into the Federal Cell Facility by using a berm surrounding the disposal area. Flow would be diverted around the site to the south and away from the Federal Cell Facility.

2.4.2 Groundwater Characterization

Numerous geologic and hydrogeologic studies have been performed within and adjacent to Section 32. DOE performed the first detailed hydrogeologic investigations within Section 32 in the 1980s. Since Energy*Solutions*' operations began in 1988, additional studies were performed at the site in order to characterize the hydrogeology. In January 2019, Energy*Solutions* prepared a Revised Hydrogeologic Report that summarizes the hydrogeology of the site based upon historical data (Energy*Solutions*, 2019).

Alluvial and lacustrine sediments that fill the valley floor are estimated to extend to depths of greater than 620 feet with unconsolidated sediments ranging from 300 to over 600 feet (as demonstrated in boring investigations completed by Energy*Solutions* in 2019). North-south trending mountains and outcrops define the hydrogeologic boundaries for the aquifer system. Lone Mountain located two miles east of the site, rises approximately 950 feet above the valley floor. The Grayback Hills located to the north with outcropping features to the west rise 500 feet and 230 feet respectively above the valley floor.

The site aquifer system consists of a shallow unconfined aquifer that extends through the upper 40 feet of lacustrine deposits. A confined aquifer begins around 40 to 45 feet below the ground surface and continues through the valley fill. Due to the low precipitation and relatively high evapotranspiration, little or no precipitation reaches the upper unconfined aquifer as direct vertical infiltration. Groundwater recharge is primarily due to infiltration at bedrock and alluvial fan deposits which then travels laterally and vertically through the unconfined and confined aquifers. Groundwater flow in this area is generally directed northeasterly to northwesterly.

Fresh water from the recharge zones along the mountain slopes develops progressively poorer chemical quality in response to dissolution of evaporite-minerals during its travel through the regional-scale flow systems and through concentration by evaporation at the points of discharge. The groundwater quality in the unconfined aquifer at the Clive Facility is considered saline with concentrations of several chemical species (sulfate, chloride, total dissolved solids, iron, and manganese) significantly exceeding EPA's secondary drinking water standards.

The groundwater flow regime beneath the Federal Cell Facility has been evaluated extensively and defined based on (1) information collected from water level measurements, (2) the aquifer hydraulic properties which were calculated from slug out tests and laboratory testing, (3) isotope dating of groundwater, and (4) hydraulic testing performed for wells in the shallow and deep aquifers. Water levels obtained from monitoring wells

PRELIMINARY REVIEW DRAFT

between 1991 and present day were used to develop contour maps and flow nets to define the direction of groundwater flow and hydraulic gradients within the aquifers. These data are combined with measured hydraulic conductivities to develop estimates of groundwater velocities.

Horizontal ground water gradients in the shallow aquifer range from 1.9 x 10^{-5} to 5.4 x 10^{-3} ft/ft. The site-wide average gradient is 8.9 x 10^{-4} ft/ft. Using these gradients, average horizontal velocities ranging from 0.004 ft/day to 0.009 ft/day are calculated (Energy*Solutions*, 2019). A hydraulic conductivity of 2.98 x 10^{-4} cm/sec has been observed for Unit 2; with minimum and maximum values of 2.3 x 10^{-6} cm/sec and 4.3 x 10^{-3} cm/sec, respectively. The Unit 3 sandy materials exhibit a saturated hydraulic conductivity of 3.2 x 10^{-4} cm/sec. The vertical hydraulic conductivity of Unit 1 was measured in the laboratory using soil core samples obtained from 43 to 60 feet below ground surface in Unit 1 ranged from 2.2 x 10^{-8} to 1.6 x 10^{-6} cm/sec, with an arithmetic mean of 2.9 x 10^{-7} cm/sec.

Data characterizing the shallow, unconfined groundwater surface are provided to the Director in the Annual Groundwater Quality Reports. The groundwater level data indicates that the water level fluctuations at any given well are generally less than one foot (with the exception of areas with localized mounding). The groundwater surface is relatively flat in Section 32, with elevations varying about two feet per mile.

The aquifer system investigated in the area of the Energy*Solutions* Clive Facility consists of unconsolidated basin-fill and alluvial-fan aquifers which extend to depths on the order of 620 feet below Section 32. The lacustrine deposits, which comprise the majority of the aquifer system below the Clive Facility, are somewhat variable in depth and thickness, which makes the exact delineation of aquifers and aquitards difficult. Characterization of the aquifer system as a whole is based on subsurface stratigraphy and potentiometric data.

A shallow, unconfined aquifer has been identified in the upper 40 feet of lacustrine deposits, with groundwater surfaces ranging from 19 to 31 feet below the ground surface (with a historic minimum depth of approximately 24 feet). The unsaturated zone consists of an upper 8 to 15 foot thick silty clay and clayey silt (Unit 4) that overlies a 10 to 20 foot thick silty sand layer (Unit 3). Groundwater occurs within the lower part of Unit 3 below the approximate western half of Section 32 and the primary movement of groundwater is assumed to be in the silty sand lenses and layer of the shallow, unconfined aquifer here. Below this silty sand layer, a silty clay deposit (Unit 2) is present at variable depths and thickness. It appears that this silty clay layer is continuous based on exploratory boreholes and monitoring well installations. The top of Unit 2 generally slopes down from east to west across Section 32. In the eastern half of Section 32, groundwater in the shallow unconfined aquifer occurs in Unit 2, and Unit 3 is above the water table. Unit 1, which consists of a relatively thick silty sand layer, is present below the silty clay (Unit 2) at depths ranging from 40 to 45 feet below the ground surface. Wells and piezometers, which penetrate into Unit 1, typically exhibit higher freshwater equivalent heads than wells screened shallower in Units 2 and/or 3.

Because the shallow aquifer contains saline water with TDS concentrations ranging from approximately 30,000 mg/L in monitoring wells GW-26 and GW-63 to 100,000 mg/L in monitoring well GW-19A, it is classified as Class IV groundwater based on the criteria of TDS greater than 10,000 mg/l of the Utah Ground Water Quality Protection Regulations. Additionally, the saline water typically exhibits a specific gravity averaging 1.033.

The majority of the recharge to the shallow aquifer appears to occur as vertical leakage from the deeper confined aquifer. In addition, a small amount of vertical infiltration from the surface and some lateral

PRELIMINARY REVIEW DRAFT

movement of water from the recharge zone to the east occurs. Movement in the shallow aquifer is primarily laterally to the north, northeast and/or northwest.

The confined aquifer consists primarily of lacustrine deposits in Unit 1, which occurs below a depth of 40 to 45 feet. This deeper aquifer primarily consists of silty sand deposits with occasional silty clay layers and is overlain by one or more silty clay layers. Wells completed with screened intervals located at least 70 to 100 feet below the ground surface have static fresh water equivalent levels ranging from 3 to 18 inches above wells screened in the shallow, unconfined aquifer. Similarly, a well completed with screened interval located between 320 and 350 feet below the ground surface have static fresh water equivalent levels ranging up to 20 inches above wells screened in the shallow, unconfined aquifer. In the vicinity of the GW-19A/B well nest, increased water levels in the shallow aquifer have caused a downward switch in gradients at the southwest corner of the site. It has been observed that as the mound decreases, and the site conditions return to normal, the vertical gradient in GW-19A/B has decreased. It is anticipated that the gradient in this area will eventually return to regional conditions.

This deeper, confined aquifer also contains saline water with TDS concentrations well above 20,000 mg/l, also classifying it as Class IV groundwater. However, it is generally better quality than the shallow groundwater. The deeper saline groundwater typically exhibits a specific gravity on the order of 1.019. Recharge to the deeper confined aquifer probably occurs south and east of the facility in the coarser alluvial deposits adjacent to Lone Mountain.

Water level measurements from deeper monitor wells screened in Unit 1 between 70 and 350 feet below the ground surface have also been obtained and analyzed. When comparing water levels within deep and shallow monitor well clusters, the deep wells exhibit higher piezometric levels than the shallow wells, indicating an upward vertical gradient of approximately one foot based on fresh water equivalent heads. While this is offset somewhat by the downward density gradient of 0.2 feet, overall groundwater flow is from the confined to the unconfined aquifer. Based on the historic minimum depth to groundwater, groundwater levels would need to rise some 20 feet below the Federal Cell Facility to begin to threaten contact with disposed waste. The historic minimum depth to shallow groundwater for this area is roughly 24 feet below original contour. The Federal Cell Facility will be constructed by excavating approximately eight feet below the ground surface, then constructing a two-foot thick liner of compacted low-permeability clay. Therefore, the groundwater would need to rise 18 feet and pass through the liner to threaten disposed waste.

Residual effects of three groundwater mounds that developed within or in the vicinity of the Federal Cell Facility are apparent in piezometric surface maps derived from monthly water level measurements at the facility. All three mounds were created by focused infiltration of non-contact (i.e., uncontaminated) surface water resulting from precipitation events. From March 1993 to spring 1997, a borrow pit was excavated within the footprint of the 11e.(2) cell to provide low permeability clay for adjacent disposal cell construction. The pit occasionally filled with rain water and infiltration from the pit resulted in a groundwater mound near wells GW-37 and GW-38, based on observed water levels in those wells. Beginning earlier, around 1991, the area also received runoff from the Vitro embankment. A temporary diversion ditch was constructed to route Vitro runoff west between the 11e.(2) embankment and (what is now) the Class A embankment and then south along the Tooele County road to the southwest pond. In 2001, Vitro runoff was re-routed to the present configuration: south along the east side of the 11e.(2) embankment and then west to the southwest pond. The groundwater mound reached its greatest height in the mid to late 1990s and has dissipated since that time. Although attenuated, the impact of the mound on shallow groundwater flow is still observed in the southwest and west portions of the facility where flow is more northerly and the gradient is steeper than average. Recent

PRELIMINARY REVIEW DRAFT

groundwater elevations in the 11e.(2) area are approximately 0.5 to 1.0 feet higher than those measured in December 2011. Energy*Solutions* attributes this observation to above-average precipitation in 2015 and 2016 (Energy*Solutions*, 2019).

The southwest pond was constructed in late 1997 to receive non-contact surface water runoff from Section 32. Following periods of elevated precipitation, typically in the spring, the pond has overflowed (by design) into Section 6. The pond reportedly leaked in 2004 (Energy*Solutions*, 2019); however, the leak was subsequently repaired.

Groundwater recharge and mounding from overflow/leakage associated with the pond have been observed in well GW-19A and piezometer PZ-1. In response to recharge events, groundwater elevation increases as high as 4 to 9 feet above static have been observed at GW-19A since 1997. The peak elevations dissipate relatively quickly; as of fourth quarter 2018, the groundwater elevation of GW-19A was approximately 2 to 3 feet above the static level. The influence of the mounding has also been observed in surrounding wells GW-36, GW-58, and GW-63.

Since November 2009, Energy*Solutions* has extracted groundwater from the southwest pond area mound to reduce the potential downward vertical hydraulic gradient at the GW-19A/19B well pair. As of December 2018, 1.2 million gallons of groundwater had been extracted from the shallow aquifer and returned to the Southwest Corner Pond. The GW-19A/19B well pair is hydrologically-upgradient of the Clive facility.

Operation of the Southwest Corner Pond was added to the Best Available Technology (BAT) performance monitoring program (Appendices J and K of GWQDP UGW450005) on September 8, 2014. The primary performance element is maintenance of the pond freeboard to a level below the spillway by pumping water from the pond onto the ground in Section 5. After four years of implementation, Energy*Solutions* suspects that increases in the groundwater level at GW-63 may be related to this practice. The BAT requirement is shifting the area of noncontact surface water infiltration from the Southwest Corner Pond spillway area (Section 6) to the northwest part of Section 5.

Beginning in late 2001, non-contact surface water runoff from the embankments in Section 32 was redirected to flow south under the access road on the south edge of Section 32 and then west to the southwest pond in a ditch paralleling the access road. This is the current configuration for drainage of non-contact runoff from Section 32.

As discussed below, infiltration of surface water has occurred in the vicinity of three wells, GW-29, GW-60 and GW-63, since drainage was redirected.

- **GW-29** – In April 2006, a groundwater mound formed near well GW-29 in response to infiltration of surface water in an area where the LARW embankment drainage joined the 11e.(2) ditch. The culvert between LARW and 11e.(2) was replaced in May 2006, and the groundwater elevation at GW-29 rapidly decreased for the next several months. Since that time, the elevation at GW-29 has increased seasonally at times in response to the presence of water in the nearby ditch. The water level dissipates relatively rapidly during the summer, and it is a localized effect, as a long-term groundwater mound is not observed.
- **GW-60** – Well GW-60 is located adjacent to the south ditch and is also near a lift station constructed in late summer 2009. Water elevations at GW-60 have fluctuated from 2003 to present due to localized recharge associated with the drainage system. Elevations have increased rapidly following

PRELIMINARY REVIEW DRAFT

large precipitation events. Peak elevations of 3 to 9 feet above static have been observed. Water elevations at GW-60 also decrease rapidly. Since construction of the lift station, Energy*Solutions* has actively removed water collecting in the station to prevent infiltration.

- **GW-63** – Well GW-63 is located adjacent to the south ditch, approximately half way from the lift station to the Southwest Corner Pond. Water elevations at GW-63 increased beginning in early 2004 presumably due to localized recharge associated with the south ditch. Unlike well GW-60, changes in groundwater levels at GW-63 are more muted. As discussed above, pumping non-contact surface water from the Southwest Corner Pond onto the ground in Section 5 may impact the groundwater level at Well GW-63.

Surface water recharge of the shallow aquifer in the area of wells GW-29 and GW-60 has contributed to northerly and westerly groundwater flow and higher gradients in the immediate vicinity of the wells. Based on rapid water elevation changes in GW-29 and GW-60 and muted elevation increases in adjacent wells, the volume of water contributing to the mounding is suspected of being substantially less relative to the southwest pond area mound and the older 11e.(2) area mound. Similar recharge from the south ditch may be occurring in the vicinity of well GW-63; however, mounding at GW-63 may also be related to surface water recharge from the Southwest Corner Pond, including pumping water onto the ground surface in Section 5.

2.5 GEOTECHNICAL CHARACTERISTICS

Analyses have been conducted to measure the geotechnical characteristics and features of the proposed Federal Cell Facility in accordance with the requirements of UAC R313-25-7(1) and UAC R313-25-23. Information evaluated demonstrates that the geotechnical and geophysical field investigations and laboratory and field testing are adequate; interpretations of the data to develop typical soil and rock laying, typical cross-sections, and design parameters for use in design are reasonable and conservative; and geotechnical characterization of the Clive site meets the applicable guidance and acceptance criteria

A significant amount of field and laboratory information has been developed for the site and surrounding area, as a result of studies and investigations conducted in and adjacent to Section 32. Available geotechnical data adequately characterizes the subsurface soil conditions below the proposed Federal Cell Facility. DOE collected initial geotechnical and hydrogeologic information to locate and dispose of the Vitro uranium waste in the north central part of Section 32. Dames & Moore, Jacobs Engineering Group and CSU collected information for DOE between 1982 and 1984 (DOE, 1985b). Additionally, Delta Geotechnical collected geotechnical and hydrogeologic information for Energy*Solutions* between 1988 and 1990 as part of the permitting process for the Mixed Waste landfill cell. Energy*Solutions* has further updated and revised the data collected in the Revised Hydrogeologic Report (Energy*Solutions*, 2019) and a Basal-Depth Aquifer Study Plan (in press).

Lacustrine deposits typically comprise the soils encountered at the site. These soils consist of silty clays and clayey silts, and oolitic silty sands and sands. Calcium carbonates in the form of aragonite and calcite contribute as much as 60 percent of the total mineralogy of the clayey materials. The remaining mineralogy consists of smectite, quartz, dolomite, K-feldspar, plagioclase, kaolin, illite and a trace of gypsum. Calcareous n nature the oolitic silty sands and sands, ranging in size from approximately 0.08 mm to 4.0 mm, will fizz when put in contact with dilute HCl.

PRELIMINARY REVIEW DRAFT

Four hydrostratigraphic units have been delineated for the Clive site soils (extending from the surface, through the unsaturated zone, and into the shallow aquifer). This upper most layer consists of an upper silty clay/clayey silt (labeled Unit 4). Below the Unit 4 materials is an upper silty sand layer (Unit 3). Beneath the Unit 3 materials is a middle silty clay layer (Unit 2). Finally, below the Unit 2 material is a lower sand/silty sand layer (Unit 1).

The clayey soils, typically encountered from the surface down to a depth of 10 feet and between depths of 30 to 45 feet, typically are medium stiff, to stiff and moderately compressible. The majority of these clayey soils exhibit low to moderate plasticity and moisture contents ranging from 20 to 40 percent by weight.

The silty sand and sand layers, typically encountered between a depth of 10 and 30 feet and below a depth of 45 feet, are medium dense and low to moderately compressible. Moisture contents of the silty sands above the water table typically range from 5 to 15 percent by weight. Field investigations did not observe any adverse conditions due to site characteristics that would affect the long-term performance of the Federal Cell Facility (AMEC, 2011).

Basal-depth geotechnical analysis found carbonate mud; insoluble residue clayey material; sand-size grains of quartz, muscovite; manganese dioxide; and weathered volcanic rock from 356 to 359 feed bgs. (Oviatt, 2020). Similarly, carbonate mud; insoluble residue clayey material; brown clay in vein-like bodies that range in width from much-less-than 1 mm, to several mm; larger clay bodies, 1-2 cm in diameter; crystalline material secondary or un-weathered phenocrysts; manganese dioxide; weathered volcanic rock; clays; and Mn-dioxides at depths from 360 feet to 382 feet bgs. Breccia consisting of conglomerate, rounded to sub-angular pebbles; calcareous cement; carbonate coated pebbles; clasts of coarse sand grains, well rounded; tiny quartz crystals line some vugs; composition of clasts: sandstone, chert, limestone, soft carbonate mud, soft, weathered volcanic rock; sand-sized dark mineral, feldspar, quartz, chert; most clasts sub-rounded to well rounded; some clasts angular; well sorted, overall (no fines); and gravel cemented by calcium carbonate and silica from 607 to 617 feet bgs (Oviatt, 2020).

Energy*Solutions*, (2019) describes the geologic information, shallow hydrogeologic cross-sections, shallow groundwater elevation contour maps, and structure and isopach maps and evaluates current conditions at the facility. Energy*Solutions*, (2019) also contains a complete and thorough evaluation of all groundwater and vadose zone water quality available. It features graphs of temporal concentration trends for all compliance monitoring parameters in each compliance monitoring well. It contains the number of water quality data available for all compliance monitoring parameters in each compliance monitoring well. There has been significant water quality data collected for the groundwater below Section 32. Since groundwater conditions were characterized for all of Section 32, this information is applicable to the Federal Cell Facility.

Energy*Solutions* Clive Disposal Complex is an operational site that has access to adequate amounts of borrow material for proposed operations in adjacent Sections (Sections 29 and 5) owned by Energy*Solutions*. The rock and borrow material is abundant in the Grayback Mountains and Energy*Solutions* has a contract for removal of sand and gravel from this site. Energy*Solutions* will continue to work with BLM and other commercial vendors to ensure sufficient amounts of material are available to complete operations. The rock must meet the construction quality assurance/quality control specifications listed in the CQA/QC Manual, prior to use.

Energy*Solutions* uses native clay materials from land owned by Energy*Solutions* for liner and radon barrier construction. In other liner and cover construction activities, Energy*Solutions* has demonstrated that the clays

PRELIMINARY REVIEW DRAFT

can be placed with a hydraulic conductivity as low as 1 x 10^{-6} cm/sec without any additives being used. Similarly, a hydraulic conductivity as low as 5 x 10^{-8} cm/sec can be achieved with the use of a deflocculant.

Table 2-4 summarizes the estimates of materials required for full cover construction of the Federal Cell Facility, including estimates of materials required for full closure of the Federal Cell Facility. As illustrated, the quantity of clay material required to construct the liner and final cover of the complete Federal Cell Facility is 706,124 yd^3. The sand, gravel, and rock materials needed to fully close the Federal Cell Facility is 279,961 yd^3. Until a performance assessment evaluating wastes other than concentrated deplete uranium and NORM is approved by the Director, an additional 2,181,199 yd^3 of unit 3 fill material between the concentrated depleted uranium and final cover will be required to fully close the Federal Cell Facility.

The calculations prepared in support of Radioactive Material License UT2300249 conservatively estimated nearly 3.2 million cubic yards of available clays from borrow areas located within Energy*Solutions'* property. Similarly, at least 1.6 million cubic yards of mineral materials is available in the Grayback Hills source (BLM, 2012a).

As is summarized in Table 2-5, the four stratigraphic units beneath the site are comprised of alternating clayey and sandy layers. All the units are Lake Bonneville lacustrine deposits and are part of the Lake Bonneville Formation. Unit 4 is the upper silty clay layer and is unsaturated across the site. The Unit 3 silty sand layer and Unit 2 silty clay layer comprise the upper aquifer. A confined aquifer extends from the top of the silty sand, Unit 1, down several hundred feet to bedrock.

Hydrogeologic cross-sections that illustrate the distribution of these units beneath Section 32 are shown in (Energy*Solutions*, 2019). The cross-sections are based on stratigraphic information from well, borehole, piezometer, and lysimeter soil classification logs. Cross sections are included in Energy*Solutions* (2019).

2.6 GEOCHEMICAL CHARACTERISTICS

A significant amount of water quality data and geochemical information has been assembled for the subsurface soil and groundwater below Section 32 (Energy*Solutions*, 2019). Since groundwater quality is well characterized for all of Section 32, this information is applicable to the facility.

Federal Cell Facility design minimizes the potential for transport of contaminants away from the waste. The cover reduces the potential for infiltration, which is already believed to be minimal in the area due to the low incident precipitation and high potential evapotranspiration. Additionally, seepage is not expected to reach the groundwater as a result of moisture redistribution within the disposal materials. The impact of this seepage on the groundwater is expected to be minimal for several reasons:

1. Waste must not exhibit free liquids at the time of disposal;
2. The volume of seepage is small, generally occurring over a long period of time;
3. There are no receptors for groundwater contamination, due to the existing poor quality of the groundwater;

PRELIMINARY REVIEW DRAFT

Table 2-4

Federal Cell Facility Construction Material Estimates

MATERIALS	FEDERAL CELL FACILITY AREA (ft^2)	THICKNESS (ft)	VOLUME (yd^3)
Concentrated Depleted Uranium Footprint Area	1,379,435		
Clay Liner Area (under top and side slopes)	2,160,610	3.0	240,068
Above Grade Fill (future Class A expansion)			2,181,199
Full Cover (less Surface Layer) Area	2,473,883		
Top Slope			
Temporary Cover (clay)	1,380,539	1.0	51,131
Radon Barrier (clay)	1,380,539	2.0	102,262
Frost Protection (bankrun)	1,380,539	1.5	76,697
Evaporative Zone (clay/loam)	1,380,539	1.0	51,131
Surface Zone (clay/loam)	1,380,539	2.0	102,262
Erosion Barrier (gravel)	1,380,539	0.5	25,566
Side Slope			
Temporary Cover (clay)	1,094,448	1.0	40,535
Radon Barrier (clay)	1,094,448	2.0	81,070
Frost Protection (bankrun)	1,094,448	1.5	60,803
Filter Zone (gravel)	1,094,448	1.0	40,535
Erosion Barrier (Rip Rap)	1,094,448	1.5	60,803
Ditch Slope			
Clay Backfill			37,665
Filter Zone (gravel)	131,980	1.0	4,888
Erosion Control (side rock)	131,980	1.5	7,332
Inspection Road			
Inspection Road	72,075	1.25	3,337
TOTAL CLAY MATERIAL			**706,124**
TOTAL SAND & GRAVEL			**279,961**

PRELIMINARY REVIEW DRAFT

Table 2-5

Geotechnical Properties of Clive Site Surface Soils

Unit Name	USCS	Approx. Thickness (feet)	Range of Particle Sizes (%) Sand	Silt	Clay	Atterberg Limits LL	PL	Bulk Density (g/cc)
Unit 4	CL	8 - 15'	2 - 11	42 -56	38 - 56	35	22	1.37-1.66
Unit 3	SM	10 - 16'	46 - 89	8 - 39	8 - 16	NA	NA	1.55-1.67
Unit 2	CL	12 - 20'	0 - 32	27 - 52	40 - 48	36	20	1.32
Unit 1	SM	100 +	40-60	20-30	10-20	NA	NA	NA

NA: Not Analyzed
Source: (DOE, 1984)

PRELIMINARY REVIEW DRAFT

4. The hydraulic head gradient in the groundwater is small, limiting the velocity of groundwater movement away from the site to a maximum of 1.1 feet per year; and

5. Analyses project that it would take approximately 400 to 600 years for leachate to move through the unsaturated zone and then another 800 years to travel to the nearest off-site groundwater well (Energy*Solutions*, 2019).

Available groundwater quality data indicates that the shallow, unconfined aquifer exhibits variable quality within Section 32. Seasonal variations in water quality appear to be relatively small. However, spatial variations appear to be significant. One indicator parameter, TDS, had concentrations ranging from approximately 30,000 mg/L to 100,000 mg/l. Deeper screened wells below 70 feet exhibit lower TDS values than the shallow screened wells. There are significant water quality variations in the shallow, unconfined aquifer possibly due to the variations in subsurface soils that leach salts to the groundwater and the small gradients and corresponding velocities in the shallow groundwater system, which limit the mixing of the groundwater. Variations may also be related to groundwater mounding, which may dilute concentrations or may increase some concentrations.

The major effects of locally increased water elevations in the Federal Cell Facility area have been changes in groundwater chemistries and local gradients. Mounding has caused increases in TDS, some metals, and total uranium. These increases are the result of re-dissolution of naturally occurring constituents of the lake sediments underlying the Clive facility.

The water quality data collected for Section 32 includes results of laboratory analyses for organic, inorganic and radionuclide constituents and is reported in annual monitoring reports to the Director. The inorganic parameters analyzed indicate that many naturally-present concentrations are above the Criterion 5C limits for groundwater. Sulfate, chloride, and TDS concentrations in all wells also exceeded the EPA secondary drinking water standards. Analytical results for the radionuclide parameters also indicate that gross alpha, gross beta, sum of radiums, and total uranium have exceeded Utah's Division of Drinking Water standards in two or more of the wells. Because of this, it is concluded there would be a minimal potential for degradation of water quality in the vicinity of the Clive site. The groundwater at the site is characterized as "*a brine*." The water is suitable for limited industrial uses, without prior extensive treatment. The nearest current use of groundwater is located over three miles from the site and up-gradient.

Energy*Solutions* has performed geochemical compatibility testing of the brown and white Unit 4 clay materials being utilized for the clay bottom liner of the Federal Cell Facility (Bingham, 1994). In addition to the geochemical compatibility testing, Energy*Solutions* has also performed numerous permeability tests of both the clay liner and radon barrier materials to evaluate the hydraulic conductivity and stability of the clay. Physical and chemical analyses, designed to approximate 80 years of leachate contact with the Federal Cell Facility liner material, show minimal loss of liner integrity for approximately 80 years, (demonstrating more than adequate performance for the time period during which the Federal Cell Facility is open for operations). This testing indicated that leachate will not reduce the hydraulic conductivity performance of the clay liner below design specifications. At the conclusion of the testing, the samples stabilized at hydraulic conductivity ranging from 5.0×10^{-8} to 1.0×10^{-7} cm/sec, comparable to their initial pre-test conductivities (Bingham, 1994). Once final cover is placed, infiltration will be minimized and leachate will not build up on top of the Federal Cell Facility liner.

PRELIMINARY REVIEW DRAFT

Laboratory permeability tests of Clive's clay indicated that no significant volume of soil was leached out (even though approximately half is characterized as water soluble). Cation exchange capacity for the Unit 4 clay was determined to be 13.4 MEQ/100 g. In previous evaluations of distribution coefficient (k_d) values (calculated from available k_{oc} values), the organic percentage for Unit 3 was assumed to be 2 percent. This percentage is the recommended value for "clean" soils without significant organic content.

2.7 NATURAL RESOURCES

In preparation of this Application, Energy*Solutions* has evaluated known natural resources in the Clive site area and demonstrated that continued exploitation of such resources will not negatively impact the Federal Cell Facility's ability to meet the performance objectives of UAC R313-25-19 through -22.

2.7.1 Geological Resources

Natural resources in Tooele County include limestone, metallic minerals, potassium, salts, tungsten, salt, clays, sand and gravel. Gravel quarries are located in the alluvial fans that flank the Cedar Mountains (DOE, 1984). Limestone is quarried in the Cedar Mountains about five miles east of the site. Presently, no oil or gas production takes place in the area. Although the area has been classified as possibly valuable for oil and gas, the classification is based on very general criteria. Additionally, little interest has been historically shown in the western desert for oil and gas exploration. Previous exploration near the west side of the Great Salt Lake revealed a low-grade product with little or no yield. There is neither coal production in the area nor geologic formations with coal resources. No active or pending mining claims or mineral leases are located on the site.

2.7.2 Water Resources

In general, the use of groundwater and surface water in the Great Salt Lake Desert is concentrated along mountain fronts where the majority of fresh groundwater and spring discharge occurs. This water is obtained from wells located up-gradient of the shallow aquifer below the site. Without extensive treatment, uses of the groundwater in the Clive area are confined to limited industrial uses.

Other than the monitoring wells installed for the Vitro project, and wells used for construction and makeup water during the Vitro project, there are no existing groundwater wells near the proposed Federal Cell Facility. The closest known wells are approximately two to three miles west, northwest and east of the site. However, the well west of the site has been destroyed. While one of the two wells east of the site is in current use to water livestock, the second well has been destroyed.

2.8 BIOTIC FEATURES

In August 1993, NRC concluded an Environmental Impact Study (EIS) and generated a report detailing the potential impacts associated with the siting of Energy*Solutions*' 11e.(2) disposal facility in Utah's West Desert. Subsequent to NRC's EIS, Energy*Solutions* compiled an Environmental Assessment in support of its application to renew Radioactive Material License UT2300478. In the process of creating the EIS and EA, extensive research was performed into the vegetative and terrestrial populations in and around Section 32. Even though it was originally conducted in support of the 11e.(2) Federal Cell Facility, the analysis is

PRELIMINARY REVIEW DRAFT

applicable to this Application. Data from the EIS was later revisited by SWCA (SWCA, 2011). This section summarizes ecological findings of SWCA and NRC.

The vegetation of the proposed Federal Cell Facility is a homogeneous, semi-desert low shrubland, primarily composed of shadscale (Atriplex confertifolia). The shrubland is part of the Northern Desert Shrub Biome of the Cold Desert Formation and is described as a Saltbush (Shadscale)-Greasewood Shrub complex. Plant communities identified on the site are Shadscale-Gray Molly (Kochia americana var. vestita), a transitional community type of Shadscale-Gray Molly-Black Greasewood (Sarcobatus vermiculatus), and Black Greasewood-Gardner Saltbush (Atriplex nuttallii). Dominant shrubs on the proposed Federal Cell Facility include shadscale, Nuttall's saltbush, and winterfat (SWCA, 2011). All three communities are low in species diversity. The proposed Federal Cell Facility occurs in the Desert Alkali range site, which is rated by BLM as being poor for grazing or forage production. However, the vegetation forms an important ground cover and deterrent to soil erosion and provides habitat for wildlife species. Annual production of the three community types ranged from 152 to 517 pounds per acre, air dry. Annual production for the range site is given as 50 to 200 and 500 to 1,500 pounds per acre during unfavorable and favorable years respectively. Livestock carrying capacity with such production would range from 3 to 80 acres per animal-unit month.

Representative of the desert shrub/saltbush community are low widely spaced shrubs, totaling approximately 10 percent ground cover (Cronquist et. al, 1972).

Dominant shrubs on the proposed Federal Cell Facility include shadscale, Nuttall's saltbush, and winterfat (SWCA, 2011). Vegetation patterns of the proposed Federal Cell Facility are correlated with soil salinity and corresponding shifts in presence or abundance of species. All three communities are low in species diversity. Seep-weed or inkweed (Suaeda torreyana) and scattered perfoliate pepperweek (Lepidium perfoliatum) are the only prominent understory species of the Shadscale-Gray Molly community. This community occurs over most of the proposed Federal Cell Facility, although black greasewood becomes prominent enough in the eastern quarter to form a Shadscale-Black Greasewood-Gray Molly community. Except for black greasewood and occasional stands of halogeton (Halogeton glomeratus), the composition is similar to the more prominent Shadscale-Gray Molly community. Maximum root depth of the late successional shadscale species is reported to be 39 inches, while fourwing saltbush roots generally extend to a maximum depth of 20 inches (SWCA, 2011).

Black greasewood may have tap roots that extend beyond 11 feet beneath the surface. The Black Greasewood-Gardner Saltbush community type is floristically the most diverse, but only occurs in the extreme northeast corner and eastern edge of the proposed Federal Cell Facility. In addition to Gardner saltbush, the flora is composed of all species found in the other communities except halogeton.

In the SWCA Study (2011), forty-one plant species were identified. However, because many desert forbs are spring ephemerals and field sampling was conducted at the end of a growing season, the plant species diversity and cover, particularly for herbaceous forbs, was underrepresented. Of the few forb species that were detected, all were dead or senesced, with the exception of Halogeton (Halogeton glomeratus), a late-season invasive annual weed. Biological soil crusts are a dominant feature of vegetation communities throughout the Great Salt Lake basin. Soil crusts were present in all vegetation associations sampled, but were more prevalent in the low desert vegetation associations (e.g., black greasewood, haltogeton-disturbed, and shadscale-gray molly) present on and adjacent to the proposed Federal Cell Facility.

PRELIMINARY REVIEW DRAFT

SWCA also examined the root density and maximum rooting depth of dominant plant species on the proposed Federal Cell Facility. Excavations were performed to obtain cross-sections of the rooting mass of dominant plant species. The roots were carefully exposed by gradual removal of vertical layers of soil with the backhoe and hand tools. Root density measurements were collected by measuring the width of the rooting mass and by counting visible roots across a set of sample widths or for the entire width of the root mass. Observed root densities were higher near the surface of the soil, where roots were mostly fibrous with few woody structures. A few large, woody roots were encountered in deeper soils. Rooting depths were shallower than expected, with the maximum rooting depth of dominant woody plant species ranging from 40 to 70 cm. Woody plant species maximum rooting depths were proportional to aboveground plant mass with an above-ground height root depth ratio of 1:1 and an above-ground width root depth ratio of approximately 1.4:1. The halogeton had higher ratios of plant height and width to maximum rooting depth (1.4:1 and 1.7:1, respectively). The low proportion of roots to above-ground biomass is expected for annual plants, which invest the bulk of their energy in reproduction and little energy in root systems.

The proposed Federal Cell Facility is located within the year-long range of the pronghorn antelope. The West Desert Herd Unit 2A occurs south of I-80 and includes the Clive site (BLM, 1988). Pronghorn are rare in the project area south of Interstate-80. The area is considered poor pronghorn habitat. Interstate-80 acts as a pseudo-barrier to most pronghorn movement south from the Puddle Valley Herd Unit.

Mourning doves are summer residents, arriving in February or March and migrating out of the area in August or September. Doves are most abundant in edge or ecotone areas, particularly interspersions of agricultural, sagebrush, and pinyon-juniper types. Mourning doves are the only game bird occurring on the proposed Federal Cell Facility.

A variety of other non-game mammals, birds, and reptiles are supported by habitats found in the area and associated utility, railroad, and access road right-of-ways. Species that may occur include the Townsend's ground squirrel, Ord's kangaroo rat, desert woodrat, western harvest mouse, side-blotched lizard, gopher snake, Brewer's sparrow, black-throated sparrow, and horned lark (BLM, 1987).

Supplemental terrestrial life analysis, conducted by SWCA (2011), also observed species of small mammal: deer mouse (Peromyscus maniculatus), northern grasshopper mouse (Onchomys leucogaster), and Great Basin kangaroo rat (Dipodomys microps). Deer mice accounted for 22 of the 24 captured mammals (92%). One northern grasshopper mouse and one Great Basin kangaroo rat were captured. At a second sampling location, SWCA observed deer mice comprised 84% of the captures, Great Basin kangaroo rats 14%, and Ord's kangaroo rat 2%. Ord's kangaroo rats were captured only at this site.

SWCA also observed several ant mounds near the proposed Federal Cell Facility. A total of 1,624 ants in the genus Pogonomyrmex was collected in SWCA Sample Locations and determined to be the western harvester ant. Four other ants collected were determined to be in the genus Lasius, with species not positively determined but most likely niger. The western harvester ant is a widely distributed ant occurring throughout most of Utah and many other western states. It frequently occurs in areas that are relatively flat and have been recently disturbed by human activities.

Aquatic ecosystems do not occur on or near the proposed Federal Cell Facility.

No important plant or animal species, as identified in NRC (1980a), are known to occur on the proposed Federal Cell Facility and no known important habitats have been identified in the area. Furthermore, no

PRELIMINARY REVIEW DRAFT

threatened or endangered plant species are known to occur in the vicinity of the proposed Federal Cell Facility. However, the Utah Division of Wildlife Resources reports that the area is used for foraging by bald eagles and American peregrine falcon, which are federally listed endangered species, during the winter (SWCA, 2011). The bald eagle is a winter resident from late November to mid-March in the project vicinity. The majority of wintering eagles are found in Rush Valley with others occurring in Skull and Cedar Valleys. No bald eagle roosts are located within the proposed project area. However, the black-tailed jackrabbit is the primary food source utilized by bald eagles in Tooele County (BLM 1988), and eagles potentially hunt within this area.

One historical aerie of the American peregrine falcon was located near Timpie Springs Wildlife Management Area in the northern end of the Stansbury Mountains. The nest site became inactive following the construction of Interstate-80 in the late 1960s (BLM, 2012a). In an attempt to re-establish a breeding pair of peregrines, the Utah Division of Wildlife Resources, in cooperation with the U.S. Fish and Wildlife Service (USFWS), erected a hack tower at the Timpie Springs Wildlife Management Area, approximately 26 miles from the Clive site. The hack tower became active in 1983 and 1984. Energy*Solutions* monitored the site between 2005 and 2012, seeing no peregrine activity. Due to the distance between the proposed Federal Cell Facility and the aerie, it is unlikely any peregrines utilize the project area.

The Great Basin fishhook cactus (Sclerocactus pubispinus) is currently under review for threatened status. This species is associated with gravelly beach terraces of Pleistocene Lake Bonneville in western Tooele County and is not expected to occur in the proposed Federal Cell Facility.

The Cedar Mountain has previously hosted approximately 362 horses or a range of 290 to 434 horses, protected under the Wild and Free Roaming Horse and Burro Act of 1971 (BLM, 2012b). This number fluctuates due to horse movement between the Cedar Mountains, the Onaqui Mountains, and Dugway Proving Grounds. Fences that might preclude horse movement between the three areas are generally insufficient to deter movement. The current established appropriate management level for the Cedar Mountains is set at 190 horses on the low end and 390 at the upper level (BLM, 2012b). Dependable summer water sources are a major problem. In drought years, natural water sources may dry up, generating the need for water to be trucked in. Hauling water is a financial impact to BLM and the transportation infrastructure. In times of reducing budgets, there is no certainty that BLM will be able to continue to haul water to wild horses in sufficient quantity to insure the quality of their existence and avoid mortality. During drought, increased stress is also placed on the water sources and adjacent vegetation as horses congregate around troughs whether or not water is in the spring. Wild horses are seldom encountered on the proposed Federal Cell Facility (BLM, 2012b), and are monitored so that the herd population does not exceed more than the environment could sustain (Grams, 2009). No wild horses have been observed in the proposed Federal Cell Facility since 2012.

The state sensitive kit fox may occur throughout the West Desert Hazardous Industry Area (UDWR, 2010).

Because nationwide populations have been declining for the past 25 years, the Greater sage-grouse have been designated a Federal Candidate species and heightened monitoring efforts are being conducted (UDNR, 2009). On March 5, 2010, the US Fish and Wildlife Service announced that greater sage-grouse now have a "*warranted, but precluded*" status, meaning the Service considers the Sage-grouse warrant listing on the Endangered Species Act, but that other species are a higher priority (BLM, 2012b). Because Sage-grouse require large tracts of sagebrush plant communities for their life-cycle, a range-wide Assessment of Greater Sage-grouse included potential distribution in the West Desert, but noted that, "*barren habitats west of the*

PRELIMINARY REVIEW DRAFT

Great Salt Lake and forested and alpine areas in mountainous areas were not historically occupied by sage-grouse," (UDNR, 2009).

The Assessment further noted that the most favorable Sage-grouse habitat is located near Vernon (eastern Tooele County) and in the Ibapah (western Tooele County), (UDNR, 2009). In 2006, a total of 190 males were counted on six mating sites in Vernon. In Ibapah, a total of 93 males were counted on five mating sites. The Assessment notes that a variable but stable pattern in sage-grouse numbers has been observed near Vernon since the late 1960s. However, because there has been difficulty in accessing private and Tribal lands, the Assessment has not been able confirm a similar trend for Sage-grouse mating sites near Ibapah. No Sage-grouse mating sites have been observed near the Clive facility. Additionally, the viable hazards identified Assessment's threat analysis (e.g., altered water distribution for irrigation, home and cabin development, tall structure construction, and aggressive road construction) have negligible to no likelihood of occurrence at the proposed Federal Cell Facility.

2.9 SITE CHARACTERISTIC PREOPERATIONAL MONITORING

As is summarized in Table 2-6, Energy*Solutions* and DOE have collected extensive radiological preoperational environmental samples before starting major construction of its various licensed and permitted disposal facilities and continues operational sampling according to the requirements of Radioactive Material Licenses UT2300249 and UT2300478. Environmental results are reported semi-annually to the Director. In addition to the proposed Federal Cell Facility, Energy*Solutions* also operates an adjacent Class A West Federal Cell Facility and 11e.(2) byproduct disposal facility under Agreement-State licenses issued by the Director. Because of the facilities' close proximity, locations used for monitoring both facilities will also inform environmental monitoring for the Federal Cell Facility. Subsequently, the results of environmental monitoring performed at those locations that are common to both facilities are reported to the Director.

PRELIMINARY REVIEW DRAFT

Table 2-6

Preoperational Radioactivity Concentrations in Soil

RADIONUCLIDE	CONCENTRATION RANGE (pCi/g)
Curium-244	0.0 +/- 0.1 - 0.1 +/- 0.1
Plutonium-238	0.0 +/- 0.1 - 0.0 +/- 0.1
Plutonium-239/240	0.0 +/- 0.1 - 0.1 +/- 0.2
Plutonium-241	0.0 +/- 0.1 - 0.0 +/- 1.6
Plutonium-242	0.0 +/- 0.1 - 0.3 +/- 0.4
Uranium-238	0.7 +/- 0.1 - 1.1 +/- 0.1
Thorium-232	0.9 +/- 0.1 - 1.1 +/- 0.2
Thorium-230	1.1 +/- 0.2 - 1.6 +/- 0.2
Radium-226	0.9 +/-0.1 - 1.2 +/- 0.1
Lead-210	1.1 +/- 0.1 - 1.8 +/- 0.2
Polonium-210	1.5 +/- 0.6 - 2.6 +/- 0.6
Cesium-137	0.4 +/- 0.1 - 1.1 +/- 0.2
Iodine-129	0.4 +/- 3.6 - 0.0 +/- 6.6
Technetium-99	0.0 +/- 0.7 - 0.7 +/- 1.0
Strontium-90	0.3 +/- 0.3 - 0.3 +/- 0.4
Nickel-63	0.0 +/- 3.1 - 5.0 +/- 1.4
Iron-55	0.0 +/- 2.1 - 0.0 +/- 2.9
Potassium-40	12.3 +/- 0.4 - 13.4 +/- 0.5
Carbon-14	0.0 +/- 6.6 - 3.1 +/- 8.9

Source: (DOE, 1984)

PRELIMINARY REVIEW DRAFT

SECTION 3. DESIGN AND CONSTRUCTION

Energy*Solutions*' Federal Cell Facility design is a near-surface landfill. Energy*Solutions'* proposes that the Federal Cell Facility be constructed using materials native to the site or found in close proximity to the site. Engineered features of the Federal Cell Facility are designed based upon State of Utah regulations, NRC guidance, EPA guidance, and Energy*Solutions*' past experience at this location. In order to simplify the information presented in this Application, the following presentation of design criteria, pertinent characteristics, and projected performance is limited to the Federal Cell Facility.

Principal design features of the Federal Cell Facility include: clay liner, waste placement, final cover, drainage systems, and a buffer zone. Adequate auxiliary systems and facilities already supporting Energy*Solutions'* other disposal facilities include utility systems, operational support facilities, fire protection systems, and water management systems.

The general design requirements for the licensing the Federal Cell Facility are set forth in the UAC R313-25, administered by the Director. UAC Rule R313-25-25 outlines six design requirements for near-surface land disposal of radioactive waste as follows:

1. Site design features shall be directed toward long-term isolation and avoidance of the need for continuing active maintenance after closure;

2. The disposal site design and operation shall be compatible with the disposal site closure and stabilization plan and lead to disposal site closure that provides reasonable assurance that the performance objectives will be met;

3. The disposal site shall be designed to complement and improve, where appropriate, the ability of the disposal site's natural characteristics to assure that the performance objectives will be met;

4. Covers shall be designed to minimize, to the extent practicable, water infiltration, to direct percolating or surface water away from the disposed waste, and to resist degradation by surface geologic processes and biotic activity;

5. Surface features shall direct surface water drainage away from disposal units at velocities and gradients which will not result in erosion that will require ongoing active maintenance in the future; and

6. The disposal site shall be designed to minimize to the extent practicable the contact of standing water with waste during disposal, and the contact of percolating or standing water with wastes after disposal.

UAC R313-25-23 requires that the Federal Cell Facility be sited, designed, used, operated, and closed to achieve long-term stability of the disposal site without the perpetual need for ongoing active maintenance. Radiation protection standards are set forth in UAC R313-25-19, R313-15-301 and R313-15-302.

The Utah Division of Water Quality (DWQ) has adopted performance based Best Available Technology (BAT) standards for Energy*Solutions*' Federal Cell Facility, requiring that groundwater protection standards

PRELIMINARY REVIEW DRAFT

will not be exceeded at compliance wells within 200 years for non-radioactive hazardous constituents and within 500 years for radioactive constituents.

Where required design criteria set forth specific criteria, the facility has been designed to meet that requirement, such as the DWQ water quality protection levels. However, the general criteria that the facility design must "*achieve long-term stability... to eliminate, to the extent practicable, the need for ongoing active maintenance of the disposal site after closure*," requires a determination of the meaning of "long-term." The EPA and the NRC, in setting design criteria for disposal facilities for LLRW have adopted standards that require that the facility be designed for 1,000 years, whenever reasonably achievable, but in any case for a minimum of 200 years. By comparison, UAC R313-25-9(5) requires a performance assessment successfully demonstrate that the performance standards specified in 10 CFR Part 61 and corresponding provisions of Utah rules will be met for the total quantities of concentrated depleted uranium for a compliance period of 10,000 years. Energy*Solutions* has adopted this standard to determine the design criteria for long-term stability.

3.1 PRINCIPAL DESIGN FEATURES

The Federal Cell Facility is designed with cover, waste placement configurations, liner, drainage systems and a buffer zone as critical principal features that provide long-term isolation of disposed depleted uranium, minimize the need for continued active maintenance after Facility closure, and improve the Facility's natural characteristic in order to protect public health and safety. These principal design features minimize the infiltration of water into the Federal Cell Facility, ensure the integrity of the Facility's cover, provide for structural stability of backfill, concentrated depleted uranium and cover, minimize contact of concentrated depleted uranium with standing water, provide adequate drainage during operations and after Facility closure, facilitate site closure and stabilization, minimize the need for long-term maintenance, provide barrier against inadvertent intrusion, maintain occupational exposure as low as is reasonably achievable, provide adequate disposal site monitoring, and provide an adequate buffer zone for monitoring and potential mitigative action.

<u>Cover System</u>
The cover design is engineered to reduce infiltration, prevent erosion, and protect from radionuclide exposure by limiting water flow to monitoring wells for at least 500 years, increasing evapotranspiration from the top slope and promoting runoff via steeply sloped sides. The general design aspect of the Federal Cell Facility is that of a hipped cover, with relatively steeper sloping sides nearer the edges. The upper part of the Federal Cell Facility, known as the top slope, has a moderate slope, while the side slope is markedly steeper. The top slopes of the cell will be finished at a 2.4% grade, with side slopes at 20%. The embankment is also constructed such that a portion of it lies below-grade. The overall length of the embankment is 1317.8 ft and the overall width is 1775.0 ft. Since depleted uranium waste is only placed beneath the top slope of the Facility's cover, the depth of the waste below the top slope is a maximum of 47.5 ft. As shown in Appendix B, the design includes both a low-angled top slope and steeper side slope section of the cover. The layers to be used in the Federal Cell Facility top slope (constructed to 2.4%) cover consist of the following, from top to bottom:

- <u>Surface layer</u>: This layer is composed of native vegetated Unit 4 material with 15 percent gravel mixture. This layer is 12 inches thick. The functions of this layer are to control runoff, minimize erosion, and maximize water loss from evapotranspiration. This layer of silty clay provides storage for water accumulating from precipitation events, enhances losses due to evaporation, and provides a rooting zone for plants that will further decrease the water available for downward movement. A residual moisture content meeting or exceeding 3.5% is required for surface layer soils (as required

PRELIMINARY REVIEW DRAFT

by Condition 1.D.4.a(3) of the GWQDP), with gradations meeting the specifications reported on Drawing 10014-C04.

- Evaporative Zone layer: This layer is composed of Unit 4 material. The thickness of this layer is 12 inches. The purpose of this layer is to provide additional storage for precipitation and additional depth for plant rooting zone to maximize evapotranspiration. A residual moisture content meeting or exceeding 3.5% is required for evaporation zone layer soils (as required by Condition 1.D.4.a(3) of the GWQDP), with gradations meeting the specifications reported on Drawing 10014-C04.
- Frost Protection Layer: This material ranges in size from 16 inches to clay size particles. This layer is 18 inches thick. The purpose of this layer is to protect layers below from freeze/thaw cycles, wetting/drying cycles, and to inhibit plant, animal, or human intrusion. (as required by Condition 1.D.4.a(3) and the rock scoring specifications in the CQA/QC Manual). Environmental sampling and performance modeling demonstrates that the frost depth will not exceed the cumulative depths of the surface, evaporation zone, and frost protection layers (Montgomery Watson, 1998; Montgomery Watson, 2000; Western Regional Climate Center, 2000; RBG 2020).
- Upper Radon Barrier: This layer consists of 12 inches of compacted clay with a low hydraulic conductivity. This layer has the lowest conductivity of any layer in the cover system. This is a barrier layer that reduces the downward movement of water to the waste and the upward movement of gas out of the disposal cell. The as-built saturated hydraulic conductivity (K_{sat}) of this layer is 5.00×10^{-08} cm/s. Modeling further demonstrates that the steady-state moisture content of the clay radon barrier will remain constant throughout the life of the Facility.
- Lower Radon Barrier This layer consists of 12 inches of compacted clay with a low hydraulic conductivity. This is a barrier layer placed directly above the waste that reduces the downward movement of water. The as-built K_{sat} of this layer is 1.00×10^{-06} cm/s. Modeling further demonstrates that the steady-state moisture content of the clay radon barrier will remain constant throughout the life of the Facility.

The design for the side slope is similar to the rock armored side slope of the 11e.(2) Byproduct Facility. The layers used in the Federal Cell Facility side slope cover (constructed to 20%) consist of the following, from top to bottom:

- Rip Rap cobbles. Approximately 18-inches of Type-A rip rap will be placed on the side slopes above the Type-A filter zone. The Type-A rip rap ranges in size from 2 to 16 inches (equivalent to coarse gravel to boulders) with a nominal diameter of 12 inches. Engineering specifications indicate that 100% of the Type-A rip rap would pass a 16-inch screen and not more than 15% would pass a 4 1/2- inch screen (as required by Condition 1.D.4.a(1) and the rock scoring specifications in the CQA/QC Manual).
- Filter Zone. The thickness of the Type B filter in the side slope will be 12 inches. The Type B filter material in the side slope will consist of granular material with a particle size ranging from 0.3125 to 3.0 inches in diameter (coarse sand to fine cobble) and a minimum hydraulic conductivity of 42 cm/sec. In order to promote drainage and avoid ponding, the filter zone is constructed with a specification that its permeability exceed 3.5 cm/sec, with strict gradation specifications (as reported on Drawing 10014-C04) and rock scoring testing exceeding 50 (as required by specifications of the CQA/QC Manual and Condition I.D.4.a(5) of the GWQDP).
- Frost Protection Layer (Sacrificial Soil). This material ranges in size from 16 inches to clay size particles. This layer is 18 inches thick. The purpose of this layer is to protect layers below from freeze/thaw cycles, wetting/drying cycles, and to inhibit plant, animal, or human intrusion. A

PRELIMINARY REVIEW DRAFT

residual moisture content meeting or exceeding 3.5% is required for sacrificial soils (as required by Condition 1.D.4.a(3) of the GWQDP), with gradations meeting the specifications reported on Drawing 10014-C04. CQA/QC Manual specifications frost protection layer require runoff water velocities not to exceed 2.3×10^{-2} ft/sec during typical rainfall events and 8.0×10^{-4} ft/sec during Probable Maximum Precipitation events (Whetstone, 2005; Neptune 2020). Environmental sampling and performance modeling demonstrates that the frost depth will not exceed the cumulative depths of the rip rap, filter zone, and frost protection layers (Montgomery Watson, 1998; Montgomery Watson, 2000; Western Regional Climate Center, 2000; RBG 2020).

- Upper Radon Barrier. This layer consists of 12 inches of compacted clay with a low hydraulic conductivity. This layer has the lowest conductivity of any layer in the cover system. This is a barrier layer that reduces the downward movement of water to the waste and the upward movement of gas out of the disposal cell. The as-built K_{sat} of this layer is 5.00×10^{-08} cm/s. Modeling further demonstrates that the steady-state moisture content of the clay radon barrier will remain constant throughout the life of the Facility.
- Lower Radon Barrier This layer consists of 12 inches of compacted clay with a low hydraulic conductivity. This is a barrier layer placed directly above the waste that reduces the downward movement of water. The as-built K_{sat} of this layer is 1.00×10^{-06} cm/s. In order to ensure cover long-term performance, clays are selected for radon barrier construction that have 85% fines (< 0.075 mm), a plasticity index between 10 and 25, and a liquid limit between 30 and 50. The clays must also demonstrate an ability to be compacted to 95% of a standard proctor when moisture contents are maintained between optimum and optimum plus 5% (as required by specifications of the CQA/QC Manual and Condition I.D.4.a(5) of the GWQDP). Modeling further demonstrates that the steady-state moisture content of the clay radon barrier will remain constant throughout the life of the Facility.

Waste Placement Configurations

When placing depleted uranium waste in the proposed Federal Cell Facility, Energy*Solutions* will utilize construction specifications successfully implemented and already approved from the CQA/QC Manual. No other novel engineering designs or construction methods will be required for management of waste or construction of the Federal Cell Facility, nor will the waste disposed in the Federal Cell Facility differ from waste currently being disposed in other disposal facilities in Energy*Solutions'* Clive Disposal Complex in regards to radioactivity, physical form, or potential hazard.

The principal objectives of the Federal Cell Facility design are to: (1) provide long-term isolation of disposed depleted uranium waste, (2) minimize the need for continued active maintenance after site closure, and (3) augment the site's natural characteristics in order to protect public health and safety. Energy*Solutions* has designed the Federal Cell Facility to effectively control any radioactive release for at least 500 years. Accordingly, the principal design features include those elements of the completed Federal Cell Facility that impact long-term performance of the facility.

Concentrated depleted uranium disposal in the Federal Cell Facility will be limited to the bottom of the Facility, below native grade and only under the cover's top slope. Dimensions for the depleted uranium disposal zone are approximately 7.4 feet thick by 968 feet wide (east–west) by 1,425 feet long (north–south) (see Appendix B). This equates to a design capacity for depleted uranium disposal of about 10.2 million cubic feet, all below native grade. To ensure stability, Energy*Solutions* commits to placing controlled low-strength material (CLSM) backfill between the depleted uranium cylinders and drums. Disposal of containers of depleted uranium in CLSM in the Federal Cell Facility mirrors the Division-approved waste placement

PRELIMINARY REVIEW DRAFT

configuration of the Class A West Embankment design. The addition of the CLSM matrix fills voids and prevents subsidence. CQA/QC Manual specifications further limit the differential settlement of placed wastes to 0.01 under abnormal conditions. Similarly, waste placement configuration is designed to ensure a static safety factor meets or exceeds 2.1 (with a minimum static factor of safety of 1.5) and a seismic safety factor meets or exceeds 1.2. Other construction specifications for application of CLSM are provided in the CQA/QC Manual. No revision to this specification will be needed for construction of the proposed Federal Cell Facility.

Liner

The general design aspect of the Federal Cell Facility is that of a hipped cover, with relatively steeper sloping sides nearer the edges. The embankment is constructed such that a portion of it lies below-grade into the native Unit 4 silty clay soil (8 feet). Waste will be placed above a Facility liner consisting of a two foot thick layer of compacted Unit 4 clayey soils (constructed to a design permeability of 1×10^{-6} cm/sec and maximum in-service permeability of 1×10^{-4} cm/sec), covered by 1 foot of liner protective media (using Unit 4 clayey soils). Groundwater does not need to be directed away from the proposed Federal Cell Facility, since the lowest top of liner elevation is more than 13 feet above the highest recorded elevation for the upper, unconfined aquifer. The lowest top of liner elevation will be at approximately 4,262 feet above sea level (see Drawing 14004-C02); the highest recorded elevation for the upper, unconfined aquifer, based on available data from recent years for wells near the proposed Federal Cell Facility is 4,251.3 feet above sea level. CQA/QC Manual specifications limit in-service liner performance to a maximum distortion of 0.001 under normal conditions and 0.007 under abnormal conditions.

Drainage Systems

The post-closure drainage system surrounding the proposed Federal Cell Facility has been designed to direct flow from ambient precipitation away from the side slope of the disposal unit. The current drainage system routes the flows from the proposed Federal Cell Facility beginning from a high point at the northwest corner, around both sides, to the south east corner. From that point, the combined flow runs south to the westward flowing ditch that runs along the south boundary of Section 32. That south ditch currently carries stormwater from all embankments in Section 32. The revised drainage system depicted on the drawings will isolate stormwater flows from the proposed Federal Cell Facility and route them to the southwest corner of proposed Federal Cell Facility, then southward along the west edge of Section 32, where the flow will discharge at the southwest corner of Section 32.

Drainage system design for the proposed Federal Cell Facility is a minimum of 4 feet deep, as detailed in Drawings 14004-C02, 14004-C03 and 14004-C04. Rock armoring of the drainage ditches with Type A filter and rip rap (with a D_{50} of 4.5 inches as noted in the specifications illustrated on 10014-C03 and in the CQA/QC Manual). A Clive Disposal Complex drainage evaluation was performed and total ditch flow calculations have been included as Appendix D. The ditch flow calculations provided in Appendix D were devised to determine whether ditch designs associated with the proposed Federal Cell Facility were rigorous enough to withstand both the normal (25 year, 24 hour) and abnormal (100 year, 24 hour) storm conditions. Flow calculations were also performed for the drainage ditch system along the southern edge of Section 32 as water for all of the embankments will flow through these ditches before reaching the drainage system outlet.

Flow velocities for the proposed Federal Cell Facility drainage ditches were calculated based on the drawings provided in Appendix B. Upon obtaining flow velocities, storm events were calculated using isopluvial maps and calculations provided by the National Oceanic and Atmospheric Administration (NOAA, Atlas 14, Volume 1, Version 5). Drainage areas, previously calculated for other designed embankments at the Clive facility, have been included with that from the proposed Federal Cell Facility. These drainage areas, and ditch

PRELIMINARY REVIEW DRAFT

volume equations were used to ascertain whether upstream storage would cause ditch overflow given the normal (25 year, 24 hour) and abnormal (100 year, 24 hour) storm conditions.

Drainage calculations were performed first for the proposed Federal Cell Facility ditches and the Section 32 southern ditches (as a representation of total site drainage). These calculations illustrate that current ditch designs meet drainage systems design criterion for the proposed Federal Cell Facility (described in Table 3.2), and are adequate to handle site-wide flows associated with both the normal and abnormal storm events during operations.

Buffer Zone

Following completion of the construction and closure of each embankment, Energy*Solutions'* licensed area (Section 32) will be permanently fenced and posted, leaving a buffer zone between the toe of waste from each embankment and the Section 32 perimeter fence. This allows room inside of the fence for an inspection roadway and groundwater monitoring wells. With the exception of the Vitro-Energy*Solutions* property line, a buffer zone of at least 300 feet will be maintained between the closest edge of any Facility (i.e., toe of waste) and the outside site boundary or property line. This 300 foot buffer zone is a requirement of the facility's Conditional Use Permit issued by Tooele County and ensures ground water protection limits are not exceeded at offsite monitoring wells within 500 years of Facility closure (Neptune 2020).

Permanent site boundary markers are affixed to provide documentation of the exact location of the disposal facilities. The markers are United States Geological Survey (USGS) quadrant "brass cap" markers, whose design disposal facility locations have been verified by licensed surveyors. All locations have been tied into the USGS survey control stations. Upon closure, permanent markers will be placed at the head and toe of the each disposal facility.

Energy*Solutions* controls all access to property at the Clive facility, through fences, gates, and security monitoring. Drawing set 14004 (provided in Appendix B) shows the relationship between the Federal Cell Facility and the property boundaries. All areas utilized for depleted uranium material receiving, unloading, hauling, handling, and placement in the Federal Cell Facility will be considered a Restricted-Access (or Controlled) Area, (as defined in UAC R313-15-2). As such, any person entering the Controlled Area must check in and out through Access Control, or through a truck/vehicle entrance gate. Radiation exposure to persons working within the controlled area is monitored using Thermo Luminescent Dosimeters (TLD), or equivalent monitoring devices. The fence is conspicuously posted with "Caution -- Radioactive Materials" signs bearing the standard radiation symbol. Other signs are posted as appropriate. The Restricted Area boundary may change as waste placement proceeds in the Federal Cell Facility. There are not, however, any changes proposed to the requirements for control of the Restricted Areas as part of this Application.

3.1.1 Minimize Infiltration

The ability of precipitation to infiltrate into the Federal Cell Facility and contact concentrated depleted uranium is limited through use of an engineered cover that maximizes evapotranspiration of near surface water while minimizing erosional cover degradation. When the near surface of the top slope of the Federal Cell Facility is saturated (such as during intense rainfall events), precipitation is directed away from the Facility into a lined drainage system. The Facility's drainage system has been designed with sufficient capacity to accommodate runoff collection from the various Clive Disposal Complex facilities. The drainage system is lined to minimize infiltration of focused runoff flow into the groundwater. Similarly, the drainage system is

PRELIMINARY REVIEW DRAFT

lined with rock armor similar to that utilized for the Federal Cell Facility's side slopes to minimize erosion degradation of the drainage collection system during operations and after Facility closure.

Infiltration modeling projects a minute amount of infiltration through the Facility's top slope ranging from 0.0067 to 0.18 mm/yr, with an average of 0.024 mm/yr (See Appendix F). Similarly, runoff is encouraged along the Facility's final cover by maintaining positive drainage (2.4% and 20% slopes). Water accumulation within the Facility's side slopes is prevented by ensuring the maximum design velocity within the drainage layers exceeds the calculated drainage velocities.

Cover infiltration is further minimized by prevention of clay desiccation cracking of the radon barriers. Desiccation is prevented by ensuring that the infiltration limitations are attained. Additionally, the thicknesses of the cover layers constructed above the clay radon barriers insulates from freeze/thaw degradation (found to occur within three feet of the surface).

3.1.2 Ensure Cover Integrity

As is demonstrated in Appendix F, the Federal Cell Facility's final cover system is designed to minimize material losses due to sheet and rill erosion. The upper part of the Federal Cell Facility, known as the top slope, has a moderate slope (2.4%). The cover's top slope is designed similar to native conditions at the Clive. This promotes long-term stability by maximizing precipitation management via evapotranspiration.

Because differential settlement within the Facility may breach the Facility's final cover, CQA/QC Manual waste and fill compaction specifications in the Federal Cell Facility are designed to minimize differential settlement. Extensive analysis has demonstrated that settlement is minimized if maximum distortion is not allowed to exceed 0.02 (AMEC, 2000; AMEC, 2005; AMEC, 2014).

Facility cover integrity is also preserved by prevention of erosion internal to the Facility's final cover system. Material loss due to internal piping is prevented when horizontal infiltration flows along the upper radon barrier within the top and side slopes does not exceed 5.4 feet/second (NUREG/CR-4620). Additionally, piping is prevented by requiring particle size limitation within the side slopes filter layer to D_{15}(filter) / D_{85} (soil) ≤ 5 and D_{50} (filter) / D_{50} (soil) ≤ 25 (Cedergren, H.R. 'Seepage, Drainage, and Flow Nets' second edition, John Wiley & Sons, New York, pp. 178-182.). Additionally, upward migration of fines within the Facility's final cover is prevented by requiring D_{15} (lower radon barrier layer) / D_{85} (upper radon barrier layer) ≤ 4 (DOE, 1989. 'Technical Approach Document, Revision II, UMTRA-DOE/AI 050425.0002, pp. 82-83). Similarly, rock armor placed on top of the Facility's side slopes minimizes cover integrity losses due to weathering and external erosion (NUREG-1623, NUREG/CR-4620).

3.1.3 Ensure Structural Stability

The fill and waste placement specifications required in the CQA/QC Manual demonstrate that long-term structural stability is created at the other facilities of the Clive Disposal Complex. Structural stability of placed waste and fill is further confirmed by required settlement monitoring. Settlement monitoring specifications include a requirement that temporary cover be placed and monitored for at least one year prior to final cover construction, with evaluation of differential settlement. If differential settlement exceeds or is projected to exceed the established criteria, surcharging of affected areas is required.

PRELIMINARY REVIEW DRAFT

Structural stability is ensured for waste, fill and cover slopes by demonstrating that the corresponding static factor of safety meets or exceeds 1.5 and the seismic factor of safety meets of exceeds 1.2 (State of Utah Statues and Administrative Rules for Dam Safety, rule R625-11-6). These factors of safety are ensured by limiting potential primary foundation settlement to 1.25 feet, secondary foundation settlement to 2.0 feet and waste settlement after cover construction to 0.7 feet (AMEC, 2011). These limitations are reflected in the CQA/QC Manual D_{50} riprap specification of 1.25 inches for the top slop and 4.5 inches for the side slopes (Energy*Solutions*, 2011). Similarly, prevention of slope reversal by minimizing ponding and preserving long term cover drainage minimizes structural compromises due to asymmetric differential settlement. The drop in elevation from the crest of the Federal Cell Facility to the shoulder eliminates the potential for slope reversal (AMEC, 2011). Settlement is further minimized by limitation of waste and fill void spacing to 15% (CAW and LARW applications). Additionally, minimizing interstitial velocities at the radon barrier and filter zone interface to 0.12 ft/sec along the top slope and 0.055 ft/sec down the side slope (Energy*Solutions*, 2011; Energy*Solutions*, 2016; Neptune 2020).

3.1.4 Minimize Contact of Wastes with Standing Water

The lack of surface water bodies, the sparse precipitation and the high evaporation rate make it unlikely that any condition creating a permanent body of standing water will occur. Standing water at the Clive Site is managed during the operational life of the facility according to Condition I.E.7 of GWQDP UGW450005,"*Run-on and Run-off Control Requirements*" and "*Waste Water, Runoff, and Storm Water Management Requirements.*" Stored and disposed wastes are isolated from any standing water that might be located in depressions outside waste management areas via run-on berms. Flow from offsite precipitation is controlled during disposal operations by run-on berms that completely surround and isolate the disposal unit from standing water. Construction specifications for run-on berms are provided in the CQA/QC Manual. Groundwater does not need to be directed away from the proposed Federal Cell Facility, since the lowest top of liner elevation is more than 13 feet above the highest recorded elevation for the upper, unconfined aquifer.

The Federal Cell Facility's liner is constructed with a permeability of 1×10^{-4} cm/sec. As this is several orders of magnitude higher than the permeability specifications for the radon barrier layers of the Facility cover (1×10^{-6} cm/sec and 5×10^{-8} cm/sec), infiltration migrates through the cover and into the disposed waste will not pool or "bathtub" within the waste zone, but will continue downward and out of the Facility.

3.1.5 Site Drainage

Precipitation falling on active disposal areas in the Federal Cell Facility areas will be removed, when necessary (as is the required practice for all active waste management areas in the Clive Disposal Complex). Most active disposal areas are designed to be free-drained into evaporation ponds or are equipped with permanent pumps. Energy*Solutions* also uses mobile pumping trucks to access and remove other contact water from active disposal site areas. Precipitation not in contact with waste is channeled to the southwest for collection and evaporation. The site has also been designed to drain any water that may accumulate during flooding (with a site depth of 1 foot during the probable maximum flood (Bingham, 1996; Whetstone 2001; Neptune 2020).

Runoff flow is diverted away from the Facility by ensuring the depth of water in the diversion ditch does not exceed the total ditch depth. This is further controlled by ensuring diversion ditch freeboard meets or exceeds 0.5 foot under normal conditions. Under flood conditions, head-driven increased infiltration through the Facility's final cover is prevented during flood conditions by ensuring the rate of water drainage and evaporation exceeds the travel time through the final cover.

PRELIMINARY REVIEW DRAFT

3.1.6 Site Closure and Stabilization

Upon placement of waste to the approved design height and assessment of any differential settlement, final cover will be constructed over the Federal Cell Facility. The CQA/QC Manual's waste placement specifications and final cover are designed to promote long-term isolation of the concentrated depleted uranium. Run-on control berms will be left in place as complementary features that improve the site's natural stability.

3.1.7 Long-Term Maintenance

The CQA/QC Manual's construction and closure specifications have been proven to promote a facility's long-term stability. Energy*Solutions* has secured capital to fund annual post-closure inspections of the Federal Cell Facility. The long term surveillance monitoring includes is intended to ensure that the Federal Cell Facility and other required elements perform as intended and that there are no adverse impacts to the environment or the public due to degradation of these elements. Sufficient capital is secured for inspection of the embankments, fencing, roads, etc. and the performance of any maintenance on these elements. Other funds for soils, airborne dust particulate and groundwater leachate migration surrounding the Clive Disposal Complex licensed footprint for low-level radioactive waste and 11e.(2) byproduct disposal have already been secured in compliance with the Clive Disposal Complex's other licenses and permits. Additional funds will also be provided to address repair following extremely improbable catastrophic events such as cover system failure, surface contamination, waste interactions, settlement, health claims.

3.1.8 Inadvertent Intruder Barrier

Utah and NRC regulations only require an intruder barrier for the disposal of Class C LLRW. Since only Class A depleted uranium waste will be disposed of in the proposed Federal Cell Facility, no intruder barrier, as specifically defined by Utah regulations, is required. In a more general sense, however, intruder protection is required by the performance objective stated in UAC R313-25-20. The Director has previously determined that these general requirements are satisfied by the remoteness of the facility from large population centers, the cover system provided to separate the waste from the atmosphere, the presence of an uppermost rock riprap layer on the side slopes of the proposed Federal Cell Facility cover, physical access barriers erected and maintained at the closed facility, access controls maintained at the closed facility, and monuments placed denoting the locations of embankment boundaries (URS, 2012).

3.1.9 Occupational Exposure

In compliance with UAC R313-15-101, Energy*Solutions* has developed a Radiation Protection Program, which contains procedures and policies to ensure that occupational radiation exposures are controlled within the limits of UAC R313-15-201, UAC R313-15-207, UAC R313-15-208, and UAC R313-15-301. The Program also ensures that exposures are maintained as low as is reasonably achievable, in accordance with UAC R313-15-101(2). Energy*Solutions* integrates the principles of ALARA into all activities related to exposures of personnel.

Energy*Solutions* has created an organizational structure and established personnel responsibilities and activities to ensure that ALARA policy and procedures are not compromised because of pressures from

PRELIMINARY REVIEW DRAFT

operational activities. In support of this position, ALARA principles are incorporated into facility operations, training, development of radiation protection procedures, and design reviews.

Energy*Solutions'* Radiation Protection Program has demonstrated that reasonable actions are taken to reduce radiation exposures and effluent concentrations to levels that are considered ALARA. Energy*Solutions'* ALARA management policy is detailed in the ALARA Program. The ALARA Program is based upon past and continuing experience with radiation operations. As new waste-handling procedures are developed, the ALARA Program is modified to reflect the changes. Specific guidelines for operational reviews and modifications to the ALARA Program are therein detailed.

The Facility's cover is designed so that the inadvertent presence of a high-gamma source at the top of waste will not result in an exposure above 3mrm/year.

3.1.10 Site Monitoring

The Environmental Monitoring Plan prepared in compliance of Condition 26 of Radioactive Material Licenses UT2300249 and Condition 9.22 of UT2300478 will provide the necessary site monitoring during operation of the proposed Federal Cell Facility. Energy*Solutions* uses the Environmental Monitoring Plan to provide an early warning of a release before it reaches the site boundary; evaluate the need for mitigative measures; evaluate health and environmental effects; estimate dose as required by UAC R313-15-301(1)(a), UAC R313-15-101(4), and UAC R313-25-19; and assist in emergency response planning if accidental releases are to occur. Results of environmental monitoring activities at the Clive Disposal Complex are reported semiannually. Radioactive airborne particulate samples are collected with low volume air samplers at perimeter locations of the Clive Disposal Complex and at background locations. Radon concentrations in outdoor air are similarly collected. Direct gamma exposure rates using TLDs are measured at the Clive perimeter. Surface soil samples are also collected along the Clive perimeter. These measurements provide data that is used to assess the potential net radiological impact of the licensed activities on the surrounding area, and form the basis for demonstrating compliance with the applicable regulations and license conditions. Data are compiled into a report and submitted semi-annually to the Director. The Environmental Monitoring Plan is designed to detect and quantify the net radiological effects in areas accessible to members of the general public that occur as a result of the licensed activities. The data is also used to proactively adjust work practices and site operations as necessary to sustain continued compliance.

An intensive program of ground water monitoring is similarly followed in accordance with Energy*Solutions'* Ground Water Quality Discharge Permit. On the basis of the results of this program, the Division of Water Quality established well-specific ground water protection levels (GWPL) for all parameters of interest. Energy*Solutions* will

3.1.11 Buffer Zone

Energy*Solutions'* licensed area is fenced and posted, leaving a minimum of a 300 foot buffer between the waste from each embankment and the Section 32 perimeter fence (e.g., the nearest point a member of the general public can come into contact with transported waste materials). This 300 foot buffer zone is a requirement of the facility's Conditional Use Permit issued by Tooele County. During operations, Energy*Solutions* controls all access to property at the Clive facility, through fences, gates, and security monitoring. Areas utilized for depleted uranium material receiving, unloading, hauling, handling, and placement in the Federal Cell Facility are considered a Restricted-Access (or Controlled) Area, (as defined in

PRELIMINARY REVIEW DRAFT

UAC R313-15-2). Persons entering the Controlled Area must check in and out through Access Control, or through a truck/vehicle entrance gate. The fence is conspicuously posted with "Caution -- Radioactive Materials" signs bearing the standard radiation symbol. Other signs are posted as appropriate.

Following closure, the buffer zone will be further established through the installation of permanent site boundary markers. The markers are United States Geological Survey (USGS) quadrant "brass cap" markers, whose design disposal facility locations have been verified by licensed surveyors. All locations have been tied into the USGS survey control stations. Upon closure, permanent markers will be placed at the head and toe of the each disposal facility.

3.2 CONSIDERATIONS FOR NORMAL AND ABNORMAL/ACCIDENT CONDITIONS

In this Application, each of the aspects of the Federal Cell Facility principal design features has been analyzed for normal conditions, abnormal conditions, and potential accident conditions. The review demonstrates that each aspect of the facility remains stable through these conditions.

In NUREG-1199 (section 6.3.2), NRC contemplates evaluation of design against a factor of safety only in the area of slope stability analysis. In the context of retention systems at uranium recovery facilities, Regulatory Guide 3.11 (Revision 3, November 2008) further elaborates on the factors of safety considered in slope stability analysis. Importantly, Regulatory Guide 3.11 defines allowable minimum factors of safety for earthquake and liquefaction analyses as being 1.0. As with previous licensing actions that consider disposal facility performance against various design criteria, a minimum factor of safety of 1.0 is applied to the Federal Cell Facility.

Although factors of safety are not required by NRC to be developed for each aspect of the design, a factor of safety is calculated for each design criteria where supporting analyses provides a value for comparison. This approach is consistent with Energy*Solutions'* other major licensing actions. Thus, only the slope stability analysis has a regulatory basis for the minimum factor of safety evaluation; other factors of safety provide information about relative robustness of the design. In each case, cited references should be consulted in order to understand and evaluate the basis for the reported safety factor.

3.2.1 Minimize Infiltration

Water infiltration is evaluated through infiltration and transport modeling in support of the performance assessment (Appendix F). The groundwater model estimates infiltration flux into the concentrated depleted uranium zone ranged from 0.0067 to 0.18 mm/yr, with an average of 0.024 mm/yr, and a log mean of 0.018 mm/yr through the proposed Federal Cell Facility top slope cover. Since concentrated depleted uranium will only be placed below the top slope, only erosion protection has been estimated for precipitation falling on the rock armor side slope. These infiltration rates are affected by the slope lengths, low precipitation, and cover system lateral drainage layers.

The ability of the liner to minimize contact of depleted uranium waste with standing water during operations is projected for various storm events (a normal condition = 25 year 24 hour storm, an abnormal condition = 100 year 24 hour storm and an accident condition of heavy equipment damage to a depleted uranium cylinder). Various degrees of liner degradation over time are also evaluated (a normal condition = liner and cover retain

PRELIMINARY REVIEW DRAFT

as-built permeability over time, an abnormal condition = cover degrades). NUREG-1199 does not require the assessment of the impact on infiltration related to an accident condition with the liner.

The ability of the cover to minimize infiltration is projected for various events (a normal condition = average annual precipitation of 7.92 inches and an abnormal condition = abnormal desiccation, limited runoff, limited frost protection and excessive biointrusion). NUREG-1199 does not require the assessment of the impact on infiltration related to an accident condition with the cover. Similarly, the ability of the cover to encourage runoff is projected for various events (a normal condition = 100 year 24 hour storm, an abnormal condition = PMP of 1 hour = 6.1 inches and an abnormal downstream blockage). The ability of the cover to prevent desiccation in the cover clays is projected for various events (a normal condition = typical weather patterns and an abnormal condition = drought). NUREG-1199 does not require the assessment of the impact on clay desiccation related to an accident condition with the cover. The ability of the cover to limit frost penetration in the cover clays is projected for various events (a normal condition = typical weather patterns and an abnormal condition = monthly average temperatures below those predicted with a 500 year return frequency). NUREG-1199 does not require the assessment of the impact on clay desiccation related to an accident condition with frost penetration. Finally, the ability of the cover to limit biointrusion in the cover clays is projected for various events (a normal condition = shallow rooted desert plant growth and an abnormal condition = deep rooted desert plant growth). NUREG-1199 does not require the assessment of the impact on clays related to an accident condition with biointrusion.

3.2.2 Ensure Cover Integrity

Design criteria for settlement and subsidence of the proposed Federal Cell Facility are described in the CQA/QC Manual. Projected performance of the cover system against these design criteria is discussed in Appendix F. Additionally, rock cover design calculations have been completed for the specific geometry of the proposed Federal Cell Facility. These calculations are provided in Appendix E.

The ability of the liner to minimize differential settlement of the cover is projected for various conditions (a normal condition = settlement completed prior to closure, an abnormal condition = one area to cover height with adjacent area less than 25 feet high). NUREG-1199 does not require the assessment of the impact on differential settlement of the cover related to an accident condition with the liner. Similarly, the ability of the waste placement to minimize differential settlement of the cover is projected for various conditions (a normal condition = all primary and majority of secondary settlement in soil layers are completed prior to closure, an abnormal condition = creep of compressible soils and additional secondary settlement of soils following closure). NUREG-1199 does not require the assessment of the impact on differential settlement of the cover related to an accident condition with waste and fill placement.

The ability of the cover to minimize differential settlement is projected for various conditions (a normal condition = all primary and portion of secondary settlement in waste and fill complete and an abnormal condition = container deterioration after 100 years, allowing creep of compressible waste and additional secondary settlement of soils and an earthquake). NUREG-1199 does not require the assessment of the impact on differential settlement of the cover related to an accident conditions.

Similarly, the ability of the cover to prevent internal piping and erosion is projected for various conditions (a normal condition = 100 year 24 hour storm and an abnormal condition = PMP of 1 hour). NUREG-1199 does not require the assessment of the impact on internal erosion related to an accident condition with the cover. Additionally, the ability of the cover to prevent internal piping and erosion is also projected for other various

PRELIMINARY REVIEW DRAFT

conditions (a normal condition = saturated conditions within dams and an abnormal condition = DOE ratios for abnormal saturated conditions within an UMTRA embankment).

Finally, the ability of the cover to endure weathering and external erosion is projected for various conditions (a normal condition = historic weather patterns and an abnormal condition = PMP of 1 hour). NUREG-1199 does not require the assessment of the impact on enduring weather without erosion related to an accident condition with the cover.

3.2.3 Ensure Structural Stability

Design criteria for ensuring structural stability are provided in Evaluations of in the CQA/AC Manual. The ability of the waste and fill to maintain slope stability is projected for various events (a normal condition = static conditions and an abnormal condition = probable maximum earthquake). NUREG-1199 does not require the assessment of the impact on stability related to an accident condition with waste and fill placement.

Similarly, the ability of the cover to maintain slope stability is projected for various events (a normal condition = evenly distributed weight loading and an abnormal condition = creep of compressible waste and additional settlement of soils after closure). Finally, the ability of the cover to maintain slope stability is projected for additional events (a normal condition = static conditions and an abnormal condition = earthquake). NUREG-1199 does not require the assessment of the impact on stability related to an accident condition with the cover.

3.2.4 Minimize Contact of Wastes with Standing Water

Projected performance against the design criteria for preventing contact of waste with standing water are provided in CQA/QC Manual. The ability of the waste and fill to maintain slope stability is projected for various events (a normal condition = static conditions and an abnormal condition = probable maximum earthquake). NUREG-1199 does not require the assessment of the impact on stability related to an accident condition with waste and fill placement.

3.2.5 Site Drainage

In contrast to the proposed Federal Cell Facility, which is designed for a 10,000-year lifetime, the drainage ditch system is evaluated based on a normal condition of the 25-year, 24-hour storm event and the abnormal condition of the 100-year, 24-hour storm. These storm events are described in the Drainage Ditch Calculations provided in Appendix D. The required function of facilitating flow away from the proposed Federal Cell Facility is met by minimizing standing water surrounding the embankments; therefore, the design criteria is to ensure water from these events is maintained within the drainage ditch system. The calculations within Appendix D demonstrate that the ditch systems are adequately designed to contain all water from the drainage area during both the normal and abnormal storm events.

The required function of ensuring ditch integrity is accomplished through an examination of the stresses upon the rock lining the ditch. Based upon the stresses exhibited by the flow during the normal and abnormal storm events, the size of rock required to manage that flow can be calculated. These calculated rock sizes and associated safety factors are provided in the drainage ditch calculations of Appendix D. The calculations within Appendix F demonstrate that infiltration is maintained under flood conditions.

PRELIMINARY REVIEW DRAFT

The ability of the drainage system to facilitate flow away from the Facility is projected for various events (a normal condition = 25 year – 24 hour storm, an abnormal condition = 100 year – 24 hour storm and an accident condition = downstream blockage). Similarly, the ability of the drainage system to minimize infiltration under flood conditions is projected for various events (a normal condition = 100 year flood, an abnormal condition = PMF and an accident condition = downstream blockage).

3.2.6 Site Closure and Stabilization

The ability of the drainage system to ensure preservation of ditch integrity is projected for various events (a normal condition = 25 year – 24 hour storm and an abnormal condition = 100 year – 24 hour storm). NUREG-1199 does not require the assessment of the impact on ditch integrity related to an accident condition with drainage system.

3.2.7 Occupational Exposure

The ability of the cover to limit surface dose rates is projected for various events (a normal condition = low to moderate gamma emitting wastes and an abnormal condition = high gamma emitters at top of waste. NUREG-1199 does not require the assessment of the impact on occupational exposures related to an accident condition with the cover.

3.2.8 Buffer Zone

The ability of the buffer zone to continue to provide for Facility monitoring is projected for various events (a normal condition = no releases and an abnormal condition = contaminant releases). NUREG-1199 does not require the assessment of the impact on site monitoring related to an accident condition with the buffer zone.

3.3 CONSTRUCTION CONSIDERATIONS

Energy*Solutions* has designed the facility to meet or exceed the performance standards established by regulatory authority. Engineering evaluations performed on the design confirm that it meets or exceeds the design criteria. Engineering evaluations have been performed for the normal, abnormal, and accident (as appropriate) conditions.

3.3.1 Construction Methods and Features

Construction methods for the proposed Federal Cell Facility will be unchanged from current approved practices as provided in the CQA/QC Manual.

<u>Site Preparation</u>
Site preparation requirements for the proposed Federal Cell Facility are provided in the CQA/QC Manual. Because these specifications are identical to those of the Class A West embankment, no technical revision to the CQA/QC Manual is needed. The existing surface of the proposed Federal Cell Facility includes areas excavated to near-foundation elevation and areas that have been disturbed but remain at or near the original native elevation.

PRELIMINARY REVIEW DRAFT

Control and Diversion of Water

Surface water is controlled by a system of run-on and run-off berms. A comprehensive discussion of berm systems for the proposed Federal Cell Facility is provided in Appendix B and CQA/QC Manual. This discussion is applicable to the proposed Federal Cell Facility because berm requirements will be identical for the Class A West embankment. The highest groundwater elevation is more than 13 feet below the top of liner elevation; therefore, groundwater control will not be necessary.

Construction of Disposal Units

The proposed Federal Cell Facility will be constructed to the existing liner, waste placement, and cover requirements of the CQA/QC Manual. See also engineering drawing series 14004.

Concrete and Steel Construction

One aspect of disposal at the proposed Federal Cell Facility will incorporate concrete as a component of disposal facility construction: Controlled Low-Strength Material (CLSM) used to fill voids in waste placement. CLSM use will be controlled in accordance with existing requirements applicable to disposal in the proposed Federal Cell Facility. CLSM requirements are located in Specification 84 through 93 of the CQA/QC Manual. CLSM is a low-strength void filling material; no reinforcing steel is used. There are no proposed differences between CLSM usage in the proposed Federal Cell Facility to CLSM usage in the Class A West.

Backfilling

Waste placement in the proposed Federal Cell Facility will be controlled in accordance with Specifications 56 through 100 of the CQA/QC Manual. No changes to existing approved waste placement methods are requested.

Closure of Disposal Unit

The cover over the proposed Federal Cell Facility will be constructed in accordance with applicable specifications of the CQA/QC Manual. See also drawing series 14004. Timing for different areas of cover construction is ultimately controlled by the open cell time limit provided at Part I.E.6 of GWQDP UGW450005.

Accordingly, cover construction will proceed in stages. Considerations that will affect the timing and areas to be covered in a particular construction project include:

1. Open cell time limit: If an area of waste placement is reaching its deadline, it will be a compliance requirement to complete cover construction.
2. Maintaining continuous progression of cover: Cover should progress in a contiguous manner. In other words, “islands” of cover surrounded by active waste placement; or conversely “islands” of waste placement surrounded by cover should be avoided.
3. Scale of construction projects: A number of factors affect the area of cover that can be physically completed within a construction season. These include the weather, size and experience of the construction crew, and when in the construction season the project begins.
4. Time required to complete waste placement to the design elevations, slopes, and grades: Cover construction cannot begin before placement of the waste column is complete for a lift area, with adjacent lift areas also at or near top of waste.

PRELIMINARY REVIEW DRAFT

Accordingly, it is not feasible at this time to provide a more detailed schedule for cover construction over the proposed Federal Cell Facility; nor is there a regulatory basis to require one. The staged approach to liner and cover construction has been standard practice at the Clive Disposal Complex since its inception, and dozens of liner and cover construction projects have been successfully completed. The CQA/QC Manual provides controls for ensuring sections of liner and radon barrier constructed at different times will perform seamlessly.

Applicable Codes, Standards and Specifications
Applicable codes and standards are discussed concurrent with establishment of design criteria for each of the principal design features, as referenced above. In addition, ASTM standards applicable to construction of the proposed Federal Cell Facility are listed in the CQA/QC Manual and referenced in individual specifications as appropriate.

Construction Materials and Quality Assurance
Construction materials for the proposed Federal Cell Facility will consist of native soils and rock. Specifications for each component are provided as discussed above. Quality assurance and quality control measures required for construction are provided in the CQA/QC Manual. All construction materials and procedures for the proposed Federal Cell Facility will be identical to those currently approved for the Class A West embankment.

Site Plans, Engineering Drawings and Construction Specifications
Engineering drawing series 14004 details the proposed Federal Cell Facility and are provided as Appendix B to this Application. In accordance with Condition I.H.6 of GWQDP UGW450005, Energy*Solutions* is required to provide an annual as-built report and drawing set documenting embankment construction.

3.3.2 Construction Equipment

Construction equipment will consist of standard heavy construction and earth-moving equipment. Equipment used to construct the proposed Federal Cell Facility will be equal to that used in construction of the Class A West embankment.

3.4 DESIGN OF AUXILIARY SYSTEMS AND FACILITIES

Auxiliary facilities include buildings and roadways that are designed to support the operational needs of the multiple Clive Facilities by directly contributing to worker safety, support the construction requirements, and not adversely affect completed closure measures.

3.4.1 Utility Systems

Due to remoteness, municipal utilities at Energy*Solutions*' Clive facility are limited. Fuel and potable water (culinary water) must be brought in from off-site locations and stored on-site for usage. Toilet facilities are available at office buildings, outside of the Restricted Area. No toilet facilities are available inside the Restricted Area. Decontamination showers are provided in the Mixed Waste Operations Building, and the LLRW Operations Building. Safety showers are available as detailed in the Contingency Plan, Attachment II-6 of the state-issued Part B Permit.

PRELIMINARY REVIEW DRAFT

For personnel working with radioactive materials in the Restricted Area, communication with other workers is available through two-way radio or cellular phone communication. Radio and cellular range is adequate to reach all areas of the site at any time. During emergencies on site, personnel contact security via radio or cell phone; then security issues a general alert to affected personnel.

The site is served with electricity by Rocky Mountain Power. This service includes three phase 440 volt supply. This service is transformed down to 120 volt single phase service for supply to the administrative building and for general site conventional electric service

3.4.2 Auxiliary Facilities

All auxiliary facilities on the site will be removed at decommissioning; accordingly, there will be no adverse impact on Federal Cell Facility performance due to failure of any of these facilities.

Decontamination Facilities

Energy*Solutions* has developed an extensive set of decontamination facilities in support of waste disposal operations. These facilities address decontamination activities necessary for equipment and tools used in shipping, receiving, managing, and disposal of LLRW. Decontamination procedures have also been developed to address release of the various shipping containers from the Restricted Area.

At the time of closure, a detailed Decommissioning Plan for the proposed Federal Cell Facility will be prepared for Director approval, consistent with applicable regulations and requirements. Additional support facilities are not expected to be required beyond that specified in this Application. It is also assumed that these support facilities will be decontaminated and decommissioned upon closure. The decontamination and decommissioning activities include:

a. Decontaminating off-site soils and rail road spur, if necessary, by removing all surface materials contaminated with LLRW materials such that the contamination in the residual soil or rail road ballast is ALARA and below the respective cleanup limits. Soil will be disposed of at the Federal Cell Facility using disposal methods approved in the CQA/QC Manual.
b. Decontaminating on-site soils within Energy*Solutions*' property but excluding the disposal Federal Cell Facility, by removing all surface soils contaminated with LLRW such that the contamination in the residual soils is ALARA and below the respective cleanup limits. Soils will be disposed of at the Federal Cell Facility using disposal methods approved in the CQA/QC Manual.
c. Decontaminating on-site structures such as the rollover facility, geotechnical laboratory, and rail spur to meet the unconditional release criteria or, remove and place structures the Federal Cell Facility.
d. Decontaminating the on-site support structures and contents including the change and laboratory facilities within the administration building to meet the unrestricted release criteria, or remove and dispose of contents and structures in the Federal Cell Facility.

Clive waste handling facilities are used for both LLRW and 11e.(2) waste management activities. Since Federal Cell Facility radionuclides represent a subset of the potential contaminants in LLRW, it is appropriate to place decommissioning waste from these facilities into the Class A West Disposal Facility.

PRELIMINARY REVIEW DRAFT

Waste Handling Facilities

Energy*Solutions*' waste handling procedures and associated facilities ensure that 11e.(2) or mixed wastes are not co-mingled with LLRW. These facilities and procedures outline the necessary precautions required to ensure that vehicle, facility and equipment cleaning occurs prior to hauling or handling LLRW material. They also address signage requirements for vehicles, facilities and equipment handling LLRW. Procedures have also been created to require unique site-specific shipment tracking numbers (Bates Numbers) be assigned used for tracking purposes, and finally accepted for disposal.

Containers approved for storage in accordance with Condition I.E.10 of Energy*Solutions*' GWQDP are visually inspected to ensure that the containers have structural integrity. Drums and barrels of material are placed on pallets and stacked a maximum of two (2) high. Storage areas are inspected daily in accordance with the GWQDP. Containers which are found to be deteriorating are re-containerized or over-packed, i.e., placed inside another, larger container of assured structural integrity.

Waste Water Facilities

During operation, Energy*Solutions*' Clive Disposal Complex is managed to prevent precipitation from flowing into the proposed Federal Cell Facility. This is accomplished by construction of a run-on berm around the perimeter of the disposal Federal Cell Facility. Therefore, there are no design features to promote deposition during operations since there is no runoff which flows into the impoundment area. Energy*Solutions*' proposed Federal Cell Facility is designed to maintain sheet flow for all precipitation that falls on it. By maintaining sheet flow, the turbulence and velocity of the water are minimized; thus improving the deposition of sediment and minimizing the erosion of the cover.

The post-closure drainage system surrounding the proposed Federal Cell Facility has been designed to direct water from precipitation or sheet flow away from the disposal unit. Drainage systems designed for the Federal Cell Facility are included in Appendix B. Potentially-contaminated standing water at proposed Federal Cell Facility will be managed during the operational life of the facility according to Condition I.E.7 of the GWQDP. Federal Cell Facility areas are managed to remove any intermediate standing water when necessary.

Energy*Solutions* will use mobile pumping trucks and other equipment as needed to access and remove water from the proposed Federal Cell Facility, which are not designed to free-drain into an evaporation pond or equipped with permanent pumps. Runoff from other areas of the Clive Disposal Complex are channeled to the southwest. Short-term bodies of standing water on the surface in other areas of the property will not affect the performance of the proposed Federal Cell Facility. This water dissipates primarily through evaporation due to the climatic features of the site rather than percolation; and thus will have no impact on groundwater horizontal gradients.

3.4.3 Fire Protection System

Due to the remoteness of the Clive Disposal Complex, the availability of municipal fire protection is limited. The nearest services of this type are in the Tooele-Grantsville area, approximately 35-50 miles away. Fires in offices or other building areas are controlled using portable fire extinguishers and/or water as available. If necessary for control, water may be obtained from nearby wells and/or the non-contact runoff containment pond located to the southwest of the site. Water trucks used for dust suppression on site roads

PRELIMINARY REVIEW DRAFT

would also be available in an emergency to provide water for fire control. There is at least one water truck on site during operations.

Fire in the proposed Federal Cell Facility could be initiated by construction equipment. Flammable waste forms (such as dry active wastes), as well as the presence of flammable fuels, represent potential fire hazards. In the event of a fire, measures taken to respond to and protect against the emergency situation will be conducted in accordance with established procedures. All employees at the proposed Federal Cell Facility are trained upon initial employment and in annual refresher training to implement this program in the case of an emergency.

3.4.4 Erosion and Flood Control Systems

During operations, the Federal Cell Facility is protected against offsite flood waters by run-on berms. Construction requirements for run-on berms are provided in the CQA/QC Manual. Run-on berms surround the perimeter of the Federal Cell Facility at all times. Once a section of the Facility cover is completed to the design toe of waste, runoff berms for that section will be replaced by drainage ditches.

Runon berms surround the perimeter of the Facility at all times. They are constructed of native soils to a minimum height of three feet above the original ground surface of the site (as determined by original engineering drawings showing site contours) and have a minimum width of 10 feet at the top. The berms are compacted to 90 percent of a standard proctor to ensure their integrity and often serve as inspection/travel roads. Run-on berms are inspected regularly during operation of the facility for degradation or low spots caused by erosion or frequent traffic. In addition, run-on berms are surveyed and improved annually to verify compliance with height requirements.

Runoff berms are constructed immediately following approval of clay liner construction for a zone to be opened for depleted uranium placement. Runoff berms are constructed of native soils directly on the clay liner to a height of three feet above the liner. Runoff berms have a minimum width of three feet at the top and are compacted to 90 percent of a standard proctor. As with the runon berms, runoff berms are inspected regularly for low spots or degradation. All runoff berms are also surveyed and improved annually.

Once the runoff berms are constructed, depleted uranium material may be placed over the clay liner. However, a minimum separation of 10 feet is maintained between the toe of the runoff berm and the toe of waste. This 10-foot separation allows for collection of runoff water from the active Facility and minimizes potential contact of depleted uranium with standing water.

3.5 DRAWINGS

Drawings cited in this Application have been included as Appendix B to this Application. Table 3-1, "Pertinent Characteristics of the Principal Design Features" summarizes construction specifications for each principal design feature.

PRELIMINARY REVIEW DRAFT

PRELIMINARY REVIEW DRAFT

SECTION 4. FACILITY OPERATIONS

Energy*Solutions'* waste receipt and inspection procedures and waste acceptance criteria are documented in the Waste Characterization Plan referenced in Condition 58 of Radioactive Material License UT2300249. Using this Plan, Energy*Solutions* ensures that arriving shipments are in compliance with applicable requirements and waste acceptance criteria. This Plan provides assurance that the waste receipt and inspection processes are conducted in accordance with UAC R313-25-35 and in a manner that assists in meeting the performance objectives of UAC R313-25-20 through UAC R313-25-23. Additionally, Energy*Solutions* verifies that the classification and characteristics of waste entering the site are in accordance with UAC R313-15-1009. Of primary focus in these procedures is Energy*Solutions'* ability and objective to protect individuals during operations (in accordance with UAC R313-25-22). In addition to ensuring conformance with applicable regulations, Energy*Solutions* demonstrates ability and commitment to identify and respond to waste packages requiring remediation. As such, waste not in compliance with regulations and License conditions are prohibited from entering the Clive Disposal Complex.

4.1 RECEIPT AND INSPECTION OF WASTE

Prior to shipment, Energy*Solutions* will obtain from the generator a description of the material in each waste stream to be managed at the proposed Federal Cell Facility. The description made by the generator will include a statement declaring that the generator has determined that the material is within the parameters of the License, that it is LLRW, and that the material is not a hazardous waste as defined by UAC R315-1. The generator's description will also include all of the nuclides, and their general range of activities, that are present in the waste, with supporting laboratory documentation. These descriptions and information will further include documents and certifications provided by the generator or the generator's agents. Each shipment will be properly characterized in order to manifest the shipment as required by UAC R313-15-1006.

During the acceptance procedures for a waste shipment, Energy*Solutions* will obtain samples of the waste in accordance with approved sampling procedures. These samples will be analyzed to confirm that the waste is within the parameters of the License. Energy*Solutions* generally receives laboratory results within 90 days of the applicable shipment's arrival (unless additional time is approved by the Director). If results from the laboratory show that the waste is beyond the limits of the License, and if the waste has been placed and disposed of in the Federal Cell Facility, Energy*Solutions* will notify the Director and respond in accordance with the Waste Characterization Plan, following the procedure below.

1. Within 24 hours of discovering nonconforming material had been disposed; Energy*Solutions* must notify the Director of the situation.

2. Within seven (7) calendar days of the notice, Energy*Solutions* must provide the Director with a written description of the situation. The following information must be included in the written description:
   a. Name of generator;
   b. Name of nonconforming waste stream;
   c. Amount of nonconforming disposed waste;
   d. Location of nonconforming waste in the disposal cell;
   e. Date nonconforming waste was accepted;

PRELIMINARY REVIEW DRAFT

f. Date nonconforming waste was placed in disposal cell; and,
g. Description of waste placed on and around non-conforming waste.

3. Provide a written plan and compliance schedule to the Director for managing the non-conforming material.

4. Obtain approval from the Director for the plan to manage the non-compliant waste. This approval may require Energy*Solutions* to modify the initial plan.

5. Carry out the approved management plan.

The minimum frequencies for waste sampling and analysis are provided in the Waste Characterization Plan.

Representative samples of the waste material must be taken. Approved analytical laboratories must:

1. Hold a National Environmental Laboratory Accreditation Conference (NELAC) accreditation; or

2. Hold a current certification from the generator's state; or

3. Meet the requirements of the generator's state for chemical or radiological laboratories; or

4. Hold a current certification for the applicable chemical or radiological analytes from the Utah Bureau of Laboratory Improvement, insofar as such official certifications are given; or

5. Be a laboratory approved by the Director.

For each bulk waste stream, the minimum number of samples to be analyzed is referenced in Subsection (a) of 40 CFR 61.81, Tests at land disposal facilities, requires that sampling is to be "appropriate or necessary for the administration of the regulations in the part".

1. One sample for each of the first ten (10) shipments (rail or highway); or,

2. One sample for each of the first 100 cubic yards (yd^3) up to 1,000 yd^3; thereafter,

3. One sample for each additional 500 yd^3 following the first ten (10) shipments or following the first 1,000 yd^3.

For ease in counting, one rail car (any type) may represent a nominal 100 cubic yards and one highway shipment (any type) may represent a nominal 20 cubic yards. The laboratory performs gamma spectrometry on all samples to identify and quantify the gamma emitting radionuclides present. Sample collection and analysis will be performed in accordance with established procedures.

When a shipment arrives at the Clive Disposal Complex, it is not considered to be accepted to the proposed Federal Cell Facility until the acceptance procedures have been completed and the material has been accepted for disposal. A transportation vehicle may be physically located on the Clive site property and may still not be considered "accepted" for disposal at the proposed Federal Cell Facility. Energy*Solutions* does not direct

PRELIMINARY REVIEW DRAFT

that containers of non-accepted materials be unloaded or that railcars of non-accepted material be dumped or unloaded. Incoming waste shipments are accepted for disposal in accordance with established procedures.

A completed Uniform Low-Level Radioactive Waste Manifest (Manifest), or equivalent documentation must be received by Energy*Solutions* before a shipment is accepted for disposal. The manifest may either accompany the shipment or may be received by Energy*Solutions* prior to the time that the shipment arrives. The manifest serves several functions. These functions include the following:

a. Complies with the requirements of a manifest as outlined in UAC R313-15-1006.

b. Describes container types, volumes, number.

c. Provides weights, activities, isotopes of material.

d. Documents generator's certification of packaging, classification, markings, labels, condition of containers, and compliance with the applicable regulations and conditions of the License.

e. Documents generator's certification as to RCRA or non-RCRA status of material.

f. Documents generator's certification that the waste is LLRW.

g. Documents generator's warranty that the information provided in the manifest is true and correct.

h. Provides a checklist for Energy*Solutions* for inspection of the incoming material and for possible violations.

i. Documents Energy*Solutions*' acceptance or rejection of the shipment for disposal.

j. Alert receiving staff to probable concentrations and gamma exposure rates to be expected.

The manifest is reviewed for completeness. The reviewer also ensures that the form is signed.

The freight container will be externally surveyed for gamma radiation readings with a micro-R meter or equivalent, to assure compliance with DOT regulations. Other portable instruments are appropriate to measure the external surface contamination. Container surveys will be performed in accordance with established procedures. Each incoming freight container will be smear tested for removable contamination for comparison to the standards of 49 CFR 173.443, in accordance with established procedures.

In accordance with UAC R313-15-906, Energy*Solutions* will immediately notify the final delivery carrier and the Director when:

1. Removable radioactive surface contamination exceeds the limits of R313-15-906; or

2. External radiation levels exceed the limits of UAC R313-25-26.

PRELIMINARY REVIEW DRAFT

Upon arrival at the proposed Federal Cell Facility, each incoming shipment will be visually inspected for the following items in compliance with the shipment inspection requirements of UAC R313-25-34(5) and established procedures:

1. To ensure accuracy of information to be submitted on the radioactive waste manifest (the container/car ID numbers, number of cars or containers) and to ensure that the material is packaged, marked, labeled, and placarded according to DOT regulations in 49 CFR. Should Energy*Solutions* discover any discrepancies in the documentation, certification, or shipment, the discrepancies must be resolved with the generator or shipper prior to acceptance of the material. Energy*Solutions* will not unload/dispose of a shipment until such discrepancies have been settled, either through a generator visit to the disposal site or through written documentation that reflects the necessary changes in the manifest.

2. To verify whether there is any evidence of physical damage to the container that might jeopardize its integrity. This will be accomplished by visually examining the containers for any appearance of packaging breach or any such potential problem.

If there are any problems with the integrity of an incoming shipment, the problems will be reported to the shipper within 24 hours of discovery. Energy*Solutions* will also provide notification to the Director within 24 hours of discovery. If a shipment arrives on site that is unacceptable under the conditions of the license, Energy*Solutions* will notify the generator and the Director within seven days. When a shipment arrives, Energy*Solutions* will take samples for laboratory analysis.

As a result of these steps, Energy*Solutions* will either accept or reject a shipment for disposal. If a shipment meets all acceptance criteria except for possible noncompliance with license conditions, it will be placed into an approved storage area until additional testing can determine its status. In accordance with established procedures, waste will not accepted from a Generator when one or more of the following conditions apply:

- The shipping and disposal documents do not agree with the waste profile record;
- The waste is exceeds License limits;
- The shipment contains PCBs and has liquid not approved by the Radiation Safety Officer;
- Generator sends a shipment to the Clive facility prior to receiving a notice to transport from Energy*Solutions*.

If the shipment is rejected for disposal at the proposed Federal Cell Facility, Energy*Solutions* will document the rejection in accordance with established procedures and notify the Director. If the shipment is accepted, the material will be placed in an approved management area or in the Federal Cell Facility.

Shipments that are not found acceptable or approvable will be returned to the Generator or to another licensed radioactive waste management facility in accordance with established procedures. A shipment which has been found to be in violation of DOT shipping regulations, but which is otherwise acceptable, will not be accepted for disposal until:

PRELIMINARY REVIEW DRAFT

1. The Director has been notified of the shipment discrepancy; and

2. The generator or generator's agent has made necessary corrections to bring the shipment into compliance with DOT regulations, if possible.

Pending such corrective action, the shipment will remain on Energy*Solutions* property in order to eliminate the potential risk associated with transporting the waste, but is not disposed. If such a shipment is in violation of DOT regulations due to leakage of radioactive materials, it will be placed over an approved surface in the Restricted Area until the situation is resolved in order to prevent contamination of the environment.

4.2 WASTE HANDLING AND INTERIM STORAGE

Waste handling and interim storage will be managed in accordance with existing controls and at existing facilities, according to the waste type being managed. Upon acceptance to the proposed Federal Cell Facility, each shipment will be transferred to an appropriate unloading area. To prevent inadvertent cross-contamination of waste types, all waste containers received will be labeled as to waste type, generator, receipt date, and disposal cell. Bulk wastes will be taken to the Federal Cell Facility for disposal or to the Intermodal Unloading Facility. Containers of depleted uranium wastes will be taken to the Federal Cell Facility, placed in storage or emptied into the Intermodal Unloading Facility. Gondola railcars are unloaded at the Rotary Dump Facility. Waste will be then placed into haul trucks and taken to the Federal Cell Facility for disposal.

Depleted uranium waste will be unloaded and managed in accordance with established procedures. All waste management facilities are visually inspected on a daily basis in accordance with the BAT Performance Monitoring Plan, Appendix J of GWQDP UGW450005, to ensure proper storage and management of the waste. Storm water is managed in accordance with Condition I.E.12 of the GWQDP.

All wastes received at the proposed Federal Cell Facility will be entered into and tracked with an electronic waste tracking system (the System). The System tracks waste type, volume, activity, and placement location within the disposal Federal Cell Facility. The System also contains waste profile information and provides automated compliance checks of the waste shipment against license limits, sampling frequency, etc.

4.3 WASTE DISPOSAL OPERATIONS

Depleted uranium will be disposed at Energy*Solutions*' Federal Cell Facility in accordance with established procedures and the CQA/QA Manual. Waste placement will be controlled in accordance with the CQA/QC Manual.

4.3.1 Waste Emplacement

Waste placement will be controlled according to the type of waste as defined by the CQA/QC Manual. Debris is defined as any radioactive waste for disposal other than compactable soils. Compactable soil is defined as:

a. Having a graded material that passes through a four-inch grizzly; or

PRELIMINARY REVIEW DRAFT

b. As having a density greater than seventy pounds per cubic foot dry weight in accordance with ASTM D-698; and

c. Having soil-like properties (i.e., standard tests in accordance with waste placement procedures can be performed).

Drums and metal containers that are to be disposed in the Federal Cell Facility will be emptied before being crushed and placed in the lift to minimize the void space. After the drums and metal containers have been emptied and mixed with soil, the entire lift will be compacted to the required density. Large pieces of concrete and other debris may be broken into manageable pieces, or disposed in Controlled Low-Strength Material (CLSM) in accordance with the CQA/QC Manual.

The disposal material will be placed in the Federal Cell Facility in lifts and is compacted before the next lift is placed. Effective spreading equipment will be used on each lift to obtain uniform distribution of the waste. Leveling and manipulating of the waste will be required to assure uniform density is achieved.

Whenever the Federal Cell Facility is covered with snow of sufficient depth to impair the quality of placement of the waste material, snow will be removed beyond the limits of active construction. Where any material is frozen, it will be removed before any compacted layers are placed. During winter months it may be necessary to stockpile contaminated material.

Computer-aided earthmoving systems will be used to approve the majority of bulk soil and debris lifts, in accordance with Specifications 56 through 70 of the CQA/QC Manual. GPS technology will be used ensure compaction of each square meter of the lift surface.

For waste lifts to be placed without GPS technology, each lift will be compacted to not less than 90 percent maximum density as determined by the Standard Proctor Method, or as otherwise approved in the CQA/QC Manual. No fill will be placed upon the Federal Cell Facility until that area of the Federal Cell Facility has been approved by a Quality Control (QC) technician. All lift approvals will be documented.

Workers will be protected during waste emplacement procedures in accordance with the policies of Energy*Solutions'* Radiation Safety Plan and ALARA Plan.

4.3.2 Filling of Void Spaces

Minimizing void spaces will be critical to long-term stability of the Federal Cell Facility. The CQA/QC Manual provides controls for filling void spaces, including:

a. Debris placed with bulk soil will be distributed throughout the lift. This will prevent void containing material or materials that may degrade and leave void spaces from concentrating in one area of the Federal Cell Facility. This will also minimize the voids that may occur between two pieces of debris by distributing the debris throughout the lift.

b. All debris placed with bulk soil will be less than ten inches (10") in at least one (1) dimension; and no more than 12 feet in all dimensions. This will minimize the possibility that significant void spaces will extend vertically through multiple lifts.

PRELIMINARY REVIEW DRAFT

c. Drums and metal containers to be disposed of in the Federal Cell Facility will be emptied before being crushed. This will eliminate potential void spaces between containers when the waste is disposed of in containers.

d. CLSM will be used as fill around debris maintains minimum flowability requirements; and QC inspections will be performed to verify it's infilling of voids.

4.3.3 Waste Covering

Waste covering operations will be controlled in accordance with the CQA/QC Manual. The designed cover has been modeled and found to be sufficiently impermeable to water, structurally sound, and erosion resistant. The liner will be protected from damage during operations by a minimum 1 ft thick layer of clean native material (referred to as liner protective cover). Similarly, the last one foot of the Federal Cell Facility below the radon barrier will be constructed with clean native material to protect the radon barrier from waste debris and to facilitate cover construction (referred to as temporary cover). The construction of both the liner protective cover and temporary cover is specified in the CQA/QC Manual. Debris placement will be subject to additional controls on size and percentage (by volume) of each lift in accordance with the CQA/QC Manual.

4.3.4 Disposal Unit Stabilization

The design of the proposed Federal Cell Facility enables isolation of the Facility after it has been filled and covered. Once the Federal Cell Facility is closed it will not be disturbed by other continuing operations at the site. The final Federal Cell Facility cover integrates long-term water and erosion control methods into the overall design, thus eliminating the need for active maintenance of the closed Federal Cell Facility.

4.3.5 Federal Cell Facility Marking

Once closed, the Federal Cell Facility will be designed to have the same recognizable features as a closed uranium mill tailings facility. In addition, permanent granite markers will be placed on the closed Federal Cell Facility. These markers are similar to those already existing on the Vitro Facility located at the Clive site. Upon Federal Cell Facility closure, the following information will be recorded upon disposal unit monuments:

- The total activity of radioactive materials in curies;
- The total amount of source material in kilograms;
- The total amount of special nuclear material in grams;
- The disposal unit Federal Cell Facility name.
- The date the Federal Cell Facility was opened and closed by completing the covering; and,
- The volume of waste in the disposal unit Federal Cell Facility.

PRELIMINARY REVIEW DRAFT

4.3.6 Buffer Zone

Upon completion of the Federal Cell Facility, it will be permanently fenced and posted, leaving a minimum 100 feet of buffer zone between the toe of waste and the fence. This allows room inside of the fence for an inspection roadway and groundwater monitoring wells. Part I.F.1(f) of GWQDP UGW450005 requires that a monitoring well network be adequately spaced to provide early warning of a contaminant release from the Federal Cell Facility before the contaminant leaves the buffer zone.

In addition, a 300-foot buffer zone exists between the closest edge of the Federal Cell Facility and the outer property boundary. Finally, the buffer zone beneath the emplaced waste will consist of the two feet-thick clay liner, followed by a minimum depth of 10 feet to the unconfined aquifer water level.

4.4 OPERATIONAL ENVIRONMENTAL MONITORING AND SURVEILLANCE

The Environmental Monitoring Plan prepared in compliance of Condition 26 of Radioactive Material Licenses UT2300249 and Condition 9.22 of UT2300478 will provide the necessary environmental surveillance during operation of the proposed Federal Cell Facility. Energy*Solutions* uses the Environmental Monitoring Plan to carry out the following functions:

1. Provide an early warning of a release before it reaches the site boundary;
2. Evaluate the need for mitigative measures;
3. Evaluate health and environmental effects;
4. Estimate dose as required by UAC R313-15-301(1)(a), UAC R313-15-101(4), and UAC R313-25-19; and
5. Assist in emergency response planning if accidental releases are to occur.

Results of environmental monitoring activities at the Clive Disposal Complex are reported to the Director semiannually. Radioactive airborne particulate samples are collected with low volume air samplers at perimeter locations of the Clive Disposal Complex and at background locations. Radon concentrations in outdoor air are similarly collected. Direct gamma exposure rates using TLDs are measured at the Clive perimeter. Surface soil samples are also collected along the Clive perimeter.

An intensive program of ground water monitoring is followed in accordance with Energy*Solutions'* Ground Water Quality Discharge Permit. On the basis of the results of this program, the Division of Water Quality established well-specific ground water protection levels (GWPL) for all parameters of interest.

Energy*Solutions* will perform environmental monitoring in accordance with the Environmental Monitoring Plan in and around its Federal Cell Facility. These measurements provide data that is used to assess the potential net radiological impact of the licensed activities on the surrounding area, and form the basis for demonstrating compliance with the applicable regulations and license conditions. Data are compiled into a report and submitted semi-annually to the Director. The Environmental Monitoring Plan is designed to detect and quantify the net radiological effects in areas accessible to members of the general public that occur as a

PRELIMINARY REVIEW DRAFT

result of the licensed activities. The data is also used to proactively adjust work practices and site operations as necessary to sustain continued compliance.

Because of the site's physical configuration, its remote location, and the nature of the licensed operations, a postulated individual member of the public near the site boundary must directly inhale airborne radionuclides to receive a measurable dose via any internal dose pathway. The results from the environmental soil samples therefore serve mainly as supplemental indicators of the degree to which otherwise undetected effluents may be accumulating on surfaces outside the restricted areas, while the airborne radioactivity and gamma monitoring provide the data used as the basis for dose estimates.

Energy*Solutions'* Clive Disposal Complex operates in accordance with Air Approval Order DAQE-AN107170021-19, administered by the Utah Division of Air Quality. Prior to the issuance of this Order the Division of Air Quality performed a review of air quality concerns, including dispersion modeling for particulate matter. The Utah Division of Air Quality performs routine audits of Energy*Solutions'* facility to determine compliance with the Order. Further, Energy*Solutions* is required in Radioactive Material License UT2300249 to cease all bulk waste handling operations when the 5-minute average wind speed reaches 35 mph. It should also be noted that the air order requires Energy*Solutions* to maintain minimum waste moisture conditions as well as optimum air opacity standards. When these conditions are not met, dust suppression is applied as needed regardless of the time of year.

4.5 EMERGENCY AND CONTINGENCY PLAN

Energy*Solutions'* currently approved Emergency Response and Contingency Plan, operating procedure CL-SH-PR-500, is applicable to the Federal Cell Facility. The Plan addresses general types of emergency, and does not specify different responses for the Class A West and 11e.(2) disposal cells. Haul routes to each Facility already exist, and waste management practices at receipt and unloading facilities will be unchanged in relation to this request. Since there is no change to the types of waste that will be managed, this Plan will be unaffected by the Federal Cell Facility.

PRELIMINARY REVIEW DRAFT

PRELIMINARY REVIEW DRAFT

SECTION 5. FEDERAL CELL FACILITY CLOSURE PLAN AND CONTROL

The Federal Cell Facility is designed to eliminate to the extent practicable the need for active maintenance after closure. Once the Federal Cell Facility is closed, no further maintenance to the Federal Cell Facility is anticipated. Closure of the Federal Cell Facility is expected to begin well before overall facility decommissioning, since cover activities for the Federal Cell Facility are expected to begin for some lift areas within the next 3 years (while the facility is expected to continue operating for up to 20 years). Prior to closure, Energy*Solutions* will submit a detailed site Decontamination and Decommissioning Plan. The Plan will address site closure in the context of current site conditions.

5.1 SITE STABILIZATION

Energy*Solutions'* Federal Cell Facility cover system is designed to minimize infiltration of water into the waste, to direct precipitation away from disposed waste and to resist degradation caused by surface geologic processes. The principal design systems are classified into two categories: 1) deep infiltration minimization, surface drainage and erosion protection, and 2) geotechnical stability.

Energy*Solutions* has modeled the fate and transport of water through this the proposed Federal Cell Facility cover system using GoldSim. The GoldSim model simulates processes known to have a significant role in water flow in landfill covers in arid regions and utilize easily measured environmental characteristics as input to its calculations, including:

- water flow in variably-saturated porous media;
- material hydraulic property functions;
- atmospheric surface boundary conditions including precipitation and evapotranspiration;
- root water uptake; and
- free-drainage boundary conditions.

5.1.1 Surface Drainage and Erosion Protection

The Energy*Solutions* facility incorporates three separate design systems in directing the surface drainage away from the site. These systems are designed to meet the requirements of UAC R313-25-7(7), UAC R313-25-8, UAC R313-25-24, and UAC R313-25-25, in that they are designed and constructed to prevent erosion and flooding of the disposal unit without active maintenance.

1. The first system consists of the two elements designed to control precipitation that falls on site. This system includes the perimeter or run-on berms and the drainage ditches. The berms and ditches are designed to promote stability and protection during normal, abnormal, and extreme storm and flood events (defined as Probable Maximum Precipitation and Flood events by UAC R313-25). The perimeter or run-on berms are constructed to sufficient height to contain water created from the worst storm event that could occur during the design life of the Federal Cell Facility. They will also prevent

PRELIMINARY REVIEW DRAFT

offsite floodwaters created during a worst-case flood event from running onto the Federal Cell Facility.

2. Likewise, the drainage ditches are constructed to a sufficient depth to promote drainage of storm waters offsite, preventing the waters from backing up and infiltrating into the Federal Cell Facility. These ditches intercept runoff from the Federal Cell Facility and direct the flow into the natural drainage patterns to the southwest of the site. Infiltration and erosion barriers cover the drainage ditches in order to protect them from erosion forces. The run-on berms and drainage ditches are a key system for the following principal design features: a) they protect against water infiltration by directing surface water offsite, b) they promote disposal unit/cover integrity by preventing erosion due to contact with surface water, c) they minimize contact of the radon barrier or emplaced waste with standing water, and d) they allow the site to be free draining.

3. Upon completion of waste placement, a clay radon and infiltration barrier is constructed. The first layer of this cover is the radon barrier, consisting of no more than 1×10^{-6} permeability clay. The radon barrier is covered by the infiltration barrier, consisting of 5×10^{-8} cm/sec permeability clay. The infiltration barrier is a key system for the following principal design features: a) it encourages precipitation evapotranspiration rather than infiltrate into the Federal Cell Facility, b) it maintains cover integrity by protecting it against severe storm events, and c) it protects against inadvertent intrusion into the radon barrier and emplaced waste.

   Immediately over the filter layers is 18 inches of frost protection zone, which protects the infiltration barriers from the influences of frost. The frost protection zone also serves as a biointrusion barrier, protecting the Federal Cell Facility from damage. It consists of bankrun borrow material, with boulders larger than 16 inches removed, to resist the erosive forces caused by severe storm events. It is a key system for the following principal design features: a) it provides leak resistance for the Federal Cell Facility by protecting the radon barrier from cracking due to extreme cold/hot weather conditions, b) it maintains disposal unit and radon barrier integrity by protecting it against erosion, c) it promotes structural stability, and d) it protects against inadvertent intrusion.

   Above the frost protection zones of the Federal Cell Facility's top slope are the evaporation (12 inches) and surface layers (12 inches). These layers consist of loam clays that are designed to trap and absorb infiltrating precipitation. This entrained moisture can then be removed from the cover system by evapotranspiration. Gravel is added to the surface layer to provide additional erosion protection (15% by volume).

   Above the frost protection zones of the Federal Cell Facility's side slope is a rock filter zone (12 inches) and rock armor layer (18 inches). These layers serve as erosion barriers (equivalent to the side slopes of the 11e.(2) Byproduct Facility). The erosion barriers will consist of large, fairly well graded rock, of sufficient diameter to resist the erosive forces caused by severe storm events. The erosion barrier covering the sides and drainage ditches of the embankment will resistance against flows caused during flood conditions. The erosion barrier provides principal design features: a) it provides leak resistance for the embankment by protecting the radon barrier from cracking due to biointrusion and/or extreme cold/hot weather conditions, b) it maintains disposal unit and radon barrier integrity by protecting it against erosion, c) it promotes structural stability, and d) it protects against inadvertent intrusion.

PRELIMINARY REVIEW DRAFT

5.1.2 Geotechnical Stability

The geotechnical stability of the Federal Cell Facility is contingent upon proper execution of the design bases and construction procedures for the Federal Cell Facility's design systems. These systems are also designed to meet the performance objectives and technical requirements of UAC R313-25. Analyses have been performed for each of these systems to justify their design and performance. Each of these systems is completed prior to closure of the Federal Cell Facility and eliminates the need for active maintenance of the facility after closure.

The clay liner provides a firm construction base for the entire Federal Cell Facility that minimizes contact of wastes with standing water. It is constructed over a compacted foundation of in situ soils. To ensure long-term stability of the Federal Cell Facility, the clay liner is compacted to near maximum compaction. It is constructed with clay materials that will maintain their strength at relatively high moisture contents to ensure that: it can remain firm under the loads of the emplaced waste; long-term settlement is minimized; and liquefaction does not occur. In addition, the liner is constructed with a permeability greater than the top foot of radon barrier, to protect against ponding or "bath-tubbing" that could cause saturation of the bottom of the Federal Cell Facility.

Drainage from the Federal Cell Facility is monitored by collection lysimeters that are placed beneath the clay liner at several locations in the Federal Cell Facility. Lysimeter piping extends along the base of the Federal Cell Facility and collects any leachate that may develop. A collection manhole is constructed with each lysimeter so that leachate can be monitored. Details of the construction and key elements of lysimeters are provided in XXXXX.

The structural stability of the Federal Cell Facility is also ensured by proper placement and compaction of waste materials. As outlined in the CQA/QC Manual, depleted uranium waste placed will be placed with CLSM to minimize voids in the Federal Cell Facility. All placed materials are tested for density, moisture and thickness to ensure compliance with design bases and construction procedures. Above depleted uranium waste, soil and soil-like fill materials will be placed in lifts and compacted near maximum compaction and optimum moisture to protect against long-term settlement. To further protect against differential settlement, uniformity of the Federal Cell Facility will be developed by terracing or tying in intersecting sections of the Federal Cell Facility. The Federal Cell Facility will be surveyed annually and As-Built drawings produced and submitted to the Director. Settlement will be monitored both before and after final cover construction in accordance with applicable specifications of the CQA/QC Manual.

Once waste and fill materials have been placed and graded to the design slopes and elevations indicated in the design drawings, a radon barrier is constructed. The radon barrier is constructed with low permeability clays and is sloped to promote precipitation runoff. This is also a key element to prevent against liquefaction as it minimizes water infiltration and saturation of the emplaced fill and depleted uranium waste. The radon barrier, like the clay liner, is compacted to almost maximum compaction and near optimum moisture to protect against long-term settlement. The final cover protects the radon barrier against cracking due to freezing/thawing, and erosion. The Federal Cell Facility's side slope of five horizontal to one vertical was studied in detail to assure that the slopes would not fail due to the expected maximum seismic event (AMEC, 2012a).

The DOE Technical Approach Document (DOE, 1989), provides data and calculations used in evaluating the slope stability and liquefaction potential for the Vitro Federal Cell Facility. It was concluded that

PRELIMINARY REVIEW DRAFT

> "*due to the short- and long-term unsaturated Federal Cell Facility conditions, the dense nature of the granular site soils and a depth to groundwater in excess of 25 feet below existing grade, liquefaction in the facility or foundation soils will not occur at the site due to [Maximum Considered Event] acceleration.*"

In an updated study conducted by AMEC for Energy*Solutions* (AMEC, 2012a), it was found that all layers above 35 feet below grade would not liquefy. AMEC reports that some relatively thick layers deeper than 35 feet might liquefy during this event, but are sufficiently deep that they should not affect the stability of the site. However, the depth to those layers exceeds the depth to which the liquefaction analysis procedure is claimed to be valid; thus, it is questionable that those layers are really liquefiable. Based on their analysis, AMEC concluded that liquefaction in the Federal Cell Facility or foundation soils will not occur at the site due to an MCE-acceleration.

AMEC also prepared an updated assessment of the seismic hazard for the Clive site consistent with the requirements of the Utah Code of Regulations R313-25-8(5). The revisited seismic hazard assessment is based on an assessment of the peak ground acceleration associated with the Maximum Credible Earthquake for known active or potentially active faults in the site region, and the peak ground acceleration obtained from a probabilistic seismic hazard analysis to assess the seismic hazard for earthquakes that may occur on unknown faults in the area surrounding the project site (i.e., background seismicity). The approach utilized by AMEC to select a Maximum Credible Earthquake peak ground acceleration from the larger of the values associated with the deterministic Maximum Credible Earthquake for faults or the probabilistic seismic hazard analysis result for background earthquakes at a 5,000 year return period is consistent with the recommendations of the Utah Seismic Safety Commission (AMEC, 2012a) and as required by the Utah Division of Water Rights (Dam Safety Section) for assessment of dams.

Based on their reevaluation, AMEC determined that the maximum peak ground acceleration from fault-specific earthquake sources is computed to be 0.28 g for a maximum magnitude earthquake occurring on the Stansbury fault (M 7.3) or the Skull Valley fault (M 7.1). The probabilistic analysis of the background seismicity shows the mean peak ground acceleration for a return period of 5,000 years is 0.28 g for non-fault-specific earthquakes up to M 7.

Liquefaction and cyclic softening evaluations, as well as previous Federal Cell Facility stability calculations, were based on a peak ground acceleration of 0.28 g. It is also higher than the median peak ground acceleration value for background earthquakes with 5,000-year recurrence intervals calculated with probabilistic seismic hazard analysis procedures. Therefore, AMEC projects that the results of seismic stability calculations at the Clive site remain appropriate and applicable because the updated peak ground acceleration for the site does not exceed the peak ground acceleration previously used. Therefore, the analysis initially conducted continues to be conservative in demonstrating Federal Cell Facility stability.

5.2 DECONTAMINATION AND DECOMMISSIONING

Decontamination and decommissioning of the Federal Cell Facility will be provided at the time of closure. Energy*Solutions* has developed an extensive set of decontamination facilities in support of the Federal Cell Facility and other waste disposal operations, addressing activities necessary for equipment and tools used in shipping, receiving, managing, and disposal of LLRW, including depleted uranium. Decontamination

PRELIMINARY REVIEW DRAFT

procedures have also been developed to address release of the various shipping containers from the Restricted Area.

In the Decontamination and Decommissioning Plan, it is assumed that additional support facilities will not be required beyond that specified in this Application. It is also assumed that these support facilities will be decontaminated and decommissioned upon closure. The decontamination and decommissioning activities directly related to the Federal Cell Facility include:

a. Decontaminating on-site soils within the Federal Cell Facility property boundary but excluding the Federal Cell disposal embankment, by removing all surface soils contaminated with depleted uranium such that the contamination in the residual soils is ALARA and below the respective cleanup limits. Soils contaminated with depleted uranium will be disposed of at the Federal Cell Facility using disposal methods approved in the CQA/QC Manual.

b. Decontaminating any on-site support structures and contents dedicated to supporting Federal Cell Facility construction and operation.

In addition to management of depleted uranium destined for placement in the Federal Cell Facility, Energy*Solutions'* waste handling facilities are also used for both Class A and 11e.(2) waste management activities. Decommissioning waste from these facilities will be placed into the Class A West Facility. Additionally, GWQDP UGW450005 requires that sludge and other wastes from eventual decommissioning of the Evaporation Ponds will also be disposed as LLRW in the Class A West Facility.

5.3 POST-OPERATIONAL ENVIRONMENTAL MONITORING AND SURVEILLANCE

Upon successful licensing of the Federal Cell Facility, Energy*Solutions* will secure financial assurance to perpetual conduct necessary post-operational monitoring. After decontamination and decommissioning of the Federal Cell Facility is complete and perpetual stewardship transferred to DOE, post-operational monitoring will include annual inspections and minor maintenance of the Federal Cell Facility and areas that may have been impacted by Federal Cell Facility operations, to ensure that the Federal Cell Facility and other required elements perform as intended and that there are no adverse impacts to the environment or the public due to degradation of the Federal Cell Facility. Monitoring and surveillance includes inspection and minor maintenance of the Federal Cell Facility, fencing, roads, and annual groundwater sampling.

The existing program for monitoring airborne particulate radioactivity (Environmental Monitoring Plan) will continue with air samplers surrounding the operational area and at least one control station remote from the area for at least one sampling event after final cleanup and closure. Composite samples from each station will be analyzed by gamma spectrometry and radiochemical techniques. Air sample collection will continue during the period required for sample analysis. Measured concentrations will be compared with the dose standards in accordance with the Environment Monitoring Plan.

Passive environmental radon monitors will be used for one year after closure at all air sampling sites employed during post-closure airborne particulate monitoring. Samplers will be exchanged at the frequency prescribed by the Environmental Monitoring Plan. If these samples all demonstrate compliance with the concentration limit of R313-15-420, Table II for Rn-222 no further radon sampling will be required. For the purpose of this

PRELIMINARY REVIEW DRAFT

evaluation the concentration will be the measured concentration, minus the sum of the average baseline concentration, plus three standard deviations.

TLDs will be used for gamma exposure monitoring at the same locations for one year post-closure and will be exchanged at the frequency prescribed by the Environmental Monitoring Plan. If the net annual exposure rate does not exceed the baseline exposure rate, plus three standard deviations as adjusted for changes in worldwide fallout levels by 25 mR/year, no further monitoring of gamma exposure rates will be required.

Energy*Solutions* will make a final collection of soil samples at site closure. No further collections will be necessary post-closure. If any site boundary samples contain concentrations of radionuclides greater than the mean plus two standard deviations determined for the background samples an investigation will be made to determine the possible cause and sampling will continue in that area and at the background sites until the levels return to background.

The Federal Cell Facility design minimizes the potential for transport of contaminants away from the disposed waste. The cover reduces the potential for deep infiltration, which is already likely to be minimal in the area due to the low incident precipitation and high potential evapotranspiration. Seepage is not expected to reach the groundwater as a result of moisture redistribution within the waste. The impact of this seepage on the groundwater is expected to be minimal for several reasons:

1. Depleted uranium waste must have equal to or less than 1% free standing liquids upon arrival. Most shipments have no free standing liquids.

2. Depleted uranium waste must have no free liquids at disposal.

3. Evaporation at the site exceeds precipitation. Accordingly, even waste with some moisture content upon receipt is likely to dry out during placement.

4. The existing poor quality of the groundwater makes it difficult to significantly degrade it.

5. The hydraulic head gradient in the groundwater is minimal, limiting the velocity of groundwater movement away from the site to a maximum of about a foot per year.

Due to the high and variable concentrations of naturally occurring radionuclides inherent with depleted uranium, results for analysis of these radionuclides will be subjected to trend analysis to identify any increase in ground-water concentrations. Manmade radionuclides are not expected to be found in groundwater as a result of releases from the Federal Cell Facility, any positive findings will be considered as evidence of possible contamination from other site operations. Any findings of radioactivity above predicted baseline values will be reason for increased frequency of sampling at the affected well to determine the reason for the finding and any possible course of action.

Settlement analyses will be performed for the Federal Cell Facility and cover materials to ensure that total and differential settlements is within an acceptable range for the cover system. The foundation soils will include both sand and clay that will settle under the weight of the depleted uranium and cover. The sand layers will be relatively free draining and will settle rapidly.

PRELIMINARY REVIEW DRAFT

Energy*Solutions'* Long Term Settlement Monitoring Plan (included in the CQA/QC Manual) was developed in accordance with the recommendations contained in "Guidance for UMTRA Project Surveillance and Maintenance" (UMTRA-DOE/AL-350124.000). The Plan specifies that geotechnical monitoring inspections will be performed by Energy*Solutions* on the completed Federal Cell Facility to evaluate settlement of the Federal Cell Facility as well as slope stability. Surveys will be performed annually and will be made to second order standards. Settlement monitoring should be conducted for the first 20 years after site closure.

In accordance with the recommendations contained in "Guidance for UMTRA Project Surveillance and Maintenance" (UMTRA-DOE/AL-350124.000), annual visual inspections of the completed Federal Cell Facility will be conducted. Among the items to be observed and/or inspected will be:

1. Adjacent off-site features.

2. Access roads, fences, gates, and signs.
   a. Needed maintenance.
   b. Breach of integrity.

3. Monuments and wells.
   a. Disturbances.
   b. Replacement or protection.

4. Crest.
   a. Observation of erosion, soil color, vegetation, trails.
   b. Subsidence, settling, cracks, etc.
   c. Deterioration of cover.

5. Slopes.
   a. Settlement, sliding.
   b. Animal and/or plant intrusion.
   c. Vandalism.

6. Periphery.

7. Diversion Channels.
   a. Functional.
   b. Erosion, sediment.
   c. Vegetation, blockage.

8. Photography

In addition to the scheduled surveillance, unscheduled inspections may be performed following unusual events (e.g., tornadoes, extremely high winds, extended or high periods of precipitation, floods, earthquakes, or human events such as vandalism or inadvertent).

PRELIMINARY REVIEW DRAFT

PRELIMINARY REVIEW DRAFT

SECTION 6. SAFETY ASSESSMENT

Neptune and Company, Inc., (Neptune) under contract to Energy*Solutions* developed the Clive depleted uranium performance assessment model to support decision making related to the proposed disposal of depleted uranium wastes at a Federal Cell Facility at Clive, Utah, operated by Energy*Solutions*. The Model provides a platform on which to conduct analyses relevant to performance assessment, as required by the State of Utah in Utah Administrative Code (UAC) R313-25, *License Requirements for Land Disposal of Radioactive Waste*. Specifically, a performance assessment is required in UAC R313 25 9, *Technical Analyses*. The model may also serve to inform decisions made by the Site operator to gain maximum utility of the resource that is the Clive Facility.

Depleted uranium is the remains of the uranium enrichment process, of which the fissionable uranium isotope ^{235}U is the product. The leftover uranium, depleted in ^{235}U, is predominantly ^{238}U, but may include small amounts of other U isotopes. In general, depleted uranium will contain very small amounts of decay products in the uranium, thorium, actinium, and neptunium series of decay chains. Some specific depleted uranium waste, resulting from introduction of uranium recycled from used nuclear reactor fuel (reactor returns) into the separations process, contains varying amounts of contaminants, in the form of fission and activation products. Since some of the depleted uranium evaluated in this performance assessment includes reactor returns. The national inventory of depleted uranium is on the order of 700 Gg (700,000 Mg, or metric tons) in mass as uranium hexafluoride (DUF_6), and the bulk of it exists in its original storage cylinders, awaiting conversion to oxide form for disposal. This conversion is being performed at the Portsmouth, Ohio, and Paducah, Kentucky gaseous diffusion plant sites, using new purpose-built "deconversion" plants to produce triuranium octoxide(U_3O_8). A much smaller mass of depleted uranium waste was generated by the Savannah River Site (SRS) in the form of uranium trioxide (UO_3), a powder stored in several thousand 200 L (55 gal) drums. While the composition of the SRS depleted uranium is reasonably well known, the content of the gaseous diffusion plant depleted uranium is not well documented. For the purposes of this assessment, it was assumed that some fraction of the gaseous diffusion plant depleted uranium waste is contaminated to the same extent as the SRS the depleted uranium waste. Depleted uranium waste from both sources is considered in the Clive the gaseous diffusion plant depleted uranium performance assessment model.

The model is written using the GoldSim probabilistic systems analysis software, which is well-suited for the purpose. In order to provide decision makers with a broad perspective of the behavior and capabilities of the Facility, the model considers uncertainty in input parameter values. This probabilistic assessment methodology is encouraged by NRC and DOE in constructing performance assessments and the models that support them. The model can be run in deterministic mode, where a single set of median model inputs is used, but running in probabilistic Monte Carlo mode provides greater insight into the model behavior, and especially into model sensitivity to the distribution of input parameter values. In Monte Carlo mode, a large number of realizations are executed with values drawn at random from the input parameter distributions using Latin Hypercube Sampling to ensure equal probability across the range of the input distributions. The distributions of results, therefore, reflect the uncertainty in these values. To the extent that the model reflects the uncertain state of knowledge at a site, the model provides insight about how the site works, and what should be expected if different actions are taken or different wastes are disposed. In this way, the model aids in decision making, even in the face of uncertainty.

The Clive Facility is a remote and environmentally inhospitable area for human habitation. Human activity at Clive has historically been very limited, due largely to the lack of potable water, or even water suitable for

PRELIMINARY REVIEW DRAFT

irrigation. The site is located on flat ground, with the bottom of the waste disposal cells shallowly excavated into local lacustrine silts, sands, and clays. A single waste disposal cell, or embankment, is considered in this model: the Federal Cell Facility housing depleted uranium. The Federal Cell Facility is modeled with an engineered cover, as per design documents. As designed, the top of the Federal Cell Facility is above grade, and the cover has layers of a rock-armored cover system similar to that constructed over the closed LARW and Vitro cells and under construction on the Class A West embankment.

Water balance modeling of the cover indicates that some water penetrates the cover system, and this infiltration has the potential to leach radionuclides from the waste and transport them down through the cell liner and unsaturated zone to the aquifer. In the saturated zone (aquifer), contaminants are transported laterally to a hypothetical monitoring well located about 90 ft from the edge of the interior of the Federal Cell Facility. Since the side slopes of the Federal Cell Facility are modeled to not contain depleted uranium waste, the effective distance to the well from the depleted uranium waste itself is about 240 ft. This environmental transport pathway is relevant for long-lived and readily-leached radionuclides such as ^{99}Tc. Contributions to groundwater radionuclide concentrations from the proposed depleted uranium waste are calculated for comparison to groundwater protection limits (GWPLs) during the next 500 years.

In addition to water advective transport, radionuclides are transported via diffusion in both water and air phases within the cover system, which can provide upward transport pathways. Gaseous radionuclides, such as ^{222}Rn, partition between air and water. Soluble constituents partition between water and solid porous media. Coupled with all these process are the activities of biota, with plants transporting contaminants to their above-ground surface tissues via their roots, and burrowing animals (ants and small mammals) moving bulk materials upward and downward through burrow excavation and collapse. Biota do not play a major role in contaminant transport contributing to human doses or uranium hazard according to model results. The model does not consider the effects of enhanced radon diffusion from a compromised radon barrier, but the model does include an expanded assessment of the performance of the radon barriers with respect to infiltration.

Once radionuclides reach the ground surface at the top of the engineered cover via the aforementioned processes, they are subject to suspension into the atmosphere and dispersion to the surrounding landscape. Atmospheric transport of gases (^{222}Rn) and contaminants sorbed to suspended particles is modeled using a standard modeling platform approved by the EPA model AERMOD. The results of this model are abstracted into the Clive depleted uranium performance assessment model, and contributions of airborne radionuclides to dose and uranium toxicity hazard are evaluated.

The impact of sheet and gully erosion in the model is evaluated by the application of results of landscape evolution models of hill slope erosion loss and channel development conducted for a borrow pit at the site. The model domain for the borrow pit includes the borrow pit floor, a 10 ft high pit face at a 1:1 slope and several hundred meters of ground surface upslope from the pit face at a slope of 0.003 (0.3 percent). The soil characteristics are consistent with the Unit 4 silty clay, though the landscape evolution model did not consider the presence of vegetation or rock cover. The surface layer of the top slope of the cover proposed for the Federal Cell Facility has a slope of about 2 percent. While the cover on the top slope part of the embankment has a greater slope than that of the undisturbed area upslope from the borrow pit face, the top slope characteristics act to minimize erosion and channel formation.

A subset of the borrow pit model domain was selected to represent the cover. Gully depths estimated by the erosion model were extrapolated to 10,000 years and a statistical model was developed that generated values of the percentage of the cover where gullies ended within a given depth interval. This model provided an

PRELIMINARY REVIEW DRAFT

estimate of the volume of embankment cover material removed by gullies. The depositional area of the gully fan is assumed to be the same as the area of waste exposed in the gullies, using projections onto the horizontal plane. If these embankment materials include depleted uranium waste components, then this leads to some contribution to doses and uranium hazards. No associated effects, such as biotic processes, effects on radon dispersion, or local changes in infiltration are considered within the gullies.

Given the remote and inhospitable environment of Clive, it is not reasonable to assume that the traditional residential receptors considered in other performance assessments are present. Traditionally, and based on DOE (DOE M 435.1) and NRC guidance (10 CFR 61), members of the public are evaluated outside the fence line or boundary of the disposal facility, and inadvertent intruders are assumed to access the disposal facility and the disposed waste directly, in activities such as well drilling or house construction. For disposal facilities in the arid west, these types of strictly defined default scenarios do not adequately describe likely human activities. Their inclusion in a performance assessment for a site in the arid west, such as Clive, will usually result in unrealistic underestimation of the performance of a disposal system, which does not lend itself to effective decision making for the Nation's needs to dispose of radioactive waste.

At Clive, there is no potable water resource to drill for, and historical evidence suggests there is little likelihood that anyone would construct a residence on or near the site. There are present day activities in the vicinity, however, that might result in receptor exposures if these activities are projected into the future when the facility is closed and after institutional control is lost. Large ranches operate in the area, so ranch hands work in the vicinity. Pronghorn antelope are found in the region, and hunters will follow them. Both of these activities are facilitated by the use of off-highway vehicles (OHVs). OHV enthusiasts also ride recreationally for sport in areas near the Federal Cell Facility.

In addition to these receptors, there are specific points of exposure within the vicinity of the Clive Facility where individuals might be exposed. About 8 miles to the west, OHV enthusiasts use the Knolls Recreation Area. Interstate 80 and a railroad are located to the north, with an associated rest area on the highway. Closer to the Clive Facility, the Utah Test and Training Range access road is used on occasion. The Model hence evaluates dose and uranium hazard to these site-specific receptors.

The State of Utah follows federal guidance by categorizing receptors in a performance Assessment in UAC R313-25-9 and 10 CFR 61.41 according to the labels "member of the public" (MOP) and "inadvertent human intruder" (IHI). NRC offers two definitions of inadvertent intruders in 10 CFR 61:

- § 61.2 Definitions. Inadvertent intruder means a person who might occupy the disposal site after closure and engage in normal activities, such as agriculture, dwelling construction, or other pursuits in which the person might be unknowingly exposed to radiation from the waste.
- § 61.42 Protection of individuals from inadvertent intrusion. Design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.

NRC offers one reference to an MOP in the context of the general population:

- § 61.41 Protection of the general population from releases of radioactivity. Concentrations of radioactive material which may be released to the general environment in ground water, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of 25 millirems [0.25 mSv] to the whole body, 75 millirems [0.75 mSv] to the thyroid, and 25 millirems [0.25 mSv] to any other organ of any member of the public. Reasonable effort should be made to

PRELIMINARY REVIEW DRAFT

maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable.

DOE definitions in DOE M 435.1 (the Manual accompanying DOE Order 435.1) are much more specific. However, the applicable federal agency that regulates disposal of low-level radioactive waste at the Clive Facility is NRC. For the Clive Facility and the Model, based on the NRC definitions, the ranch hand, hunter and OHV enthusiast are expected to engage in activities both on and off the site. These receptors fit the NRC definition of inadvertent intrusion because they are assumed to occupy the site, albeit for limited periods of time, and also because the use of OHVs on the cover may precipitate the creation of gullies. The receptors that are located at specific offsite locations, instead, fit the NRC definition of MOP. The Model presents predicted doses to the receptors identified above, under the conditions and assumptions that provide the basis for the Model. These doses are presented as the results of the Model. A comparison of doses to both MOP and IHI performance objectives is also presented.

The Model addresses radiation doses to human receptors who might come in contact with radionuclides released from the disposal facility into the environment subsequent to facility closure. In accordance with UAC R313-25-9, doses are calculated within a 10,000 year compliance period. The doses are compared to a performance criterion of 25 mrem in a year for a MOP, and 500 mrem in a year for an inadvertent intruder. The dose assessment component of the model, like the transport modeling components described above, supports probabilistic Monte Carlo analysis. Spatiotemporal scaling is a critical component of the Model development. For example, the Model differentiates the impact of short-term variability in exposure parameters (values applicable over a few years or decades, such as individual physiological and behavioral parameters) from the longer-term variability of transport parameters (values applied over the full 10,000 year performance period, such as hydraulic and geochemical parameters). This distinction facilitates assessment of uncertainties that relate to physical processes from uncertainties relating to inter-individual differences in potential future receptors.

In addition to radiation dose, uranium is also associated with non-radiological toxicity. The potential chemical toxicity of uranium disposed at the Clive Facility is evaluated in the Model. Potential receptor chronic daily intake of uranium is compared to toxicological criteria developed by EPA that pertain to a threshold of adverse effect associated with kidney toxicity.

These doses and the supporting contaminant transport modeling that provides the dose model with radionuclide concentrations in exposure media are evaluated for 10,000 yr, in accordance with UAC R313-25-9(5)(a). After that time, the modeling focus turns to long-term, or "deep time" scenarios. Peak activity of the waste occurs when the progeny of the principal parent, ^{238}U (with a half-life that is approximately the age of the earth— over 4 billion years), reach secular equilibrium. This occurs at roughly 2.1 My from the time of isotopic separation, and the model evaluates the potential future of the site in this context. At 2.1 million years (My) the activity of the last modeled member of the chain, ^{210}Pb, is equal to that of ^{238}U, within less than one half of one percent. While the calculation could be carried out further in time to achieve a greater degree of accuracy, there is no benefit in doing so for decision-making purposes. This time frame borders on geologic, and needs to take into account the likely possibility of future deep lakes in the Bonneville Basin. The return of such lakes is understood to be inevitable, and the Clive Facility, as constructed, will not survive in its current configuration. Many lakes, of intermediate and deep size, are expected to occur in the 2.1 My time frame, following the climate cycle periodicity of about 100,000 yr, based on current scientific understanding of paleoclimatology. In these timeframes, it is also important to consider processes such as eolian (i.e., wind-borne) deposition, which can be seen in geologic formations in the Clive area. Deposition builds up the ground

PRELIMINARY REVIEW DRAFT

surface over time, such that the ground surface when a lake returns is 2 – 3 m higher than the current ground surface.

As each lake returns, estimates are made of the radionuclide concentrations in the lake and in the sediments surrounding and subsuming the site. Because the exact behavior of lake intrusion and site destruction is speculative, the model makes several conservative assumptions. Upward movement of radionuclides, via diffusion and biota, is assumed to occur until the first lake returns. At that point in time, the radionuclides that are above ground are assumed to comingle with sediments, dispersed over an uncertain area approximately the size of an intermediate lake. In the presence of a lake, the radionuclides migrate into the water, in accordance with their aqueous solubility. For U_3O_8, which is considered to be the only form of uranium oxide remaining by the time the first lake arrives (since UO_3 moves out of the waste first and what is left will become more like U_3O_8 or UO_2 in the presence of a wetter climate), the solubility of U is very low. As each lake recedes, radionuclides are co-deposited with the sediment, only to be dissolved into the water again with the next lake. This is a very conservative approach, especially for the lake concentrations, since in reality each blanket of sediment could entrap constituents, and the concentrations in water and sediment over time should decrease consequently. The analysis, therefore, focuses on the arrival of the first lake, which will be the most destructive in terms of sudden release of radionuclides, and would provide the least amount of sediment to encapsulate them. Subsequent lakes would see progressively less radionuclide activity as the site is slowly buried under ever-deeper lacustrine deposits through the eons.

The utility of such a calculation, aside from responding to the UAC requirement, is to inform decisions regarding the placement of wastes in the embankment. With downward pathways influencing groundwater concentrations, and upward pathways influencing dose and uranium hazard, a balance must be achieved in the placement of different kinds of waste. No depleted uranium waste has been modeled under the side slopes. In version 1.4 of the Model, the erosion modeling was conducted under the assumption that gullies will occur on the embankment. Additionally, the only depleted uranium waste configuration presently evaluated is for disposal of these wastes in layers of the embankment below the current grade of surrounding soil. Dose results for each type of potential receptor are presented in Table 6-1.

There is a question of which statistic from the many Model realizations is most appropriate for comparison to performance criteria. The statistics in Table 6-1 represent summaries of the mean, median, and 95th percentiles of the dose at 10,000 yr for the 10,000 realizations. The peak mean dose is sometimes of interest for comparison with performance objectives, and in this model, the peak mean dose occurs at or near 10 thousand years (ky). In effect, 10 ky is the worst case year in terms of dose. Under these circumstances, the 95th percentile is analogous to the 95% upper confidence interval of the mean at 10 ky that is commonly used to represent reasonable maximum exposure in CERCLA risk assessments.

Compliance with the performance objectives for the inadvertent intruder dose of 500 mrem in a year and for the MOP of 25 mrem in a year is clearly established for all three types of potential future receptors. This indicates that for the disposal configuration where depleted uranium wastes are placed below grade, doses are expected to remain well below applicable dose thresholds even if gullies are assumed to occur on the embankment.

Results are also available for the offsite (MOP) receptors. None of the 95th percentile dose estimates for these receptors exceeds 1 mrem in a year, and all of the peak mean dose estimates are at or below 0.1 mrem in a year.

PRELIMINARY REVIEW DRAFT

Table 6-1

Peak TEDE: Statistical Summary

	peak TEDE (mrem in a yr) within 10,000 yr		
receptor	**mean**	**median (50th %ile)**	**95th %ile**
ranch worker	6.2E-2	5.1E-2	1.5E-1
hunter	4.5E-3	3.8E-3	9.9E-3
OHV enthusiast	8.4E-3	7.5E-3	1.8E-2

Results are based on 10,000 realizations of the Model.
TEDE: Total effective dose equivalent

PRELIMINARY REVIEW DRAFT

For those radionuclides for which GWPLs exist, as specified in the facility's permit (UWQB 2009), results are shown in Table 6-2. For all such radionuclides compliance with the GWPLs is clearly demonstrated. The mean values for ^{99}Tc and ^{129}I are much greater than the median, indicating that the distributions of these concentrations have a very strong degree of skewness.

Sensitivity analyses on the Model results indicate that receptor doses are dominated by radon inhalation, whereas the downward migration pathway is dominated by groundwater concentrations of ^{99}Tc. A trade-off is indicated in terms of depleted uranium waste placement. The lower the depleted uranium waste is placed, particularly the ^{99}Tc-contaminated depleted uranium waste, the greater the groundwater concentrations of ^{99}Tc, but the lower the doses due to increases in the diffusion path length to the ground surface. Conversely the higher the depleted uranium waste is placed in the embankment, the lower the ^{99}Tc groundwater concentrations, and the greater the dose to receptors. Placement of depleted uranium waste below surface grade in the Federal Cell Facility satisfies both dose and groundwater performance objectives. Sensitivity analyses on the groundwater concentration of ^{99}Tc indicate that these results are primarily sensitive to the α parameter of van Genuchten equation and secondarily to the molecular diffusion coefficient.

In addition to the dose assessment for hypothetical individuals described above, the structure of the model allows the cumulative population dose to be tracked. For the objective of keeping doses as low as reasonably achievable (ALARA), estimated dose to the entire population of ranch workers, hunters, and OHV enthusiasts over the 10,000 yr simulation was evaluated. These cumulative population doses are shown in Table 6-3.

The population doses presented in Table 6-3 may be evaluated relative to doses received from natural background radiation and by considering the person-rem costs suggested in recent NRC (2015) guidance. NRC has suggested value of a statistical life (VSL)-based cost of $5,100 per person rem. Using such a cost, the total ALARA cost over 10 ky (for example, $61,200 using the mean estimate of total population dose, or $6 per yr.) is very small compared to the cost of waste operations and disposal. Average annual individual background dose related to natural background radiation in the United States is approximately 310 mrem; (NCRP, 2009), which for the total cumulative receptor population of about 3,200,000 individuals in 10,000 years is approximately 992,000 rem—a level that is many orders of magnitude greater than the population doses shown in Table 6-3. ALARA is intended to support evaluation of options to reduce doses in a cost-effective manner. Given the results of this ALARA analysis, it is not clear that further reduction in dose is necessary.

The final set of analyses conducted with the Model are the deep-time analyses. As described above, the deep-time model is very conservative in many ways with respect to dispersal of the depleted uranium waste material. Deep lakes that obliterate the Federal Cell Facility are assumed to return periodically. Simplified processes are used to keep the deep time model from becoming overly complicated for the amount of uncertainty in both parameters and processes.

Concentrations of ^{238}U in lake water and sediment at the time of peak lake occurrence (90,000 years) are presented in Tables 6-4 and 6-5. These results simply show the concentrations that might occur in response to obliteration of the site by wave action during return of a lake to the elevation of Clive and subsequent dispersal of the waste in a relatively confined system. The concentrations presented would continue to decrease with each lake and climate cycle as more sediment is deposited with each lake event, and each lake event allows radionuclides to be dispersed ever further afield.

PRELIMINARY REVIEW DRAFT

Table 6-2

Peak Groundwater Activity Concentrations within 500 yr, Compared to GWPLs

radionuclide	GWPL[1] (pCi/L)	peak activity concentration within 500 yr (pCi/L)		
		mean	median (50th %ile)	95th %ile
^{90}Sr	42	0	0	0
^{99}Tc	3790	26	4.3E-2	150
^{129}I	21	1.7E-2	4.3E-11	1.1E-1
^{230}Th	83	2.2E-28	0	0
^{232}Th	92	1.4E-34	0	0
^{237}Np	7	1.5E-19	0	3.7E-27
^{233}U	26	5.6E-24	0	3.9E-28
^{234}U	26	2.1E-23	0	2.2E-28
^{235}U	27	1.6E-24	0	2.0E-29
^{236}U	27	2.7E-24	0	3.3E-29
^{238}U	26	1.5E-22	0	1.8E-27

[1]GWPLs are from UWQB (2009) Table 1A.
Results are based on 10,000 realizations of the Model.

PRELIMINARY REVIEW DRAFT

Table 6-3

Cumulative Population TEDE: Statistical Summary

	population TEDE (person-rem) within 10,000 yr		
receptor type	**mean**	**median (50th %ile)**	**95th %ile**
total population	12	11	26
ranch worker	2.8	2.5	5.7
hunter	1.5	1.3	3.0
OHV enthusiast	8.3	7.4	17

Results are based on 10,000 realizations of the Model.
TEDE: Total effective dose equivalent

PRELIMINARY REVIEW DRAFT

Table 6-4

Statistical Summary of Lake Water Concentrations at Peak Lake Occurrence

	Lake concentrations (pCi/L) at 90,000 yr		
radionuclide	**mean**	**median (50th %ile)**	**95th %ile**
uranium-238	2.1E-5	0.018	0.11
radium-226	0.15	0.54	2.4
thorium-230	0.15	0.55	2.4

Results are based on 1,000 simulations of the Model

PRELIMINARY REVIEW DRAFT

Table 6-5

Statistical Summary of Sediment Concentrations at Peak Lake Occurrence

	Sediment concentrations (pCi/g) at 90,000 yr		
radionuclide	**mean**	**median (50th %ile)**	**95th %ile**
uranium-238	1.8E-3	2.0E-2	9.5E-2
radium-226	1.2E-3	5.0E-3	2.2E-2
thorium-230	1.2E-3	5.0E-3	2.3E-2

Results are based on 1,000 simulations of the Model

PRELIMINARY REVIEW DRAFT

The deep-time model disperses the above-ground radionuclides that have migrated upward from the depleted uranium waste prior to the occurrence of the first returning lake. The current disposal scenario has the entire depleted uranium waste disposed below grade. The model assumes that no material below grade is dispersed. Based on these results, it is reasonable to expect that the deep-time concentrations could be close to or possibly less than background concentrations for uranium in soil of about 1 pCi/g (Myrick, et al., 1981) and approximately 2 pCi/L for background uranium concentrations in the Great Salt Lake (CRWQCB, 1990). In addition, the return of the first lake is considered likely to be several tens of thousands of years, or even a few hundreds of thousands of years, into the future, at which point eolian deposition will result in sedimentation deposits around the site of several meters. This deposition will both stabilize the site and make it even less likely that any below-grade material will be dispersed.

The quantitative results for all Model analyses are summarized in Table 6-6. Doses to all receptors are always less than the 500 mrem (IHI) and 25 mrem (MOP) annual performance criteria. Groundwater concentrations are always less than the GWPLs. Even in the case of ^{99}Tc, the peak median, mean and 95% groundwater concentrations are well below the GWPL of 3,790 pCi/L.

The results overall demonstrate that the below-grade disposal configuration can be used to dispose of the quantities of depleted uranium waste included in the Model in a manner adequately protective of human health and the environment.

PRELIMINARY REVIEW DRAFT

Table 6-6

Quantitative Assessment Results for Model Analyses

performance objective	meets performance objective?
Dose to MOP below regulatory threshold of 25 mrem in a year	Yes
Dose to IHI below regulatory threshold of 500 mrem in a year	Yes
Groundwater maximum concentration of ^{99}Tc in 500 years < 3790 pCi/L	Yes
ALARA average total population cost equivalent over 10,000 years:	$61,200

PRELIMINARY REVIEW DRAFT

SECTION 7. OCCUPATIONAL RADIATION PROTECTION

In compliance with UAC R313-15-101, Energy*Solutions* has developed a Radiation Protection Program, which contains procedures and policies to ensure that occupational radiation exposures are controlled within the limits of UAC R313-15-201, UAC R313-15-207, UAC R313-15-208, and UAC R313-15-301. The Program also ensures that exposures are maintained as low as is reasonably achievable, in accordance with UAC R313-15-101(2). Energy*Solutions* integrates the principles of ALARA into all activities related to exposures of personnel.

7.1 OCCUPATIONAL RADIATION EXPOSURES

Energy*Solutions* has created an organizational structure and established personnel responsibilities and activities to ensure that ALARA policy and procedures are not compromised because of pressures from operational activities. In support of this position, ALARA principles are incorporated into facility operations, training, development of radiation protection procedures, and design reviews.

Energy*Solutions'* Radiation Protection Program ensures that all reasonable actions are taken to reduce radiation exposures and effluent concentrations to levels that are considered ALARA. Energy*Solutions'* ALARA management policy is detailed in the ALARA Program. The ALARA Program is based upon past and continuing experience with radiation operations. As new waste-handling procedures are developed, the ALARA Program is modified to reflect the changes. Specific guidelines for operational reviews and modifications to the ALARA Program are therein detailed.

7.2 RADIATION SOURCES

In order to produce suitable fuel for nuclear reactors and/or weapons, uranium has to be enriched in the fissionable ^{235}U isotope. Uranium enrichment in the US began during the Manhattan Project in World War II. Enrichment for civilian and military uses continued after the war under the U.S. Atomic Energy Commission, and its successor agencies, including DOE.

The uranium fuel cycle begins by extracting and milling natural uranium ore to produce "yellow cake," a varying mixture of uranium oxides. Low-grade natural ores contain about 0.05 to 0.3% by weight of uranium oxide while high-grade natural ores can contain up to 70% by weight uranium oxide (NRC, 2010). Naturally occurring uranium contains three isotopes, ^{238}U, ^{235}U, and ^{234}U. Each isotope has the same chemical properties, but they differ in radiological properties. Naturally occurring U has an isotopic composition of about 99.2739±.0007% ^{238}U, 0.7204±.0007% ^{235}U, and 0.0057±.0002% ^{234}U (Rich et al., 1988).

The milled ore is refined to remove the decay products (^{226}Ra, ^{230}Th, etc.) that have built up in the material naturally to the degree of secular equilibrium, leaving more or less pure uranium oxide. This uranium, still at natural isotopic abundances, is enriched to obtain the ^{235}U, with vast quantities of ^{238}U as a by-product. Although a variety of technologies exist for enrichment, the most prevalent enrichment process at the time was by gaseous diffusion, which requires that the uranium be converted to a gaseous form: uranium hexafluoride (UF^6). This gas is introduced to a diffusion cascade, which separates the isotopes, generating enriched uranium as a product, and depleted uranium hexafluoride (DUF_6) as a waste stream. Depleted

PRELIMINARY REVIEW DRAFT

uranium isotopic ratio values from gaseous diffusion plants are roughly 99.75% ^{238}U, 0.25% ^{235}U, and 0.0005% ^{234}U (Rich, et al., 1988), but the ^{235}U assay found in the cylinders today varies with fluctuating enrichment goals, operational conditions, and where in the cascade process the depleted uranium was removed. Because processing of uranium has been practiced for only about 60 years, there has not been sufficient time for appreciable in-growth of decay products in this by-product. Depleted uranium is therefore considerably less radioactive than natural uranium because it has less ^{234}U and other decay products per unit mass. The bulk of this material is still stored in the original cylinders in which it was first collected at the gaseous diffusion plants.

Uncontaminated depleted uranium consists principally of three isotopes of uranium (^{238}U, ^{235}U, and ^{234}U) and a small amount of progeny from radioactive decay of these isotopes. Trace amounts of other uranium isotopes (^{232}U, ^{233}U, and ^{236}U) may also exist. The bulk of the depleted uranium at the gaseous diffusion plants is uncontaminated uranium, but a significant amount of contaminated depleted uranium also exists, both at the gaseous diffusion plants and in all the depleted uranium waste from the Savannah River Site.

The contamination problem arises from the past practice of introducing reactor returns into the isotopic separations process. Irradiated nuclear fuel underwent a chemical separation process to remove the plutonium for use in nuclear weapons. Uranium, then thought to be a rare substance, was also separated out, but contained some residual contamination from activation and fission products. This uranium was again converted to UF_6 for re-enrichment, and was introduced to the gaseous diffusion cascades, contaminating them and the storage cylinders as well. Based on laboratory analysis of the contents of contaminated depleted uranium waste (including all radionuclides in the containers), the species in the disposed inventory include X(Beals, et al. 2002, Energy*Solutions* 2009b, and ORNL 2000c).

The types and quantities of depleted uranium materials are sources of external gamma, alpha, beta, and neutron radiation. Personnel exposure to these materials will happen at various times e.g while in the delivery conveyances awaiting unloading; during storage; while being sampled and prepared for laboratory analysis; while being actively worked in the proposed Federal Cell Facility; and while exposed following disposal. While unlikely for depleted uranium, dose rate on packages could be in excess of 200 R/hr.

Depleted uranium wastes may also be potential sources of internal exposure during unloading at the rail car rollover or bulk unloading area; while being sampled and prepared for laboratory analysis; while being worked in the disposal cell or mixed waste treatment; and while exposed following placement in the Federal Cell Facility. Internal doses are not expected to exceed 50 mrem per year.

The most consistent source of radiation dose at the Clive Disposal Complex is external gamma radiation. In recognition of that, Energy*Solutions* has set aggressive dose investigation levels for workers, based upon annual ALARA goals per quarter deep dose equivalent. It is highly unlikely that workers at Clive exceed that level each quarter. Control of external gamma exposures during waste handling operations is the primary method of reducing dose. Energy*Solutions* will continue to rely primarily upon time, distance and shielding to control employee exposure. Energy*Solutions* manages shipments under a radiation work permit (RWP) to keep doses ALARA.

Energy*Solutions* has an aggressive policy of dose minimization. Waste streams require the preparation of a Radiation Work Permit (RWP) that lists the specific radiation protection requirements. Common requirements include clothing to be worn, the use of self-reading personal dosimeters, respiratory protection, and special monitoring requirements. Special situations may include requiring a Radiation Safety technician

PRELIMINARY REVIEW DRAFT

to be present, the use of remote handling equipment, dust suppression requirements, air monitoring or survey requirements, stay times, or other controls needed to keep exposure ALARA. In addition, all workers are trained in ALARA principles, especially in maintaining their distances from gamma sources and spending the least amount of time necessary in gamma fields to get the job done.

Energy*Solutions* will continue to use standard health physics practices of limiting time in areas with higher gamma dose rates, using respiratory protection at low airborne radioactivity concentrations, covering higher activity wastes with lower activity wastes or clean soil to reduce gamma exposures and resuspension of airborne particulates, and routinely monitoring work area radiation levels to protect workers from chronic exposure from low level radiation sources.

All personnel entering the Restricted Area are required to wear radiation dosimeters at all times. Permanent employees are issued a TLD badge or equivalent, as approved by the Clive Facility Radiation Safety Officer. These badges are exchanged quarterly or read as soon as practical upon termination of employment. Badges are selected that measure the skin dose equivalent (shallow dose) as well as the deep dose equivalent for compliance with UAC R313-15-203 and UAC R313-15-502 and are worn in the proper place as instructed by the Radiation Safety Officer. All badges, along with control badges, are maintained in designated areas at the Clive site when the employee is not at work.

Should the Radiation Safety Officer determine that it is necessary to measure the shallow dose rather than use a TLD, or equivalent devices, Energy*Solutions* implements a procedure to calculate the shallow dose by applying a correction factor to the TLD, or equivalent reading(s). All exposures will be recorded when received from the dosimetry vendor to demonstrate compliance with the standards. In the event that an individual loses their TLD or equivalent, the Radiation Safety Officer or his designee will investigate the potential exposure conditions and provide a record of the exposure.

Because of the low radionuclide activities in the waste, there is little potential for a significant penetrating or non-penetrating external radiation dose from airborne radioactive material. The deep dose equivalent component of this small dose will be included in the employee's personal dosimeter reading. Energy*Solutions* allows visiting members of the public to access the Controlled and Restricted Areas of the site for tours, visits, and inspections. All visitors requiring access to the Restricted Area are provided dosimetry and an informational briefing appropriate for the expected hazards, and are accompanied by a responsible Energy*Solutions* radiation worker. Procedurally, visitors are not allowed in posted radiation areas or areas where respiratory protection is required. Individuals who are visiting the site on a limited basis will be issued a pocket dosimeter or other self-reading dosimetry to monitor their external gamma radiation dose. The dosimeter is read upon exiting the Controlled Area and recorded on the Access Log. In the case of individuals visiting as a group, one dosimeter may be used providing they stay together.

Energy*Solutions* pursues a policy of dust prevention to keep airborne particulate radioactivity ALARA. However, as part of its ALARA Program, Energy*Solutions* requires all workers, in situations where they may be unknowingly exposed to airborne particulate radioactivity, to wear respiratory protection providing a protection factor of at least 10. With the combination of dust control and respiratory protection it is anticipated that internal doses will never exceed 50 mrem per year.

Ambient air radon concentrations are continuously monitored at the environmental stations on and around the site. Outdoor radon measurements have not shown any definite elevations above background levels. Laboratory measurements, where samples are stored and prepared for analysis, show occasional

PRELIMINARY REVIEW DRAFT

concentrations approximately 0.5 pCi/L above ambient concentrations (less than two percent of the DAC for radon with daughters present).

The regulatory requirements for determining the occupational internal dose are in UAC R313-15-204. Energy*Solutions* uses the dose calculations methods described in Regulatory Guide 8.34, but uses data based on the updated Dose Conversion Factors of ICRP 68 in lieu of the ICRP 30 Dose Conversion Factors to perform these dose calculations. The chemical form of significant dose contributors are determined as needed from the waste manifests, air sample data, or other available sources of information. The applicable lung clearance class is determined from the tables in ICRP 68. If the chemical form of significant dose contributors cannot be determined, the most restrictive class is used in the dose assessment. The Environmental Monitoring Plan lists the specific method, formula, and dose conversion factors that are used at the Facility to determine internal dose to workers, based on the Effluent Concentration Limit (ECL) Radionuclide which, if inhaled or ingested continuously over the course of a year, would produce a stochastic total effective dose equivalent of 50 mrem.

The indication provided by workplace air sampling guides the subsequent assessments of possible internal doses from inhaled radioactive materials. Regulatory Guide 8.34 provides several acceptable methods for determining internal doses from inhaled radionuclides. When necessary to calculate an employee's internal dose from inhaled radioactive material, Regulatory Guide 8.34 guides the dose calculations, with updated data based on the Dose Conversion Factors of ICRP Publication 68. When initial estimates indicate a potential dose equivalent in excess of 100 mrem (CDE or CEDE), additional evaluations are performed to further assess the dose and guide follow-up actions.

The ingestion of radionuclides at the Energy*Solutions* site is suppressed primarily by prohibiting eating and drinking inside Restricted Areas (with the exception that drinking from closeable beverage containers is allowed). In addition, the use of respiratory protection in the most highly contaminated areas minimizes the potential for facial contamination and subsequent ingestion of radioactive material.

Employees at the Energy*Solutions* Clive site are normally protected from intake through wounds and skin absorption by wearing protective clothing. Requirements for wearing person protective equipment included in each Radiation Work Permit. Should an accident result in an open wound, the Radiation Safety Officer notifies the attending physician located at the Tooele County or University of Utah Hospitals, of the fact for his guidance in effecting removal or reduction of the amount of radioactive material remaining in the wound. The Radiation Safety Officer then performs an investigation and estimates the intake using data from wound monitoring or other available information.

7.3 RADIATION PROTECTION DESIGN FEATURES

Energy*Solutions* has incorporated the design and operational experience of its other facilities into the design of this License's Federal Cell Facility to minimize the potential for radiation exposures. As such, the Federal Cell Facility design is directed toward reducing the occupational exposures. The entire Federal Cell Facility will be enclosed by a fence, and considered a Restricted Area. All personnel working in the Restricted Area are required to pass through an Access Control point. Access to exposure areas at the facility is controlled. All vehicles and personnel working in the Restricted Area are monitored for removable contamination prior to release.

PRELIMINARY REVIEW DRAFT

Energy*Solutions* employs the radiation exposure controls of time, distance and shielding, as appropriate. Waste receipts with dose rates in excess of 5 mrem/hr are controlled and posted as described in the Radiation Safety Program. Radiation Work Permits are used to control worker exposure during waste handling and include time controls or take advantage of natural shielding afforded by equipment as necessary and appropriate. Higher activity wastes are covered, except when being actively worked, by lower activity wastes to reduce exposures to workers in the area. For management of bulk wastes, the primary radiation control factors are time and distance. Conversely, the use of portable shielding during the waste disposal process is used as needed to minimize dose to the workers. Additionally, the nuclear density gauges are stored away from active work areas and are shielded by lead bricks when in storage.

Since waste handling and disposal activities are generally conducted outdoors, no special ventilation provisions are made for those activities. However, laboratory areas require normal ventilation and hoods. Work area air samples are collected in the building to confirm the effectiveness of ventilation.

External gamma radiation monitors are used to document gamma radiation exposure levels. Surveys of gamma dose rates and surface contamination are collected weekly. Any areas meeting the definition of a Radiation Area are posted.

Airborne radioactive particulates are monitored on a continuous basis. The continuous airborne particulate samplers, operated on-site as part of the Environmental Monitoring Plan, provide an overall average airborne radioactivity concentration. In addition to the fixed-location environmental stations, work-place samples are also collected to better assess potential exposure to employees. The work area air samplers are used at locations such as the rail car rollover, haul roads, the mixed waste treatment building, or near excavation, disposal and other work activities to collect workday samples. Work area samples are collected several times a week.

In addition to the passive environmental radon monitors used at environmental monitoring stations, indoor radon concentrations are measured in the LLRW and Mixed Waste Operations buildings.

Radiation Safety instrumentation used for Energy*Solutions*' Radiation Protection Program include a variety of portable and laboratory equipment selected to perform specific functions in monitoring of gross gamma exposure rates, surface contamination, alpha and beta radioactivity of filters and smear samples and personnel contamination. Instruments are calibrated, at a minimum every 12 months and are checked each working day for consistency of response to a known source.

7.4 RADIATION PROTECTION PROGRAM

Energy*Solutions*' Radiation Protection Program has been developed to establish Clive Facility requirements to receive, possess, process, use, transfer or dispose of licensed LLRW. Energy*Solutions* is committed to managing its operations involving exposure to ionizing radiation and radioactive materials by incorporating the philosophy that such doses should be ALARA. Energy*Solutions*' Radiation Protection Program establishes the measures that management uses to ensure that appropriate regulatory requirements and policies, programs and procedures are met. The Radiation Safety Officer reviews Energy*Solutions*' Radiation Protection Program annually.

PRELIMINARY REVIEW DRAFT

A respiratory protection program has been implemented, based on NRC guidance (NRC, 1976). The program elements include employee training, quantitative fit testing, cleaning and maintenance, written standard operating procedure covering the program, medical surveillance, and recordkeeping. The Radiation Safety Officer is responsible for administering the Respiratory Protection Program.

It is the policy of Energy*Solutions*, to maintain personnel/occupational radiation exposures ALARA. Because of the nature of LLRW, experience has shown that radiation exposures are normally low and Energy*Solutions* is committed to continuing to minimize exposures to the workers and the environment. As is illustrated in Table 7-1, the employee doses since 1992 have been well below federal standards for radiation workers (as compared to the average annual dose for 294 workers involved in the Vitro Remedial Action Project during 1986 which was 50 mrem, with maximum exposures of 250 mrem). This maximum value is only 5% of the radiation dose standard of UAC R313-15-1101. Energy*Solutions*' annual employee dose summary since 1992 is presented in Table 7-1. Procedures and methods to keep internal exposures ALARA include:

a. Dust suppression on all operational roads by application of water or other dust suppressant materials or methods (e.g., Magnesium Chloride) as necessary;

b. Speed limit of 25 mph on all site roads;

c. Stopping operations in high wind conditions (all operations cease at winds of greater than or equal to 35 mph; radiation safety personnel have authority to stop operations at lower wind speeds if dusting or other safety considerations warrant);

d. Weekly area radiation surveys with investigation of increasing levels to determine the cause;

e. Requiring workers to wear respirators in areas of potential high dust concentrations, for example, the rollover and selected heavy equipment operations;

f. Pre-planning tasks that have the potential for higher than normal exposures to limit exposures through efficient use of time and handling procedures; and

g. Reviews of new proposed Waste Profile Records to assure that Energy*Solutions*' procedures, facilities, and equipment are appropriate and sufficient to limit exposures to workers and the environment.

PRELIMINARY REVIEW DRAFT

Table 7-1

Energy*Solutions* Employee Annual Dose Summary

Year	Dose (mrem) <1	Dose (mrem) 10-50	Dose (mrem) 51-100	Dose (mrem) 101-150	Dose (mrem) 151-200	Dose (mrem) 201-250	Dose (mrem) 251-500	Dose (mrem) 500+
1992	20	40	11	2	1	1	0	0
1993	92	5	1	0	0	0	0	0
1994	93	15	1	0	0	0	0	0
1995	84	62	4	0	0	0	1	0
1996	209	16	0	2	0	0	0	0
1997	325	61	1	0	0	0	0	0
1998	412	104	4	0	1	0	0	0
1999	363	138	19	5	2	1	1	0
2000	431	154	37	6	5	6	5	1
2001	538	85	21	8	5	0	1	0
2002	483	105	27	5	4	3	1	0
2003	520	74	13	3	2	7	0	0
2004	441	142	30	9	6	7	0	0
2005	649	103	26	14	3	9	0	0
2006	495	70	15	6	2	2	6	0
2007	287	59	5	6	2	3	5	0
2008	232	45	8	5	3	2	5	0
2009	239	39	12	3	2	0	6	0
2010	263	42	8	6	2	1	3	0
2011	215	54	14	7	4	4	6	0
2012	240	34	8	3	0	0	6	0
2013	160	25	17	3	1	0	5	0
2014	123	22	9	6	2	1	7	0
2015	136	33	11	3	5	1	6	3
2016	152	42	13	7	4	1	5	3
2017	232	25	17	3	3	2	2	2
2018	216	25	12	1	1	2	2	0
2019	233	32	11	3	2	0	3	0

PRELIMINARY REVIEW DRAFT

The Radiation Safety Officer has the day-to-day responsibility for maintaining occupational and environmental radiation exposures ALARA, consulting such guidance documents as NRC Regulatory Guides 8.31 (NRC, 2002) and 8.37 (NRC, 1993a). The Radiation Safety Officer documents ALARA activities including:

a. Monthly reviews of work area, perimeter, and environmental air monitoring results noting trends and adjusting work procedures when practical to further reduce potential exposures; and

b. Monthly reviews of work area gamma-ray exposure rates and advising the Vice President and General Manager of Clive Operations on operational changes that will reduce radiation exposure.

An audit of ALARA activities is conducted and documented by the Radiation Safety Officer at least annually.

All personnel working in the Restricted Areas are monitored for potential skin contamination each time they exit the area. Workers are advised to consider any measurable skin contamination as excessive, and all personnel must meet release criteria before they leave the Restricted Area. Energy*Solutions* has set ALARA limits for personnel contamination monitoring at 100 dpm/100 cm^2 gross alpha for skin and clothing, 300 dpm/100 cm^2 gross alpha for the soles of shoes, and 1,000 dpm/100 cm^2 gross beta for skin, clothing, and the soles of shoes. A hand and foot monitor, or equivalent, sensitive to both alpha and beta contamination are used for routine monitoring for personnel contamination.

Personnel are expected to accomplish any necessary decontamination by washing exposed areas of the skin with soap and water. If this does not reduce the levels below the criteria, the Radiation Safety Officer is notified and other attempts made. Special radiation decontamination cleansers may be used to reduce skin contamination levels as needed. Personnel with skin contamination above the limits are not allowed to leave the site without approval of the Radiation Safety Officer. All personal contaminated clothing or personal articles that cannot be decontaminated below the limits are retained at the site and managed as radioactive waste. All personnel contamination events are documented.

Routine external gamma surveys using a gamma scintillation survey meter are conducted in waste management and disposal. In addition, random external gamma surveys are performed during daily operations as considered necessary by Radiation Safety personnel.

Routine smear surveys for surface contamination are conducted in office and laboratory areas. The smears are analyzed for gross alpha and gross beta contamination. Smear samples are compared to previous samples from the same area. The Radiation Safety Officer reviews any increase in surface contamination, deciding on the need for decontamination. In keeping with Energy*Solutions'* ALARA goals, any increase in contamination is normally cleaned when found and the area re-sampled.

Routine worker evaluations demonstrate that it is extremely unlikely that any employee could receive a lung burden of radioactivity that would require any action. If such an event happens, the individual involved receives a whole-body count to evaluate the potential dose. Subsequent actions, such as reassignment to a function not involving radiation exposure are then considered.

A worker might also be injured in an accident that would result in the impaction of radioactive material into a wound. In such a case, Energy*Solutions* attempts to monitor injured employees before they are transported

PRELIMINARY REVIEW DRAFT

to medical care. In any case, the treating physician is informed that the injury involves possible radioactive contamination. Because the radionuclides involved are relatively insoluble, normal cleansing of the wound generally removes most, if not all, of the radioactivity. A radiation survey is used to estimate any remaining radioactivity and potential doses calculated. The determination of need for additional treatment is based on monitoring results.

Bioassay samples are used, as necessary, to help determine the body burden of any radioactivity that has resulted from an unusual inhalation or wound. Any employees who are believed to have received a TEDE of greater than 100 mrem from any source in one quarter are notified and assist in determining the source of the exposure and in finding a way to reduce future exposures.

Summation of external and internal doses is required in UAC R313-15-202 when both internal and external monitoring of an individual are required by UAC R313-15-502(1) and (2). The cumulative operating experience at the Clive site indicates that the monitoring criteria of UAC R313-15-502(1) and (2) are not likely to be exceeded. However, should Energy*Solutions* find that summation of occupational internal and external doses is necessary, one of the five methods for calculating the Committed Effective Dose Equivalent (CEDE), as described by NRC (NRC, 1993b), or an equivalent method, is used. ALI, DAC, and ECL values based on the ICRP 68 conversion factors will be calculated, as needed for internal dose estimation, following the methodology described in Appendix B of 10 CFR 20.

If any employee is anticipated to receive an occupational dose in excess of 10 percent of the occupational limits, Energy*Solutions* will determine the previous radiation exposure for use in limiting the annual dose equivalent to the allowable limits and for planning special exposures. Determination of prior occupational exposures will be done by:

1. Obtaining a written, signed statement from the employee or his most immediate employer, that discloses the nature and the amount of any occupational dose that the individual may have received during the current year; or

2. Obtaining or attempting to obtain from the employee's most recent employer, a written, signed statement in the form of an NRC Form 4 or an equivalent form, showing the life-time occupational exposure history. In case this cannot be done, the guidance in UAC R313-15-205 will be followed.

Energy*Solutions* does not anticipate authorizing planned special exposures since the radiation levels and radioactive constituent concentrations in depleted uranium are low. In the event that circumstances warrant a planned special exposure, Energy*Solutions* does so in full compliance with the guidance in UAC R313-15-206.

The annual occupational dose limits for minors are 10 percent of the annual dose limits specified for adults. However, in accordance with Energy*Solutions*' Radiation Protection Program, minors are not granted access to the Restricted Area. Similarly, the dose limit to an embryo/fetus is 0.5 rem during the entire pregnancy (in accordance with UAC R313-15-208). Energy*Solutions*' policy is to inform female workers of the regulations regarding protection of the embryo/fetus and to ask them to inform Energy*Solutions* in writing, upon discovery or suspicion of a pregnancy. The Radiation Safety Officer reviews the work assignments and offers the woman the opportunity to take available positions in non-radiation areas for the duration of the pregnancy. If no positions are available, the Radiation Safety Officer counsels the individual to assure an understanding by the individual of the additional risks of continued employment. If the woman continues to work in the

PRELIMINARY REVIEW DRAFT

Radiation Area, the Radiation Safety Officer monitors the work assignments and activities to assure that the Total Effective Dose Equivalent (TEDE) to the embryo/fetus is ALARA and limited to 0.5 rem.

Operations are conducted such that the resulting dose equivalent to any individual members of the public is less than the limits of UAC R313-15-301, UAC R313-25, and the ALARA constraint of UAC R313-15-101. Compliance with UAC R313-15-301 is demonstrated using the data acquired under the Environmental Monitoring Plan. Airborne particulate monitoring is performed to confirm those predictions.

The analysis addresses the specific impacts of releases under normal operating conditions. Release mechanisms were evaluated, exposures to workers and the public assessed, and the results compared to applicable standards and regulations. It was concluded that with the proposed waste characteristics and operating procedures, exposures to the workers and the public will be within acceptable limits and the design limits the radon flux to less than 20 pCi/m^2/s as provided in Appendix A of 10 CFR Part 40.

Energy*Solutions'* Federal Cell Facility will be operated in accordance with Energy*Solutions*' Air Approval Order (DAQE-AN107170021-19), which requires Energy*Solutions* to apply dust suppression when minimum waste moisture conditions as well as optimum air opacity standards do not exist. Air is continuously sampled at work place locations surrounding the Federal Cell Facility, Restricted Area, and the Clive Facility. Individual results with a net alpha or net beta concentration above the applicable Particulate Air Sample Action Level are also analyzed by gamma spectroscopy. Gamma spectroscopy analysis results are reviewed to determine if any additional actions need to be taken. Air is also continuously sampled for radon.

The following items are surveyed each week,

- Site warning signs must be visually checked weekly to determine that the signs are present, visible and legible.

- The supply of personal protection equipment is inspected weekly to ensure that each employee has a proper supply or access to gloves, boots, coveralls, hard-hat, goggles, and respiratory protection.

The daily BAT inspection includes:

- **Check roads**. The inspector must drive the access and facility roads to visually inspect them for deterioration, erosion and evidence of spills;

- **Loading and Unloading Areas**. Visually inspect the loading and unloading areas. Note stains, residues, and any evidence of a spill or leak;

- **Container storage area**. The container storage area must be inspected for evidence of a spill; and

- **Inspect containers.** The inspector visually inspects the exterior surface area for evidence of leaks, corrosion, deterioration, holes, bulges, and poorly fitting lids.

PRELIMINARY REVIEW DRAFT

Daily BAT inspections are to be performed each day that the facility is in operation. Problems are corrected accordingly:

- Problems that pose an imminent threat to human health or the environment are corrected as soon as possible but no later than 24 hours from the time of discovery;

- Problems that do not pose an imminent threat to human health or the environment are corrected within 72 hours of discovery; and

- If a longer time period is required to correct the problem, Energy*Solutions* notifies the Director prior to the end of the 72-hour period. At the time of notification, Energy*Solutions* proposes a time schedule for correcting the problem. The Director must approve the correction schedule.

The daily security inspection includes:

- **Check fences**. The inspector must inspect the site security devices (fences, gates, doors, and locks) to check for items such as proper functioning, breaks, gaps, erosion, vandalism or damage to the fence fabric, fence posts, gates, etc. The inspector must also check the gates and doors to ensure that the gates and doors are locked or attended by a person assigned to control entry; and

- **Check communication systems**. The inspector performs an audio test on the external communication system (telephone) by ensuring that dial tone exists and that the phone is operational. This test may be conducted by placing and completing a telephone call. The inspector tests the internal communication system (two-way radios, intercom, etc.) by operating the system and achieving communication through the system.

The facility is considered to be in operation in the following instances:

- When off-site LLRW shipments have been received to the facility;

- When LLRW is being added to or removed from the Federal Cell Facility; or

- When LLRW containers are being added to or removed from the storage area.

All equipment, conveyances, railcars, and vehicles exiting the Restricted Area must be monitored, decontaminated if necessary, and released before leaving the Restricted Area. Designated Commercial transports for the exclusive use of waste transport may be released from a Restricted Area as long as the 49 CFR criteria are met. Entrances into parts of the Restricted Area that are not expected to be contaminated under routine conditions may not require equipment (vehicles, cement trucks, haul trucks, etc.), personnel or personal item decontamination. These areas include but are not limited to areas of new construction inside the Restricted Area, unloading docks, and areas in which Federal Cell Facility closure is being performed inside the Restricted Area.

Depending on individual circumstances, vehicles or equipment leaving the site are surveyed in accordance with the unrestricted use of release criteria or to the standards of the DOT release. Unrestricted use release entails decontamination and release to the standards of 49 CFR 173.443. All vehicles, packages, equipment,

PRELIMINARY REVIEW DRAFT

or other items leaving the Restricted Area, except conveyances used for commercial transport of radioactive waste material, are unrestricted use released.

Closed trucks and rail cars used exclusively for transport of radioactive materials are released as described in Radioactive Material License UT2300249, measuring the removable contamination on the exterior surfaces only. Transport vehicles that are being released from exclusive use service will be released as described above, measuring removable contamination on both exterior and interior surfaces. Closed containers used solely for the transportation of radioactive materials may be released, provided that the radiation level at any point on the external surface of the container does not exceed 0.5 millirem per hour:

a. The non-fixed (removable) radioactive surface contamination on the external surface of the container does not exceed the limits of Radioactive Material License UT2300249;

b. The container does not contain more than 15 grams of U-235, the container is in unimpaired condition and is securely closed so that there will be no leakage of radioactive material under conditions normally incident to transportation;

c. Internal contamination does not exceed 100 times the limits of the table above; and

d. Any labels previously applied are removed, obliterated, or covered and the "Empty" label prescribed in 49 CFR 172.450 and the notices are affixed to the container.

Regardless of the type of release, all items must be visibly clean, meaning that all potentially contaminated material that can be removed by a broom, shovel or other tool must be removed. Typical road dust and grime that is on a vehicle as it arrives and is not part of the radioactive waste material being carried does not have to be removed. Trucks, rail cars or reusable containers hauling waste to Energy*Solutions* are released to the DOT standards of 49 CFR 173.443, as set forth in Table 7-1, below.

Documentation of release surveys are kept in the operating record, including item identification number, item type, instruments used, survey results, surveyor's signature, and reviewer's signature. A Radiation Safety Technician performs the release survey and signs the completed form. As a quality control check, a second Radiation Safety Technician signs the completed forms daily after reviewing them for completeness and adherence to release policy. Release of waste conveyances may be performed remotely using field measurements.

Contaminated equipment or vehicles may be decontaminated using brooms, shovels, high pressure water, or other effective means. The waste water is allowed to drain into tanks and transferred to permitted evaporation ponds. In accordance with GWQDP UGW450005, wastewater may also be used for dust suppression on the Federal Cell Facility.

All personnel entering the Restricted Area are required to wear radiation dosimeters at all times. Permanent employees are issued a TLD badge or equivalent, as approved by the Radiation Safety Officer. Badges are exchanged quarterly or read as soon as practical upon termination of employment. They are selected to measure the skin dose equivalent (shallow dose) as well as the deep dose equivalent for compliance with UAC R313-15-203 and UAC R313-15-502 and are worn in the proper place as instructed by the Radiation Safety Officer. All badges, along with control badges, are maintained in designated areas at the Clive site when the employee is not at work.

PRELIMINARY REVIEW DRAFT

All employees will notify their supervisor immediately upon discovery that a TLD or equivalent has been lost. A new dosimeter will be issued prior to the employee's reentry into the Restricted Area. When the Radiation Safety Officer or designee determines that extremity monitoring is warranted, appropriate dosimeters will be obtained from the dosimetry vendor.

All visitors requiring access to the Restricted Area are provided dosimetry and an informational briefing appropriate for the expected hazards, and are accompanied by a responsible Energy*Solutions* radiation worker. Procedurally, visitors are not allowed in posted radiation areas or areas where respiratory protection is required. Individuals who are visiting the site on a limited basis will be issued a pocket dosimeter or other self-reading dosimetry to monitor their external gamma radiation dose. The dosimeter is read upon exiting the Controlled Area and recorded on the Access Log. In the case of individuals visiting as a group, one dosimeter may be used providing they stay together.

Areas near or at the Access Control points are provided for the donning or doffing of personal protective equipment and clothing. Lockers are provided for employees inside the Restricted Area for storage of clothing, personal items, and personal protective equipment. These lockers are located near showers for decontamination if necessary. Lockers outside the Contaminated Restricted area also available to employees for storage of personal items or PPE.

Release limits for skin and clothing are based on the removable and fixed contamination limits specified in Regulatory Guide 1.86. The great majority of alpha-emitting nuclides in the LLRW are uranium and natural thorium with its decay products. For those nuclides, the appropriate alpha release limit for skin and clothing is 1,000 dpm/ 100 cm^2. Similarly, the removable limit for beta/gamma-emitting nuclides is 1,000 dpm/ 100 cm2. Energy*Solutions* also uses this level as the release limit for contamination of skin and clothing by beta/gamma-emitters. Regulatory Guide 8.30 recommends the use of fixed contamination limits for the soles of shoes. Following this example, the release limit for the soles of shoes has been set at 5,000 dpm/ 100 cm^2 for both alpha and beta/gamma activity.

Energy*Solutions* has set an ALARA goal for alpha-emitting radionuclides on the skin and clothing at 100 dpm/ 100 cm^2. Because of the high natural backgrounds associated with beta/gamma monitors, the ALARA goal is the same as the release limit for beta/gamma emitters - 1,000 dpm/ 100 cm^2. The ALARA goal for contamination of the soles of shoes is set at 500 dpm/ 100 cm^2 alpha and 1,000 dpm/ 100 cm^2 beta/gamma.

Contamination of personnel in the Restricted Area is controlled through the use of protective clothing, access control, atmospheric monitoring, and bioassay analysis. Protective clothing is selected according to the requirements of the Safety and Health Manual. Each employee is responsible to keep contaminated clothing and other material inside the Controlled Area. Furthermore, access to the Restricted Area is controlled according to Standard Operating Procedures. While in the Restricted Area, engineering controls and dust suppression techniques are used to minimize levels of airborne particulates. Work area air samples are routinely collected and analyzed.

All monitored individuals are required to participate in a whole body count, with a random selection further required to follow a bioassay program to assist in evaluating internal deposition of radionuclides. A baseline sample is taken either through urinalysis or use of a whole body counter at the beginning of the monitoring period. A termination sample is taken whenever possible either through urinalysis or use of a whole body counter. All in-vivo baseline and termination samples are analyzed by gamma spectroscopy for naturally

PRELIMINARY REVIEW DRAFT

occurring radioactive material, including uranium and Ra-226. Urine samples are analyzed for total uranium and Ra-226. Energy*Solutions* evaluates laboratory bioassay analysis results in accordance with NRC Regulatory Guide 8.9 (NRC, 1993b).

For monitored individuals, a combination of air sampling, personnel contamination monitoring, and bioassay sampling are used to initiate action levels and assess dose intakes and/or uptakes. The radiation safety staff is responsible for taking appropriate actions when certain action levels are exceeded. In accordance with NRC Regulatory Guide 8.9, the action levels for monitored individuals working directly with the waste are:

> Evaluation Level: If internal bioassay measurements indicate that an intake is greater than an intake of 0.02 ALI, additional available data, such as airborne measurements or additional bioassay measurements, should be used to obtain the best estimate of actual intake.
>
> Investigation Level: If a potential intake exceeds an investigation level of 0.1 ALI, multiple bioassay measurements and an evaluation of available workplace monitoring data will be conducted.

Special bioassay sampling is done for individuals involved in an incident determined by the Radiation Safety Officer as having the potential for a significant intake of radionuclides in accordance with the established action levels. Appropriate samples are collected on a periodic basis until activities are below the minimum detectable levels or a determination is made that continued monitoring is not necessary. If the waste contained high Th-232 concentrations, lung or whole-body counting techniques may be employed to measure deposition in the body.

Specific bioassay sampling is also used on a periodic basis for individual personnel working in areas with an elevated potential of intake. The potential of an intake is evaluated by review of air sampling results, work practices, and pre-operational modeling.

Excretion models are used along with waste characterization data, bioassay data, and operational data to estimate the radionuclide intake and the resultant dose to the organs. Methods recommended by NCRP are used (NCRP, 1987). The guidance of UAC R313-15-201 is followed in cases where significant organ doses or Total Effective Dose Equivalents are found.

The worker exposure pathway for radionuclides under normal operations is via the inhalation pathway. Routine chronic exposure to radionuclides is limited by dust control measures and use of respiratory protection. However, to check the adequacy of these measures, in vivo or in vitro methods may be employed periodically, as determined by the Radiation Safety Officer or designee, to assure that intakes are a small fraction of the regulatory limits.

The radiation safety staff under the direction of the Radiation Safety Officer are responsible for selecting appropriate methods, properly assessing dose intakes and reporting the intakes.

The Radiation Safety Officer directs the Radiation Safety and Health Program. In addition, an Independent Industrial Hygienist conducts quarterly industrial hygiene audits.

PRELIMINARY REVIEW DRAFT

SECTION 8. CONDUCT OF OPERATIONS

Energy*Solutions'* corporate level management and technical organizations provide the technical resources to support site characterization, facility design, construction, testing, and operation. Energy*Solutions* corporate organization and technical staff also provide support for safe facility operation, closure, and post-closure activities.

8.1 ORGANIZATIONAL STRUCTURE

Detailed requirements and qualifications for significant organizational positions are described in the Organization Layout of Radioactive Material License UT2300249.

8.2 QUALIFICATIONS OF APPLICANT

Detailed requirements and qualifications for significant organizational positions are described in the Organization Layout of Radioactive Material License UT2300249 (referenced in Condition 32.A), such as the Radiation Safety Officer, Assistant Radiation Safety Officer and Radiation Safety Technicians.

8.3 TRAINING PROGRAM

Energy*Solutions'* Training Program is designed to educate the employees in the fundamentals of handling depleted uranium and other radioactive materials, to provide information on ways of minimizing exposure, and to inform employees of practices and programs aimed at preventing possible spread of contamination. During this training, procedures and precautions are explained and the trainees are required to complete a written or computer based examination. In addition to the above training, all Energy*Solutions* site employees receive periodic refresher training. This training is tailored to the specific employee needs and duties and covers such topics as general occupational safety, radiological safety, and training on any specific items such as new procedures or safety deficiencies. Elements of the training program include evaluation and testing, initial training, continuing training, required qualifications, documentation and storage, and badging.

General facility training is overseen by the Safety and Health Manager. The Radiation Training Program is operated under the direction of the Radiation Safety Officer. Radiation safety training is provided to all persons before they are allowed to enter the Restricted Area. The amount of radiation safety training required for persons to enter the Restricted Area is related to the activities for which the person will enter the Restricted Area. There are three categories of Restricted-Area functions:

1. Permanent Employee. A "*Permanent Employee*" is an employee of Energy*Solutions* hired for a period longer than 20 days, or a long-term employee of a contractor to Energy*Solutions*;

2. Temporary Worker. A "*Temporary Worker*" is a service contractor (electrician, welder, consultant, surveyor, driller, sampler, engineer, fence installer, forklift operator, laborer, mechanic, liner installer, excavator, etc.) who works inside the Restricted Area under a contract or service order but who is not

PRELIMINARY REVIEW DRAFT

an employee on the payroll of Energy*Solutions* or a long-term contractor performing work inside the Restricted Area; and

3. Visitor. A "*Visitor*" is a person whose main interest inside the Restricted Area is to communicate with personnel in the Restricted Area, to observe and/or inspect the operations, facilities, programs, location and compliance at the site. Examples of visitors are compliance inspectors, visiting dignitaries, representatives of organizations and corporations, tour groups, and associates of the above. Most visitors will be required to be in the presence of a qualified escort while in the Restricted Area. Certain visitors, such as compliance inspectors or auditors will not require escorts.

Training requirements have been established for each category. Refresher training is provided to review and update training information. Radiation Safety training is directed by the Radiation Safety Officer. The training includes the following items and topics:

- radioactive nature of the material being handled;
- fundamentals of handling radioactive materials;
- ionizing radiation and biological effects;
- radiation safety standards, principles and procedures;
- emergency procedures;
- methods of radiation protection; and
- a written or computer based examination.

Records of training attendance and a copy of the examination provided are maintained by Energy*Solutions*.

8.4 EMERGENCY PLANNING

Clive Facility Procedure CL-SH-PR-50-0 and Energy*Solutions'* Contingency Plan (Attachment II-6 of the state-issued Part B Permit) established emergency response requirements to protect personnel and the environment in the event of an explosion, a fire, or an unplanned release to the environment. In addition to Energy*Solutions* Clive staff, the Contingency Plan also applies to contractors and visitors at the Clive facility. A copy of the current Contingency Plan is located next to every hard-wired telephone at the Clive Facility.

Notification of the implementation of the Contingency Plan is transmitted on the Emergency Channel or EMT Channel of the Site Radio System and following the protocol established for emergency announcements on the mobile phone system. Emergency communication lists are established as follows:

- Emergency Coordinators and Site Managers: Notifications are made via Assigned Mobile Phone and/or e-mail to this distribution list.

PRELIMINARY REVIEW DRAFT

- Facility EMTs First Responders and Ambulance Drivers: Notifications are made to Assigned Mobile Phones.

- Spill Response Team Members: Notifications are made to Assigned Mobile Phones.

- Facility Leads: Notifications are made to Assigned Mobile Phones (also include e-mail).

- All facility personnel: Notifications are made to group-assigned radios.

A radio group has been established for all facility EMTs. A radio compatible with transmission between facility EMTs is also maintained in the security office and on the facility ambulance. Prior to the beginning of each week the following responsibilities are assigned to qualified personnel:

- Emergency Coordinator

- EMT Leads

- Spill Response Team Leads

These designations are communicated in a weekly coordination meeting among the site management. An ambulance driver is also specified.

Leaking shipments of LLRW are managed and reported in accordance with the requirements found in the License. If the initial identifier observes liquids draining from a waste container or conveyance, the initial identifier contacts Security and implements the Emergency Response Plan.

If the Spill Response Team Leader or Emergency Coordinator is unable to determine the source of the liquid, they must direct action to be taken to control the leaking liquid and move the container into the restricted area (if outside) so that further evaluation can be done to determine the source. The period of time for evaluation will not exceed twenty four hours.

If the Spill Response Team Leader or Emergency Coordinator determines that the liquid is potentially contaminated by means of analytical (pH, radiation detection, etc.) or visual (obvious container integrity breach, free liquids present inside the waste package, etc) observation, the Division will be notified of the incident within 24 hours.

At a minimum, measure the pH of the potentially contaminated liquid and record result(s) on 24 Hour/5 Day Spill Notification Report. Liquid grab sample(s) for radiological analysis may be taken if at least 500 ml of volume is collected.

Surface swipe for radiological or chemical analysis may be performed to identify contamination. All samples submitted to the lab require a Chain of Custody. All reviewed analytical data and Chain of Custodies are attached to the 24 Hour/5 Day Spill Notification Report.

PRELIMINARY REVIEW DRAFT

8.5 REVIEW AND AUDIT

Energy*Solutions'* program for facility review and audit is managed by the Quality Assurance Department. The Quality Assurance audits and surveillances focus on facility operations staff's review of operational activities, the independent review of facility operations, and the independent assessment of activities pertaining to safety enhancement:

1. The functioning of the onsite organization with respect to the review of proposed changes to systems or procedures and of unplanned events that have operational safety significance, including subject matter to be reviewed, organizational provisions for conducting the reviews, and the documentation and reporting of review activities;

2. The procedures and organization used to evaluate safety-related operational activities independent of the operating organization, including how and when such a program is to be implemented, subject matter to be reviewed, organizational provisions for conducting the review, and the documentation and reporting of review activities; and;

3. The provisions to perform independent reviews and assessments of facility activities, including the functions of the review group, organizational provisions for conducting the activities, and the documentation and reporting of these activities.

8.6 FACILITY ADMINISTRATIVE AND STANDARD OPERATING PROCEDURES

No additional administrative or standard operating procedures are expected to be required to support the Federal Cell Facility than those already in use at the Energy*Solutions'* Clive Disposal Complex.

8.7 PHYSICAL SECURITY

The Site's physical security is managed in accordance with the Site Radiological Security Plan (referenced in Condition 54 of Radioactive Material License UT2300249), which establish a barrier and a means to control entry to accomplish the requirements of site security. Additional measures are also identified for specific waste access areas within the Bulk Waste Facility. The Plan and procedures introduce a multi-layer security model containing specific security controls for site access, Restricted Area boundary, and overall waste access. This Plan applies to all personnel who access Energy*Solutions'* facilities. The Plan and procedures further define those subjects and locations germane to physical security, responsible individuals for the implementation and requirements for site security. Security requirements are separated into three general areas:

1. Site Access Boundary Controls: This area addresses population flow control into and out of the Site. It includes security measures in place at the entrance gate to the facility and information electronically gathered from individuals who badge into and out of the Site.

2. Restricted Area Access Controls: All personnel and equipment enter and exit the Restricted Area through designated Access Control Points monitored by Health Physics personnel.

PRELIMINARY REVIEW DRAFT

3. Waste Access Area Control: Security personnel perform daily random security searches on personnel and vehicles accessing these areas. The railcar rollover and intermodal unloading facility are monitored by security personnel, security cameras, or qualified access control personnel.

PRELIMINARY REVIEW DRAFT

SECTION 9. QUALITY ASSURANCE

Energy*Solutions'* Quality Assurance Program addresses design, construction, and operations of the facility. It includes a description of the management systems, assignments of responsibilities, and the organizational structure necessary to accomplish the performance objectives of UAC R313-25. Energy*Solutions* sees the Program as critical to prevent recurrence of problems. As such, root causes of problems are promptly identified and corrected.

Energy*Solutions'* policy is to perform all of the work activities comprising facility operations in such a manner that required quality is attained or exceeded. In pursuit of this objective, Energy*Solutions* has developed a Quality Assurance Program, which is consistent with guidance provided by the Nuclear Quality Assurance Standard, ANSI/ASME NQA-1, Quality Assurance Program Requirements for Nuclear Facilities, and satisfies the special needs of a LLRW disposal facility. This Program is described in the Energy*Solutions'* Quality Assurance Program Document, containing a series of quality methods and procedures that define the requirements. The Energy*Solutions'* Quality Assurance Program is further documented by, and implemented using more specific and detailed functional procedures. This Program will ensure that risks, safety, reliability, and performance are maximized through the application of effective management systems commensurate with the risk posed by the facility and its operations. In addition, this program will provide an environmental management system to minimize environmental impacts with the prevention of pollution and continuous improvement of environmental performance.

Energy*Solutions'* organizational structure, functional responsibilities, levels of authority and lines of communication for activities affecting quality are established and documented. The Waste Management (WM) Director of Quality Assurance is responsible for assuring that the Quality Assurance Program is established and verifying activities affecting quality have been correctly performed. The WM Director of Quality Assurance has sufficient authority, access to work areas and organizational freedom to:

- Identify quality problems;
- Initiate, recommend, or provide corrective actions to quality problems;
- Verify implementation of corrective actions; and
- Control further processing, installation or use of an item or activity until proper disposition of a nonconformance, deficiency, or unsatisfactory condition has occurred.

The WM Director of Quality Assurance has direct access to responsible management at a level where appropriate actions can be effected. The WM Director of Quality Assurance reports to the WM Division President.

Quality is achieved and maintained by those individuals who are assigned responsibility for performing the work. Quality achievement is verified by other individuals not directly responsible for directing the work. Where more than one organization is involved in the execution of verifying activities that affect quality, the responsibility and authority of each organization shall be clearly established and documented.

PRELIMINARY REVIEW DRAFT

9.1 DESIGN CONTROL

Energy*Solutions* has established measures to define, control and verify design. Applicable design inputs is appropriately specified on a timely basis and correctly translated into design documents. Design interfaces shall be identified and controlled. Persons other than those who designed the item verify design adequacy. Design changes, including field changes, are governed by control measures commensurate with those applied to the original design. Design documents are adequate to support facility design, construction, and operation. Appropriate quality standards are identified and documented and their selection reviewed and approved. Changes from specified quality standards, including the reasons for the changes, are identified, approved, documented and controlled.

9.2 PROCUREMENT DOCUMENT CONTROL

Energy*Solutions*' procurement system ensures that items and services comply with established requirements and perform as specified. Applicable design bases and other requirements necessary to assure adequate quality are included or referenced in documents for the procurement of items or services.

Design and operational requirements are incorporated into corresponding purchase requirements so that prospective suppliers are evaluated before orders are placed; and that items received, and services provided are verified as complying with purchase requirements.

Procedures provide instructions for identifying, controlling, distributing and approving documents, including those provided by the supplier. They also specify criteria for purchasing commercial grade items and for preventing the purchase of suspect or counterfeit material.

Procurement documents require that all suppliers have an established management system that implements appropriate controls for the service of items being procured. The extent of the program required depend on the type and use of the item or service being procured.

9.3 INSTRUCTIONS, PROCEDURES, AND DRAWINGS

Activities affecting quality are prescribed by documented instructions, procedures, or drawings of a type appropriate to the circumstances and are accomplished in accordance with these instructions, procedures, or drawings.

Instructions, procedures, or drawings include appropriate quantitative or qualitative acceptance criteria for determining that prescribed activities have been satisfactorily accomplished.

9.4 DOCUMENT CONTROL

Energy*Solutions* controls the preparation, approval, issue, and changes of documents that specify quality requirements or prescribe activities affecting quality. Such documents, including changes thereto, are reviewed for adequacy, and approved for release by authorized personnel.

PRELIMINARY REVIEW DRAFT

Document Control is the act of assuring that documents are reviewed for adequacy, approved for release by authorized personnel, and distributed to and used at the location where the prescribed activities performed.

Energy*Solutions*' control system provides for:

- Identification of documents to be controlled and their specific distribution;
- Assignment of responsibility for preparing, reviewing, approving, and issuing documents;
- Review of documents for adequacy, completeness, and correctness prior to approval and issuance.

Revisions to documents are reviewed and approved by the same individuals or organizations that performed the original review and approval.

9.5 CONTROL OF PURCHASED ITEMS AND SERVICES

Energy*Solutions* controls the procurement of items and services affecting quality to assure conformance with specified requirements. Such control provides for the following as appropriate: source evaluation and selection, evaluation of objective evidence of the quality furnished by the supplier, source inspection, audit, and examination of items and services upon delivery or completion.

Procurement activities are planned and documented to assure a systematic approach to the procurement process.

The selection of suppliers is based on evaluation of their capability to provide items or services in accordance with the requirements of the procurement documents. The methods selected for evaluating a supplier are based on the importance, complexity, and value of the items or services being procured.

Suppliers are monitored to ensure compliance with performance and schedule. Monitoring may include assessments, surveillance of work activities; inspection of items, facilities and processes; review of plans and progress reports; processing change information; and review and disposition of nonconformance reports.

The procurement process includes verification of acceptability of items or services. Verification includes (as appropriate) inspecting materials, equipment or activities at the supplier facility; reviewing objective evidence; testing items before or after shipment; inspecting products of services at receipt; or testing items after installation.

Nonconforming items or services are documented and controlled to preclude inadvertent use. Deviations from procurement requirements are documented and reviewed and approved in accordance with implementing procedures.

Commercial grade items are procured in accordance with the Quality Assurance Program Document. Commercial grade items are identified in the purchase requisition by the manufacturer's published product description. Receipt inspection are performed for damage, and that any specified documentation was received and is acceptable.

Commercial grade items are items not subject to design or specification requirements that are unique to nuclear facilities; used in applications other than nuclear facilities; and/or ordered from the

PRELIMINARY REVIEW DRAFT

manufacturer/supplier on the basis of specifications set forth in the manufacturer's published product description (for example, catalog).

9.6 IDENTIFICATION AND CONTROL OF ITEMS

Energy*Solutions* assures that only correct and accepted items are used, treated, installed or disposed. Identification shall be maintained on the items or in documents traceable to the item, or in a manner, which assures that identification is established and maintained.

Physical identification is the preferred method of identification. Where physical identification on the item is either impractical or insufficient, physical segregation, procedural control, or other appropriate means are employed.

When specified by permits, licenses, or specifications that include specific identification or traceability requirements, the program is designed to provide such identification and traceability control.

9.7 CONTROL OF PROCESSES

The scope of Energy*Solutions*' quality-affecting business activities requires no welding, heat treating or non-destructive examination, therefore this criterion is Not Applicable.

9.8 INSPECTION

Energy*Solutions* plans and executes inspections required to verify conformance of an item or activity to specified requirements. Inspection results are documented. Persons other than those who perform or directly supervise the activity perform inspections for acceptance.

Inspection requirements and acceptance criteria include specified requirements contained in the applicable design documents or other pertinent technical documents. Inspection activities are documented and controlled by instructions, procedures, drawings, checklist, travelers, or other appropriate means.

Each person who verifies conformance of work activities for the purpose of acceptance is qualified to perform the assigned inspection task. Inspections by persons during on-the-job training for qualification are performed under direct supervision of a qualified person and verification of conformance is by the qualified person until certification is achieved.

Inspection of items in process or under construction is performed for work activities where necessary to verify quality. If inspection of processed items is impossible or disadvantageous, indirect control by monitoring of processing methods, equipment, and personnel is provided. Both inspection and process monitoring is provided when control is inadequate without both.

Completed items are inspected for completeness, markings, calibration, adjustments, protection from damage or other characteristics as required to verify quality and conformance of an item to specified requirements.

PRELIMINARY REVIEW DRAFT

Final inspections include a record review of the results and resolution of nonconformance identified by prior inspections.

Inspection and test records as a minimum identify the following:

- Item inspected,
- Date of inspection,
- Inspector,
- Type of observation,
- Results or acceptability, and
- References to information or action taken in connection with nonconformance

9.9 TEST CONTROL

Energy*Solutions* plans and executes tests required to verify conformance of an item or of a computer program to specific requirements and to demonstrate satisfactory performance for service. Characteristics to be tested and test methods to be employed are specified. Test results are documented and their conformance with acceptance criteria shall be evaluated.

Test requirements and acceptance criteria are provided or approved by the organization responsible for design of the item to be tested. Required tests, including, as appropriate, prototype qualification tests, production tests, proof tests prior to installation; construction tests, pre-operational tests and operation tests, hardware integration, verification test, or in-use tests are controlled. Test requirements and acceptance criteria are based upon specified requirements contained in applicable design or other pertinent technical documents.

Test procedures include or reference test objectives and provisions for assuring that prerequisites for a given test have been met. In lieu of specially prepared written test procedures, appropriate sections of related documents, such as ASTM methods, supplier manuals, equipment maintenance instructions, or approved drawings with acceptance criteria can be used. Such documents include adequate instructions to assure the required quality of work.

Test results shall be documented and evaluated by a responsible authority to assure that test requirements are satisfied.

9.10 CONTROL OF MEASURING AND TEST EQUIPMENT

Tools, gauges, instruments and other measuring and test equipment used for activities affecting quality are controlled and at specific periods calibrated and adjusted to maintain accuracy within necessary limits.

The selection of measuring and test equipment are controlled to assure that such items are of proper type, range, accuracy and tolerance to accomplish the function for determining conformance to specified requirements.

Measuring and test equipment are calibrated, adjusted, and maintained at prescribed intervals or, prior to use, against certified equipment having known relationships to nationally recognized standards. If no nationally known standard exists, the basis for the calibration shall be documented.

PRELIMINARY REVIEW DRAFT

Measuring and test equipment is calibrated at intervals depending on the required accuracy, intended use, stability characteristics and other conditions affecting the performance of the instrument.

When measuring and test equipment is found to be out of calibration, an evaluation is performed and documented of the validity of previous inspection or test results and the acceptability of the items previously inspected or tested. Out-of-calibration devices are tagged and segregated and not used until they have been recalibrated. If any measuring or test equipment is consistently found to be out of calibration, it is repaired or replaced. A calibration is performed when the accuracy of the equipment is suspect.

Calibration and control measures are not required for rulers, tape measures, levels and other such devices; normal commercial equipment provides adequate accuracy. These items must be treated with care to prevent damage or excessive wear and be replaced before accuracy becomes questionable.

Measuring and test equipment are properly stored and handled to maintain accuracy. Calibration records are be maintained and equipment shall be suitably marked to indicate calibration status.

9.11 HANDLING, STORAGE, AND SHIPPING

Energy*Solutions* controls handling, storage, packaging, shipping and preservation of items to prevent damage or loss and to minimize deterioration.

Handling, storage and shipping of items is conducted in accordance with established work and inspection instructions, drawings, specifications, shipment instructions, or other pertinent documents or procedures specified for use in conducting the activity. Specific procedures are used when required for critical, sensitive, perishable or high-value articles.

Instructions for marking and labeling for packaging, shipment, handling, and storage of items are established as necessary to adequately identify, maintain and preserve the item, including indication of the presence of special environments or the need for special controls.

9.12 INSPECTION, TEST, AND OPERATING STATUS

The status of inspection and test activities is identified either on the items or in the documents traceable to the items where it is necessary to assure that required inspections and tests are performed and to assure that items which have not passed the required inspections and tests are not inadvertently installed, used or operated. Status is maintained through indicators, such as physical location and tags, markings, travelers, inspection records or other suitable means. The authority for the application and removal of tags, markings and labels is specified. Status indicators are also provide for indicating the operating status of systems and components of the facility, such as tagging valves and switches, to prevent inadvertent operation.

PRELIMINARY REVIEW DRAFT

9.13 CONTROL OF NONCONFORMING ITEMS

Energy*Solutions* controls items that do not conform with specified requirements to prevent inadvertent use or installation. Controls provide for identification, documentation, evaluation and segregation when practical and disposition of nonconforming items, and for notification of affected organizations.

Identification of nonconforming items is by marking, tagging, or other methods, which do not adversely affect the end use of the item. The identification is legible and easily recognizable. If identification of each container is not practical, the container, package, or segregated storage area, as appropriate, is identified.

Nonconforming characteristics are reviewed and recommended dispositions of nonconforming items are proposed and approved in accordance with documented procedures. Authorized personnel control further processing, delivery, installation or use of a nonconforming item pending an evaluation and an approved disposition.

The responsibility and authority for the evaluation and disposition of nonconforming items is defined. Personnel performing evaluations to determine a disposition are competent and they have an adequate understanding of the requirements and have access to pertinent background information.

The disposition, such as use-as-is, reject, repair or rework of nonconforming items are identified and documented. Technical justification for the acceptability of a nonconforming item, dispositioned repair or use-as-is is documented. Nonconformance to design requirements dispositioned use-as-is or repair is subject to design control measures commensurate with those applied to the original design. The as-built records, if such records are required, reflect the accepted deviation.

Repaired or reworked items are reexamined in accordance with the applicable procedures and with the original acceptance criteria unless the nonconforming item disposition has established alternate acceptance criteria.

9.14 CORRECTIVE ACTION

Conditions adverse to quality are identified promptly and corrected. In the case of a significant condition adverse to quality, the cause of the condition is determined and corrective action taken to preclude recurrence. The identification, cause and corrective action for conditions adverse to quality are documented and reported to appropriate levels of management. Follow-up action are taken to verify implementation of this corrective action.

Corrective actions are prescribed in written form that provides adequate control; and are documented in a manner that permits reviewing, evaluating and verifying the results of the activities. Where corrective or preventive measures have already been taken to address conditions adverse to quality based on the program elements covered in design, nonconformance surveillance or audit, no further action is required under that element unless the conditions are judged to be significant.

Conditions adverse to quality are defined as follows:

- Deficiencies in design, manufacturing, construction, testing, or process requiring substantial rework, repair or replacement.
- Loss of essential data.

PRELIMINARY REVIEW DRAFT

- Repeated failure to implement a portion of an approved procedure.
- Deviations from licensing or permit requirements.

9.15 QUALITY ASSURANCE RECORDS

Records that furnish documentary evidence of quality are specified, prepared and maintained. Records are legible, identifiable and retrievable. Records are protected against damage, deterioration, or loss. Requirements for record transmittal, distribution, retention, maintenance and disposition are established and documented.

An OnBase record system is established and this system is defined, implemented and enforced in accordance with written procedures or instructions.

The applicable design specification, procurement documents, test procedures, operational procedures or quality procedures specify the records to be generated, supplied or maintained by or for Energy*Solutions'* documents that are designated to become records are legible, accurate, and completed appropriate to the work accomplished.

When required, records are corrected in accordance with procedures, which provide for appropriate review or approval. The correction includes the date and the identification of the individual making the correction.

Each organization responsible for the receipt of records designates an individual responsible for receiving the records. This individual or organization is responsible for implementing a receipt control system.

Records are stored in a manner to preclude deterioration or damage of the records. Provisions are made in the storage arrangement to prevent damage from moisture, temperature, and pressure. Records are firmly attached in binders, or placed in folders or envelopes for storage in steel file cabinets or shelving in containers.

9.16 AUDITS

Energy*Solutions* performs audits and has audits performed to verify compliance with all aspects of the quality assurance program and to determine its effectiveness. These audits are performed in accordance with written procedures by personnel who do not have direct responsibility for performing the activities being audited. Audit results are documented and reported to and reviewed by responsible management. Follow-up action is taken where indicated.

9.17 QUALITY ASSURANCE IMPLEMENTATION

The Quality Assurance Program is implemented through the following documents:

- The Statement of Corporate Quality Assurance Policy;
- Quality Assurance Program Document;

PRELIMINARY REVIEW DRAFT

- Quality Assurance Procedures; and

- Implementing Procedures – Controlled documents that prescribe processes (a sequence of actions) to be performed to achieve a desired outcome. Implementing procedures may apply to the entire company, an organization, a program or a project.

The Program identifies the activities and items to which it applies. The Program includes considerations of the technical aspects of the activities affecting quality. The Program provides control over activities affecting quality to the extent consistent with their importance. The Program provides assurance that activities affecting quality are documented and accomplished in accordance with written procedures, instructions and drawings.

The Program provides for the accomplishment of activities affecting quality under controlled conditions. Such conditions include the use of appropriate equipment, suitable environmental conditions, and prerequisites for a certain activity have been satisfied.

The Program takes into account the need for special controls, processes, test equipment, tools and skills to attain the required quality and verification of quality.

The Program provides for indoctrination and training of personnel performing quality related activities to assure that proficiency is achieved and maintained.

The WM Director of Quality Assurance reports to the WM President of Energy*Solutions* and is responsible and accountable for the effective implementation of the Quality Assurance Program. The CQAM has the authority, responsibility, and accountability for establishing and maintaining the Quality Assurance Program.

Vice Presidents, Corporate Directors and Managers, and Facility/Department Leads (Energy*Solutions* Management) have the authority, responsibility and accountability for establishing and maintaining programs and procedures consistent with the system description provided in this document. Energy*Solutions* Management may delegate tasks to contributing individuals or organizations, but they retain overall responsibility for:

- Providing resources to accomplish quality objectives in each work task;

- Continuously improving processes, products, and services;

- Ensuring that schedule and budget considerations are not used to compromise the attainment of the requisite level of quality;

- Identifying, monitoring, evaluating, and reporting results of selected performance indicators;

- Providing employees with adequate education and training;

- Participating in recommending specific changes to policy, programmatic, or procedural documents;

PRELIMINARY REVIEW DRAFT

- Identifying, preparing and approving procedures necessary to implement requirements applicable to the scope of work;

- Working with support organizations to resolve concerns and issues; and

- Conducting management assessments.

All employees of Energy*Solutions* are responsible for achieving quality in their activities. Employees are empowered by Management to continuously improve their performance, identify and report problems, and participate in their resolution.

For each employee who enters the Clive Facility Restricted Area and is likely to have received in a year an occupational dose requiring monitoring, Clive management:

- Determines the occupational radiation dose received during the current year; and

- Attempts to obtain the records of lifetime cumulative occupational radiation dose.

Clive management may also:

- Accept as a record of the occupational dose that the individual received during the current year, a written signed statement from the individual, or from the individual's most recent employer for work involving radiation exposure that discloses the nature and the amount of any occupational dose that the individual may have received during the current year;

- Accept, as the record of lifetime cumulative radiation dose, an up-to-date NRC Form 4, or equivalent signed by the individual and countersigned by an appropriate official of the most recent employer for work involving radiation exposure, or the individual's current employer (if the individual is not employed by Energy*Solutions*); and

- Obtain reports of the individual's dose equivalent(s) from the most recent employer for work involving radiation exposure, or the individual's current employer (if the individual is not employed by Energy*Solutions*) by telephone, electronic media, or letter. Energy*Solutions* may request a written verification of the dose data if the authenticity of the transmitted report cannot be established.

Clive management records the dose history, as required on NRC Form 4 or other clear and legible record, of all the information required on the form. The form or record shows each period in which the individual received occupational dose to radiation or radioactive material. For each period for which Clive management obtains reports, Clive management uses the dose shown in the report in preparing NRC Form 4. For any period in which Clive management does not obtain a report, Clive management places a notation on NRC Form 4 indicating the periods of time for which data are not available. Records of all employees whom monitoring was required and records of doses received during planned special exposures, accidents, and emergency conditions include, when applicable:

- DDE, EDE, SDE to the skin, and SDE to the extremities;

PRELIMINARY REVIEW DRAFT

- The estimated intake or body burden of radionuclides;
- The CEDE assigned to the intake or body burden of radionuclides;
- Specific information used to calculate the CEDE ;
- The TEDE when required; and
- The total of the DDE and the ODE to the organ receiving the highest total dose.

Personal dose records are updated at least annually. Personal dose records are maintained on NRC Form 5 or in clear and legible records containing all the information required by NRC Form 5. Electronic records are maintained until license termination. Hardcopy records are maintained in accordance with the CL-QA-PR-005, *Quality Assurance Records.*

Required personal dose records are protected from public disclosure. Records of dose to an embryo/fetus are maintained with the dose to the declared pregnant woman. Declarations of pregnancy, including the estimated date of conception, are also kept on file. Radiation dose records contain information sufficient to identify each person, or employee number.

PRELIMINARY REVIEW DRAFT

SECTION 10. FINANCIAL ASSURANCE

Surety protects the State of Utah and DOE from having to fund the closure and perpetual care of the Clive Disposal Complex. The Surety provides adequate monies for site decommissioning, reclamation and ongoing monitoring in the event that Energy*Solutions* is unable to provide funds at the time of closure. The amount required is based on closure to the standards approved by the Director. The Surety funding projects are based on conservative estimates for the amount of funding required to:

- Decontaminate, treat, and/or dispose of all contaminated equipment, structures, and soils;
- Place all waste material in the appropriate disposal embankment;
- Close the embankment(s) as outlined in Energy*Solutions'* Permit and Licenses; and
- Complete required post-closure monitoring, inspections, and long-term surveillance.

10.1 PREMATURE CLOSURE

Energy*Solutions* expects to close the Federal Cell Facility and perform the required maintenance and monitoring. However, in order to protect the State of Utah and DOE from having to fund premature closure of the Federal Cell Facility (in the event that Energy*Solutions* is unwilling or unable to do so), additional monies will be added to the Clive Disposal Facility surety to specifically address the premature closure of the Federal Cell Facility (in accordance with regulatory requirements).

As is included in Appendix G, the amount of financial surety (initially calculated using RSMeans reference rates) as the amount estimated for the placement of applicable contaminated material in storage into the Federal Cell Facility, for decommissioning and decontamination of the Federal Cell Facility, for premature completion of Federal Cell Facility construction to the required standards, to perform all required post closure monitoring and maintenance activities and to transition its long term care stewardship to DOE. The volume of unplaced waste included in the Federal Cell Facility surety calculations serves as a compliance point, limiting the volume of waste requiring placement to less than the funds secured in surety. The Decontamination and Decommissioning Plan and the Environmental Monitoring Plan of Radioactive Material Licenses UT2300249 and UT2300478 form the basis for surety calculations.

PRELIMINARY REVIEW DRAFT

Table 10-1

Combined Clive Disposal Complex Surety Matrix

	Class A West	Mixed Waste	11e.(2)	Federal Cell
Premature Closure				
Demolish buildings and dispose	All buildings associated with LLRW and 11e.(2) management with in the restricted area	Mixed waste treatment and operations buildings	None	LLRW buildings support federal cell
Excavate evaporation ponds and dispose	All LLRW and 11e.(2) ponds	MW evaporation pond and surface impoundment	None	LLRW ponds used for federal cell
Excavate storage pads and dispose	All LLRW and 11e.(2) pads	MW Storage pads and asphalt areas	None	LLRW storage pads used for federal waste
Decontaminate shipping containers left onsite (casks)	All LLRW and 11e.(2) containers for release	None	None	None
Treatment of waste in stockpile	Waste Treatment not licensed	Treatment of untreated waste onsite	Waste Treatment not licensed	Waste Treatment not licensed
Dispose of waste left to unload or in stockpile	All LLRW waste onsite	All treated MW onsite	All 11e.(2) waste onsite	All federal waste onsite
Excavate haul roads within restricted area and dispose	All roads within LLRW and 11.e(2) restricted area	MW Turn around area and haul roads	None	Federal Cell haul road
Remove railroad track and rail bed materials within RA and dispose	LLRW rail within Sections 29 and 32 - other than MW	Rail car unloading track and area	None	LLRW rail supports federal cell
Demolish and dispose of storm water storage tanks used during closure	LLRW and 11e.(2) tanks	Grey water and other holding tanks	None	None
Size reduce and dispose of equipment remaining in restricted area	LLRW and 11e.(2) equipment	MW equipment	None	LLRW equipment used for federal waste
Demolish and dispose of other miscellaneous structures in restricted area	LLRW and 11e.(2) misc. equipment	MW Misc. equipment	None	None
Hiring of health physics staff and survey equipment to support closure	HP Staff for LLRW and 11e.(2)	HP Staff for MW operations	None	Included with Class A West
Health physics monitoring	Section 32 monitoring	None	None	Included with Class A West
Construct addition cell liner necessary for disposal and closure	Class A West liner	MW sumps	11e.(2) liner	Federal Cell liner
Place temporary cover over waste cell	Class A West Fill	MW Fill	11e.(2) fill	Federal Cell Fill
Temporary settlement monitoring of temporary cover	Class A West embankment	MW cell	11e.(2) embankment	Federal Cell embankment

PRELIMINARY REVIEW DRAFT

	Class A West	Mixed Waste	11e.(2)	Federal Cell
Construct final cell cover, drainage and embankment fencing	Final Cover	Final Cover	Final Cover	Final Cover
General closure of Licensed area (section 32) - revegetation, removal of operational fencing	All LLRW and 11.e(2) areas	All MW areas	Included with Class A West	Included with Class A West
General cleanup following completion of closure activities	All remaining site areas	Included with Class A West	Included with Class A West	Included with Class A West
Mobilize security, survey and settlement monitoring staff	For full Clive site	Included with Class A West	Included with Class A West	Included with Class A West
Remediate potential groundwater plumes (if necessary)	GW wells and treatment for LLRW	GW wells and treatment for MW	GW wells and treatment for 11e.(2)	[included with 11e.(2)]
Stewardship transfer to DOE	N/A	N/A	90 days	90 days
Indirect multipliers (typical for third party industry)				
SG&A Overhead	5.50%	5.50%	5.50%	5.50%
Mobilization	(included in unit costs)	(included in unit costs)	(included in unit costs)	(included in unit costs)
Contingency	10%	10%	10%	10%
Engineering and Redesign	2.25%	2.25%	2.25%	2.25%
Profit and Overhead	15%	15%	15%	15%
Management Fee and Legal Expenses	4%	4%	4%	4%
DEQ Oversight	4%	4%	4%	4%
Institutional Control Period (closure to 100 years)				
Duration	100 years	30 years	None	Perpetual
Embankment inspections	Annually	Annually	None	Annually
Access road maintenance	Annually from year 5 to 100	Annually	None	Annually
Fence maintenance	Twice in 100 years	Annually	None	Annually
Gate maintenance	Once every 5 years	None	None	Annually
Sign maintenance	Once every 5 years	Annually	None	Annually
Monument maintenance	Three times during 100 years	Annually	None	Annually
Groundwater well replacement	Once every 10 years (well circle LLRW and 11e2 licensed section perimeter)	Annual inspection (no replacement)	None	Already included in LLRW
Minor embankment slope maintenance	Once every 5 years	Annually	None	Annually
Embankment Structure	Annual inspection Maintenance every 5 years	Annually	None	Annually
Inspect, remove vegetation and regrade diversion channels	Annually	None	None	Annually

PRELIMINARY REVIEW DRAFT

	Class A West	Mixed Waste	11e.(2)	Federal Cell
Written report of inspection and maintenance activities	Annually	Annually	None	Annually
Analysis of ground water samples	Annually for LLRW	Annually for RCRA	None	Already included in LLRW
Embankment survey	Annually for years 1 to 5	Annually for years 1 to 5	None	Annually
Airborne dust monitoring and analysis	Year 1	Year 1	None	Already included in LLRW
Surface soil sampling and analysis	Year 1	Year 1	None	Already included in LLRW
External radiation surveys	Year 1	Year 1	None	Annually
Radon exposure monitoring and analysis	Year 1	Year 1	None	Annually
Perpetual Care				
Embankment inspections	Annually	None	None	Annually
Access road maintenance	None	None	None	Annually
Fence maintenance	None	None	None	Annually
Gate maintenance	None	None	None	Annually
Sign maintenance	Once every 5 years	None	None	Annually
Monument maintenance	None	None	None	Annually
Groundwater well replacement	Once every 10 years	None	None	Already included in LLRW
Minor embankment slope maintenance	Once every 5 years	None	None	Annually
Embankment Structure	Annual inspection Maintenance every 5 years	None	None	Annually
Inspect, remove vegetation and regrade diversion channels	Annually	None	None	Annually
Written report of inspection and maintenance activities	Annually	None	None	Annually
Analysis of ground water samples	Annually for LLRW	None	None	Already included in LLRW
Embankment survey	None	None	None	Annually
Airborne dust monitoring and analysis	Annually	None	None	Already included in LLRW
Surface soil sampling and analysis	Annually	None	None	Already included in LLRW
External radiation surveys	Annually	None	None	Annually
Radon exposure monitoring and analysis	Annually	None	None	Annually
Disposal Cell Inspection (gullys, cell condition, slope stability, signs of intrusion)	Assumed equivalent to annual institutional control environmental monitoring costs surrounding full licensed area	None	$1,006,848 (inflated annually per 10 CFR 40, Appendix A)	Costs from annual institutional control environmental monitoring costs (except groundwater and airborne dust - addressed in CAW)

PRELIMINARY REVIEW DRAFT

	Class A West	Mixed Waste	11e.(2)	Federal Cell
Repair following catastrophic impact to embankment	URS Analysis considered costs to repair cover system failure, surface contamination, waste interactions, settlement, health claims. Of these costs embankment reconstruction, fill and cover replacement were highest bounding costs (URS, 2015)	None	None	All depleted uranium below grade. Catastrophic repair assumed to impact above grade portion of federal cell. Repair cost assumes regrading and compacting embankment fill and replacement of final cover and monitoring for settlement

PRELIMINARY REVIEW DRAFT

Energy*Solutions* follows NRC, State of Utah, and EPA guidelines in developing its Clive Disposal Facility surety.

- NRC instructs that surety calculations should include, "*a detailed site-specific cost estimate for decommissioning, based on the costs of an independent contractor to meet the criteria for unrestricted use in 10 CFR 20.1402*" (U.S. Nuclear Regulatory Commission. (2012), Consolidated Decommissioning Guidance: Financial Assurance, Recordkeeping, and Timeliness – Final Report, NUREG-1757, Volume 3, Revision 1, February 2012).

- UAC R313-25-31(1)(b) states "*[T]he applicant's cost estimates shall take into account total costs that would be incurred if an independent contractor were hired to perform the closure and stabilization work.*"

- UAC R315-264-142(a)(2) states, "*[T]he closure cost estimate shall be based on the costs to the owner or operator of hiring a third party to close the facility.*"

Furthermore, Utah Code §19-3-104(12)(f)(ii) allows the following option for a Licensee or Permittee to determine closure and post closure costs:

> "*(A) for an initial financial assurance determination and for each financial assurance determination every five years thereafter, a competitive site-specific bid for closure and post-closure care of the facility at least once every five years; and*
>
> *(B) for each year between a financial assurance determination described in Subsection (12)(f)(ii)(A), a proposed financial assurance estimate that accounts for current site conditions and that includes an annual inflation adjustment to the financial assurance determination using the Gross Domestic Product Implicit Price Deflator of the Bureau of Economic Analysis, United States Department of Commerce, calculated by dividing the latest annual deflator by the deflator for the previous year;*"

Based on these regulatory requirements, Energy*Solutions* commissioned an independent evaluation by a facility decommissioning- and closure-experienced third-party entity to estimate the process and activities associated with all premature closure activities for the Clive Disposal Facility. This process was completed in late 2015 and a final approved combined surety was approved on January 26, 2017. Subsequent annual reviews since the 2015 combined surety was approved, account for current site conditions and include annual inflation adjustments. Clive Disposal Complex annual surety reviews conducted after this licensing action will include evaluation of the premature closure of the Federal Cell Facility. The calculations and cost estimates will be included in the Director's annual review and adjustment to assure that the amount remains appropriate to account for inflation, construction of new facilities, and other cost adjustments.

A summary of each necessary surety decommissioning activities for the Federal Cell Facility is presented below. The activities descriptions, associated unit costs, numbering and titles proposed are consistent with existing surety sections for the LLRW Facility. Each summary includes the general location of the item; a brief description of the item; how the item will be decommissioned; and any major assumptions. References will be included for construction specifications of the Construction Quality Assurance / Quality Control (CQA/QC) Manual. Details of premature embankment design and construction are presented in Appendix G.

PRELIMINARY REVIEW DRAFT

31. Placement of Material

This item includes the maximum volume of material that is allowed on-site in container or bulk storage awaiting disposal. This surety item's volume storage limit is expected to be reflected as a condition to the Radioactive Material License authorizing depleted uranium disposal in the Federal Cell Facility. During premature closure, sufficient funds will be pledged so that all depleted uranium waste in storage or in conveyances at the site are offloaded and placed in the Federal Cell Facility, in accordance with current construction requirements. This surety item conservatively assumes the maximum volume allowed is in storage or on site at the time of closure.

204. Liner/Liner Protective Cover

This item includes the use of clay and soil materials to construct additional cell liner and cover necessary to complete premature closure of the Federal Cell Facility. This activity will include the excavation of native clays and soils from surrounding areas and placement in the embankment to specification and design.

205. Settlement Monitoring of Temporary Cover

In accordance with embankment construction requirements, fill and temporary cover will be placed to specification over the depleted uranium waste and settlement monuments placed on a 150 foot grid over the top slope of the embankment. The proposed temporary cover for the Federal Cell Facility is a one-foot thick layer of native soil and is monitored for settlement prior to final cover construction. This item includes the cost of excavation and placement of the required volume of native soil (and overburden) along with the purchase and placement of settlement monuments. The item also includes costs of monument surveys and engineering reviews for the required one year of settlement monitoring.

207. Cover Construction

This item will include construction of the final cover over the Federal Cell Facility, roads and drainage ditches around the Facility, and the installation of permanent monuments for the Facility. The final cover consists of several elements including radon barriers, a filter zone, and a rock erosion control barrier. Radon barrier borrow material will be excavated from adjacent sections owned by Energy*Solutions*. Rock will be imported from the BLM quarry located approximately five miles north of the Facility. The rock will be screened to meet applicable gradation requirements for the individual cover layers. The final cover area will be based on the premature closure plan and updated each year as part of the annual surety review.

211. Final Cover Settlement Monitoring

In accordance with embankment construction requirements, final cover will be placed to specification over the depleted uranium waste and settlement monuments placed on a 150 foot grid over the top slope of the embankment. This item includes the cost of excavation and placement of the required volume of native soil (and overburden) along with the purchase and placement of settlement monuments. The item also includes costs of monument surveys and engineering reviews for the required one year of settlement monitoring.

PRELIMINARY REVIEW DRAFT

300. SG&A Overhead Costs

In accordance with Energy*Solutions'* 2015 third-party surety estimate, a contractor charge of 5.5% of the sum of direct costs will be required for general and administrative expenses.

302. Contingency

In accordance with Energy*Solutions'* 2015 third-party surety estimate, a contractor charge of 10% of the sum of direct costs will be required as contingency for unanticipated expenses.

303. Engineering and Redesign

In accordance with Energy*Solutions'* 2015 third-party surety estimate, a contractor charge of 2.25% of the sum of direct costs will be required to account for engineering analysis and redesign for premature closure of the Federal Cell Facility.

304. Profit and Overhead

In accordance with Energy*Solutions'* 2015 third-party surety estimate, a contractor charge of 15% of the sum of direct costs will be required for contractor profit and overhead expenses.

305. Management Fee and Legal Expenses

In accordance with Energy*Solutions'* 2015 third-party surety estimate, a contractor charge of 4% of the sum of direct costs will be required for project management and legal expenses.

306. DEQ Oversight of Project

In accordance with Energy*Solutions'* 2015 third-party surety estimate, a contractor charge of 4% of the sum of direct costs will be required for regulatory oversight during premature closure.

320. Facility Stewardship Transfer to DOE

Transfer of stewardship from DWMRC oversight to DOE-LM is projected to require 2 individuals for 90 days.

400. Perpetual Surveillance (equivalent to costs and activities contemplated in LLRW Sections 400 through 407)

This item includes the annual inspections and maintenance that will be performed at the Federal Cell Facility and off-site features that may have been impacted by operations. In addition to an embankment survey, this section includes costs to annually sample external radiation exposures from the embankment and atmospheric radon gas flux from the Federal Cell Facility. The long term surveillance monitoring includes is intended to ensure that the Federal Cell Facility and other required elements perform as intended and that there are no adverse impacts to the environment or the public due to degradation of these elements. This item includes inspection of the embankments, fencing, roads, etc. and the performance of any maintenance on these elements. Since funding for soils, airborne dust particulate and groundwater leachate migration surrounding the Clive Disposal Complex licensed footprint for low-level radioactive waste and 11e.(2) byproduct disposal, they are not duplicated in Section 400. The cost for this surety item is sufficient principle to generate adequate interest at an assumed 2% investment credit for the annual activities (consistent with that used by the Director in calculation of the required LLRW perpetual care funds, URS, 2015).

PRELIMINARY REVIEW DRAFT

450. Catastrophic Event Repair

In support the LLRW Perpetual Care Fund, analysis considered costs to repair the Class A West embankment following highly improbable catastrophic events such as cover system failure, surface contamination, waste interactions, settlement, health claims. Of these costs embankment reconstruction, fill and cover replacement were highest bounding costs (URS, 2015). The analysis projected that a fund balance of $13 million will be necessary at the time of closure for the Director to conduct routine monitoring of the facility in perpetuity and to remediate the Class A West Facility following a single catastrophic event.

This same methodology is following for estimation of the necessary fund principle to perpetually generate adequate funds for DOE to perpetually manage the Federal Cell Facility. Additionally, funds are projected for repair to the Federal Cell Facility from a catastrophic event. In utilizing this methodology, it is important to recognize several differences between the Class A West LLRW Facility and the Federal Cell Facility. Primarily, all depleted uranium will be placed below grade and entombed in controlled low-strength material. Therefore, it is reasonable to assume that the impact of an event requiring catastrophic repair of the Federal Cell Facility would be limited to significant damage to the Federal Cell Facility final cover and the fill material placed between the depleted uranium and cover. Repair cost assumes replacing, regrading and compacting embankment fill and replacement of final cover and monitoring for settlement.

Additionally, since the Class A West footprint is significantly larger than the Federal Cell Facility's would be if prematurely closed following one year of operation, initial surety and perpetual care funds secured for the Federal Cell Facility are dramatically less than those currently pledged for the Class A West Facility. Because funds are secured to prematurely close the Federal Cell Facility in its current condition, the total amount of closure and perpetual care funds will be reviewed and revised annually to ensure they reflect the current Federal Cell Facility condition, as part of Energy*Solutions'* annual surety revision.

The financial assurance mechanism proposed for premature closure of Energy*Solutions'* Federal Cell Facility will be a Surety Bond pledged for $2,411,186 with a Standby Trust Agreement executed with Zions Bank and includes the necessary amount of coverage to provide for the following:

a. The Surety Bond will be sufficient to cover all the costs of closure and stewardship transfer of the Federal Cell Facility. The Surety Bond includes identification and specification of the types and number of activities required for each of Clive's facilities.

b. The amount of the financial assurance will be equal to the cost estimates for premature closure of the Federal Cell Facility after the first year of operation, and reflects the total costs incurred if an independent contractor were hired.

c. The Surety Bond provides coverage throughout the term of the License.

PRELIMINARY REVIEW DRAFT

d. As part of the annual review/revision, the Surety Bond will be adjusted so that it represents the current condition of the Federal Cell Facility (accounting for depleted uranium placed in the embankment and other related operational changes). As is allowed by UAC R313-25-31(2), activities in common for premature closure of the Class A West Facility, Mixed Waste RCRA Facility, 11e.(2) Byproduct Facility and Federal Cell Facility are generally funded in the Class A West Facility calculations.

e. As part of the annual review/revision, the Surety Bond will be adjusted for inflation, using the inflation factor derived from the annual implicit price deflator for gross national product, as published in the U.S. Department of Commerce's Survey of Current Business and as reported by the Division of Waste Management and Radiation Control.

The design modification and construction for the premature closure of the Federal Cell Facility will be accomplished by following the approved embankment and cover design principles. These principles will guide the redesign of the Federal Cell Facility as suggested in the following conceptual redesign plan.

1. Conduct an aerial survey of the embankment and develop current topographical data to be used as the base of the redesign.

2. Overlay on the aerial survey of the embankment the following areas:
   a. Limits of disposed waste,
   b. Extents of completed liner,
   c. CLSM entombment of placed depleted uranium, and
   d. Any additional areas of interest.

3. Determine the best areas for the placement for waste generated from the decommissioning of the Federal Cell support facilities.

4. Redesign the Federal Cell Facility per the following criteria:
   a. Work within the criteria used for the modeling performed for the licensed embankment designs,
   b. Side slopes cannot exceed 5:1,
   c. Top slopes should be 2.4%,
   d. Storm water must freely drain off of and away from the embankment, and
   e. Final contours (geometry) cannot concentrate storm water flow that may lead to erosion of the cover materials.

5. Drainage ditches will be designed based on the approved closure ditch designs for the Federal Cell Facility. In general, the ditches slope from the northeast to the southwest where they connect to the southwest corner discharge.

Once the aerial survey is completed and converted into an electronic file, a team of one engineer and one CAD designer (utilizing AutoCAD Land Desktop or similar software) will redesign, including reviews and revisions, the premature closure embankment design within ten to twelve (10-12) working weeks.

Considering the annual Federal Cell Facility waste configuration at the time of the As-Built survey and design criteria, a suitable premature closure design will be a reduced Federal Cell Facility within the design Federal

PRELIMINARY REVIEW DRAFT

Cell Facility limits. In addition, Rock Cover Design Calculations will be performed, demonstrating that the Federal Cell Facility riprap design is adequate for the possible varied slope lengths.

Projections of additional debris and soil needed within the prematurely closed embankment will be estimated. Energy*Solutions* will ensure sufficient capacity is reserved with the premature closure Federal Cell Facility for the surety decontamination volumes. This volume will be calculated from a summation of all other closure cost volumes within the Federal Cell Facility surety calculations.

The proposed location for the clay borrow required for Federal Cell Facility closure is Section 29. There are three work elements identified in the surety calculations that require clay material. The calculated surety volumes for Clay Liner/Protective Cover, Temporary Cover and Radon Barrier. The current premature closure Federal Cell Facility embankment design may require the construction of additional clay liner. Energy*Solutions* will ensure that sufficient clay materials within the borrow pit limits of Sections 5 and 29 are reserved for premature closure needs. Similarly, The BLM Community Pit 24 is projected to have a sufficient remaining reserve of material required to cover the premature Federal Cell Facility embankment.

At completion of premature closure, the final conditions of the Federal Cell Facility, including airborne particulate monitoring, will be defined and characterized as serve as the baseline for long term surveillance and maintenance. This information will be assembled into a Federal Cell Facility file that will be reviewed by the Director and DOE prior to stewardship transition.

As it is reasonable to expect that premature closure of each of Facility in the Clive Disposal Complex will occur concurrently, a combined surety estimate for the entire Clive Disposal Complex was first proposed in 2015 and approved in late 2016. As is reflected in Table 10-1, the combined approach eliminates unnecessary duplicative activities. The Surety is reviewed annually to account for inflation and changes in activities or design. This annual review ensures that the amount is adequate to fund the decommissioning of the Clive Facility in the event that Energy*Solutions* is unable to perform these activities. A combined surety estimate for the entire Clive Disposal Complex is required to be repeated by March 1, 2021. Premature closure and perpetual care of the Federal Cell Facility is expected to be included in that combined estimate.

10.2 SITE TRANSISTION

The Federal Cell Facility will be constructed in a manner that minimizes the need for long-term maintenance. The containment structure will be made completely of natural materials. The only item at the facility that is man-made will be the chain link fence that surrounds the site. With the exception of the chain link fence all of the materials incorporated in the final Federal Cell Facility have been designed to remain intact for 10,000 years. Since the Federal Cell Facility will be resistant to water erosion, wind erosion, and slope failure for the 10,000 year design life of the facility, the need for ongoing active maintenance of the Federal Cell Facility after closure is minimized. Even so, inspection and custodial maintenance, such as occasional repair of a damaged perimeter fence is expected to be required at the site is included in the surety calculations. Extreme natural events, intentional intrusion, or other events may also occur at a site that will require contingency repair to ensure that the waste facility continues to function as intended.

Following closure and decommissioning, Energy*Solutions* and the Director will participate with DOE to support transition of the Federal Cell Facility and compile documentation required by the Site Transition Framework for Long-Term Surveillance and Maintenance, (DOE, 2019). Funding to address transition

PRELIMINARY REVIEW DRAFT

activities of the Federal Cell Facility from DWMRC to DOE-LM are included in Section 320 of the premature closure calculations (see Appendix G). The Framework follows a systematic process of identifying a baseline for the closed Federal Cell Facility to facilitate a smooth transition of Federal Cell Facility stewardship from Licensee's and Director's closure (or premature closure) to DOE's Office of Legacy Management (DOE-LM). Site Transition information will be compiled and reviewed by representatives from DOE-LM, Director's staff and Energy*Solutions*.

10.2.1 Authorities and Accountabilities will be Assigned and Documented

The Roles and responsibilities of interested parties documented in the Memorandum of Agreement (located in Appendix C) will be reviewed and revised, as necessary.

- Responsibilities during transition responsibilities and funding sources;
- Applicable federal and state requirements, policies and procedures for managing resources;
- Legal authority authorizing transfer of Federal Cell Facility stewardship to DOE-LM (including any related reservation of rights); and
- Discussion of authorities related to DOE-LM's institutional controls.

10.2.2 Site Conditions will be Accurately and Comprehensively Documented

Federal Cell Facility's historical uses, characterization and remediation (including Preliminary and Final Closeout Reports) will be released to the General Public. This information will include a description of the Federal Cell Facility's condition at time of closure, including remedies and remaining hazards and associates Geographical Information Systems (GIS) references, where applicable.

- Physical features of the Facility, including site topography, geology, hydrogeology, geomorphology, seismicity, site and area boundaries and other features relevant to the long-term performance of the Facility;
- Locations of active, inactive and decommissioned buildings, structures and surface and subsurface infrastructure;
- Locations of residual hazards and associated engineered and institutional control systems;
- Locations of groundwater wells, wastewater outfalls and air quality monitoring stations (as depicted on Facility maps);
- Locations of off-site buildings and structures, important ecological resources and associated potential receptors in the vicinity of the Facility;
- Characteristics of the remaining contaminants (e.g., radionuclide activity and physical/chemical forms);

PRELIMINARY REVIEW DRAFT

- Descriptions of the initial risk at the Facility and the risk remaining at the Facility following remediation;

- The existence of and basis for decisions on cleanup levels for the end state;

- A conceptual Facility model, depicting relationships between existing residual hazards, environmental transport mechanisms, exposure pathways and human/ecological receptors;

- Completion, documentation and Director-approval of all remedial actions; and

- Identification of any Natural Resource Damage Assessment claims (including DOE-LM's potential environmental liability at the Facility).

10.2.3 Engineered Controls, Operation and Maintenance Requirements and Emergency / Contingency Planning will be Documented

Engineering controls, any remaining operational or maintenance requirements necessary and the contingency plans will be documented.

- Engineered controls will be identified and documented, including design and construction drawings, specifications and completion report; site physical and geotechnical data; locations of engineered controls on the Facility maps; any ongoing remediation and related waste management activities; and performance history assessments supporting successful Facility operations;

- A life-cycle cost estimate, including basis and assumptions. The life-cycle cost estimate will be based on best available data (including reasonable and prudent expectations for future contingencies);

- Master schedule of any ongoing activities;

- Risk-based end state, including exit criteria outlining when engineered controls will no longer be necessary;

- Operation and maintenance activities (such as surveillance and monitoring) will be documented and funding needed and available sources identified; and

- Contingency planning authority and responsibilities will be identified (including uncertainties associated with residual hazards, fate and transport mechanisms and exposure pathways; scenarios related to uncertainties; role, responsibilities and procedures to respond to each scenarios; conceptual Facility model and emergency/catastrophic planning for fires, floods, etc.);

10.2.4 Institutional Controls, Real and Personal Property and Enforcement Authorities will be Identified

Land use and institutional controls will be identified and implemented. For those engineered barriers relied upon as part of a remedy requiring institutional controls, longevity and performance of the barrier will be projected.

PRELIMINARY REVIEW DRAFT

- Engineered controls will be identified and documented, including design and construction drawings, specifications and completion report; site physical and geotechnical data; locations of engineered controls on the Facility maps; any ongoing remediation and related waste management activities; and performance history assessments supporting successful Facility operations;

- Property records will be completed; and

- Personal property transfers will be completed in accordance with 41 CFR 101 and DOE Property Management Regulations.

10.2.5 Regulatory Requirements and Authorities will be Identified

Regulatory requirements regarding residual contamination will be identified. Pertinent regulatory documents will be maintained and made available to the public, including:

- Regulatory decision documents and Facility characterizations will be identified, completed and maintained in accordance with regulatory requirements;

- Any remedies will be verified and confirmed as compliant with regulatory requirements;

- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Five-Year Review will be made prepared;

- EPA National Priority List status and/or RCRA permit status of state requirements and the basis for these requirements will be clearly indicated;

- NRC license status will be established. This status information will identify the license holder and the development of license transfer plans; and

- Locations of documents will be identified, and the documents made accessible.

10.2.6 Long-Term Surveillance and Maintenance Budget, Funding and Personnel Requirements will be Identified

Stewardship transition of the Federal Cell Facility will follow the prescribed guidance, budget, funding and personnel requirements, including:

- A Technical Basis for DOE-LM management of the Federal Cell Facility will be developed;

- Funding and associated cost-estimates will be compiled;

- Personnel requirements will be identified; and

- A business closeout process will be developed.

PRELIMINARY REVIEW DRAFT

10.2.7 Information and Records Management Requirements will be Satisfied

Post-closure disposition plans will reflect records and information for DOE-LM turnover and retention plans, including

- Agreements in place that will identify the disposition of records transfer to the Facility custodian and records that transfer to other organizations;
- Information and records needed for DOE-LM, property management, contractor personnel benefits other than pensions, worker compensation and Energy Employees Occupational Illness Compensation Program Act will be identified;
- Practices and procedures for the transition of information systems and records will be established;
- The guidance and operations information for information systems transferring to the Facility custodian, including metadata, will be identified and transferred along with the information systems;
- A Facility Information and Records Transition Plan will be developed and approved to establish a framework to address Facility-specific records and information requirements, including storage locations, special handling needs, geospatial data and access and retrieval requirements;
- The locations for storage and maintenance of Facility records and standards for data formats will be provided for Facility transfer;
- Information from the transfer Facility's records tracking systems will be migrated to the tracking system, along with locator guides and indices;
- Necessary records and record locations will be identified, including points of contact;
- Systems and procedures used for the archival of Facility information will be developed;
- Retention schedules for continuity of benefits, worker compensation and Energy Employees Occupational Illness Compensation Program Act claims will be developed;
- Systems and procedures to establish and facilitate public access to and retrieval of records and information critical to DOE-LM stewardship of the Federal Cell Facility will be created;
- National Archives and Records Administration will be engaged through the DOE Office of Chief Information Officer, to approve any transfer of records past their retention schedule;
- The DOE Librarian and Historian will be consulted regarding the transfer of non-record materials;
- User class and access requirements will be identified and solutions implemented; and
- Information in DOE-approved information systems will be implemented.

PRELIMINARY REVIEW DRAFT

10.2.8 Public Education, Outreach, Information and Notice Requirements will be Documented and Satisfied

Community involvement and associated Community Relations Plans will be developed from existing participation standards and systems, including:

- List of Facility stakeholders with associated address information will be developed and a process created for updating this list;
- Updates (at least annual) of the Administrative Record will be made available to interested parties;
- Community involvement tools will be developed; and
- Costs associated with public involvement will be projected and funds sufficient for public involvement included in secured perpetual care funds.

10.2.9 Natural, Cultural and Historical Resource Management Requirements will be Satisfied

A system or process will be created to protect information about sensitive and natural resources from unauthorized access or use, including:

- Biological resources, threatened and endangered species, archaeological and cultural resources, Native American treaty rights and natural and cultural resource requirements will be identified.
- Locations and characteristics of natural and cultural resources will be identified. A management system will be created and operated.

10.2.10 Business Closure Functions, Pension and Benefits, Contract Closeout or Transfer and Other Administrative Requirements are Satisfied

Actions required by Energy*Solutions* and DOE-LM related to business closeout functions will be identified and will reflect requirements, policies and procedures, schedules and cost estimates and budget.

- Responsibilities will be determined for the administration and funding of retiree benefits and pension funds, work force transition services, National Defense Authorization Act – Section 3161 tuition, worker compensation claims and EEOIPA claims;
- Contractor pensions and benefits needs will be identified and planned;
- Status of pending litigation and liabilities will be identified;
- Contract closeout actions for closure of restoration contracts and financial agreements will be identified; and
- Requirements from DOE's applicable orders will be satisfied.

PRELIMINARY REVIEW DRAFT

10.2.11 Real Property Requirements

All real property information requirements will be identified and documentation obtained prior to the transfer of the Federal Cell Facility to DOE-LM. Real property assets will include land, together with the improvements, facilities, structures and fixtures located thereon, including prefabricated movable structures and appurtenances thereto, under the control of DOE. Real property assets are further defined in the Federal Management Regulations, Sections 101-476.103-12 and describe land, mineral rights, water rights, well permits, leasehold interests and infrastructure.

10.2.12 Post-Closure Benefit Information and Data Needs

A list of current health and welfare benefit plans will be provided, including financial/custodian data, actuarial information and applicable employer plan documents.

10.3 PERPETUAL CARE

The Director's system for licensing and regulating byproduct and low-level radioactive waste management facilities include numerous requirements and features that significantly limit the probability that closure and post-closure costs would exceed those covered through financial assurance, including performance objectives, waste characteristics requirements, siting requirements, embankment design requirements, operating and closure requirements and environmental monitoring requirements. These requirements and features provide substantial assurance that depleted uranium disposed in the Federal Cell Facility will remain in a safe, isolated and secure condition, will not threaten or degrade public health or environmental media and will not require actions that result in financial burden to Utah's citizens.

10.3.1 Performance Objectives (UAC R313-25-20)

- Concentrations of any radioactive material released to the general environment in ground water, surface water, air, soil, plants or animals must not result in an annual dose exceeding an equivalent of 25 millirem (mrem) to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ of any member of the public.

- No greater than 4 mrem committed effective dose equivalent or total effective dose equivalent to any member of the public may come from groundwater.

- Reasonable efforts should be made to maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable (ALARA).

- Operations at the Federal Cell Facility must be conducted in compliance with the standards for radiation protection set out in UAC R313-15.

- Every reasonable effort should be made to maintain radiation exposures ALARA.

PRELIMINARY REVIEW DRAFT

- Design, operation, and closure of the Federal Cell Facility must ensure protection of any individuals inadvertently intruding into the disposal site and occupying the site or contacting the waste after active institutional controls over the disposal site are removed.

- The Federal Cell Facility must be sited, designed, used, operated, and closed to achieve long-term stability of the disposal site and to eliminate, to the extent practicable, the need for ongoing active maintenance of the disposal site following closure so that only surveillance, monitoring, or minor custodial care are required.

10.3.2 Waste Characteristics Requirements (UAC R313-15-1008(2)(a))

- Depleted uranium wastes must be packaged in conformance with the conditions of the license issued to Energy*Solutions*.

- Depleted uranium wastes must not be packaged for disposal in cardboard or fiberboard boxes.

- Depleted uranium waste containing liquid must contain as little free-standing and non-corrosive liquid as is reasonably achievable, but in no case may the liquid exceed one percent of the volume.

- Depleted uranium wastes containing hazardous, biological, pathogenic, or infectious material must be treated to reduce to the maximum extent practical the potential hazard from the non-radiological materials.

10.3.3 Technical Analyses (UAC R313-25-9)

- A site-specific performance assessment for depleted uranium disposal must be approved by the Director prior to disposal of depleted uranium waste.

  - The performance assessment includes (a) analyses demonstrating that the general population will be protected from releases of radioactivity that consider the pathways of air, soil, ground water, surface water, plant uptake, and exhumation by burrowing animals; (b) analyses of the protection of inadvertent intruders; (c) analysis of the protection of individuals during operations that include assessments of expected exposures due to routine operations and likely accidents during handling, storage, and disposal of waste; and (d) analyses of the long-term stability of the disposal site that address active natural processes including erosion, mass wasting, slope failure, settlement of wastes and backfill, infiltration through covers over disposal areas and adjacent soils, surface drainage of the disposal site, and the effects of changing lake levels.

  - The performance assessment must evaluate Federal Cell Facility performance for a compliance period of 10,000 years.

10.3.4 Siting Requirements (UAC R313-25-24)

- As is described in Section 3, the primary emphasis in Federal Cell Facility site isolates wastes and to disposal site features that ensure that the long-term performance objectives are met.

PRELIMINARY REVIEW DRAFT

- The Federal Cell Facility disposal site is characterized, modeled, analyzed, and monitored (see Sections 3, 4 and 8)

- Within the region where the Federal Cell Facility is to be located, the Clive Disposal Complex has been selected so that projected population growth and future developments are not likely to affect the ability of the disposal facility to meet the performance objectives of UAC R313-25-20. (see Section 2)

- There are no areas having known natural resources are which, if exploited, would result in failure to meet the performance objectives of UAC R313-25-20 (see Section 2).

- The Federal Cell Facility site is well drained and free of areas of flooding or frequent ponding (see Section 2)

- Waste is not disposed of in a 100-year flood plain, coastal high-hazard area or wetland (see Section 2)

- Upstream drainage areas are minimized to decrease the amount of runoff that could erode or inundate waste disposal units (see Section 3).

- The Federal Cell Facility site provides sufficient depth to the water table that ground water intrusion, perennial or otherwise, into the waste will not occur, (see Sections 2 and 3).

- The hydrogeologic unit used for disposal does not discharge ground water to the surface within the disposal site, (see Section 3).

- Areas are avoided where tectonic processes such as faulting, folding, seismic activity, vulcanism, or similar phenomena do not occur with such frequency and extent to significantly affect the ability of the disposal site to meet the performance objectives of UAC R313-25-20 or preclude defensible modeling and prediction of long-term impacts, (see Section 2).

- Areas are avoided where surface geologic processes such as mass wasting, erosion, slumping, landsliding, or weathering occur with sufficient such frequency and extent to significantly affect the ability of the disposal site to meet the performance objectives of UAC R313-25-20, or may preclude defensible modeling and prediction of long-term impacts, (see Section 2).

- The Federal Cell Facility site is not located where nearby facilities or activities could adversely impact the ability of the site to meet the performance objectives of UAC R313-25-20 or significantly mask the environmental monitoring program, (see Section 2).

10.3.5 Design Requirements (UAC R313-25-25) – See Section 3

- Site design features are directed toward long-term isolation and avoidance of the need for continuing active maintenance after Federal Cell Facility closure.

PRELIMINARY REVIEW DRAFT

- The Federal Cell Facility site design and operation are compatible with the Federal Cell Facility closure plan and lead to disposal site closure that provides reasonable assurance that the performance objectives of UAC R313-25-20 will be met.

- The Federal Cell Facility site is designed to complement and improve, where appropriate, the ability of the disposal site's natural characteristics to assure that the performance objectives of UAC R313-25-20 will be met.

- Federal Cell Facility cover is designed to minimize, to the extent practicable, water infiltration, to direct percolating or surface water away from the disposed waste, and to resist degradation by surface geologic processes and biotic activity.

- Surface features direct surface water drainage away from the Federal Cell Facility at velocities and gradients that will not result in erosion that will require ongoing active maintenance in the future.

- The Federal Cell Facility site is designed to minimize to the extent practicable the contact of water with waste during storage, the contact of standing water with waste during disposal, and the contact of percolating or standing water with wastes after disposal.

10.3.6 Operating and Closure Requirements (UAC R313-25-26)

- Wastes is emplaced in a manner that maintains the package integrity during emplacement, minimizes the void spaces between packages, and allows the void spaces to be filled.

- Void spaces between waste packages are filled with earth or other material to reduce future subsidence within the fill.

- Waste is placed and covered in a manner that limits the radiation dose rate at the surface of the cover to levels that at a minimum will allow the Licensee to comply with all standards against radiation protection at the time the Federal Cell Facility is closed and stabilized.

- The boundaries and locations of Federal Cell Facility are accurately located and mapped by means of a land survey.

- Federal Cell Facility is marked in such a way that the boundaries of the units can be easily defined. Three permanent survey marker control points, referenced to United States Geological Survey or National Geodetic Survey control stations, must be established on the site to facilitate surveys.

- Horizontal and vertical controls are provided by United States Geological Survey or National Geodetic Survey control stations as checked against United States Geological Survey or National Geodetic Survey record files.

- A buffer zone of land are maintained between the Federal Cell Facility and the Clive Disposal Complex boundary and beneath the disposed waste. The buffer zone must be of adequate dimensions to carry out environmental monitoring activities and take mitigative measures, if needed.

PRELIMINARY REVIEW DRAFT

- Closure and stabilization measures as set forth in the approved site closure plan will be carried out as the Federal Cell Facility is filled and covered.

- Active waste disposal operations do not have an adverse effect on completed closure and stabilization measures.

10.3.7 Environmental Monitoring Requirements (UAC R313-25-27)

- Energy*Solutions* has conducted a preoperational monitoring program to provide basic environmental data on the Federal Cell Facility site characteristics. As reflected this Application, information includes descriptions about the ecology, meteorology, climate, hydrology, geology, geochemistry, and seismology of the Federal Cell Facility.

- During the Federal Cell Facility construction and operation, Energy*Solutions* will maintain an Environmental Monitoring Program. Measurements and observations will be made and recorded to provide data to (a) evaluate the potential health and environmental impacts during both the construction and the operation of the Federal Cell Facility; (b) enable the evaluation of long-term effects and need for mitigative measures; (c) provide early warning of releases of waste from the disposal site before they leave the Federal Cell Facility boundary; (d) after the Federal Cell Facility is closed, Energy*Solutions* will transfer responsibility to DOE for post-operational surveillance of the disposal site and will maintain a monitoring system based on the operating history and the closure and stabilization of the Federal Cell Facility. The post-operational monitoring system must also be capable of providing early warning of releases of waste from the disposal site before they leave the site boundary.

- Energy*Solutions* takes mitigating measures if the Environmental Monitoring Program detects migration of waste which would indicate that the performance objectives may not be met.

10.3.8 Funding for Routine Perpetual Care Activities

Upon completion of embankment closure and decommissioning, the Legacy Management Division of DOE will assume title and perpetual stewardship of three facilities in the Clive Disposal Complex (Vitro Federal Disposal Facility, 11e.(2) Federal Byproduct Facility and the Federal Cell Facility). As is summarized in Table 10-2, DOE is expected to perform similar routine perpetual surveillance activities for these embankments. Each of these facilities serves as final disposition for waste materials containing uranium decay products. The facilities are designed with compacted clay cover materials to limit infiltration into the waste and to isolate gaseous uranium decay products from release to the environment. The 11e.(2) Federal Byproduct and the Federal Cell facilities also include compacted clays beneath the waste to minimize contaminant leachate from migrating into the area's groundwater. Because it was not considered a viable source of potable water, the Vitro Federal Disposal Facility was not constructed with a compacted clay liner. As part of their stewardship, DOE is expected to regularly inspect the site, either during a site visit or a visual inspection from an aircraft. Ongoing surveillance will include time spent in preparing for the inspection, travel to the site, conduct of the inspection, and annual report writing (NUREG-1620, ppE-8).

PRELIMINARY REVIEW DRAFT

Table 10-2

Similarities in DOE Long-Term Stewardship at the Clive Disposal Facility

	VITRO	11E.(2)	FEDERAL CELL FACILITY
Long-Term Steward / Owner	DOE-LM	DOE-LM	DOE-LM
Radionuclides	U-235/U-238 decay chains	U-235/U-238 decay chains	U-235/U-238 decay chains
Environmental Concern	Rn-222 emanation and diffusion into atmosphere and groundwater leaching	Rn-222 emanation and diffusion into atmosphere and groundwater leaching	Rn-222 emanation and diffusion into atmosphere and groundwater leaching
Atmospheric Barrier	7 feet compacted radon barrier rock armor protection from erosion	2 and 7 feet compacted radon barrier rock armor protection from erosion	2 feet compacted radon barrier rock armor protection from erosion
Groundwater Barrier	NRC and DOE do not consider GW pathway viable - 40 CFR 192.11	2 feet compacted clay barrier	2 feet compacted clay barrier
Waste Form	Soils	Soils / Dry Active Waste	Soil-like, cement fill, steel containers
Perpetual Care Activities	Annually inspect cell, area around cell, gully formation, slope erosion, and intrusion by animal or human	Annually inspect cell, area around cell, gully formation, slope erosion, and intrusion by animal or human	Annually inspect cell, area around cell, gully formation, slope erosion, and intrusion by animal or human
Source of Additional Funding for Unanticipated Events	Congressional Appropriation	Congressional Appropriation	Congressional Appropriation
Licensee Provided Perpetual Care Funds for Routine Monitoring	$0	$1,006,648 adjusted annually ($250,000 in 1978 dollars) per 10 CFR 40 Appendix A - Criterion 10	Principle reserve of $770,290.82 needed to generate $15,405.82 (adjusted annually for inflation). 2% of Revenue in Cash plus Surety Bond for Gap Coverage
Licensee Provided Perpetual Care Funds for Remediation Following Catastrophic Event	$0	$0	$2,383,386 additional funds above reserve perpetual care principle - adjusted annually for inflation and changes in embankment footprint.

PRELIMINARY REVIEW DRAFT

Similarities between the expected 11e.(2) Byproduct Disposal and Federal Cell facilities long-term stewardship activities to be performed by DOE-LM suggest it reasonable to assume onsite DOE inspections of the Vitro Federal Disposal Facility, 11e.(2) Federal Byproduct Facility and the Federal Cell Facility will occur concurrently, securing equivalent perpetual care funding for routine care of the Federal Cell Facility in addition to that required for the 11e.(2) Federal Byproduct Facility is very conservative. However, because the amount of funds required by Criterion 10 of Appendix A in 10 CFR 40 for perpetual care of the 11e.(2) Byproduct Facility does not provide the cost basis for the required total perpetual activities, funds for routine perpetual care of the Federal Cell Facility are conservatively calculated using activities conducted during institutional control of the Class A West Facility. Therefore, perpetual funds are pledged to conduct annual inspection and embankment surveys, to support annually sample external radiation exposures from the embankment and atmospheric radon gas flux from the Federal Cell Facility. Class A West Facility funds for airborne dust particulate and groundwater leachate monitoring are provided for the entire Clive Disposal Complex's licensed footprint and are not duplicated for the Federal Cell Facility. The amount of funds pledge for perpetual routine care of the Federal Cell Facility is sufficient principle ($770,290.82) to generate adequate interest at an assumed 2% investment credit for the annual activities (in a manner consistent with that used by the Director to determine the necessary Perpetual Care Funds for the Class A West Facility). This value will be adjusted annually to reflect additional depleted uranium disposal in the Federal Cell Facility.

10.3.9 Impact of Highly Unlikely Catastrophic Events

Notwithstanding the precautions Energy*Solutions* will take to ensure safe operation, funds to support remediation following reasonably well-known but highly unlikely future events, conditions, circumstances, and environment will also be secured (as determined by URS (2015) for the Class A West embankment). Uncertainties about the future might produce unplanned effects, including:

- the worsening of natural conditions beyond expectations (such as climatic conditions change and produce excessive precipitation, run-on, or runoff; climatic conditions change and produce extreme aridity; earthquake ground motions are greater than projected; or vegetation or burrowing animals intrude more aggressively than expected),

- unanticipated human activities (such as aircraft impacts the closed facility; waste constituents dispersed by a terrorist attack or disgruntled employee; critical material, fuel, labor, or other prices are higher than projected; claims of health impacts attributable to the closed facility create new financial liabilities; laws and/or regulatory requirements change to create unanticipated financial liabilities; or litigation delays or extends needed actions), or

- components of the Federal Cell Facility fail to perform as designed (such as water infiltration is greater than anticipated; water accumulates within disposal unit; water or wind erosion is greater than anticipated; excessive differential settlement damages the cover system; waste or constituents are exposed at the surface of the facility; wastes interact with unanticipated deleterious effects; or construction flaws compromise facility performance).

The probabilities of these unanticipated incidents vary widely. Instead of securing funds for those events where the probability of occurrence is vanishingly small, the Utah public interest is better protected by providing funds to remediate following events with greater probability that it might occur. Without more detailed information about the possible events and outcomes listed, attempts to manage these risks would be based on simple speculation. In cases that result in the closed Federal Cell Facility failing to perform as

PRELIMINARY REVIEW DRAFT

required, reasonable estimates are made of their costs and information developed in support of decision making.

Notwithstanding the ambiguity and uncertainties associated with conditions that increase monitoring and maintaining closed facilities, upper and lower bounds of probabilities for unlikely occurrences to the Clive Disposal Complex were estimated and perpetual care funds secured for management of Energy*Solutions'* Class A West embankment (URS, 2015). These same estimated probability bounds serve as the basis for cost estimates to repair the Federal Cell Facility, in the unlikely event of their occurrence, as summarized in Table 10-3. This same methodology is following for estimation of the necessary fund for repair to the Federal Cell Facility from a catastrophic event. In utilizing this methodology, it is important to recognize several differences between the Class A West LLRW Facility and the Federal Cell Facility. Primarily, all depleted uranium will be placed below grade and entombed in controlled low-strength material. Therefore, it is reasonable to assume that the impact of an event requiring catastrophic repair of the Federal Cell Facility would be limited to significant damage to the Federal Cell Facility final cover and the fill material placed between the depleted uranium and cover. Repair cost assumes replacing, regrading and compacting embankment fill and replacement of final cover and monitoring for settlement. The costs for re-grading, compaction, replacement of final cover and final settlement monitoring for the closed Federal Cell Facility and mirror those projected in Sections 31, 207 and 211 of the Federal Cell Facility premature closure cost estimates.

It is important to note that funds required to cover costs expected to mitigate impact of the Federal Cell Facility from the most likely financial risks (as determined by URS, 2015) of unplanned and unanticipated events, are significantly lower than those projected for the Class A West Facility (URS, 2015). URS analysis considered funds at time of closure necessary for repair cover system failure, surface contamination, waste interactions and settlement to the Class A West embankment to be $13 million. Of these costs embankment reconstruction, fill and cover replacement were highest bounding costs (URS, 2015). Repair following catastrophic impact to the Federal Cell Facility following its first year of waste placement will be dramatically less than the Class A West Facility footprint. Additionally, since all depleted uranium will be placed below grade and entombed in controlled low-strength material, risk of waste dispersal is negligible. Therefore, repair of the Federal Cell Facility following a highly unlikely unanticipated event does not assume the depleted uranium will require mitigation, but rather limited to regarding and compacting above-grade fill and reconstruction and settlement monitoring of the final cover.

Because the probabilities that a singular catastrophic event will occur are highly unlikely, the need to fund correction of multiple events was deemed as negligible (URS, 2015). Therefore, in addition to funds secured for DOE to perform routine perpetual surveillance, Energy*Solutions* will secure additional $2,383,386 to remediate a compromise to the closed Federal Cell Facility that resulted from an unlikely catastrophic event. The amount of funds necessary for routine perpetual care and remediation following a catastrophic event will be reassessed and adjusted to account for site and facility changes, as part of the required annual revision to the Federal Cell Facility surety analysis. Therefore, a total of $3,153,677 ($770,290.82 per routine surveillance and $2,383,386 for repair following a catastrophic event after one year of depleted uranium waste disposal) will be secured for in perpetual care funds for the Federal Cell. Perpetual care funds will be composed of annual contributions of 2% depleted uranium disposal revenue in the Federal Cell Facility and separate surety bond adjusted in value annually to an amount necessary to bring the total perpetual care fund value to that required for annual perpetual management and remediation following a catastrophic event.

PRELIMINARY REVIEW DRAFT

Table 10-3

Summary of Inexact Ranges of Probabilities of Unplanned and Unanticipated Future Events

	AS ESTIMATED (Prob. Range)	**PLAUSIBLE MAXIMUM (Prob. Range)**
Cover System Failures (reworked/replaced cover)	Less than 10 in 1,000	200 in 1,000
Excessive Water Enters Federal Cell Facility (augment cover)	Less than 10 in 1,000	200 in 1,000
Surface Contamination Observed (remediate contamination)	Less than 10 in 1,000	200 in 1,000
Wastes Interact with Unanticipated Deleterious Effects (reworked/replaced cover)	Less than 1 in 1,000	50 in 1,000
Aircraft Impacts the Closed Federal Cell Facility or Waste Constituents Are Dispersed by a Terrorist Attack (reworked/replaced cover)	Less than 1 in 10,000	1 in 1,000

PRELIMINARY REVIEW DRAFT

10.4 ANNUAL ADJUSTMENTS

Surety and perpetual care funding for the Federal Cell Facility will be reviewed annually to account for inflation and changes in activities or design. This annual review ensures that the amount is adequate to fund the decommissioning of the Clive Facility in the event that Energy*Solutions* is unable to close the embankments. As with the funds secured for premature closure, Energy*Solutions* will annually revise and adjust the required level of funding for DOE's perpetual care (routine and following a catastrophic event) of the Federal Cell funds. The value of the surety instrument secured to address any deficiency between the Trust's perpetual care cash balance and the amount needed will be adjusted annually, as determined annually as the result of the Director's annual review. As is reflected in the stewardship transfer agreements in Appendix C, Energy*Solutions* anticipates that the Director will closely coordinate the annual review and revision of the Federal Cell Facility's premature closure and perpetual care surety calculations with DOE-LM.

PRELIMINARY REVIEW DRAFT

SECTION 11. REFERENCES

AGRA "Report: Evaluation of Settlement of Incompressible Debris Lifts LARW Facility Near Clive, Tooele County, Utah," AGRA Earth & Environmental, Inc., June 1, 2000. (AGRA, 2000b).

AGRA. "Evaluation of Settlement of Compressible Debris Lifts, LARW Facility." AGRA Earth & Environmental, Inc., June 1, 2000. (AGRA, 2000a)

AMEC, "Energy*Solutions* Clive Facility Clay Cracking Study Plan." AMEC Environmental & Infrastructure, Inc., 1 August 2012. (AMEC, 2012b)

AMEC, Report: "Geotechnical Update Report, Energy Solutions Clive Facility, Class A West Federal Cell Facility", AMEC Environmental & Infrastructure, Inc., February 15, 2011. (AMEC, 2011).

AMEC. "Response to Interrogatory CAW R313-25-8(4)-16/3: Seismic Hazard Evaluation/Seismic Stability Analysis Update, Energy*Solutions* Clive Facility – Class A West Federal Cell Facility, Clive, Tooele County, Utah." (Job No. 10-817-05290) AMEC Environmental & Infrastructure, Inc., 6 April 2012. (AMEC, 2012a)

AMEC, "Geotechnical Study: Increase in Height and Footprint." AMEC Environmental & Infrastructure, Inc., 27 May 2005. (AMEC, 2005).

AMEC. "Placement of Large Liners in Caissons." AMEC Environmental & Infrastructure, Inc., 5 August 2002. (AMEC, 2002).

AMEC. "Response to Interrogatory Number 2: Placement of HICs in Caissons." AMEC Environmental & Infrastructure, Inc., 1 October 2001. (AMEC, 2001).

Bingham Environmental. "HEC-1 and HEC-2 Analysis, LARW Application for License Renewal", Envirocare Disposal Facility, Clive, Utah. November 26, 1996. (Bingham Environmental, 1996).

Bingham. "Liner Compatibility Report." Bingham Environmental, Inc., 8 March 1994. (Bingham, 1994).

Bisdorf, R.J., and Zohdy, A.A.R. "Preliminary geologic map of Fish Springs NE and Fish Springs SE Quadrangles, Juab and Tooele counties, Utah." USGS Miscellaneous Field Studies Map: 11476. 1980. (Bisdorf and Zohdy, 1980).

Black. "" (Black et al., 1999).

BLM. "Cedar Mountain and Onaqui Mountain Wild Horse Herd Management Areas Capture, Treat, and Release Plan." Environmental Assessment (DOI-BLM-UT-W010-2011-0031-EA), Bureau of Land Management, January 2012. (BLM, 2012b).

BLM. Personal communication between Mike LeBaron or Energy*Solutions* and Kim Hershey of the U.S. Bureau of Land Management, 28 May 2012. (BLM, 2012a).

PRELIMINARY REVIEW DRAFT

BLM. "Proposed Pony Express Resource Management Plan and Environmental Impact Statement," Salt Lake District Office, Salt Lake City, UT, U.S. Department of Interior, May, 1988. (BLM, 1988).

BLM, "Timpie Solar Evaporation Pond System Environmental Assessment," Salt Lake District Office, Salt Lake City, UT, Prepared by Bio/West, Inc. U.S. Department of the Interior, 1987. (BLM, 1987).

Brough, C., et. al. "Utah's Tornadoes and Waterspouts – 1847 to the Present." National Weather Service Forecast Office, Salt Lake City, Utah 2010. (Brough, et.al; 2010).

Bucknam, R.C. "Map of Suspected Fault Scarps in Unconsolidated Deposits, Tooele 20 Sheet." USGS Open-file Report 77-495, 1977. (Bucknam, 1977).

Census. "United States Census 2019." Electronic accessed at https://factfinder.census.gov/ on 15 January 2020. (Census, 2019).

Census. "United States Census 2010." Electronic accessed at http://www.census.gov/2010census/data/ on 5 March 2013. (Census, 2012).

Cook, K.L., M.O. Halverson, J.C. Steep, and J.W. Berg, Jr. "Regional Gravity Survey of the Northern Great Salt Lake Desert and Adjacent Areas in Utah, Nevada, and Idaho," Geological Society of America Bulletin, Vol., 75, p. 715-741, August 1964. (Cook et. al, 1964).

Cronquist, A., A. H. Holmgren, N. H. Holmren, and J. L. Reveal. "Intermountain Flora: Vascular Plants of the Intermountain West, U.S.A." Hafner Publishing Co., New York, 1972. (Cronquist et. al, 1972).

CRWQCB. "" (CRWQCB, 1990).

DOE. "Site Transition Framework for Long-Term Surveillance and Maintenance." U.S. Department of Energy, 2019. https://www.energy.gov/sites/prod/files/framework.pdf . (DOE, 2019).

DOE. "Technical Approach Document, Revision II. UMTRA-DOE/AL 050425.0002." U.S. Department of Energy, 1989. (DOE, 1989).

DOE. "Disposal Site Characterization Report for the Uranium Mill Tailings Site at Salt Lake City, Utah", (UMTRA-DOE/AL-050102.0001), Uranium Mill Tailings Remedial Action Project Office, January 1985. (DOE, 1985b).

DOE. "Final Environmental Impact Statement for Remedial Actions at the Former Vitro Chemical Company Site, South Salt Lake, Salt Lake County, Utah", (DOE-EIS-0099-F), U.S. Department of Energy Report, July 1984. (DOE, 1984).

Energy*Solutions*. "Revised Hydrogeologic Report – Waste Disposal Facility – Clive, Utah Version 4.0" Report from EnergySolutions, January 15, 2019. (Energy*Solutions*, 2019).

Grams, Kayla. "Hitch a Ride in Wild Horse Country." The Humane Society of the United States, (http://www.humanesociety.org/news/news/2009/11/hsus_land_rover_wild_horse_country_111909.html) accessed 30 May 2012, published 19 November 2009. (Grams, 2009).

PRELIMINARY REVIEW DRAFT

Lietz, J. "Tornado History Project." National Climatic Data Center, accessed at http://www.tornadohistoryproject.com on 15 January 2020. (Lietz, 2017).

Los Alamos National Laboratory, "Performance assessment and composite analysis for Los Alamos National Laboratory Technical Area G, Revision 4." LA-UR-08-06764. Los Alamos National Laboratory, Los Alamos, NM. (LANL, 2008)

Lundberg, R. "Policy Regarding the Application of Existing Performance Assessment Rules (R313-25-8, Technical Analyses, Utah Administrative Code) and U.S. Nuclear Regulatory Commission (NRC) Direction (SRM-SECY-2013-075) and Applicable Federal Guidance for Performance Assessments (NUREG-1573)." Memorandum from the Utah Division of Radiation Control. February 25, 2014.

Montgomery Watson. "LARW Cover Frost Penetration." , March 1, 2000. (Montgomery Watson, 2000).

Moore, W.J., Sorensen, M.L. "Geologic Map of the Tooele 10 x 20 Quadrangle, Utah. U.S. Geological Survey, I-1132," 1979. (Moore, 1979).

MSI. "January 2011 Through December 2011 and January 1993 Through December 2018 Summary Report of Meteorological Data Collected at Energy*Solutions'* Clive, Utah Facility." Meteorological Solutions, Inc Project No. 011110111 Report, February 2019. (MSI, 2019).

Myrick, et al. "" (Myrick, et al., 1981).

NRCP. "" NRCP, 2009).

NCRP. "Report No. 87, Use of Bioassay Procedures for Assessment of Internal Radionuclide Deposition," 1987. (NCRP, 1987).

Neptune. "Final Report for the Clive DU PA Model – Clive DU PA Model v1.4". Neptune, November 24, 2015 (Neptune, 2015).

NOAA. "NOAA Atlas 2 Precipitation Frequency Estimates in GIS Compatible Formats." Accessed at http://www.nws.noaa.gov/oh/hdsc/noaaatlas2.htm on 20 October 2012. (NOAA, 2012).

NRC, (NUREG-1620).

NRC. "" (NRC, 2015).

NRC. "" (NRC, 2012).

NRC, "NUREG-1623: Design of Erosion Protection for Long- Term Stabilization. Final Report," September, 2002. (NRC, 2002).

NRC. "Consolidated Guidance About Materials Licenses: Guidance About Administrative Licensing Procedures." (NUREG-1556, Volume 20). U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, December 2000. (NRC, 2000).

PRELIMINARY REVIEW DRAFT

NRC, "A Performance Assessment Methodology for Low-Level Radioactive Waste Disposal Facilities." (NUREG-1573), 1999. (NRC, 1999).

NRC. "Final Environmental Impact Statement to Construct and Operate a Facility to Receive, Store, and Dispose of 11e.(2) Byproduct Material Near Clive, Utah." (NUREG-1476). Office of Nuclear Materials Safety and Safeguards. August, 1993. (NRC, 1993c).

NRC. "Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program." (Regulatory Guide 8.9, revision 1) Office of Nuclear Regulatory Research, July 1993. (NRC, 1993b).

NRC. "ALARA Levels for Effluents from Materials Facilities." (Regulatory Guide 8.37) Office of Nuclear Regulatory Research. July 1993. (NRC, 1993a).

NRC. "Standard Format and Content of a license application for a Low-Level Radioactive Waste Disposal Facility" (NUREG-1199), U.S. Nuclear Regulatory Commission, January 1991. (NRC, 1991).

NRC, "NUREG/CR-4620: Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments," June 1986. (NRC, 1986).

NRC. "Final Generic Environmental Impact Statement on Uranium Milling, Project M-25." (NUREG-0706, Volumes I – III). Office of Nuclear Material Safety and Safeguards, September, 1980. (NRC, 1980a).

NRC. "Acceptable Programs for Respiratory Protection." (Regulatory Guide 8.15). U.S. Nuclear Regulatory Commission, October 1976. (NRC, 1976).

Stephens, Jerry C. "Hydrologic Reconnaissance Of The Wah Wah Valley Drainage Basin, Millard And Beaver Counties, Utah." Utah Department of Natural Resources, Technical Publication No. 47, 1974. (Stephens, 1974).

SWCA, Inc. "Field Sampling of Biotic Turbation of Soils at the Clive Site, Tooele County, Utah." Report prepared by SWCA Environmental Consultants (submitted to the Division - CD11-0153), January 2011. (SWCA, 2011).

UDWR. "Kit Fox." Wildlife Notebook Series No. 9, Utah Division of Wildlife Resources, 2010. (UDWR, 2010).

UDNR. "Utah Greater Sage-Grouse Management Plan 2009." (Publication 09-17). State of Utah. Department of Natural Resources, Division of Wildlife Resources, 4 June, 2009. (UDNR, 2009).

UDNR. "Hydrologic reconnaissance of the southern Great Salt Lake Desert and summary of the hydrology of west-central Utah." Utah Department of Natural Resources Technical Publication 71:55. 1981. (UDNR, 1981).

UGS. "Utah Geological and mineral Survey, Map 111", Utah Survey Special Study 96, accessed online at http://geology.utah.gov/maps/geohazmap/index.htm on 20 October 2012. 1999. (UGS, 1999).

PRELIMINARY REVIEW DRAFT

URS. “” (URS, 2015).

UWQB. “” (UWQB, 2009).

Wong, I., W. Arabasz, B. Carey, C. DuRoss, W. Lund, J. Pechmann, and B. Welliver, 2013, Opinion, Seismological Research Letters, Vol. 84, 165-169. (Wong, 2013)

PRELIMINARY REVIEW DRAFT

APPENDIX A

Proposed Radioactive Material License

For the Federal Cell Facility

PRELIMINARY REVIEW DRAFT

PRELIMINARY REVIEW DRAFT

UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF WASTE MANAGEMENT AND RADIATION CONTROL
RADIOACTIVE MATERIAL LICENSE

Pursuant to the Utah Code Annotated, Title 19, Chapter 6 and R313 of the Utah Administrative Code (UAC) and in reliance on statements and representations heretofore made by the licensee designated below, a license is hereby issued authorizing such licensee to transfer, receive, possess and use the radioactive material designated below; and to use such radioactive material for the purpose(s) and at the place(s) designated below. This licensee is subject to all applicable rules, and orders now or hereafter in effect and to any conditions specified below.

****

LICENSEE	
1. Name:	Energy*Solutions*, LLC (the Licensee)
2. Address:	299 South Main Street Suite 1700 Salt Lake City, Utah 84111

3. License Number UT 2300XXX
Amendment #0

4. Expiration Date
December 31, 2030

5. License Category – 4-a

****

6. Radioactive material (element and mass number)	7. Chemical and/or physical form	8. Maximum quantity Licensee may possess at any one time
Depleted uranium and naturally-occurring radioactive material (NORM).	Packaged or Bulk Radioactive Waste	X,XXX,XXX Cubic Yards

****

9. AUTHORIZED USE:

A. The Licensee may receive, store and dispose by land burial, radioactive material as naturally occurring and accelerator produced material (NARM) and concentrated depleted uranium radioactive waste. Prior to receiving NARM or depleted uranium waste shipments for disposal from a generator, the Licensee shall obtain documentation which demonstrates that the wastes have been approved for disposal in the Federal Cell Facility by the U.S. Department of Energy.

B. In accordance with Utah Code Annotated 19-3-105, the Licensee may not receive Class B or Class C low-level radioactive waste for management in the Federal Cell Facility without first receiving approval from the U.S. Department of Energy, the Director of the Division of Waste Management and Radiation Control (Director), the Governor for the State of Utah and the Utah State Legislature.

C. The Licensee shall comply with all license conditions and shall meet all compliance schedules stipulated in the Ground Water Quality Discharge Permit, number UGW 450005 (hereafter GWQ

PRE-DRAFT

DIVISION OF WASTE MANAGEMENT AND RADIATION CONTROL
RADIOACTIVE MATERIALS LICENSE
SUPPLEMENTARY SHEET

License # UT 2300XXX
Amendment # 0

Permit), issued by the Director.

D. The Licensee shall only dispose of depleted uranium radioactive waste and Naturally Occurring and Accelerator Produced Radioactive Materials (NARM) below the native grade in the Federal Cell Facility described in License Condition 10.

E. The Licensee shall not accept, possess, store or dispose of any radioactive waste delivered to the Federal Cell Facility by any conveyance, unless the associated Uniform Low-Level Radioactive Waste Manifest has a valid Generator Site Access Permit number issued by the Director, thereon affixed.

****

SITE LOCATION:

10. A. The Licensee may receive, store, transload, and dispose of depleted uranium and NARM at the Licensee's Federal Cell Facility located in Section 32 of Township 1 South and Range 11 West, SLBM, Tooele County, Utah. The Licensee may receive, transload closed packages as defined in 57.B.iii, and store licensed materials within certain portions of the Licensee's facility located in Section 29 of Township 1 South, Range 11 West, SLBM, Tooele County, Utah, in accordance with Condition 57.

B. The Federal Cell Facility is defined by the following points of reference:

Southwest Corner:	Latitude 40° 40' 55.05547" N Longitude 113° 07' 24.76157" W Elevation 4266 feet above mean sea level (amsl)
Southeast Corner:	Latitude 40° 40' 54.93295" N Longitude 113° 07' 07.66161" W Elevation 4266 feet above mean sea level (amsl)
Northwest Corner:	Latitude 40° 41' 12.59025" N Longitude 113° 07' 24.54541" W Elevation 4266 feet above mean sea level (amsl)
Northeast Corner:	Latitude 40° 41' 12.46773" N Longitude 113° 07' 07.44420" W Elevation 4266 feet above mean sea level (amsl)

PP DRAFT

DIVISION OF WASTE MANAGEMENT AND RADIATION CONTROL
RADIOACTIVE MATERIALS LICENSE
SUPPLEMENTARY SHEET

License # UT 2300XXX
Amendment # 0

CONDITIONS:

11. The open cell area within the Federal Cell Facility, where uncovered waste disposal/placement has occurred shall be limited to a surface area of X,XXX,XXX square feet.

PROHIBITIONS AND WASTE ACCEPTANCE REQUIREMENTS:

12. A. Sealed sources as defined in UAC R313-12 shall not be accepted for disposal.

    B. Waste containing untreated biological, pathogenic or infectious material including radiologically contaminated laboratory research animals is prohibited.

    C. Receipt of non-aqueous liquid waste for management in the Federal Cell Facility is prohibited unless specifically approved by the Director.

    D. The Licensee shall not accept for disposal in the Federal Cell Facility any neutron source (e.g., polonium-210, americium-241, radium-226 in combination with beryllium or other target).

    E. Incinerator ash shall be treated, in preparation for disposal, in a manner that renders it non-dispersible in air.

    F. The Licensee shall not accept containerized depleted uranium waste unless:
       i. Each disposal container has been classified in accordance with UAC R313-15-1009. In addition, the Licensee shall require that all radioactive waste received for disposal meet the requirements specified in the Nuclear Regulatory Commission, " Concentration Averaging and Encapsulation Branch Technical Position,", as amended.
       ii. Each disposal container is marked as either Class A Stable or Class A Unstable as defined in the most recent version of the "Low-Level Waste Licensing Branch Technical Position on Radioactive Waste Classification" issued by the U.S. Nuclear Regulatory Commission. The marking may be affixed to either the disposal container or transport package, in accordance with UAC R313-15-1006(4) and Section III of Appendix G of 10 CFR 20.1001 to 20.2402 (incorporated by reference).
       iii. Each disposal container is marked with a unique package identification number, clearly visible on the package that can be correlated with the manifest for the waste shipment in which the package arrives at the facility.

PRELIMINARY DRAFT

DIVISION OF WASTE MANAGEMENT AND RADIATION CONTROL
RADIOACTIVE MATERIALS LICENSE
SUPPLEMENTARY SHEET

License # UT 2300XXX
Amendment # 0

PRE-DRAFT

MANAGEMENT OF FREE LIQUIDS:

13. A. In accordance with UAC R313-15-1009(2)(a)(iv), solid waste received for disposal at the Federal Cell Facility shall contain as little free standing and non-corrosive liquid as reasonably achievable, but shall contain no more free liquids than one percent of the volume of the waste.

    B. Solid waste received for disposal at the Federal Cell Facility, that contains unexpected aqueous free liquid in excess of 1% by volume shall have the liquid removed and placed in the evaporation ponds or the liquid solidified prior to management.

    C. Unexpected non-aqueous free liquids less than 1% of the volume of the waste within the container shall be solidified prior to disposal.

    D. Should shipments arrive with greater than 1% unexpected free liquids (total of aqueous and non-aqueous), the Licensee shall notify the Director within 24 hours that the shipment(s) failed the requirements for acceptance and manage in accordance with the Waste Characterization Plan.

RADIATION SAFETY:

14. The Licensee may transport licensed material or deliver licensed material to a carrier for transport in accordance with the provisions of UAC R313-19-100, "Transportation."

15. Written procedures incorporating operating instructions and appropriate safety precautions for licensed activities shall be maintained and available at the location specified in License Condition 10.A. The written procedures established shall include the activities of the radiation safety and environmental monitoring programs, the employee training program, operational procedures, analytical procedures and instrument calibration. At least annually, the Licensee shall review all procedures to determine their continued applicability.

16. The Licensee's Radiation Safety Officer (RSO) shall review and approve written procedures as stated in License Condition 15 and subsequent changes to the procedures related to waste disposal operations.

ROUTINE MONITORING AND CONTAMINATION SURVEYS:

17. The operational environmental monitoring program shall be conducted in accordance with the current Environmental Monitoring Plan approved by the Director.

18. Vehicles, containers, facilities, materials, equipment or other items for unrestricted use shall not be released from the Licensee's control if contamination exceeds the limits found in Table 19-A. When not released

DIVISION OF WASTE MANAGEMENT AND RADIATION CONTROL
RADIOACTIVE MATERIALS LICENSE
SUPPLEMENTARY SHEET

License # UT 2300XXX
Amendment # 0

from the Licensee's control for unrestricted use, conveyances released for commercial transport of radioactive waste or materials shall comply with the requirements and applicable contamination limits set forth in 49 CFR 173 and the requirements of 10 CFR 71.5.

TABLE 18-A

Nuclide[a]	Column 1 Average [b,c,f]	Column 2 Maximum [b,d,f]	Column 3 Removable [b,e,f]
U-nat, U-235, U-238, and associated decay products	5,000 dpm alpha/ 100cm^2	15,000 dpm alpha/ 100cm^2	1,000 dpm alpha/ 100cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100cm^2	300 dpm/100cm^2	20 dpm/100cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100cm^2	3,000 dpm/100cm^2	200 dpm/100cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emissions or spontaneous fission) except Sr-90 and other noted above.	5,000 dpm beta, gamma/100cm^2	15,000 dpm beta-gamma/100cm^2	1,000 dpm beta-gamma/100cm^2

a. Where surface contamination on both alpha-and beta-gamma emitting nuclides exists, the limits established for alpha-and beta-gamma emitting nuclides should apply independently.
b. As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency and geometric factors associated with the instrumentation.
c. Measurements of average contamination should not be averaged over more than one square meter. For objects of less surface area, the average should be derived for each such object.
d. The maximum contamination level applies to an area of not more than 100 cm^2.
e. The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping the area with dry filter or soft absorbent paper, applying moderate pressure and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.
f. The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters shall not exceed 0.2 mrad/hr at one cm and 1.0 mrad/hr at one cm, respectively, measured through not more than seven mg/cm^2 of total absorber.

PRE-DRAFT

DIVISION OF WASTE MANAGEMENT AND RADIATION CONTROL
RADIOACTIVE MATERIALS LICENSE
SUPPLEMENTARY SHEET

License # UT 2300XXX
Amendment # 0

DRAFT

REPORTING AND NOTIFICATION:

19. The Licensee shall submit to the Director a quarterly summary report detailing the radioisotopes, activities, weighted average concentrations, volume and tonnage for waste received for management at the Federal Cell Facility during the calendar quarter. The report(s) shall be submitted within 30 days after the expiration of each calendar quarter. Calendar Quarter shall mean:

First Quarter	January, February, and March
Second Quarter	April, May, and June
Third Quarter	July, August, and September
Fourth Quarter	October, November, and December

CONSTRUCTION ACTIVITIES:

20. The Licensee shall construct the Federal Cell Facility identified in the Ground Water Quality Discharge Permit No. UGW450005 and in accordance with approved engineering design drawings "Series 14004."

21. Waste placement and backfilling within the Federal Cell Facility shall be conducted in accordance with the following:

    A. The Federal Cell Facility shall conform to the characteristics defined, analyzed and described in the Engineering Justification Report, Addendum "Fifteen Percent Void Space Criteria" (Revision 1 dated October 10, 2001); and the AMEC letter to Envirocare of Utah, Inc. "Placement of Drums and B-25 Containers with 15 Percent Voids; Envirocare Class A - Containerized Waste Facility Near Clive, Utah" (dated October 2, 2001). Waste containers that have void space in excess of 15 percent shall be filled to the top of the container opening using Controlled Low Strength Material (CLSM) in accordance with the Construction QA/QC manual. The Licensee is exempt from the CLSM cold weather requirements and the 48-hour notification for void remediation at the Federal Cell Facility.

    B. Waste container configurations, backfill materials and associated placement activities, shall be those approved by the Director following specifications contained in the Work Element: Federal Cell Facility-Waste Placement Test Pad and the Work Element: Federal Cell Facility - Waste Placement Sections of the currently approved LLRW Construction Quality Assurance/Quality Control Manual.

    C. Disposal of non-containerized decomposable or compressible waste at the Federal Cell Facility shall be in accordance with debris placement requirements of the currently approved LLRW and 11e.(2) CQA/QC Manual.

DIVISION OF WASTE MANAGEMENT AND RADIATION CONTROL
RADIOACTIVE MATERIALS LICENSE
SUPPLEMENTARY SHEET

License # UT 2300XXX
Amendment # 0

DRAFT

22. The Licensee shall fulfill all requirements and maintain compliance with all License Conditions in the LLRW and 11e.(2) CQA/QC Manual and engineering drawings currently approved by the Director.

23. All engineering related soil tests conducted by the Licensee to demonstrate compliance with Condition 32 shall be performed by a laboratory certified and accredited by the AASHTO Materials Reference Laboratory (AMRL). Said certification/accreditation shall apply to clay liner, clay radon barrier, soil filter layers, sacrificial soils and riprap materials or other soil or man-made materials as directed by the Director. Certification is not required for the Director approved sealed single ring infiltrometer permeability test contained in Appendix B to the LLRW and 11e.(2) CQA/QC Manual.

24. The Licensee shall not initiate disposal operations in newly excavated or newly tied-in areas until the Director has approved the Federal Cell Facility liner.

25. A. The Licensee shall not dispose of wastes other than NARM and significant quantities of concentrated depleted uranium prior to the approval by the Director of a performance assessment required by UAC R313-25-9.

    B. Performance assessment: A performance assessment, in general conformance with the approach suggested by the Nuclear Regulatory Commission (NRC) in NUREG-1573, shall be submitted for the Director's review and approval. As described in the Director's 2014 Memorandum to staff, the Licensee shall exhibit compliance the requirements of UAC R317-6-4.7 by demonstrating non-degradation of the groundwater for 200 years for non-radiological contaminants and 500 years for radiological contaminants (incorporated by reference). The performance assessment shall otherwise demonstrate that the Federal Cell Facilities performance for a compliance period of 1,000 years.

    C. Revised disposal embankment design: If the performance assessment required by License Condition 25.B indicates that changes to disposal operations and cover design are necessary to ensure compliance with the requirements of 10 CFR Part 61 or UAC R313, the Licensee shall provide a revised design that meets those requirements for Class A wastes other than NARM and concentrated depleted uranium prior to their receipt at the facility.

SITE OPERATING PROCEDURES

26. A. The Licensee shall apply on a biweekly basis (once every two weeks) between the first day of May and the last day of September a polymer-based stabilizer in accordance with the manufacturer's instructions on all exposed contaminated areas and areas of waste within the Federal Cell Facility which have been disturbed in the previous two weeks. Except when sufficient precipitation has fallen within two weeks to create ground surface conditions beyond the manufacturer's recommended specifications (the polymer-based stabilizer specifications shall be provided to the Director prior to any application thereof), the Licensee shall notify the Director's engineering staff via email when enough precipitation

DIVISION OF WASTE MANAGEMENT AND RADIATION CONTROL
RADIOACTIVE MATERIALS LICENSE
SUPPLEMENTARY SHEET

License # UT 2300XXX
Amendment # 0

PP DRAFT

has fallen that is beyond manufacturer's recommended specifications and the polymer solution will not be applied.

B. The Licensee shall minimize the dust created during the process of placing and moving waste, through the use of water. Water or other engineering controls shall be placed on roads and in areas which work is being performed.

C. The Licensee shall cease loading, hauling and dumping of un-containerized waste whenever the five-minute average wind velocities exceed 35 miles per hour. When both the five-minute average and five-minute maximum wind velocities are less than 35 mph as observed on the meteorological station, management of un-containerized waste may resume.

27. The Licensee shall limit disposal of depleted uranium below native grade and beneath the top slope of the Federal Cell Facility.

MANIFEST/SHIPPING REQUIREMENTS

28. The Licensee shall not accept radioactive waste for storage and disposal unless the Licensee has received from the shipper a completed manifest that complies with UAC R313-15-1006 and UAC R313-25-33(8).

29. The Licensee shall maintain copies of complete manifests or equivalent documentation required under License Condition 30 until the Director authorizes their disposition.

30. The Licensee shall notify the Director in writing within seven days 24 hours followed by written notification within seven days of any waste shipment that arrives at the Licensee's property and does not comply with applicable rules or license conditions. Specifically, notifications required under this license condition shall be made for shipments that:

A. contain wastes prohibited under Utah Code Annotated 19-3-103.7,

B. contains wastes not authorized in Condition 9,

C. do not conform to Generator Site Access requirements found in UAC R313-26-4(5), and

D. contains free liquids (greater than 1% unexpected free liquids) or leaking shipment discrepancies.

All other shipment discrepancies (i.e. DOT and waste manifest) shall be noted on the waste manifest and the waste manifest retained on site for Director review.

31. The Licensee shall not accept radioactive waste from entities not in compliance with UAC R313-15-1006.

32. The Licensee shall acknowledge receipt of the waste within one week of waste receipt by returning a signed

DIVISION OF WASTE MANAGEMENT AND RADIATION CONTROL
RADIOACTIVE MATERIALS LICENSE
SUPPLEMENTARY SHEET

License # UT 2300XXX
Amendment # 0

copy of the manifest or equivalent document to the shipper. The shipper to be notified is the Licensee who last possessed the waste and transferred the waste to the Licensee. The returned copy of the manifest or equivalent documentation shall indicate any discrepancies between materials listed on the manifest and materials received.

33. The Licensee shall notify the shipper (e.g., the generator, the collector or processor) and the Director when any shipment or part of a shipment has not arrived within 60 days after receiving the advance manifest.

34. The Licensee shall maintain a record for each shipment of waste disposed of at the Federal Cell Facility. At a minimum, the record shall include:
    A. The date of disposal of the waste;

    B. The location of the waste in the disposal site;

    C. The condition of the waste packages received;

    D. Any discrepancy between the waste listed on the shipment manifest or shipping papers and the waste received in the shipment;

    E. A description of any evidence of leaking or damaged packages or radiation or contamination in excess of applicable regulatory limits; and

    F. A description of any repackaging of wastes in any shipment.

FINANCIAL ASSURANCE/CLOSURE

35. The Licensee shall at all times maintain a surety that satisfies the requirements of UAC R313-25-31 in an amount adequate to fund the decommissioning and reclamation of the Federal Cell Facility by an independent contractor.
    A. At its election, the Licensee's annual proposed closure and post-closure costs shall be based on either:

        i. an annual cost estimate using unit rates from the current edition of RS Means Facilities Construction Cost Data and other site-specific processes, indirect costs based on the sum of applicable direct costs in accordance with the indirect cost multipliers in Table 37 or others mutually agreed to by the Licensee and the Director; or

Table 35

PRELIMINARY DRAFT

DIVISION OF WASTE MANAGEMENT AND RADIATION CONTROL
RADIOACTIVE MATERIALS LICENSE
SUPPLEMENTARY SHEET

License # UT 2300XXX
Amendment # 0

Surety Reference No.	Description	Percentage
300	Working Conditions	5.5%
301	Mobilization/ Demobilization	4.0%
302	Contingency	11.0%
303	Engineering and Redesign	2.25%
304	Overhead and Profit	19.0%
305	Management Fee and Legal Expenses	4.0%
306	DEQ Oversight	4.0%

ii. an initial financial assurance determination and for each financial assurance determination every five years thereafter, a competitive site-specific estimate using a third party contractor for closure, 100 years of post-closure active care and perpetual care of the Federal Cell Facility.

iii. either the method in Condition 35.A.i or in Condition 35.A.ii shall be updated annually as required by Condition 35.B.

B. The Licensee shall annually review the surety amount and basis of the surety and submit a written report of its findings by March 1 each year for Director approval. At a minimum, this annual report shall include an accounting for current site conditions and that includes an annual inflation adjustment to the financial assurance determination using the Gross Domestic Product Implicit Price Deflator of the Bureau of Economic Analysis, United States Department of Commerce, calculated by dividing the latest annual deflator by the deflator for the previous year shall be used.

C. The combined annual surety for the Federal Cell Facility is $XX,XXX,XXX.

D. Electronic Format. The Licensee shall provide the report in both paper and electronic formats, as directed by the Director.

E. Within 60 days of Director approval of said annual report, the Licensee shall submit written evidence that the surety has been adequately funded.

36. One year prior to the anticipated closure of the Federal Cell Facility, the Licensee shall submit for review and approval by the Director a Federal Cell Facility decontamination and decommissioning plan. As part of this plan, the Licensee shall demonstrate by measurements and/or modeling that concentrations of radioactive materials which may be released to the general environment, during the compliance period after closure, will

PRE-DRAFT

DIVISION OF WASTE MANAGEMENT AND RADIATION CONTROL
RADIOACTIVE MATERIALS LICENSE
SUPPLEMENTARY SHEET

License # UT 2300XXX
Amendment # 0

not result in an annual dose exceeding 25 millirems to the whole body, 75 millirems to the thyroid and 25 millirems to any other organ of any member of the public.

SPECIAL HANDLING

37. The Licensee shall notify the Director in writing at the earliest possible date, but no later than 10 days before scheduled receipt of each shipment with contact radiation levels in excess of 200 R/hr. The notification shall include the anticipated dates of receipt and plan for disposal in the Federal Cell Facility.

38. The RSO or other qualified person designated by the RSO shall be present for and shall observe the receipt, processing, handling and disposal of each waste package with contact radiation levels in excess of 200 R/hr.

CLOSEOUT CONDITIONS

39. Except as specifically provided otherwise in this license, the Licensee shall conduct its program in accordance with the statements, representations, and procedures contained in the documents, including any enclosures, listed below. The UAC R313 shall govern unless the statements, representations and procedures in the Licensee's application and correspondence are more restrictive than the rules.

    A. Federal Cell Facility Radioactive Material License Application, Revision 0, dated January 20, 2020.
    B. Lundberg, Rusty "Policy Regarding the Application of Existing Performance Assessment Rules (R313-25-8, Technical Analyses, Utah Administrative Code) and U.S. Nuclear Regulatory Commission (NRC) Direction (SRM-SECY-2013-075) and Applicable Federal Guidance for Performance Assessments (NUREG-1573)." Memorandum to Division Staff – Low-Level Radioactive Waste, Utah Division of Radiation Control, February 25, 2014.

DIVISION OF WASTE MANAGEMENT AND RADIATION CONTROL

_____ _____
Date Ty Howard, Director

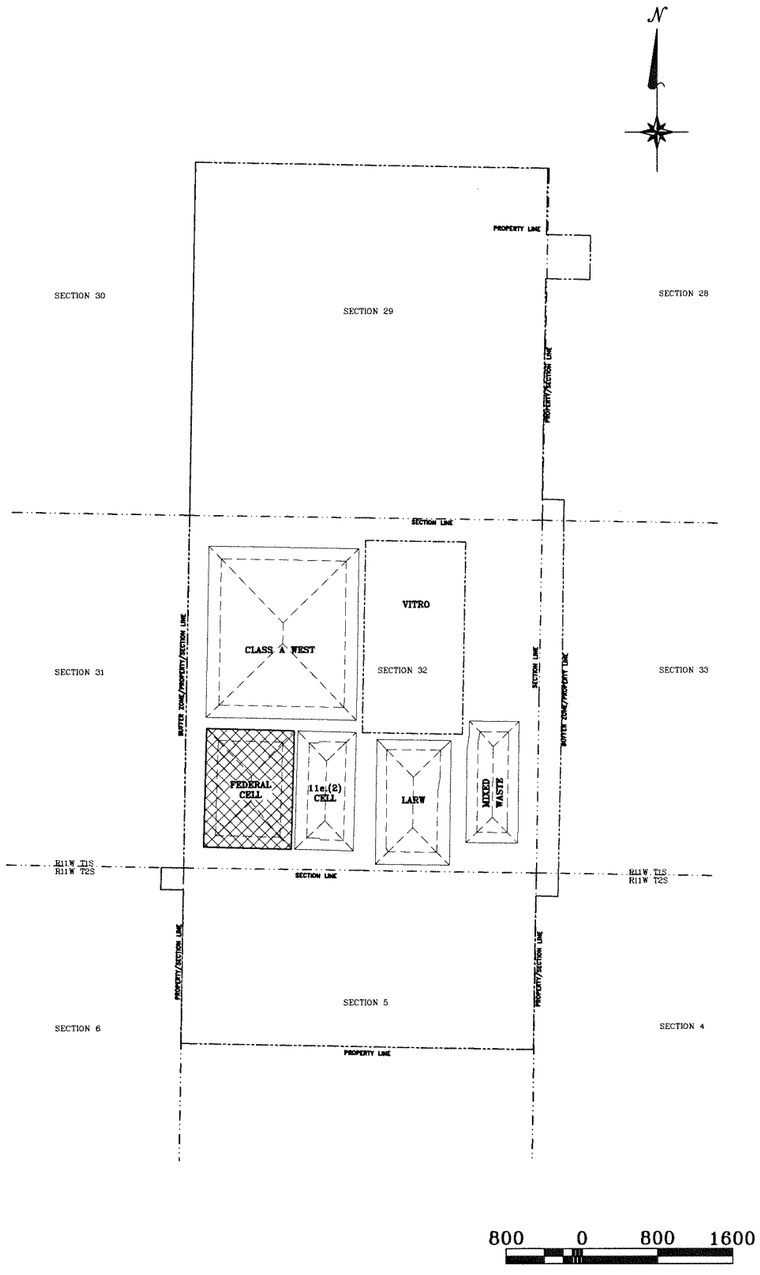
DRAFT

APPENDIX B

Engineering and Construction Drawings

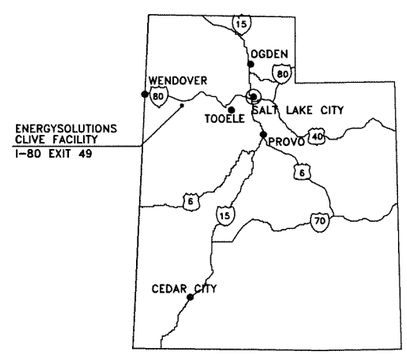
PRELIMINARY REVIEW DRAFT

PRELIMINARY REVIEW DRAFT



FEDERAL WASTE DISPOSAL CELL

DWG. NO.	DESCRIPTION
14004-G01	PROJECT TITLE SHEET
14004-U1	DISPOSAL CELL BUFFER ZONE
14004-U2	DISPOSAL CELL WASTE LIMITS-LATITUDES & LONGITUDES
14004-C01	EMBANKMENT FEATURES AND CONTROLS
14004-C02	EMBANKMENT CROSS SECTIONS
14004-C03	SECTIONS AND DETAILS, 1 OF 3
14004-C04	SECTIONS AND DETAILS, 2 OF 3
14004-C05	SECTIONS AND DETAILS, 3 OF 3



UTAH
VICINITY MAP

DATE	BY	DESCRIPTION OF CHANGE
1/14/20	DFB	FOR INTERNAL REVIEW

ENERGYSOLUTIONS

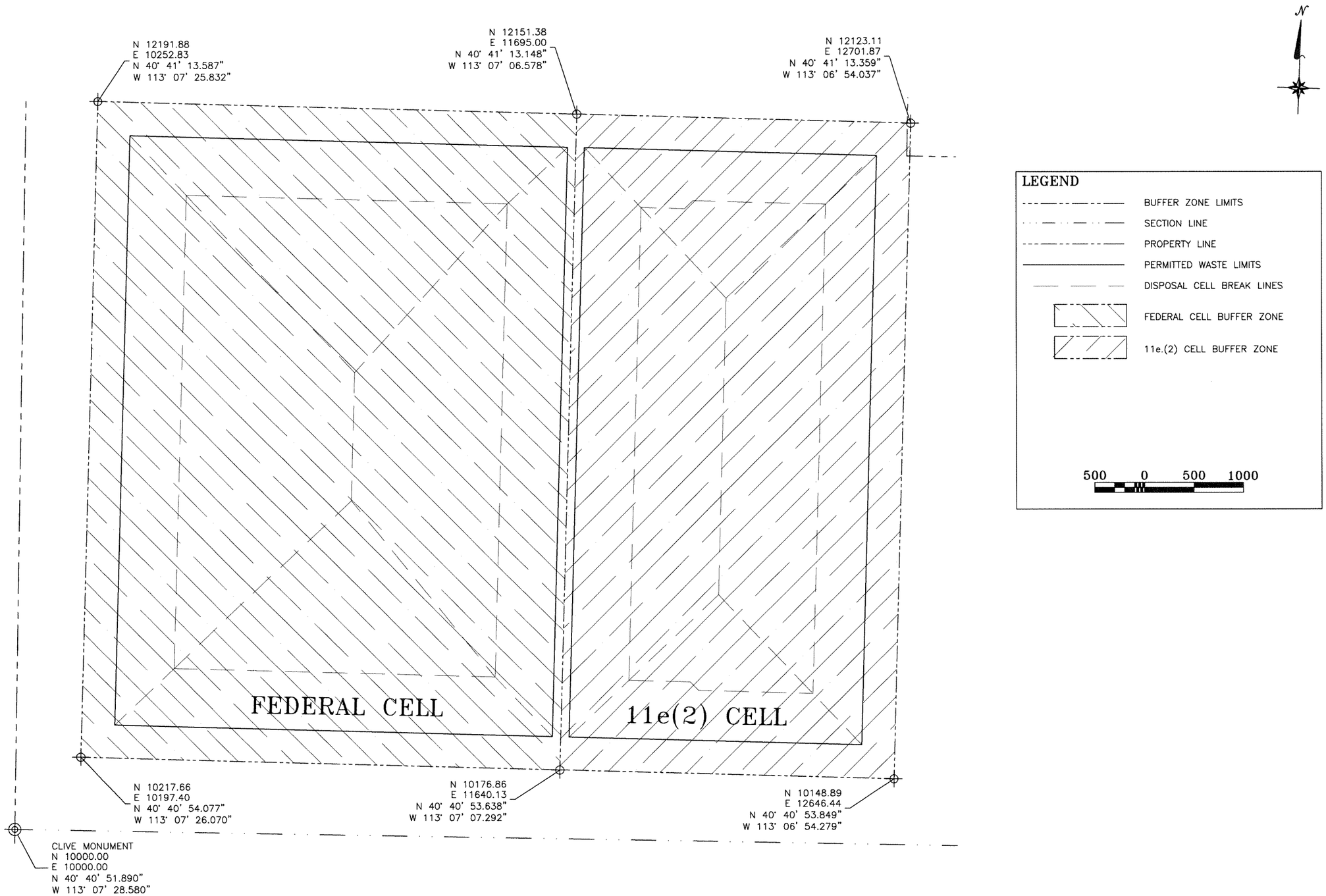
CLIVE FACILITY

FEDERAL WASTE CELL

PROJECT TITLE SHEET

CLIVE, UTAH

DRAFTED BY: D. BOOTH
REVIEWED BY: T. ORTON
APPROVED BY: D. BOOTH
SCALE: AS NOTED | DATE: 01/14/20 | REV.
DRAWING NO. 14004 G01



DATE	BY	DESCRIPTION OF CHANGE
1/14/20	DFB	FOR INTERNAL REVIEW

ENERGYSOLUTIONS

CLIVE FACILITY

FEDERAL WASTE CELL

DISPOSAL CELL BUFFER ZONE

CLIVE, UTAH

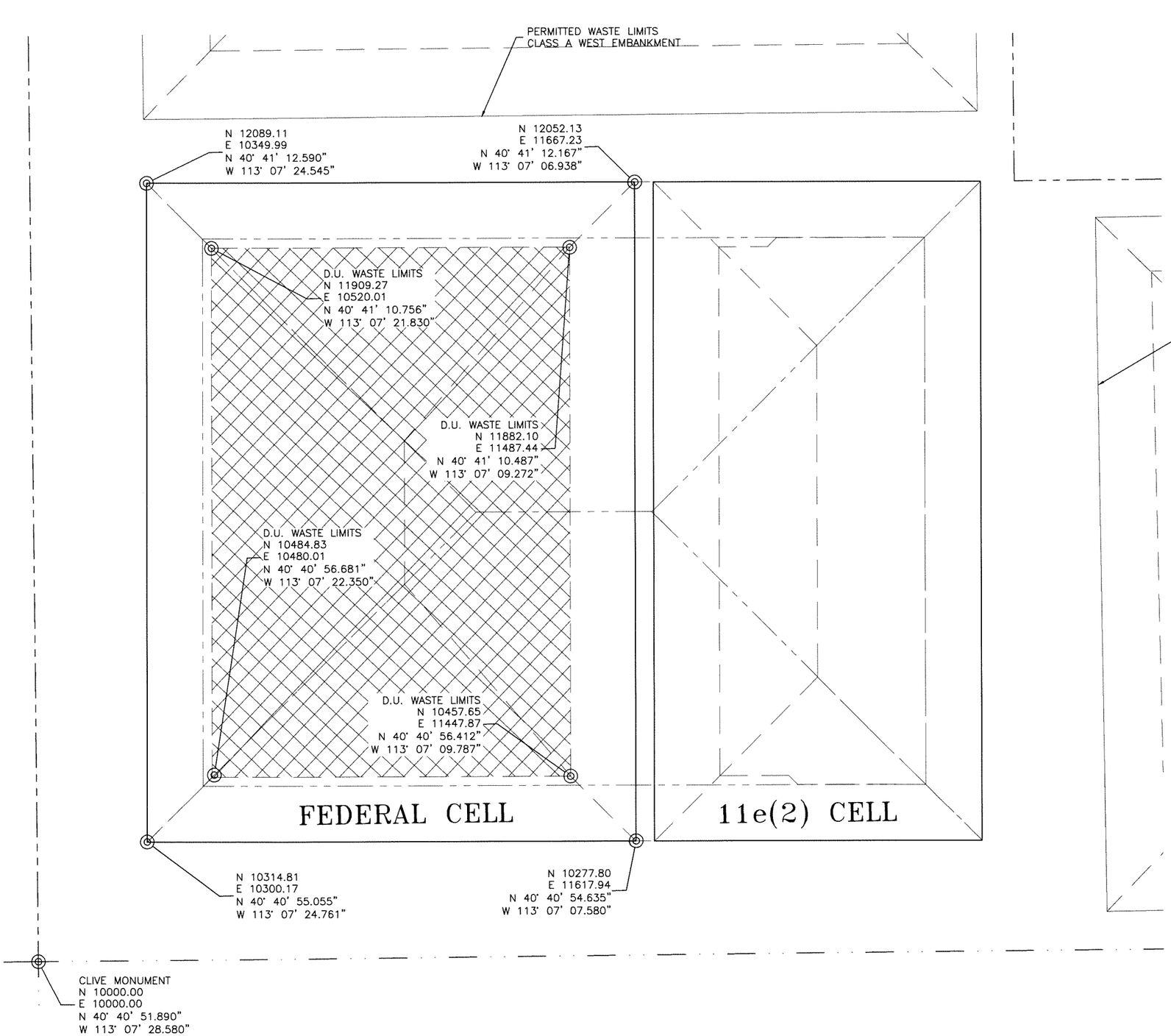
DRAFTED BY: D. BOOTH

REVIEWED BY: G. DUTSON

APPROVED BY: D. BOOTH

SCALE: AS NOTED | DATE: 01/14/20 | REV.

DRAWING NO. 14004 U01



LEGEND

- WASTE LIMITS
- WASTE BREAK LINES
- ORIGINAL 11e.(2) WASTE LIMITS
- SECTION LINE
- PROPERTY LINE
- D.U. CYLINDER & DRUM DISPOSAL AREA (D.U. WASTE LIMITS)

150 0 150 300

NOTES

1. THE 11e.(2) EMBANKMENT IS SHOWN FOR REFERENCE ONLY. REFER TO 11e.(2) LICENSE DRAWINGS FOR ADDITIONAL DESIGN DETAIL.
2. D.U. CYLINDERS AND DRUMS DISPOSED OF WITHIN THE FEDERAL CELL IS LIMITED TO THE AREA SHOWN. ALL CYLINDERS AND DRUMS SHALL BE DISPOSED OF AT OR BELOW THE ORIGINAL GROUND SURFACE.

DATE	BY	DESCRIPTION OF CHANGE
3/31/14	DFB	PRELIMINARY

ENERGYSOLUTIONS

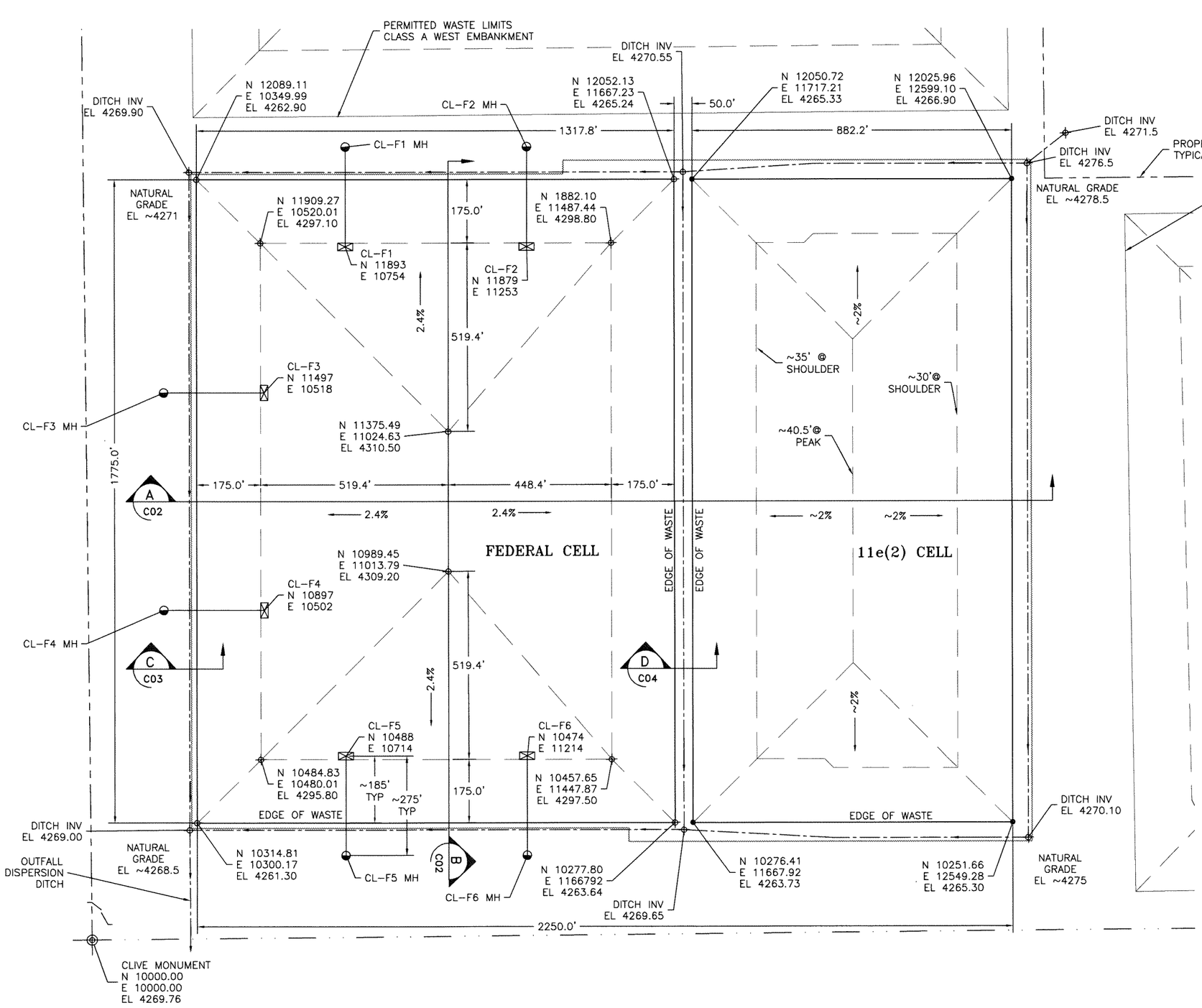
CLIVE FACILITY

FEDERAL WASTE CELL

DISPOSAL CELL WASTE LIMITS–LATITUDES & LONGITUDES

CLIVE, UTAH

DRAFTED BY D.BOOTH
REVIEWED BY G.DUTSON
APPROVED BY D.BOOTH
SCALE AS SHOWN DATE 03/28/14 REV. 1
DRAWING NO. 14004 U2



LEGEND

- SECTION LINE
- PROPERTY LINE
- WASTE LIMITS (TOE OF WASTE)
- WASTE BREAK LINES
- LINER LIMITS (MINIMUM)
- DRAINAGE DITCH CENTERLINE
- LYSIMETER PAN
- LYSIMETER MANHOLE (MH)

150 0 150 300

NOTES

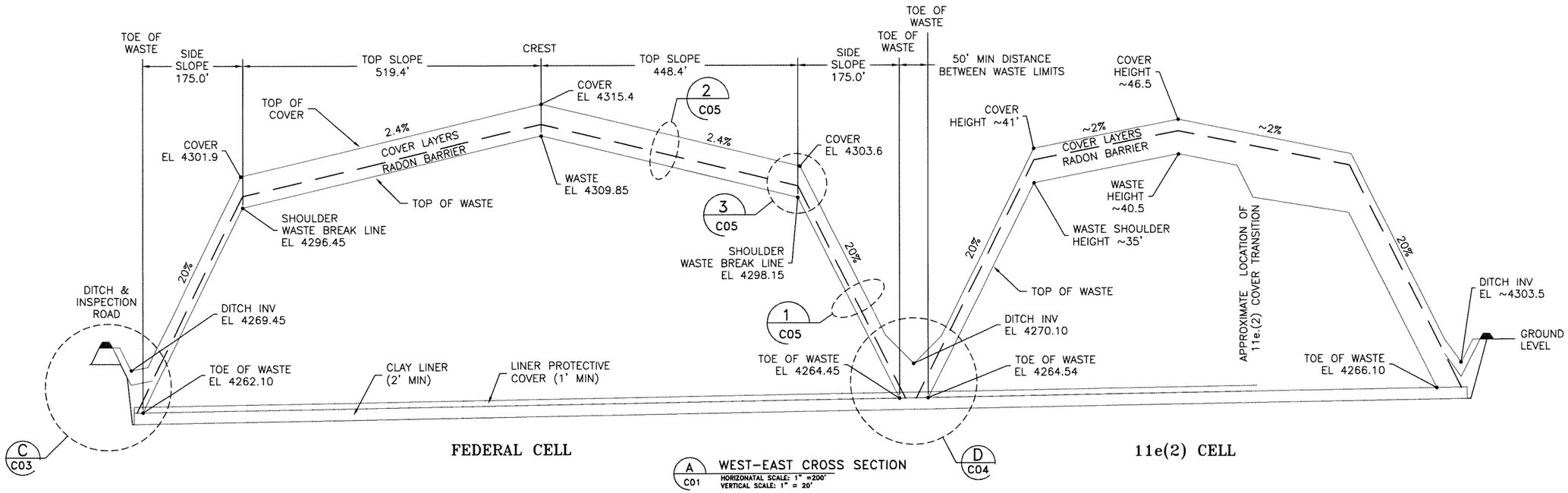
1. ALL ELEVATIONS SHOWN ARE FOR TOP OF WASTE UNLESS OTHERWISE NOTED.
2. COORDINATES ARE BASED ON THE CLIVE MONUMENT.
3. THE CALCULATED VOLUME OF THE FEDERAL CELL IS 2,559,266 YD^3.
4. FIELD LOCATE THE LYSIMETER MANHOLES AS NEEDED.
5. REFER TO THE LLRW AND 11e.(2) CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL (CQA/QC) MANUAL FOR MATERIAL AND CONSTRUCTION SPECIFICATIONS.
6. THE 11e.(2) EMBANKMENT IS SHOWN FOR REFERENCE ONLY. REFER TO 11e.(2) LICENSE DRAWINGS FOR ADDITIONAL DESIGN DETAIL.

DATE	BY	DESCRIPTION OF CHANGE
1/14/20	DFB	FOR INTERNAL REVIEW

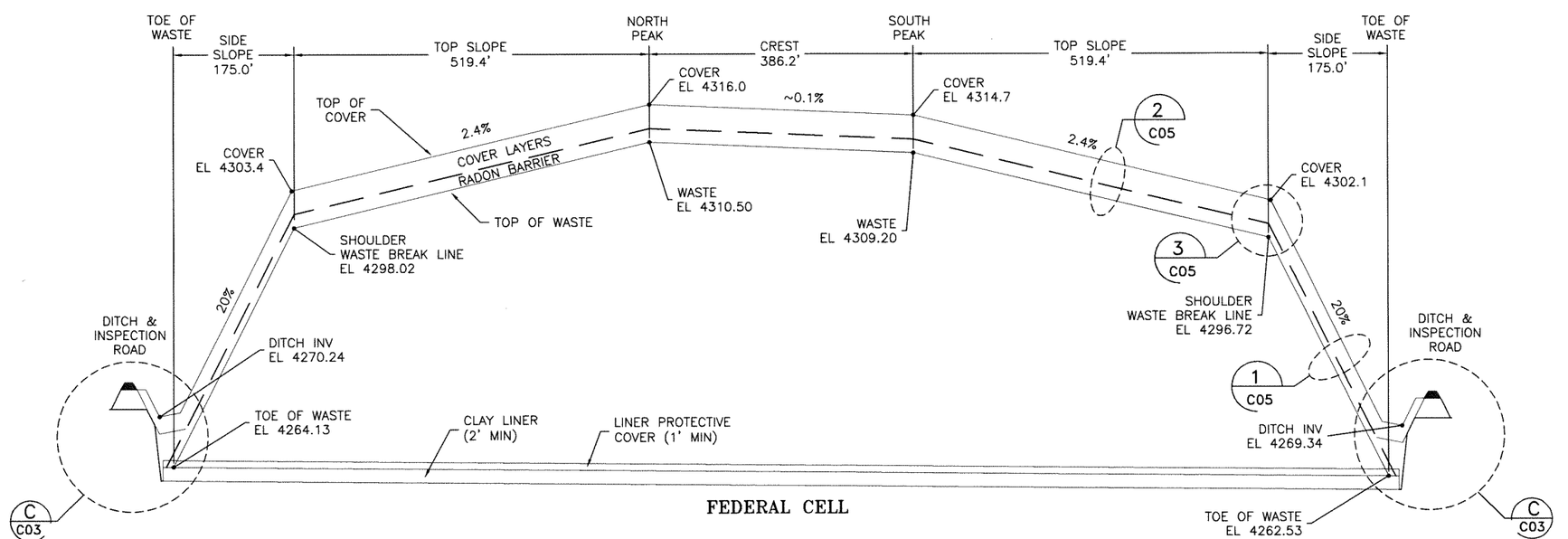
ENERGYSOLUTIONS

CLIVE FACILITY
FEDERAL WASTE CELL
EMBANKMENT FEATURES AND CONTROLS
CLIVE, UTAH

DRAWN BY: D. BOOTH
REVIEWED BY: T. ORTON
APPROVED BY: D. BOOTH
SCALE: AS NOTED
DATE: 01/08/20
REV.
DRAWING NO. 14004 C01



A C01 WEST–EAST CROSS SECTION
HORIZONATAL SCALE: 1" =200'
VERTICAL SCALE: 1" = 20'

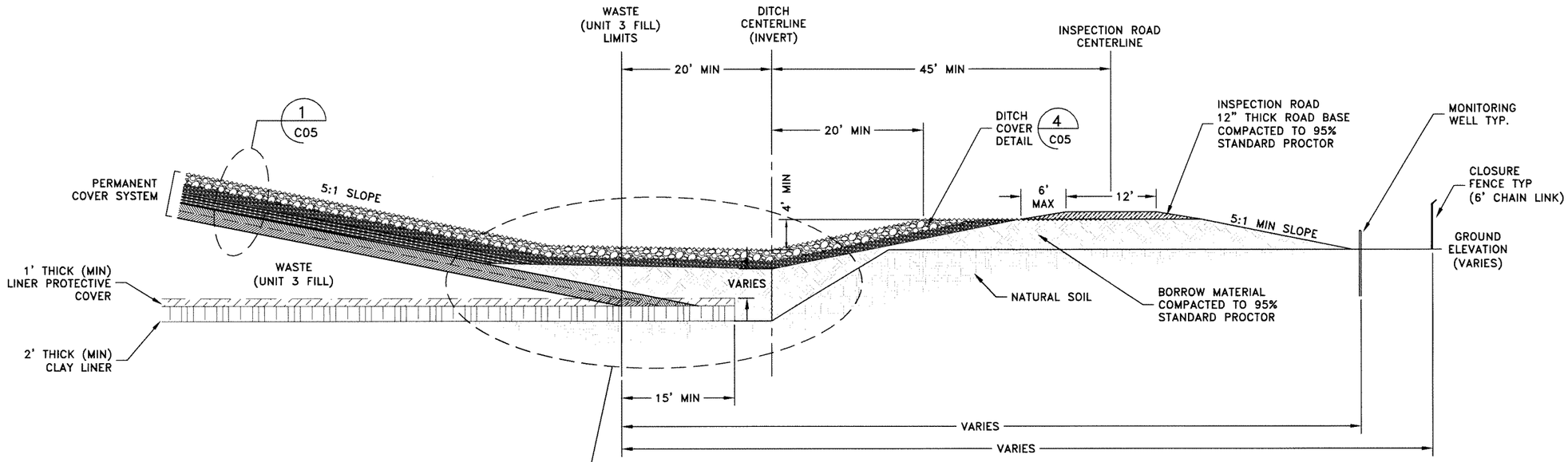


B C01 SOUTH–NORTH
HORIZONATAL SCALE: 1" =200'
VERTICAL SCALE: 1" = 20'

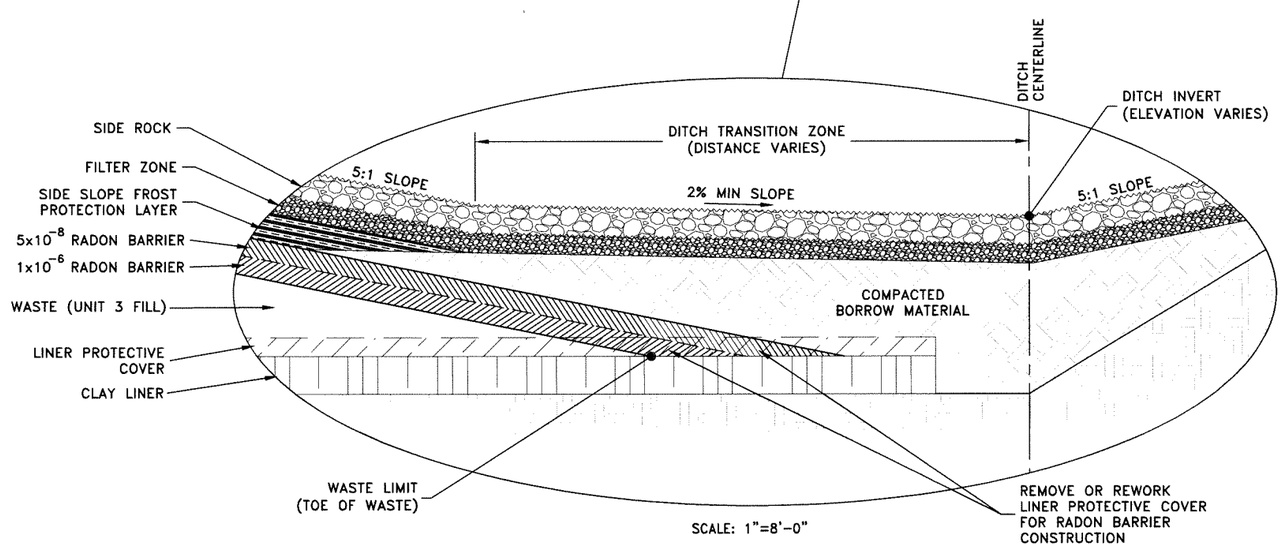
DATE	BY	DESCRIPTION OF CHANGE
1/14/20	DFB	FOR INTERNAL REVIEW

ENERGYSOLUTIONS
CLIVE FACILITY
FEDERAL WASTE CELL
EMBANKMENT CROSS SECTIONS
CLIVE, UTAH

DRAFTED BY D. BOOTH
REVIEWED BY T. ORTON
APPROVED BY D. BOOTH
SCALE AS NOTED DATE 01/08/20 REV.
DRAWING NO. 14004 C02



C
C01
DITCH & ROAD DETAIL TYP.
SCALE: 1"=16'-0"



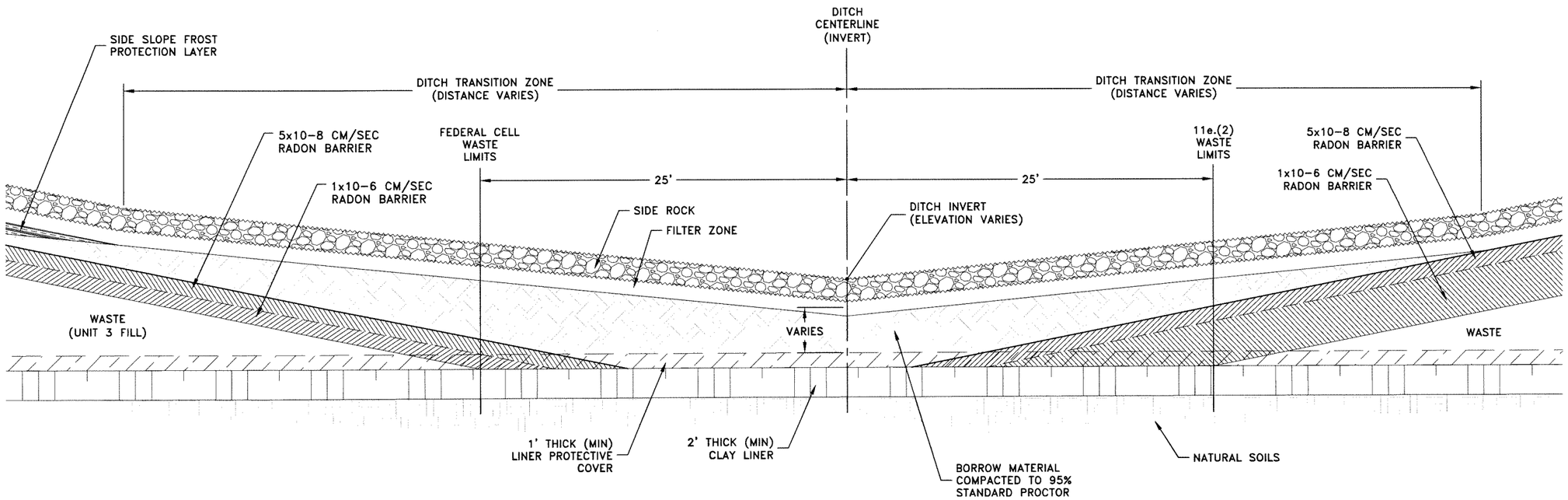
SCALE: 1"=8'-0"

DATE	BY	DESCRIPTION OF CHANGE
1/13/20	DFB	FOR INTERNAL REVIEW

ENERGYSOLUTIONS

ENERGYSOLUTIONS "CLIVE" FACILITY
FEDERAL WASTE CELL
SECTIONS AND DETAILS, 1 OF 3
CLIVE, UTAH

DRAFTED BY: D. BOOTH
REVIEWED BY: T. ORTON
APPROVED BY: D. BOOTH
SCALE: AS NOTED | DATE: 01/13/20 | REV.
DRAWING NO. 10014 C03



D / C01 DITCH DETAIL BETWEEN CELLS

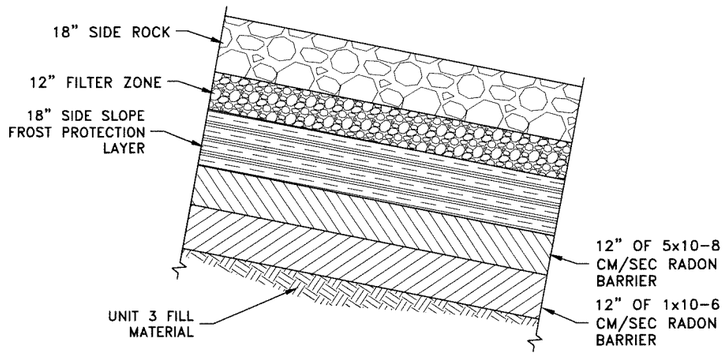
SCALE: 1"=8'-0"

DATE	BY	DESCRIPTION OF CHANGE
1/14/20	DFB	FOR INTERNAL REVIEW

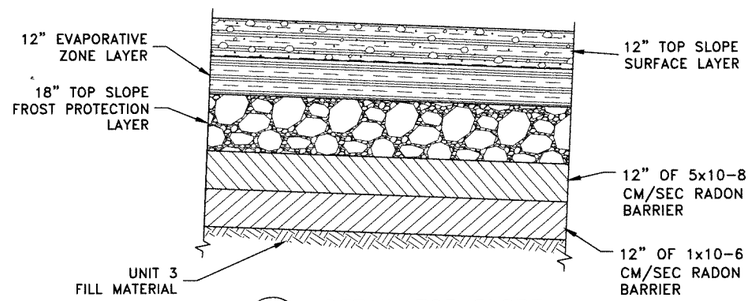
ENERGYSOLUTIONS

ENERGYSOLUTIONS "CLIVE" FACILITY
FEDERAL WASTE CELL
SECTIONS AND DETAILS, 2 OF 3
CLIVE, UTAH

DRAFTED BY: D. BOOTH
DESIGNED BY: T. ORTON
APPROVED BY: D. BOOTH
SCALE: AS NOTED | DATE: 01/14/20 | REV.
DRAWING NO. 10014 C04



1 DETAIL-SIDE SLOPE
C02 NTS TYPICAL SIDE SLOPE COVER DETAIL



2 DETAIL-TOP SLOPE
C02 NTS TYPICAL TOP SLOPE COVER DETAIL

COVER MATERIAL SPECIFICATIONS

SURFACE LAYER, TOP SLOPE LAYER:
85% UNIT 4 MATERIAL AMENDED WITH 15% (±3%), BY VOLUME, GRAVEL. GRAVEL IS SPECIFIED AS FOLLOWS.
D_{100} <= 3 INCH
D_{30} <= .85 INCH (40 mm)

EVAPORATIVE ZONE LAYER:
UNIT 4 CLAY MATERIAL. NO COMPACTION SPECIFICATION.

TOP SLOPE FROST PROTECTION LAYER:
BANK RUN COBBLE/GRAVEL/SOIL MATERIAL. WELL GRADED
D_{100} <= 16 INCH

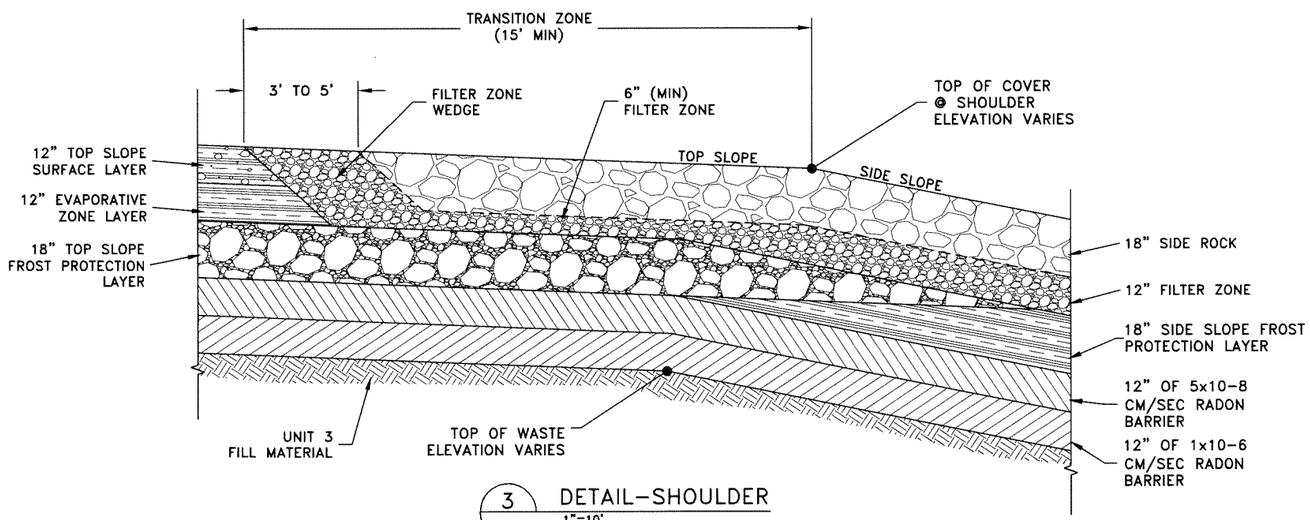
SIDE SLOPE FROST PROTECTION LAYER:
UNIT 4 CLAY MATERIAL. COMPACTED TO AT LEAST 90% OF STANDARD PROCTOR, ASTM D668.

SIDE ROCK:
D_{100} = 12 TO 16 INCH
D_{95} = 8 TO 12 INCH
D_{50} = 4.5 TO 8 INCH
D_{15} = 2 TO 4 INCH
D_5 >= NO. 200 SIEVE

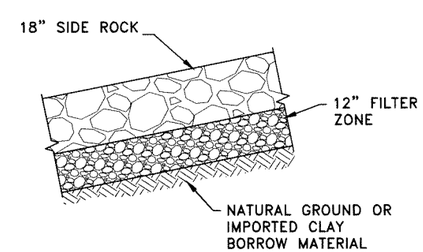
FILTER ZONE
D_{100} = 1.5 TO 3 INCH
D_{85} = 1 TO 2.5 INCH
D_{50} = 0.75 TO 2 INCH
D_{15} = 0.3125 TO 0.625 INCH
D_{10} >= NO. 10 SIEVE (2mm)
D_5 >= NO. 200 SIEVE

NOTES:

1. REFER TO THE CURRENT APPROVED LLRW & 11e.(2) CQA/QC MANUAL FOR ADDITIONAL MATERIAL SPECIFICATIONS, GRADATIONS, CONSTRUCTION AND TESTING REQUIREMENTS.
2. SEED THE TOP SLOPE SURFACE LAYER WITH AN APPROVED SEED MIXTURE AND METHOD.



3 DETAIL-SHOULDER
C02 1"=10'



4 DETAIL-DITCH OUTER SLOPE
C03 NTS TYPICAL PERIMETER DITCH COVER DETAIL

DATE	BY	DESCRIPTION OF CHANGE
1/13/20	DFB	FOR INTERNAL REVIEW

ENERGYSOLUTIONS
ENERGYSOLUTIONS "CLIVE" FACILITY
FEDERAL WASTE CELL
SECTIONS AND DETAILS, 3 OF 3
CLIVE, UTAH

DRAFTED BY: D. BOOTH
REVIEWED BY: T. ORTON
APPROVED BY: D. BOOTH
SCALE: AS NOTED DATE: 01/09/20 REV.
DRAWING NO. 10014 C05

APPENDIX C

Long-Term Stewardship Agreement for the Federal Cell Facility

[UNDER NEGOTIATION]

PRELIMINARY REVIEW DRAFT

PRELIMINARY REVIEW DRAFT

APPENDIX D

Drainage Ditch Calculations

PRELIMINARY REVIEW DRAFT

PRELIMINARY REVIEW DRAFT

FEDERAL CELL FACILITY
DRAINAGE DITCH FLOW CALCULATIONS

1.0 INTRODUCTION

Drainage calculations have been conducted for the design ditches surrounding the proposed Federal Cell Facility utilizing the methodologies described in NUREG-1623 and NUREG/CR-4620. Additional calculations have been completed for the entire site drainage system to the southwest corner of the Federal Cell Facility. An examination of outlet culverts from the Class A West, Federal Cell Facility and 11e.(2) drainage systems has also been made.

This assessment was performed specifically for the introduction of the Federal Cell Facility. After operations cease, Energy*Solutions* will take no credit for the remaining ditch systems.

As currently planned, drainage from completed portions of all embankments will be directed throughout the ditch systems to an outlet in the southwestern corner of the site. At this point, the water is dispersed into the desert south of the facility. A simple depiction of the site drainage plan is provided in Figure D-1.

Figure D-1 also provides details on the length/width geometry of each of the embankments that are part of this drainage system. With the exception of the Vitro embankment, the dimensions presented in Figure D-1 are the waste limit dimensions for each embankment. The stated dimensions of the Vitro Embankment are for the entire run-off area. Different dimensions are provided for the north and south sides of the Federal Cell Facility as depicted in the drawing.

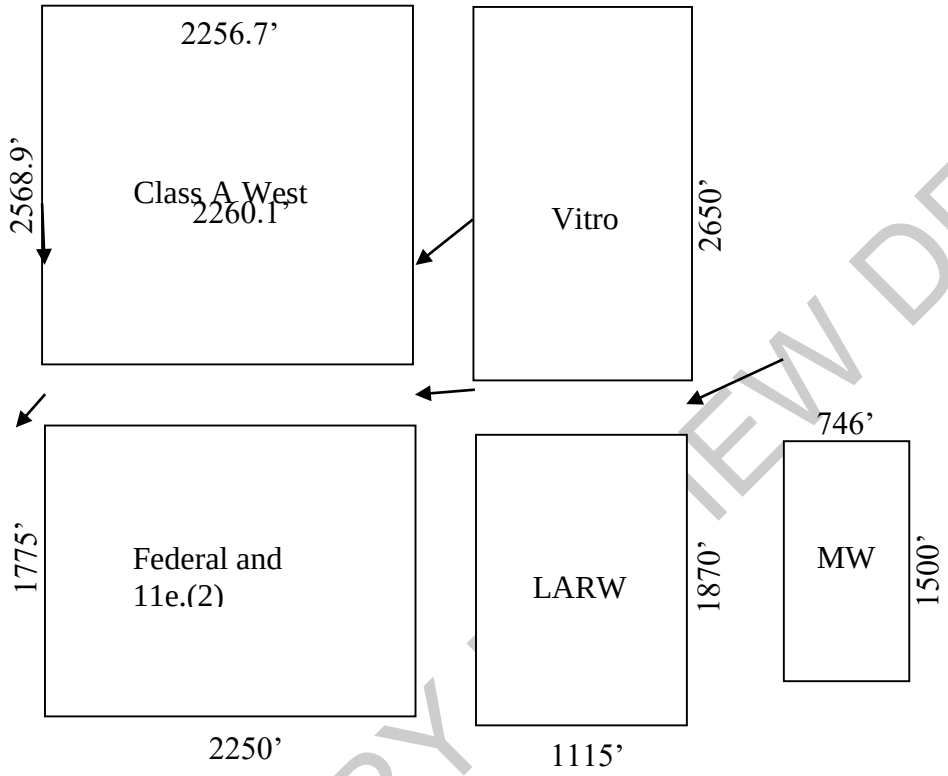
2.0 FLOW VELOCITIES

To begin the performance assessment of the Federal Cell Facility ditches, the peak flow velocities for the ditches must be calculated. These flow velocities are based upon the flow area and slope of the ditches. The ditches surrounding the Federal Cell Facility are trapezoidal with a minimum base of 15.3 feet and 5:1 slopes on each of the sides. To make the calculations less cumbersome, the 2% slope in the base of the trapezoid has been ignored. The drainage ditches surrounding the Federal Cell Facility and 11e.(2) embankment are "V" ditches with 5:1 side slopes.

Drawing XXXXXX shows design dimensions for the Federal Cell Facility ditches. Drawing XXXXXX shows the distance between the toe of waste and the centerline of the ditch is 15.3 feet; therefore, the ditch length along each side of the Federal Cell Facility is 30.6 feet further than that described in Figure D-1 above. Table D-1 uses this information, along with the specifications described in Drawing XXXXXX to provide resulting slopes for each side of the Federal Cell Facility.

PRELIMINARY REVIEW DRAFT

Figure D-1. Simple schematic of the site with general drainage flows (not to scale)



PRELIMINARY REVIEW DRAFT

Table D-1. CAW Ditch Slope Evaluation

Corner	Ditch Invert Elevation	Side	Length (ft)	Drop in Elevation (ft)	Slope (ft/ft)
NE	4275.6	North	2,287.3	1.6	7.00E-4
NW	4274.0	West	2,599.5	2.9	1.12E-3
SW	4271.1	South	2,290.7	1.6	6.98E-4
SE	4272.7	East	2,599.5	2.9	1.12E-3

PRELIMINARY REVIEW DRAFT

Slopes for the Federal Cell Facility and 11e.(2) ditch system may be discerned from the ditch centerline elevations provided in Drawing 9420-4. For the Federal Cell Facility and 11e.(2) ditch system, the following slopes are calculated based on ditch centerline drop in elevation across the ditch centerline length (note that the dimensions of the ditch centerline are the edge of waste dimensions plus 42.5 feet in all directions):

North/South Lengths: 1.1 feet / 2335 feet = 4.71×10^{-4} foot/foot
East/West Lengths: 0.9 feet / 1860 feet = 4.84×10^{-4} foot/foot

Based on these slopes, and using Manning's Formula, the maximum flow rate for each ditch may be calculated. Manning's Formula is:

$$Q = \frac{1.486}{n} AR^{2/3} S^{1/2}$$

where,

Q = flow in cubic feet per second

n = Manning's Coefficient of Roughness (= 0.035 for ditches with earth, stone, and weeds)

A = cross-sectional area of flow (ft^2)
R = hydraulic radius; area of flow divided by wetted perimeter (WP) (ft)
S = slope (ft/ft)

Since the side slopes are 5:1, the water in the ditch, at the surface, will extend five times the depth (d) in each direction. For the trapezoidal ditches surrounding the CAW embankment, the cross sectional area will include a rectangular area which is the base length (15.3 feet) times the depth as well as a triangular area on each side with a base of 5d and a height of d. Therefore, the total cross-sectional area of the trapezoidal ditches surrounding the CAW embankment, based on the variable depth of water in the ditch, is $15.3d + 5d^2$. For the "V" ditches of the 11e.(2) embankment, the cross-sectional area is simply equal to $5d^2$.

The wetted perimeter for the trapezoidal ditches consists of the base length and the two angled lengths of the triangle with a base of 5d and a height of d. This yields a wetted perimeter of $15.3 + 2 \times (d^2 + 25d^2)^{1/2} = 15.3 + 2(26)^{1/2}d$. For the "V" ditch, the wetter perimeter, in relation to the depth, is simply $2(26)^{1/2}d$.

5.1. Manning's Coefficient of Roughness, n

The literature value for the Manning's Coefficient of Roughness for ditches with earth, stone, and weeds (0.035) may be found in several references; the particular reference used for this analysis was Lindeburg, 2001. This value may alternatively be calculated based on the size of the riprap in the ditch. Several empirical equations have been derived in the

PRELIMINARY REVIEW DRAFT

literature; two of the more accepted equations are presented herein to demonstrate that the chosen coefficient is applicable and conservative.

Equation 4.41 of NUREG/CR-4620 was developed by the Army Corps of Engineers and others in 1970 and relates the roughness coefficient to the mean diameter (d_{50}) of the riprap. The formula is as follows:

$$n = 0.0395 * (d_{50})^{1/6}$$

where d_{50} is the mean rock size in feet.

The ditch design utilizes Type A riprap with a d_{50} of 4.5 inches (0.375 feet). Using this information and the NUREG/CR-4620 equation, the Manning's Coefficient of Roughness based on the riprap rock is 0.0335.

Another accepted empirical equation for determination of the roughness coefficient is the Strickler equation which is described in USACE, 1994. This equation uses the d_{90} of the riprap rock. The equation is provided as equation 5-2 of USACE, 1994, and is as follows:

$$n = 0.034 * (d_{90})^{1/6}$$

The d_{90} of the Type A riprap rock is 12 inches, or one foot. Therefore, using the Strickler equation, the estimated Manning's Coefficient of Roughness is 0.034.

These examples demonstrate that the literature value for the Manning's Coefficient of Roughness used in these calculations provides a conservative estimate of the flow of water in the ditches.

Tables 1 and 2, on the next page, display the calculated flow rates of the CAW, Federal Cell Facility and 11e.(2) ditch systems using Manning's formula. The tables also depict the peak flows each of the ditch systems is able to manage.

PRELIMINARY REVIEW DRAFT

Table 2. Ditch Flow Rates for the CAW Drainage Ditches

Height of water in Ditch (ft)	Flow area in Ditch A (ft^2)	Wetted Perimeter WP (ft)	Hydraulic Radius R=A/WP	North (S = 0.07%)		East (S = 0.11%)		South (S = 0.07%)		West (S = 0.11%)	
				Flow Rate Q (cfs)	Flow Rate Q (cfm)	Flow Rate Q (cfs)	Flow Rate Q (cfm)	Flow Rate Q (cfs)	Flow Rate Q (cfm)	Flow Rate Q (cfs)	Flow Rate Q (cfm)
0.5	8.9	20.40	0.44	5.75	344.94	7.26	435.61	5.74	344.68	7.26	435.61
1.0	20.3	25.50	0.80	19.58	1,174.87	24.73	1,483.70	19.57	1,174.00	24.73	1,483.70
1.5	34.2	30.60	1.12	41.36	2,481.75	52.24	3,134.10	41.33	2,479.90	52.24	3,134.10
2.0	50.6	35.70	1.42	71.70	4,302.01	90.55	5,432.84	71.65	4,298.81	90.55	5,432.84
2.5	69.5	40.80	1.70	111.32	6,679.38	140.59	8,435.14	111.24	6,674.43	140.59	8,435.14
3.0	90.9	45.89	1.98	160.98	9,659.08	203.30	12,198.07	160.87	9,651.90	203.30	12,198.07
3.5	114.8	50.99	2.25	221.43	13,286.05	279.64	16,778.43	221.27	13,276.18	279.64	16,778.43
4.0	141.2	56.09	2.52	293.41	**17,604.49**	370.53	**22,232.03**	293.19	**17,591.42**	370.53	**22,232.03**

Table 3. Ditch Flow Rates for the Federal Cell Facility and 11e.(2) Drainage Ditches

Height of water in Ditch (ft)	Flow area in Ditch A (ft^2)	Wetted Perimeter WP (ft)	Hydraulic Radius R=A/WP	North/South (S = 0.05%)		East/West (S = 0.05%)	
				Flow Rate Q (ft^3/sec)	Flow Rate Q (ft^3/min)	Flow Rate Q (ft^3/sec)	Flow Rate Q (ft^3/min)
0.5	1.25	5.10	0.25	0.45	27.07	0.46	27.44
1.0	5.00	10.20	0.49	2.86	171.89	2.90	174.21
1.5	11.25	15.30	0.74	8.45	506.80	8.56	513.63
2.0	20.00	20.40	0.98	18.19	1,091.46	18.44	1,106.16
2.5	31.25	25.50	1.23	32.98	1,978.95	33.43	2,005.61
3.0	45.00	30.59	1.47	53.63	3,217.98	54.36	3,261.34
3.5	61.25	35.69	1.72	80.90	4,854.10	81.99	4,919.49
4.0	80.00	40.79	1.96	115.51	**6,930.33**	117.06	**7,023.70**

PRELIMINARY REVIEW DRAFT

3.0 STORM EVENTS

The performance of the drainage ditches to contain runoff is only important during the active life of the facility (approximately 25 years). Upon closure, the drainage ditches will either be removed or become silted in to allow sheet flow across the site over the natural grade of the area. Therefore, a reasonable maximum normal storm event over the active life of the ditches is the 25 year, 24 hour storm event (1.9 inches). A reasonable abnormal event during the active life of the ditches is the 100 year, 24 hour storm event (2.4 inches).

The National Oceanic and Atmospheric Administration (NOAA) has put together precipitation and intensity maps for the western United States. The approximate location of the Clive facility was plugged into the NOAA website (NOAA, 2006) and the rainfall intensity profiles for the 25-year, 24-hour and the 100-year, 24-hour storms were downloaded. The storm intensity distributions from this website are provided in Table 4.

Table 4. Storm Intensity Distributions

Time (minutes)	Normal Event (25-Year Storm) (inches/hour)	Abnormal Event (100-Year Storm) (inches/hour)
5	3.43	5.22
10	2.61	3.98
15	2.16	0.28
30	1.45	2.21
60	0.899	1.37
120	0.491	0.720
180	0.334	0.484
360	0.184	0.245
720	0.103	0.130
1440	0.061	0.074

4.0 DRAINAGE AREAS

As mentioned previously, with the exception of the Vitro embankment, the dimensions presented in Figure 1 are the waste limit dimensions for each embankment. The stated dimensions for the Vitro embankment are for the entire run-off area. For the Federal Cell Facility and 11e.(2) embankments, the distance between the waste limits and the centerline of the ditch is 42.5 feet (8.5 feet of cover times 5 for a 5:1 side slope). For the Mixed Waste Landfill, the distance between the waste limits and the centerline of the ditch is 65 feet. For the LARW embankment, the distance between the waste limits and the centerline of the ditch varies between 15 and 35 feet, but a more

PRELIMINARY REVIEW DRAFT

conservative 35 feet is used in the area calculation. For the Class A West embankment, the distance between the waste limits and the centerline of the ditch is at least 15.3 feet (see Drawing 10014 C03, Revision 1). Further, for all embankments except Vitro, the drainage area conservatively extends another 45.6 feet beyond the centerline of the ditch to the outer edge of the inspection road (see drawing 10014 C03, Revision 1). Using the information described above, the actual drainage dimensions and areas for each embankment are provided in Table 5.

Table 5. Drainage Areas

Embankment	Length (E-W) (ft)	Width (N-S) (ft)	Drainage Area (ft^2)	Drainage Area (acres)
Class A West	2,380.2*	2,690.7	6,407,875.63	147.02
Vitro	1,310	2,650	3,471,500.00	79.69
LARW	1,276.2	2,031.2	2,592,217.44	59.51
11e.(2)	2,426.2	1,951.2	4,734,001.44	108.68
MW	967.2	1,721.2	1,664,744.64	38.22

* For the CAW drainage area, the length dimension is an average of the northern and southern embankment dimensions as described in Drawing 10014 C01, Revision 1.

In addition to these drainage areas, the calculations within this report use partial drainage areas to estimate the run-off into individual ditches within the system. From Drawing 10014 C01, Revision 1, the CAW drainage area can be subdivided into four areas, one for each side of the embankment. The north and south side drainage areas are triangles with a base of 2,380.2 feet and a "height" of 942 + 188 + 60.9 = 1190.9 feet. The east and west side drainage areas are parallelograms with a base of 2690.7 feet, a top length of 308.9 feet, and a depth of 1190.9 feet.

The overall site drainage area may also be subdivided as flows branch out before coming back together at the exit in the southwest corner of the 11e.(2) ditch system. Examining Figure 1, the site can be divided into two drainage areas:

(1) Western Site: CAW and the northwestern half of 11e.(2) combining into the 11e.(2) western ditch; and

(2) Eastern Site: Vitro, MW, LARW, and the southeastern half of 11e.(2) combining into the 11e.(2) southern ditch.

The calculated drainage areas associated with these additional subsections are provided in Table 6.

PRELIMINARY REVIEW DRAFT

Table 6. Site Sub-Drainage Areas

Area Description	Drainage Area (ft^2)	Drainage Area (acres)
CAW N/S	1,417,290.09	32.54
CAW E/W	1,784,911.98	40.98
Western Site	8,771,404.86	201.36
Eastern Site	10,095,462.80	231.76
Overall Site	18,866,867.67	433.12

4.1 Run-Off Coefficient, C

In addition to the drainage areas, the calculations require a run-off coefficient that describes the fraction of the rainfall that will run-off the drainage area and collect within the ditches.

The literature value run-off coefficient, C, for earth with stone surface is 0.5. This run-off coefficient has been estimated based upon a worst-case review of literature values for similar surfaces (see Lindeburg, 2001). The value of 0.5 provides a conservative estimation for drainage from the embankments at the Clive facility. The Cover Test Cell (CTC) is a simulation of the designed embankment cover. The CTC has been providing run-off data for nine years. Calculated run-off data from the CTC combined with precipitation data from the site weather station provides an observed run-off coefficient for the embankment cover design. The data for the nine years of operation are provided in Table 7.

Table 7. Cover Test Cell Run-Off Coefficient Data

Year:	2002	2003	2004	2005	2006	2007	2008	2009	2010
Run-off (in/yr):	0.112	0.000	0.727	1.341	0.838	0.335	0.000	0.112	0.009
Precip (in/yr):	5.75	7.46	9.06	10.16	7.39	8.29	3.20	8.12	9.00
Run-off Coefficient:	**0.019**	**0.000**	**0.080**	**0.132**	**0.113**	**0.040**	**0.000**	**0.014**	**0.001**

Disregarding the two years that no run-off was observed (2003 and 2008), the average annual run-off coefficient is calculated at 0.057. Therefore, the literature value run-off coefficient of 0.5 used in these calculations provides conservative drainage results.

5.0 DRAINAGE CALCULATIONS

The methodology described in Section 3 of Appendix D of NUREG-1623 has been used to evaluate the depth of flow in the drainage ditches around the CAW embankment as well as the western and southern ditches of the 11e.(2) embankment. In addition, superelevation of run-off due to bends within the ditches of the CAW embankment has also been evaluated.

PRELIMINARY REVIEW DRAFT

5.1 Normal Flows

5.1.1 CAW Embankment Drainage

Step 1. Determine Time of Concentration

The maximum distance for water to travel within the CAW embankment ditch system is from the northern crest of the embankment, down the northeast corner slope, through the ditches, to the discharge point in the southwest corner of the embankment ditch. Ditch flow will either go across the northern ditch and then down the western ditch, or down the eastern ditch and then across the southern ditch. Since slopes and lengths are similar in the northern and southern ditches and the eastern and western ditches, both of these flow paths will result in similar calculated travel times. The distance that water must travel can be broken down into four discrete sections:

1. Northern crest to northeast corner shoulder of embankment;
2. Down northeastern shoulder to northeast corner of ditch system;
3. Down the eastern or across the northern ditch to the corner; and
4. Across the southern ditch or down the western ditch to the exit in the southwest corner.

The appropriate equation to determine the time of concentration (T_c) within each segment is provided in NUREG/CR-4620 (equation 4.45) and NUREG-1623 (equation D-1). This equation is:

$$T_c = \left(\frac{11.9L^3}{H}\right)^{0.385}$$

Where L is the length of travel in miles and H is the elevation difference in feet. Using the known lengths and slopes of each section (from Drawing 10014 C01, Revision 1), a complete time of concentration table can be compiled for each of the paths. Table 8 lists each of the parameters and the time of concentrations for each segment as well as the overall time of concentration for the CAW ditch system for both of the paths around the embankment.

PRELIMINARY REVIEW DRAFT

Table 8. CAW Ditch System Time of Concentration

Segment	N/W Path					E/S Path				
	L (ft)	L (mi)	S	H (ft)	T_c (hrs)	L (ft)	L (mi)	S	H (ft)	T_c (hrs)
1	1329.4	0.25	0.04	53.2	0.114	1329.4	0.25	0.04	53.2	0.114
2	287.5	0.05	0.2	57.5	0.019	287.5	0.05	0.2	57.5	0.019
3 (N/E)	2378.5	0.45	7E-4	1.66	0.849	2690.7	0.51	1E-3	3.00	0.780
4 (W/S)	2690.7	0.51	1E-3	3.00	0.780	2381.9	0.45	7E-4	1.66	0.851
		TOTAL		**hrs**	**1.762**				**hrs**	**1.764**
				min	**105.7**				**min**	**105.8**

As expected, the travel times are almost identical through each of the paths. As a slightly conservative estimation, the E/S Path will be used in further calculations.

Step 2: Determine Rainfall Intensities of the Design Storm

The rainfall intensities associated with this time of concentration for each of the design storms are found through extrapolation from Table 4. For the E/S Path time of concentration of 105.8 minutes, the extrapolated rainfall intensities are as follows:

25-Year Event: i = 0.587 in/hr

100-Year Event: i = 0.874 in/hr

Step 3: Determine Design Flow Rate

For this small of a drainage area, the Rational Formula is acceptable for calculating the peak flow rate through the ditch system. The Rational Formula is:

$$Q = CiA$$

where, Q is the flow rate in cubic feet per second (cfs);
C is the run-off coefficient described in Section 4.1.;
i is the rainfall intensity in inches/hour; and
A is the drainage area in acres.

Using the data provided above, the peak flow rate for each of the design storm events is:

25-Year Event: Q = 43.18 cfs

100-Year Event: Q = 64.22 cfs

PRELIMINARY REVIEW DRAFT

Step 4: Calculate the Maximum Height of Water in the Ditches

The maximum height of water in the ditches may be found by means of an iterative process using the parameters found in Table 2. The maximum height of water will be at the lowest point of the CAW ditch system, the southwest corner. The height of water in the eastern and/or southern ditches can be adjusted until the flow rate in the specific ditch is equivalent to that calculated above for each of the storm events. Table 9 provides the results of these iterative calculations.

Table 9. Maximum Height of Water in the CAW Ditch System

Storm Event	Ditch	Maximum Height of Water (ft)	Freeboard in four-foot ditch
25-Year, 24-Hour	Southern	1.54	2.46
	Western	1.36	2.64
100-Year, 24-Hour	Southern	1.89	2.11
	Western	1.67	2.33

Therefore, the four-foot trapezoidal ditch surrounding the CAW embankment is designed adequately to contain all run-off from the system and maintain a freeboard of at least one foot under normal flow situations.

5.1.2 Overall Site Drainage

Step 1: Determine Time of Concentration

As described in Section 4, the overall site drainage may be subdivided into western site flows and eastern site flows. The maximum distance for water to travel is different for each system. For the western site system, the maximum distance is from the northern crest of the CAW embankment and follows the same flow path as described for the CAW system and then flows down the western ditch of the 11e.(2) ditch system to the drainage outlet in the southwest corner of the facility (five discrete sections). For the eastern site system, the maximum distance is from the northern crest of the Vitro embankment, down its top and side slopes, through the western and southern Vitro ditches, down the eastern 11e.(2) ditch, and finally through the 11e.(2) southern ditch to the outlet (six discrete sections). In both instances, the transition areas between embankments has been ignored as the time through those systems will be very short in comparison to the other travel times.

Using the same equation as described above for the CAW ditch system, the time of concentration has been calculated for each of the site subdivisions. Table 10

PRELIMINARY REVIEW DRAFT

provides the information for the western site system and Table 11 defines the eastern site system. Note that in Table 11, the slopes and top of cover lengths within the Vitro embankment and ditch system have been assumed the same as the slopes and top of cover lengths within the CAW embankment and ditch system.

Table 10. Overall Site Western System Time of Concentration

Segment	L (ft)	L (mi)	S	H (ft)	T_c (hrs)
1 (CAW Top)	1329.4	0.25	0.04	53.2	0.114
2 (CAW Side)	287.5	0.05	0.2	57.5	0.019
3 (CAW East)	2690.7	0.51	1E-3	3.00	0.780
4 (CAW South)	2381.9	0.45	7E-4	1.66	0.851
5 (11e.(2) West)	1860.0	0.35	5E-4	0.90	0.810
		TOTAL		**hrs**	**2.574**
				min	**154.4**

Table 11. Overall Site Eastern System Time of Concentration

Segment	L (ft)	L (mi)	S	H (ft)	T_c (hrs)
1 (Vitro Top)	1329.4	0.25	0.04	53.2	0.114
2 (Vitro Side)	287.5	0.05	0.2	57.5	0.019
3 (Vitro East)	2650.0	0.50	1E-3	2.96	0.771
4 (Vitro South)	1310.0	0.25	7E-4	0.92	0.537
5 (11e.(2) East)	1860.0	0.35	5E-4	0.90	0.810
6 (113.(2) South)	2335.0	0.44	5E-4	1.10	0.975
		TOTAL		**hrs**	**3.225**
				min	**193.5**

<u>Step 2: Determine Rainfall Intensities of the Design Storm</u>

The rainfall intensities associated with this time of concentration for each of the design storms are found through extrapolation from Table 4. For the Overall Site Western System time of concentration of 154.4 minutes, the extrapolated rainfall intensities are as follows:

25-Year Event: i = 0.401 in/hr

100-Year Event: i = 0.551 in/hr

For the Overall Site Easter System time of concentration of 193.5 minutes, the extrapolated rainfall intensities are as follows:

PRELIMINARY REVIEW DRAFT

25-Year Event: i = 0.323 in/hr

100-Year Event: i = 0.466 in/hr

Step 3: Determine Design Flow Rate

Using the Rational Formula and the data provided above, the peak flow rate for the Overall Site Western System for each of the design storm events is:

25-Year Event: Q = 40.37 cfs

100-Year Event: Q = 55.47 cfs

For the Overall Site Eastern System, the peak flow rates are calculated as:

25-Year Event: Q = 37.40 cfs

100-Year Event: Q = 54.01 cfs

Step 4: Calculate the Maximum Height of Water in the Ditches

The maximum height of water in the ditches may be found by means of an iterative process using the parameters found in Table 3. The maximum height of water will be at the lowest point of the overall site system, the southwest corner. The height of water in the eastern and/or southern 11e.(2) ditches can be adjusted until the flow rate in the specific ditch is equivalent to that calculated above for each of the storm events. Note that the western ditch calculation is associated with the data from the Overall Site Western System and the southern ditch is associated with the data from the Overall Site Eastern System. Table 12 provides the results of these iterative calculations.

Table 12. Maximum Height of Water in the 11e.(2) Ditch System

Storm Event	11e.(2) Ditch	Maximum Height of Water (ft)	Freeboard in four-foot ditch
25-Year, 24-Hour	Southern	2.70	1.30
	Western	2.61	1.39
100-Year, 24-Hour	Southern	3.04	0.96
	Western	2.99	1.01

Therefore, the four-foot "V" ditch surrounding the 11e.(2) embankment is designed adequately to contain all run-off from the system and maintain a freeboard of at least one foot during the 25-Year storm event.

5.2 Superelevation around corners

PRELIMINARY REVIEW DRAFT

Superelevation of the water in the ditch may occur around bends. Superelevation for channel bends is described in chapter 5 of Soil Conservation Services (SCS), 1977 and also in chapter 5 of the U.S. Department of Transportations HEC-22, 2009. In general, when fluid flows around a bend, the fluid on the inside of the bend is lowered slightly and the fluid on the outside of the bend is elevated. Superelevation is defined as the vertical distance between these two extremes. Therefore, the amount of additional height in the channel associated with superelevation will be the calculated value divided by two.

As described in SCS, 1977, the amount of superelevation for subcritical flow is:

$$s = \frac{V^2(b + 2zd)}{2(gR_c - 2zV^2)}$$

where, s = superelevation in feet
V = velocity in the ditch (ft/sec)
b = bottom width of the channel = 15.3 feet
z = cotangent of the side slope angle = 5
d = the depth of the fluid (ft)
g = gravitational acceleration = 32.2 ft/sec^2
R_c = radius of curvature of bend, to the center of the channel = 39.1 ft

To calculate superelevation in the northwest corner, it is necessary to examine the parameters associated only with the northern CAW ditch; similarly, for the southeast corner, the parameters associated with the eastern CAW ditch will need to be examined. Furthermore, superelevation in the southwest corner of the CAW ditch system will need to be examined from each side as different flows merge at this point. To obtain the velocity and depth of the water in each of the ditch sections, the four-step analysis utilized above was done for each section. Results of these analyses, with all essential parameters, are shown in Table 13 on the next page. The maximum depth of flow after considering superelevation is listed in the last column (d + s/2).

The radius of curvature (R_c) for a 90-degree bend is the square-root of two times the length used to measure the parameter. In this case, the radius of curvature is to the centerline of the ditch. The ditch is 55.3 feet across; therefore, the centerline is 27.65 feet and Rc = $27.65 * 2^{½}$ = 39.1 feet.

The calculations show that superelevation is very small, bordering on inconsequential, for the low flows associated with the design ditch surrounding the CAW embankment. Greater than one foot of freeboard is easily maintained even after considering superelevation in this ditch system.

PRELIMINARY REVIEW DRAFT

Table 13. Superelevation Results

Storm Event	Area / Situation	T_c (min)	i (in/hr)	A (acres)	Q (cfs)	d (ft)	A_{flow} (sf)	V (ft/s)	Fr	s (ft)	s/2 (ft)	d + s/2 (ft)
25-Year	NW Corner	58.9	0.919	32.54	14.94	0.86	16.87	0.886	0.032	0.007	0.004	0.86
	SE Corner	54.8	0.995	40.98	20.38	0.90	17.78	1.146	0.040	0.013	0.006	0.90
	N/W – SW Corner	105.7	0.588	73.51	21.61	0.93	18.50	1.168	0.039	0.013	0.007	0.93
	E/S – SW Corner	105.8	0.587	73.51	21.59	1.06	21.72	0.994	0.029	0.010	0.005	1.06
100-Year	NW Corner	58.9	1.400	32.54	22.77	1.09	22.53	1.011	0.029	0.011	0.005	1.09
	SE Corner	54.8	1.516	40.98	31.05	1.13	23.76	1.307	0.036	0.018	0.009	1.14
	N/W – SW Corner	105.7	0.874	73.51	32.14	1.15	24.33	1.32	0.036	0.019	0.009	1.16
	E/S – SW Corner	105.8	0.874	73.51	32.11	1.31	28.64	1.12	0.027	0.014	0.007	1.32
25-Year	SW Corner – Worst Case Southern Ditch	105.8	0.874	147.02	43.18	1.54	35.28	1.22	0.025	0.018	0.009	1.54
	SW Corner – Worst Case Western Ditch					1.36	29.91	1.44	0.033	0.024	0.012	1.37
100-Year	SW Corner – Worst Case Southern Ditch				64.22	1.89	46.78	1.37	0.023	0.026	0.013	1.90
	SW Corner – Worst Case Western Ditch					1.67	39.59	1.62	0.030	0.034	0.017	1.69

PRELIMINARY REVIEW DRAFT

6.0 ROCK SIZE CALCULATIONS

Rock size calculations have been completed for normal, straight flow through the channels, as well as the additional strength needed for the stresses around bends in the ditches.

6.1 Normal Flow Rock Size Calculations

In general, the shear forces on the riprap within the ditches are the overruling parameter that defines the size of the rock necessary in the ditch. An iterative procedure for calculating the mean rock diameter is discussed in Section 3 of Appendix D of NUREG-1623. A similar iterative procedure, the Safety Factors Method, is discussed in NUREG/CR-4620. In both of these iterative procedures, the Manning's Coefficient of Roughness, n, is calculated based upon the assumed mean diameter (d_{50}) of the rock and the stresses on the riprap calculated using that n-value. However, as discussed in Section 5.1, the analysis provided herein assumes a conservative literature value Coefficient of Roughness of 0.035; therefore, the iterative analysis is not necessary. A third method, discussed in Johnson and Abt, 1998, that does not use the shear forces to calculate the mean rock diameter, has also been used.

The equation to find the peak shear stress in normal channels is provided in NUREG-1623 and in NUREG/CR-4620 as follows:

$$\tau = \gamma d S$$

where, τ is the normal shear stress (lb/ft^2);
γ is the density of water = 62.4 lb/ft^2;
d is the depth of flow (ft); and
S is the slope of the ditch.

Using the maximum depth of flow from Table 9, along with the corresponding ditch slope, the shear stresses associated with the designed southern and western CAW ditches can be calculated for both storm events. These calculations are tabulated in Table 14. This stress is the stress imparted on the ditch bottom. For the side slopes, the stress is increased slightly using the side slope factor, K_1, which is defined in USACE, 1994 (equation 3-4) as:

$$K_1 = \sqrt{1 - \frac{\sin^2\theta}{\sin^2\phi}}$$

where, θ is the angle of the side slope with the horizontal; and
φ is the angle of repose of riprap material = 40 degrees

The angle of the side slope with the horizontal is simply the arctangent of 0.2 or 11.3 degrees. Using the equation above, these angles yield a side slope factor of 0.952. The stress on the side slopes is simply the stress on the bottom of the ditch divided by this side slope factor. This calculated stress is also provided in Table 14 as τ_0.

PRELIMINARY REVIEW DRAFT

Table 14. Maximum Shear Stress During Normal Flow

Storm Event	Ditch	d (ft)	S	τ (lb/ft^2)	τ_0 (lb/ft^2)
25-Year, 24-Hour	Southern	1.54	6.98E-4	0.067	0.070
	Western	1.36	1.12E-3	0.094	0.099
100-Year, 24-Hour	Southern	1.89	6.98E-4	0.082	0.087
	Western	1.67	1.12E-3	0.116	0.122

The mean riprap size required for this stress can be calculated using equations 4.32 and 4.33 within NUREG/CR-4620:

$$d_{50,bottom} = \frac{\tau}{0.04(\gamma_s - \gamma)} \qquad \text{and} \qquad d_{50,side} = \frac{\tau_0}{0.04(\gamma_s - \gamma)}$$

where, γ_s and γ are the densities of the stone and water, respectively.

The Safety Factors Method also has an expression for d_{50} that is provided in equation 4.20 of NUREG/CR-4620. Assuming a stability number of one and rearranging this equation yields the following expression for d_{50}:

$$d_{50} = \frac{21\tau}{(S_s - 1)\gamma}$$

In this latter equation, S_s is the specific gravity of the rock. The density of the rock used at Clive has been quantified over the years. Examining results of these tests, the average specific gravity for rock used at Clive is 1.61, or a density of approximately 163 lbs/ft^2.

The Johnson and Abt, 1998 method does not use the shear stress to calculate the mean rock size in a trapezoidal channel. This method uses the flow rate, Q, the bottom width of the channel, b, and the slope of the channel, S, to determine the mean rock diameter. The method first calculates the design discharge as:

$$q = 1.35(Q/b).$$

The mean diameter (in inches) is then found using the following empirical equation:

$$d_{50} = 5.23S^{0.43}q^{0.56}.$$

Similar to the other methods, the Johnson and Abt, 1998 method calculates the rock size in the bottom of the channel and then uses the side slope factor to calculate the rock size necessary on the side slopes. Table 15 is an analysis of the results of all three of these rock sizing calculations.

PRELIMINARY REVIEW DRAFT

Table 15. Calculated Required Mean Riprap Size (d_{50})

Storm Event	Ditch	Stress Method				Safety Factors Method				Johnson/Abt	
		$d_{50,bottom}$		$d_{50,side}$		$d_{50,bottom}$		$d_{50,side}$		$d_{50,bottom}$	$d_{50,side}$
		feet	inches	feet	inches	feet	inches	feet	inches	inches	inches
25-Year	South	0.016	0.196	0.017	0.205	0.019	0.231	0.020	0.242	0.404	**0.424**
	West	0.023	0.276	0.024	0.290	0.014	0.164	0.014	0.172	0.330	**0.346**
100-Year	South	0.020	0.241	0.021	0.253	0.024	0.285	0.025	0.299	0.504	**0.529**
	West	0.028	0.341	0.030	0.358	0.017	0.202	0.018	0.212	0.412	**0.432**

All three of these rock calculation methods suggest that the situations present at the site require a rock much smaller then the 4.5-inch mean diameter Type A riprap. The largest calculated mean diameter rock is 0.53 inches on the side slopes using the Johnson & Abt, 1998 methodology.

6.2 Additional Stresses around Bends

Water flowing around bends in the ditches creates additional shear stress that the riprap rock within the ditch is required to manage. The additional shear stresses imparted on the rock is discussed in SCS, 1977 and HEC-22, 2009. A graphical factor, K_b, relating the radius of curvature of the bend to the bottom width of the channel has been developed and presented in these references. The relationship generally multiplies the shear stress of the straight flow by this factor to arrive at an increased shear stress on the rock at the bend.

As explained in Section 5.2, the radius of curvature for the 90-degree bends of the CAW ditch system is approximately 39.1 feet. The bottom width of the trapezoidal ditches, by design, is a minimum of 15.3 feet. The ratio of these two parameters is 39.1/15.3 = 2.6. Chart 21 in HEC-22, 2009 provides a graphical method to determine K_b. Using this chart and an Rc/B ratio of 2.6, K_b is approximated around 1.9. Table 16 shows the riprap size required for this increased shear using this factor. The largest required riprap median size is 0.7 inches, which remains well below the design criteria of 4.5 inches.

Table 16. Calculated Required Mean Riprap Size (d_{50}) around Bends

Storm Event	Ditch	Stress Method				Safety Factors Method			
		$d_{50,bottom}$		$d_{50,side}$		$d_{50,bottom}$		$d_{50,side}$	
		feet	inches	feet	inches	feet	inches	feet	inches
25-Year	South	0.045	0.534	0.047	**0.561**	0.037	0.450	0.039	0.472
	West	0.032	0.379	0.033	**0.398**	0.027	0.319	0.028	0.335

PRELIMINARY REVIEW DRAFT

100-Year	South	0.055	0.660	0.058	**0.693**	0.046	0.555	0.049	0.583
	West	0.039	0.467	0.041	**0.490**	0.033	0.393	0.034	0.412

7.0 CULVERT CALCULATIONS

Culverts are necessary to direct the flow from the CAW ditch system into the 11e.(2) ditch system and again from the 11e.(2) ditch system out into the desert southwest of the facility.

Design of the culverts has been evaluated against both of the storm events described in Section 3.0. The culverts have been analyzed as cylinders with both a concrete design and a plastic/HDPE design. These calculations provide the minimum diameter of the cylindrical culvert necessary to accommodate the design flow.

7.1 Culvert Design Equations

Assuming uniform flow, the Chezy-Manning Equation is applicable for the design velocity through the culvert. This equation is:

$$\mathbf{v = \left(\frac{1.49}{n}\right) R^{2/3} \sqrt{S}}$$

where,

v = velocity (ft/sec)
n = Manning's Roughness Coefficient
R = hydraulic radius (ft)
S = slope (ft/ft)

The design flow through the culvert can be calculated as Q = vA, where A is the cross-sectional area of the culvert: $\pi D^2/4$. Further, the hydraulic radius for a circular culvert is one-fourth the diameter: R = D/4. Combining these equations yields the following equation for total flow within the culvert:

$$\mathbf{Q = \left(\frac{\pi D^2}{4}\right)\left(\frac{1.49}{n}\right)\left(\frac{D}{4}\right)^{2/3} \sqrt{S}}$$

Rearranging this equation and solving for D, the required diameter of the cylindrical culvert yields the following:

$$\mathbf{D = \left[\frac{nQ4^{5/3}}{1.49\pi\sqrt{S}}\right]^{3/8}}$$

7.2 CAW – 11e.(2) Interface Culvert

The culvert may be made of concrete or plastic/HDPE. From Lindeburg, 2001, the value of n for concrete is 0.013 and for plastic/HDPE is 0.009.

PRELIMINARY REVIEW DRAFT

From Drawing 10014 C03, Revision 1, the following dimensions are noted:

Length of Culvert = 110 feet

Drop in Elevation = 4271.1 – 4269.9 = 1.2 feet

Therefore, S = 1.2/110 = 0.0109 ft/ft.

Table 17 provides the calculated culvert size required for the flow parameters. The flow rate is the total CAW drainage area converging at the southwest corner. These values were previously calculated in Section 5.1.

Table 17. CAW – 11e.(2) Culvert Design

Storm Event	Q (cfs)	n	S	D (ft)
25-Year	43.18	0.013	0.0109	**2.50**
100-Year	64.22	0.013	0.0109	**2.91**
25-Year	43.18	0.009	0.0109	**2.18**
100-Year	64.22	0.009	0.0109	**2.53**

Thus a three-foot diameter culvert is adequate for this transition zone.

7.2 CAW Outlet Culvert

The culvert may be made of concrete or plastic/HDPE. From Lindeburg, 2001, the value of n for concrete is 0.013 and for plastic/HDPE is 0.009.

From Drawing 9420-7B, Revision ? **[Dave, is this correct? If so, what is the appropriate revision?]**, the following dimensions are noted:

Length of Culvert = 196.7 feet

Drop in Elevation = 0.18 feet

Therefore, S = 0.18/196.7 = 9.2E-4 ft/ft.

Table 18 provides the calculated culvert size required for the flow parameters. The flow rate is the total sitewide drainage area converging at the southwest corner. This is calculated from the Rational Formula using the longest time of concentration rainfall intensities (as calculated in Section 5.1.2) and the overall site drainage area (433.12 acres from Table 6).

PRELIMINARY REVIEW DRAFT

Table 18. CAW – 11e.(2) Culvert Design

Storm Event	Q (cfs)	n	S	D (ft)
25-Year	69.89	0.013	0.000915	**4.78**
100-Year	100.93	0.013	0.000915	**5.48**
25-Year	69.89	0.009	0.000915	**4.16**
100-Year	100.93	0.009	0.000915	**4.78**

Thus, a six-foot culvert is adequate for this outlet. Multiple smaller culverts may be utilized for this outlet as long as the total area of flow is equivalent to that predicted by these diameter culverts.

8.0 CONCLUSIONS

These calculations demonstrate that the drainage ditches surrounding the CAW embankment are adequately designed to contain all of the flow from the worst-case storm events at Clive. Furthermore, the designed rock armor within the ditches is adequate for the site parameters.

The maximum height of water in the CAW ditch system during the normal storm event is 1.54 feet, leaving a freeboard distance of 2.46 feet. This provides a safety factor of 2.27 (3.5/1.54) from the design criterion for the normal condition of ½-foot of freeboard. The maximum height of water in the CAW ditch system during the abnormal storm event is 1.89 feet, leaving a freeboard distance of 2.11 feet. This provides a safety factor of 2.12 (4.0/1.89) from the design criterion for the abnormal condition that the ditch be able to contain all of the runoff from the embankment. For the overall site capacity, the 11e.(2) ditches reach a maximum height of 2.70 feet under the normal condition and 3.04 feet during the abnormal condition.

Rock sizing calculations show a minimum d_{50} for the riprap of 0.561 inches under the normal condition and 0.693 inches under the abnormal condition. The actual design rock d_{50} for the Type A riprap in the ditches is 4.5 inches. Therefore, the safety factors are 8.02 (4.5/0.561) for the normal condition and 6.49 (4.5/0.693) for the abnormal condition.

Additional calculations show that a concrete culvert with a minimum diameter of 2.91 feet would adequately convey water from the CAW embankment during the abnormal condition storm. This minimum diameter is calculated at 2.53 feet if the culvert were a plastic. For the 11e.(2) outlet ditch, a concrete culvert should have a minimum diameter of 5.48 feet and a plastic culvert a minimum diameter of 4.78 feet. For all of these culverts, multiple smaller pipes may be utilized as long as the total area equates to the calculated area associated with these diameters.

PRELIMINARY REVIEW DRAFT

9.0 REFERENCES

Johnson, T.L. and Abt, S.R., *Design of Channel Riprap Using Overtopping Flow Methods*, Proceedings of the First Federal Interagency Hydrologic Modeling Conference, Las Vegas, NV, April 19-23, 1998.

Lindeburg, Michael R., *Environmental Engineering Reference Manual for the PE Exam*, Professional Publications, Inc., 2001.

NOAA (National Oceanic and Atmospheric Administration), *Atlas 14, Precipitation-Frequency Atlas of the United States: Volume 1 Version 4.0: Semiarid Southwest (Arizona, Southeast California, Nevada, New Mexico, Utah)*. U.S. Department of Commerce, NOAA, National Weather Service, Silver Spring, MD 2004 (revised 2006). URL: http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ut.

NUREG-1623. NRC (U.S. Nuclear Regulatory Commission). *Design of Erosion Protection for Long Term Stability*. September 2002.

NUREG/CR-4620. Nelson, J.D., Abt, S.R., Volpe, R.L., van Zyl, D., Hinkle, N.E., and Staub, W.P. *Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments*. June 1986.

U.S. Army Corps of Engineers (USACE), *Hydraulic Design of Flood Control Channels*, EM 1110-2-1601, Office of the Chief of Engineers, Washington DC, 1994.

U.S. Department of Transportation, *Hydraulic Engineering Circular No. 22 (HEC-22), 3rd edition, Urban Drainage Design Manual*, Federal Highway Administration, Publication No. FHWA-NHI-10-009, 2009.

U.S. Soil Conservation Service (SCS), *Design of Open Channels, Technical Release 25*, U.S. Department of Agriculture, Engineering Division, Washington DC, 1977.

PRELIMINARY REVIEW DRAFT

10.0 CERTIFICATIONS

Calculations Performed by:

_____

Timothy L. Orton, P.E. Date

Calculations Checked by:

_____

David F. Booth, P.E. Date

PRELIMINARY REVIEW DRAFT

APPENDIX E

Cover/Liner Construction Estimates

PRELIMINARY REVIEW DRAFT

PRELIMINARY REVIEW DRAFT

FEDERAL EMBANKMENT SURETY ET/ROCK HYBRID COVER SYSTEM COST ESTIMATES

COVER MATERIALS	Premature Closure (Phase 1)					Full Capacity Closure				
	AREA (ft2)	THICKNESS (ft)	VOLUME (yd3)	Unit Cost	Subtotal	AREA (ft2)	THICKNESS (ft)	VOLUME (yd3)	Unit Cost	Subtotal
Cover Area to Ditch Centerline	235,456					2,473,883				
Waste Area Top Slope	23,500					1,379,435				
Side Slope Area	211,956					1,094,448				
Clean Fill Material										
Unit 3 Material Fill above DU			110,031	$ 4.78	$ 525,950			2,181,199	$ 4.78	$ 10,426,129
Top Slope (apply slope factor =1.0008)	23,519					1,380,539				
Radon Barrier (clay)										
1x10-6 Clay Layer										
Mine, Stockpile and Place	23,519	1	871	$ 8.84	$ 7,700	1,380,539	1	51,131	$ 8.84	$ 451,999
Remove Overburden	2,587	1	96	$ 8.84	$ 847	151,859	1	5,624	$ 8.84	$ 49,720
5x10-8 Clay Layer										
Mine, Stockpile, Amend, Place	23,519	1	871	$ 10.99	$ 9,573	1,380,539	1	51,131	$ 10.99	$ 561,930
Remove Overburden	2,587	1	96	$ 8.84	$ 847	151,859	1	5,624	$ 8.84	$ 49,720
ET Cover										
TS Frost Protection Layer (Bankrun)	23,519	1.5	1,307	$ 9.39	$ 12,269	1,380,539	1.5	76,697	$ 9.39	$ 720,181
Evaporative Zone (clay/loam)	23,519	1	871	$ 8.84	$ 7,700	1,380,539	1	51,131	$ 8.84	$ 451,999
Surface Zone (clay/loam/gravel blend)										
Surface Zone (gravel)	23,519	1	131	$ 13.39	$ 1,750	1,380,539	1	7,670	$ 13.39	$ 102,697
Surface Zone (clay/loam)	23,519	1	740	$ 8.84	$ 6,545	1,380,539	1	43,461	$ 8.84	$ 384,199
Blended Surface Zone Placement	23,519	1	871	$ 1.41	$ 1,228	1,380,539	1	51,131	$ 1.41	$ 72,095
Side Slope (apply slope factor=1.0198)	211,956					1,094,448				
Radon Barrier (clay)										
1x10-6 Clay Layer										
Mine, Stockpile and Place	211,956	1	7,850	$ 8.84	$ 69,396	1,094,448	1	40,535	$ 8.84	$ 358,330
Remove Overburden	23,315	1	864	$ 8.84	$ 7,634	120,389	1	4,459	$ 8.84	$ 39,416
5x10-8 Clay Layer										
Mine, Stockpile, Amend, Place	211,956	1	7,850	$ 10.99	$ 86,274	1,094,448	1	40,535	$ 10.99	$ 445,481
Remove Overburden	23,315	1	864	$ 8.84	$ 7,634	120,389	1	4,459	$ 8.84	$ 39,416
Rock Cover										
SS Frost Protection Layer (Clay)	211,956	1.5	11,775	$ 8.84	$ 104,094	1,094,448	1.5	60,803	$ 8.84	$ 537,496
Filter Zone	211,956	1	7,850	$ 26.02	$ 204,263	1,094,448	1	40,535	$ 26.02	$ 1,054,724
Side Rock	211,956	1.5	11,775	$ 29.62	$ 348,785	1,094,448	1.5	60,803	$ 29.62	$ 1,800,975
Ditch (apply slope factor =1.0198)										
Clay Backfill (compacted)	78,200		8,688.89	$ 8.84	$ 76,810	254,240		37,665.19	$ 8.84	$ 332,960
Grading	78,200			$ 0.35	$ 27,370	254,240			$ 0.35	$ 88,984
Erosion Materials (rock)										
Filter Zone	41,763	1	1,547	$ 26.02	$ 40,247	131,980	1	4,888	$ 26.02	$ 127,190
Side Rock	41,763	1.5	2,320	$ 29.62	$ 68,723	131,980	1.5	7,332	$ 29.62	$ 217,180
Inspection Road & Fence										
Inspection Road	27,600	1.25	1,278	$ 38.00	$ 48,556	72,075	1.25	3,337	$ 38.00	$ 126,799
Fence	2,000 LF			$ 14.00	$ 28,000	5,000 LF			$ 14.00	$ 70,000
SUBTOTAL (Includes a 2% Inflation Increase)					$ 1,726,038					$ 18,879,811
Mobilization/Demobilization; (Included)					$ -					$ -
Contingency & Adders (40.75%)					$ 703,361					$ 7,693,523
TOTAL					**$ 2,429,399**					**$ 26,573,334**
Cost per Square Foot (waste footprint)	#REF!				#REF!	#REF!				#REF!

NOTE: Areas are adjusted for slopes with a factor of 1.0008 for 4% slopes and 1.0198 for 20% (5 to 1) slopes.

Prepared by: David Booth
Updated: 1/16/2020

PRELIMINARY REVIEW DRAFT

Construction Estimate Sheet

Project Number: *ENG TBD* | Date: *January 16, 2020*

Project Description: *Federal Embankment Liner - Phase 1*

01 GENERAL REQUIREMENTS				
Mobilization & Demobilization. 160 mile roundtrip from SLC to Clive, Utah site.	1	LS	$0.00	$0.00
Construction and Dust Control Water (includes replacing water withdrawn from holding ponds)	1	LS	$20,000.00	$20,000.00
Project Employee (Gate Guard @ $18/hr, 12 wks, 50 hrs/wk)	1	LS	$12,000.00	$12,000.00
			Subtotal:	**$32,000.00**
02 SITEWORK				
Foundation	68,400	SF		
Excavation	2,533	CY	$4.60	$11,653.33
Soft Spot Over Excavation and Backfilling (assume 10% of foundation area)	507	CY	$7.75	$3,926.67
Grading & Compacting	7,600	SY	$2.25	$17,100.00
Clay Liner (1x10-6 cm/sec)	63,000	SF		
Topsoil Removal & Stockpiling	0	CY	$4.60	$0.00
Mine, Stockpile and Dry	8,960	CY	$8.15	$73,024.00
Load, Haul and Place	8,960	CY	$5.00	$44,800.00
Finish Grading	7,000	SY	$1.25	$8,750.00
Haul Road	1,336	LF	$17.25	$23,046.00
Runoff Control Berm	932	LF	$18.20	$16,962.40
			Subtotal:	**$199,262.40**

TOTAL CONSTRUCTION COST (with 2% Inflation Added) **$277,514.88**

Prepared By: *D. Booth* Checked By:

PRELIMINARY REVIEW DRAFT

Construction Estimate Sheet

Project Number: *ENG TBD* | Date: *January 16, 2020*

Project Description: *Federal Cell Liner - Entire Cell (Assumes 6 Separate Projects to Complete)*

01 GENERAL REQUIREMENTS				
Mobilization & Demobilization. 160 mile roundtrip from SLC to Clive, Utah site.	6	LS	$50,000.00	$300,000.00
Construction and Dust Control Water (includes replacing water withdrawn from holding ponds)	12	LS	$25,000.00	$300,000.00
Project Employee (Gate Guard @ $18/hr, 9 wks, 50 hrs/wk)	6	LS	$8,910.00	$53,460.00
			Subtotal:	**$653,460.00**
02 SITEWORK				
Foundation	2,178,706	SF		
Excavation	80,693	CY	$4.60	$371,186.95
Soft Spot Over Excavation and Backfilling (assume 10% of foundation area)	16,139	CY	$7.75	$125,073.86
Grading & Compacting	242,078	SY	$2.25	$544,676.50
Clay Liner (1x10-6 cm/sec)	2,160,610	SF		
Topsoil Removal & Stockpiling	33,802	CY	$4.60	$155,487.10
Mine, Stockpile and Dry	307,287	CY	$8.15	$2,504,387.06
Load, Haul and Place	307,287	CY	$5.00	$1,536,433.78
Finish Grading	240,068	SY	$1.25	$300,084.72
Haul Road	2,500	LF	$17.25	$43,125.00
Runoff Control Berm	15,532	LF	$18.20	$282,675.12
			Subtotal:	**$5,863,130.09**

TOTAL CONSTRUCTION COST (with 2% Inflation Added) **$6,646,921.89**

Prepared By: *D. Booth* Checked By:

PRELIMINARY REVIEW DRAFT

APPENDIX F

Depleted Uranium Performance Assessment

(digital copy)

PRELIMINARY REVIEW DRAFT

PRELIMINARY REVIEW DRAFT

APPENDIX G

Financial Surety Calculations

PRELIMINARY REVIEW DRAFT

PRELIMINARY REVIEW DRAFT

	A	B	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Z	AA	AB	AC	AD	AE	AF
1158	**31**	**DISPOSAL OF STORED FEDERAL WASTE**																												
1159		This item includes the maximum volume of radioactive waste that is allowed on site that has																												
1160		not been placed to approved disposal specifications.																												
1161																														
1162		MAXIMUM VOLUMES DEFINED AS:																												
1165		In Rail Cars, Not Unloaded																					=	243	cy					
1166		Time required to unload waste (cars or containers):									10	cy per hour per worker											=	24	hrs			$ 51.75	$ 1,255.35	
1167																														
1170		In Storage Building																					=	2,184	cy					
1171																														
1172		DISPOSAL CALCULATIONS																												
1184		CLSM Required is									2,426	cy depelted ur	x		1.87	cy	CLSM / cy of depleted uranium						=	4,537	cy	Using Exc Unit Price		$ 9.33	$ 22,644.68	
1222																														
1223		**PLACEMENT OF SRS DU WASTE**																												
1224																														
1225		Palletized drums will be removed from the storage building, transferred to the Federal Cell using an Extended Reach Forklift (assume forklift available on site)																												
1226		16 pallets per container at the staging area																												
1234		Palletized drums will be hauled to the cell.																												
1235		Assumed that on-site equipment will be used for transfer to the embankment from storage building.																												
1236		Assumed 4 drums per pallet																												
1237		Assumed number of drums																					=	5,408.00	ea		x			
1238		Assumed number of pallets																					=	1,352.00	ea		x			
1239																														
1240		Assumed hours per to transfer pallets																												
1241		Labor required is as follows:																												
1242																														
1243		Assumed hours to remove from storage area																												
1244		Equipment Operators									2	ea		x	120	hr							=	240.00	hr		x	$ 30.90	$ 7,415.91	
1245		Labor Foreman																												
1246																														
1247		Assumed hours to transfer to Federal Cell																												
1248		Equipment Operators									1	ea		x	160	hr							=	160.00	hr		x	$ 35.89	$ 5,743.08	
1252																														
1256																														**$ 37,059.01**

PRELIMINARY REVIEW DRAFT

	A	B	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Z	AA	AB	AC	AD	AE	AF
3195	**204**	**LINER CONSTRUCTION**																												
3196		This item includes construction of the liner. The liner design is assumed to be consistent with plan drawings																												
3197		in the Radioactive Material License.																												
3311		Open Embankment Limitation																					=	197,414.00 sf						
3312		This includes areas for the construction of sideslopes.																												
3313																														
3322		LINER																												
3323		Based on the current footprint of the Federal Cell Facility conceptual																												
3324		premature closure design, the amount of clay liner to be constructed is as follows.																												
3325																														
3326		Assume that 8 ft of excavation to design depth is used as fill and clay source for liner/radon barrier; thus																												
3327		minimal haul distance. Assume 11% is overburden.																												
3328																														
3329		Liner Volume						63,800 sf										x	3 ft				=	7,088.89 cy				$ 5.05	$ 35,772.44	
3330		(includes an additional 1 ft thickness for liner protective cover)																												
3331		Liner Area						63,800 sf		+		0 sf	+			0 sf							=	63,800.00 sf						
3335																														
3336																														
3337																														
3338																														
3339																														**$ 35,772.44**
3340	**205**	**SETTLEMENT MONITORING**																												
3341																														
3344		Temporary cover will be placed on area with uncovered waste and will consist of native soil																												
3346		Clean native fill will be required to close the embankments per the Premature Designs--no credit for future waste disposal.																												
3347																														
3348		Clean Fill Material (Similar to Grade Restoration Backfill) to Construct Premature Closure Embankments to Design Grades																												
3349		Required Fill Material																						110,031.00 cy						
3351		Total Fill Material																						110,031.00 cy				$ 5.05	$ 555,246.07	
3352																														
3353		Temporary Cover Volume																												
3354		Federal Cell										23,519 sf	x			1 ft							=	871.00 cy						
3356		Total Native Soil Volume																						871.00 cy						
3357																														
3359		Total Temporary Cover						871 cy		-		0 cy											=	871.00 cy				$ 9.33	$ 8,129.72	
3361																														
3362		Temporary settlement monuments will be installed and monitored for one year prior to cover construction.																												
3363		Assume that surcharging will be required if settlement data is not acceptable for final cover construction.																												
3366							Monument Total (estimated cost per monument $27.50)																=	4.00 ea				$ 4.22	$ 16.90	
3367		All temporary settlement monuments will be surveyed six times.																												
3368		Surveying will be provided by differential GPS using an existing site system, and using a one person crew.																												
3369		The analysis of settlement data for the temporary cover will be performed twice per year.																												
3370																														
3371		Performance of embankment surveys																												
3373		1 day per quarter (One Surveyor)										1 days		x		4 qtr							=	4.00 hr				$ 675.86	$ 2,703.45	
3374																														
3375		Purchase of monuments										4 Ea																$ 47.52	$ 190.09	
3377		Placement of monuments included as incidental cost of temporary cover placement																												
3378																														
3379		Bi-annual engineering review (based on 4 hours)										2 events			4 hr/event								=	8.00 hr				$ 132.00	$ 1,056.04	
3380							Rate for an independent engineer is $125/hr																							
3381																														
3382		Assume that temporary cover is placed immediately after completion of waste placement and that settlement																												
3383		monitoring begins immediately. Assume preparation and stockpiling of cover clay and rock materials during																												
3384		one year of monitoring keeps the construction contractor occupied, reducing the scope of multiple mobilizations.																												
3385		Assume a supplemental mobilization event to relocate surcharged material and complete final cover construction.																												
3386																														
3387																														
3388																														
3389																														
3390																														**$ 567,342.26**

PRELIMINARY REVIEW DRAFT

	A	B	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Z	AA	AB	AC	AD	AE	AF
3391	**207**	**COVER CONSTRUCTION**																												
3392		This item includes the construction of the final cover, roads around the embankments, drainage																												
3393		structures around the embankments, and permanent fencing. The final cover design is																												
3394		assumed to be consistent with approved plan drawings listed in Groundwater Quality Discharge Permit UGW450005.																												
3395		Reclamation of the pits, used for erosion barrier and filter material, is covered under a bond with the BLM.																												
3396																														
3397		The final cover area funded is based on the area listed in the premature closure plan.																												
3398		This includes cover that extends past the edges of the waste that is needed to meet the design slopes.																												
3399		At the time of closure a temporary cover will be placed. Upon completion of settlement monitoring																												
3400		and surcharging, the remainder of the cover will be placed. Costs for placement of Temporary Cover																												
3401		are accounted for within Item 205. A conceptual embankment design is shown below. All cover calculations																												
3402		are based on this drawing. The costs reflect use of an approved Rock Armor Cover.																												
3453																														
3454																														
3471		**TOP SLOPE**																												
3485		Assume uniform cover design; construct cover (to the ditch centerline) in accordance with the premature closure plan; 11% of mined volume is overburden.																												
3486		Note that open cell area limitation during operations will not be exceeded in accordance with the Radioactive Material License.																												
3487		Radon Barrier 5E-08																												
3488		Radon Barrier Volume									23,519	sf	x			1	ft						=	871.07	cy			$ 9.33	$ 8,130.41	
3491		Remove Overburden									2,587	cy	x			0.11							=	284.57	cy			$ 9.33	$ 2,656.11	
3492		Floculant Addition & Blending																												
3493		Applied at a rate of 3.5 lbs STPP per 50 cf radon barrier clay.									2,587	cy																		
3494											69,849	cf		x		0.07	=		4,889	lbs							$ 0.79	$ 3,841.58	
3495		Mix and Place (conservatively use unburdened soil placement unit cost)																					=	2,587.00	cy			$ 1.49	$ 3,845.24	
3496																														
3497		Radon Barrier 1E-06																												
3498		Radon Barrier Volume									23,519	sf	x			1	ft						=	871.07	cy			$ 9.33	$ 8,130.41	
3501		Remove Overburden									2,587	cy	x			0.11							=	284.57	cy			$ 9.33	$ 2,656.11	
3502																														
3503		Bankrun Borrow																					=	1,307.00	cy			$ 9.39	$ 12,272.73	
3511		Gravel																					=	131.00	cy			$ 13.39	$ 1,754.09	
3512		Clay Loam																					=	1,611.00	cy			$ 8.84	$ 14,241.24	
3513		Blended Surface Placement																					=	871.00	cy			$ 1.41	1228.11	
3531																														
3548		**SIDE SLOPE**																												
3562		Radon Barrier 5E-08																												
3563		Radon Barrier Volume									23,315	sf	x			1	ft						=	863.52	cy			$ 9.33	$ 8,059.89	
3566		Remove Overburden									864	cy	x			0.11							=	95.04	cy			$ 9.33	$ 887.08	
3567		Floculant Addition & Blending																												
3568		Applied at a rate of 3.5 lbs STPP per 50 cf radon barrier clay.									864	cy																		
3569											23,328	cf		x		0.07	=		1,633	lbs							$ 0.79	$ 1,283.00	
3570		Mix and Place (conservatively use unburdened soil placement unit cost)																					=	864.00	cy			$ 1.49	$ 1,284.22	
3571																														
3572		Radon Barrier 1E-06																												
3573		Radon Barrier Volume									23,315	sf	x			1	ft						=	863.52	cy			$ 9.33	$ 8,059.89	
3576		Remove Overburden									864	cy	x			0.11							=	95.04	cy			$ 9.33	$ 887.08	
3577																														
3578		Clay Loam (frost protection)									211956	sf	x			1.5	ft						=	11,775.33	cy			$ 8.84	$ 104,093.95	
3586		Filter Zone									211,956	sf	x			1.00	ft						=	7,850.22	cy			$ 26.02	$ 204,262.78	
3587		Side Rock									211,956	sf	x			1.5	ft						=	11,775.33	cy			$ 29.62	$ 348,785.37	
3588																														
3589																														
3590		**ROAD AROUND EMBANKMENT**																												
3591		Length of roads calculated using AutoCAD																												
3592		Width of area for grading (road prep) calculated using AutoCad																												
3593		Average width of road calculated using AutoCad																												
3596		Roadbase									27600	lf				15	ft	w	x	1	ft		=	1,278.00	cy			$ 8.84	$ 11,295.60	
3597																														
3598		**DRAINAGE**																												
3599		Clay Backfill (bompacted)																					=	8,688.89	cy			$ 8.84	$ 76,796.75	
3600		Grading																					=	78,200.00	ft			$ 0.35	$ 27,370.00	
3601		Erosion Material (rock)																					=	3,867.00	cy			$ 13.39	$ 51,779.13	
3602																														
3603		**FENCES**																												
3604		Construction of new fence																					=	2,000.00	lf			$ 14.00	$ 28,000.00	
3605																														
3606																														**$ 931,600.80**
3736	**211**	**SETTLEMENT MONITORING**																												
3737		Initial Aerial Survey to provide As-Found information for closure of the site																					=	1.00	each			$ 4,224.15	$ 4,224.15	
3738																														
3739		Performance of embankment surveys																												
3740		1 eight-hour days per quarter (One Surveyor)									1	days	x			8	hr		x	4	qtr	x	=	32.00	hr			$ 51.75	$ 1,655.86	
3741		Bi-annual Engineering Review																												
3742		The analysis of settlement data for the temporary cover will be performed twice per year.																												
3743											3	events											=	3.00	each			$ 132.00	$ 396.01	
3744																														**$ 6,276.02**
3761		**SUB TOTAL**																												**$ 1,578,050.54**
3762	**300**	**SG&A OVERHEAD COSTS (WORKING CONDITIONS)**																												
3763		Assume 5.5% of direct cost																										6%	$ 86,792.78	
3764																														
3765																														
3770	**302**	**CONTINGENCY**																												
3771		Assume 10% of direct cost																										10%	$ 157,805.05	
3772																														

PRELIMINARY REVIEW DRAFT

2020 FEDERAL CELL FACILITY SURETY
QUANTITY CALCULATIONS AND ASSUMPTIONS

	A	B	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Z	AA	AB	AC	AD	AE	AF
3773																														
3774	**303**		**ENGINEERING AND REDESIGN**																											
3775			Includes re-engineering required to address partial filling of cell																									2%	$ 35,506.14	
3776			Includes QA/QC and Final Closure Report																											
3777																														
3778	**304**		**PROFIT AND OVERHEAD**																											
3779			Assume 15% of direct costs																									15%	$ 236,707.58	
3780																														
3781																														
3782	**305**		**MANAGEMENT FEE AND LEGAL EXPENSES**																											
3783			Assume 4% of direct costs																									4%	$ 63,122.02	
3784																														
3785																														
3786	**306**		**DEQ OVERSIGHT OF PROJECT**																											
3787			Assume 4% of direct costs																									4%	$ 63,122.02	
3788																														
3789																														
3790	**320**		**FACILITY STEWARDSHIP TRANSFER**																											
3791			Assumes 2 inspectors for hour days for 90 days									90 days		x		8 hrs/day			2 inspectors		=			1,440.00 man-hrs			$ 132.00	$ 190,080.00	**$ 2,221,106.13**
3792																														
3793																														
3794			**FEDERAL CELL FACILITY PREMATURE CLOSURE SURETY BOND VALUE**																											**$ 2,411,186.13**
3795																														
3796																														
3797	**400**		**ROUTINE PERPETUAL SURVEILLANCE**																											
3798			This item includes annual environmental sampling and the annual inspections and maintenance that will be performed on the Surety area																											
3799			and off-site features that may have been impacted by operations. The value is based on																										$ -	
3800																														
3801			Annual monitoring activities from Section 400 of LLRW (conducted annually post closure for LLRW from years 1 to 100)																											
3802			Conducted annually for Federal Cell perpetually																						(activity/year)			$ 7,176.93		
3803																														
3804			Radiological water samples from Section 401 of LLRW (conducted annually post closure for Licensed area perimeter wells from years 1 to 100)																											
3805			Wells monitoring for 100 years post-closure will also enclose the Federal Cell Facility and not duplicated here																						(activity/year)			$ -		
3806																														
3807			Embankment Survey from Section 402 of LLRW (conducted annually post closure for the LLRW from years 1 to 5)																											
3808			Assumed conducted annual for the Federal Cell perpetually																						(activity/year)			$ 4,329.75		
3809																														
3810			Radiological air samples from Section 403 of LLRW (conducted annually post closure for Licensed area fence line perimeter year 1)																											
3811			Air monitoring perimtere will also enclose the Federal Cell Facility and not duplicated here																						(activity/year)			$ -		
3812																														
3813			Radiological soil samples from Section 404 of LLRW (conducted annually post closure for Licensed area fence line perimeter year 1)																											
3814			Soil monitoring perimtere will also enclose the Federal Cell Facility and not duplicated here																						(activity/year)			$ -		
3815																														
3816			Annual gamma monitoring activities from Section 406 of LLRW (conducted annually post closure for LLRW from year 1)																											
3817			Conducted annually for Federal Cell perpetually																						(activity/year)			$ 1,900.87		
3818																														
3819			Annual radon gas monitoring activities from Section 407 of LLRW (conducted annually post closure for LLRW from year 1)																											
3820			Conducted annually for Federal Cell perpetually																						(activity/year)			$ 1,998.27		
3821																														
3822																									**Annual Routine Surveillance**			**$ 15,405.82**		
3823																														
3824			**Principle required to generate sufficient interest to fund annual surveillances (URS, 2015 - basis for Utah Code 19-3-106.2)**																										**$ 770,290.82**	
3825																														
3992	**450**		**CATISTROPHIC EVENT REPAIR**																											
3998																														
3999			Regrading and Compaction of Federal Cell Facility												110,031.00	cy			(labor plus indirect multipliers)								$ 13.14	$ 1,445,509.23	
4000			Placement of final cover (costs from Surety Section 207)												235475	sf			(labor plus indirect multipliers)									$ 931,600.80	
4001			Settlement monitoring of repaired cover (costs from Surety Section 211)												23500	sf			(labor plus indirect multipliers)									$ 6,276.02	
4002			**FEDERAL CELL FACILITY PERPETUAL CARE SURETY BOND VALUE**																											**$ 3,153,676.87**
4003																														

PRELIMINARY REVIEW DRAFT