Div of Waste Management
and Radiation Control

ENERGY*SOLUTIONS*

OCT 19 2020

DRC-2020-017343

October 19, 2020

CD-2020-157

Mr. Ty Howard
Director
Utah Division of Waste Management and Radiation Control
195 North 1950 West
Salt Lake City, Utah 84114-4880

Re: Radioactive Material License UT 2300478 -
Groundwater Quality Discharge Permit UGW450005; **Amendment and Modification Request to Reduce Capacity and Disposal Footprint**

Dear Mr. Howard:

Energy*Solutions* hereby requests the Director of the Division of Waste Management and Radiation Control amend Radioactive Material License UT2300478 to authorize a reduced by-product disposal capacity and waste footprint. On November 30, 2017, the Director of the Utah Division of Waste Management and Radiation Control renewed Radioactive Material License UT2300478. Since then, Energy*Solutions* has recognized a dramatic reduction in the volume of 11e.(2) by-product material received for disposal. In support of this amendment request, Energy*Solutions'* hereby supports its amendment request with revision of sections of its 2015 License Renewal Application that are impacted by this requested reduction in footprint and byproduct waste capacity.

Energy*Solutions* also requests the Director modify Table 3 of Groundwater Quality Discharge Permit UGW450005 to reflect the following corner coordinates for the reduced disposal footprint.

- <u>Northwest Corner</u>
  - Local Clive Coordinates - Northing 12,051.32, Easting 11,696.02
  - Global Coordinates - Latitude(N) 40° 41' 12.159", Latitude(W) 113° 07' 06.565"
- <u>Southwest Corner</u>
  - Local Clive Coordinates - Northing 10,277.00, Easting 11,646.73
  - Global Coordinates - Latitude(N) 40° 40' 54.627", Latitude(W) 113° 07' 07.206"

- Southeast Corner
  - o Local Clive Coordinates - Northing 10,251.66, Easting 12,549.28
  - o Global Coordinates - Latitude(N) 40° 40' 54.845", Latitude(W) 113° 06' 55.564"

- Northeast Corner
  - o Local Clive Coordinates - Northing 12,025.96, Easting 12,599.10
  - o Global Coordinates - Latitude(N) 40° 41' 12.380", Latitude(W) 113° 06' 55.346"

Please contact me at (801) 649-2000 if you have any questions regarding this License Amendment and Permit Modification request.

Sincerely,

Vern C. Rogers
Vern C. Rogers
Oct 19 2020 2:17 PM
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Vern C. Rogers
Director of Regulatory Affairs

enclosures

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STATE OF UTAH 11e.(2) BYPRODUCT RADIOACTIVE MATERIAL LICENSE AMENDMENT REQUEST (UT2300478)

October 19, 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 144850
195 North 1950 West
Salt Lake City, UT 84114-4880

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On November 30, 2017, the Director of the Utah Division of Waste Management and Radiation Control renewed Radioactive Material License UT2300478. The License's 2017 renewal authorized a byproduct disposal embankment with total by-product design capacity of 5,048,965 cubic yards and embankment waste footprint of 3,993,750 square feet (in response to Energy*Solutions'* renewal application; 2015). Since then, Energy*Solutions* has recognized a dramatic reduction in the volume of 11e.(2) by-product material received annually for disposal. As shown in Figure 1-1, the annual by-product receipt rate for disposal under License UT2300478 has significantly decreased in 2019 to less than 5% of that received in 2010. As a result of this analysis, Energy*Solutions* hereby requests the Director amend License UT2300478 to authorize a reduced by-product disposal capacity of 1,629,255 cubic yards and waste footprint of 1,603,136 square feet.

In support of this amendment request, Energy*Solutions'* hereby submits revision of those sections of its 2015 License Renewal Application (Energy*Solutions*, 2015) that served as the basis for the 2017 renewal of License UT2300478 that are impacted by the requested reduction in footprint and byproduct waste capacity (see Table 1-1). Proposed revisions to Radioactive Material License UT2300478 are provided in redline/strikeout format in Appendix C. The proposed changes to the 11e.(2) Radioactive Material License include the following:

1. <u>Condition 8</u>: Maximum quantity Licensee may possess at any one time 1,629,255 cubic yards

2. <u>Condition 10.14(c)</u>: The total embankment capacity shall not exceed 1,245,655 m^3 (1,629,255 yd^3)

Energy*Solutions* similarly requests that the reduced disposal cell footprint also be reflected in Table 3 of Groundwater Discharge Permit UGW450005.

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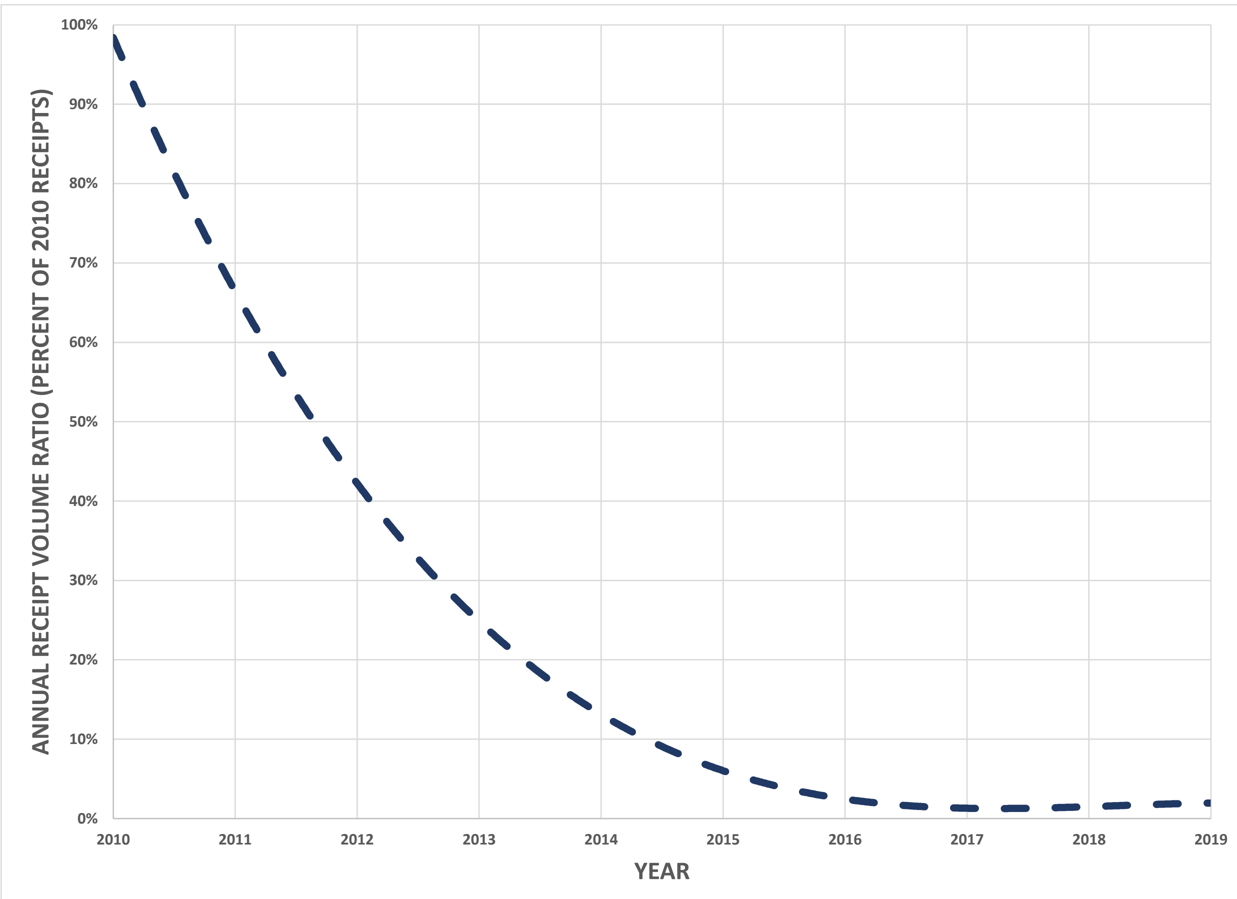

Figure 1-1 Annual By-Product Receipt Rate for Disposal Under License UT2300478

Table 1-1

Impacted Sections of the 2015 Renewal Application (Energy*Solutions*, 2015)

2015 - LICENSE RENEWAL APPLICATION SECTION		AMENDMENT IMPACT
SECTION 1. PROPOSED ACTION		The reduced footprint and dispsoal capacity are introduced.
SECTION 2. SITE CHARACTERIZATION		Unimpacted
SECTION 3. DESCRIPTION OF FACILITY		The smaller footprint is described.
3.1	EMBANKMENT	The smaller footprint is described.
3.1.1	*Storm-Water Design*	Runoff management of the smaller footprint is described.
3.1.2	*Waste Disposal Operations and Procedures*	Unimpacted
3.2	UNLOADING FACILITIES	Unimpacted
3.2.1	*Procedures For Receiving and Opening Shipments*	Unimpacted
3.3	DECONTAMINATION FACILITIES	Unimpacted
3.3.1	*Waste-Water Facilities*	Unimpacted
3.4	WASTE HANDLING FACILITIES	Unimpacted
3.4.1	*Procedures for Waste Handling*	Unimpacted
3.4.2	*Procedures for Waste Disposal*	Unimpacted
3.5	INSTRUMENTATION AND CONTROL	Unimpacted
SECTION 4. EFFLUENT CONTROL SYSTEMS		Unimpacted
4.1	GASEOUS AND AIRBORNE PARTICULATES	Unimpacted
4.2	LIQUIDS AND SOLIDS	Unimpacted
4.3	CONTAMINATED EQUIPMENT	Unimpacted
SECTION 5. OPERATIONS		Unimpacted
5.1	CORPORATE ORGANIZATION AND ADMINISTRATIVE PROCEDURES	Unimpacted
5.1.1	*Standard Operating Procedures*	Unimpacted
5.2	MANAGEMENT CONTROL PROGRAM	Unimpacted
5.3	MANAGEMENT AUDIT, INSPECTION, AND RECORDKEEPING PROGRAM	Unimpacted
5.3.1	*Management Audit, and Internal Inspection Program*	Unimpacted
5.3.2	*Recordkeeping and Record Retention*	Unimpacted
5.4	QUALIFICATIONS FOR PERSONNEL	Unimpacted
5.4.1	*Radiation Safety Officer*	Unimpacted
5.4.2	*Radiation Safety Staff*	Unimpacted
5.5	RADIATION SAFETY TRAINING	Unimpacted

2015 - LICENSE RENEWAL APPLICATION SECTION		AMENDMENT IMPACT
5.6	SECURITY	Unimpacted
5.6.1	*Access Control*	Unimpacted
5.6.2	*Signs and Postings*	Unimpacted
5.7	RADIATION SAFETY CONTROLS AND MONITORING	Unimpacted
5.7.1	*ALARA Program*	Unimpacted
5.7.2	*Radiation Protection Program*	Unimpacted
5.7.3	*Radiation Work Permits*	Unimpacted
5.7.4	*Respiratory Protection*	Unimpacted
5.7.5	*Radiological Surveys*	Unimpacted
5.7.6	*Effluent Control Techniques*	Unimpacted
5.7.7	*External Radiation Exposure Monitoring Program*	Unimpacted
5.7.8	*Airborne Radiation Monitoring Program*	Unimpacted
5.7.9	*Exposure Calculations*	Unimpacted
5.7.10	*Bioassay Program*	Unimpacted
5.7.11	*Contamination Control Program*	Unimpacted
5.7.12	*Airborne Effluent and Environmental Program*	Unimpacted
5.7.13	*Ground-Water and Surface-Water Monitoring Programs*	Unimpacted
5.7.14	*Quality Assurance*	Unimpacted
SECTION 6. GROUND-WATER QUALITY RESTORATION, SURFACE RECLAMATION, PLANT DECOMMISSIONING		Unimpacted
6.1	PLANS AND SCHEDULES FOR GROUND-WATER QUALITY RESTORATION	Unimpacted
6.2	PLANS AND SCHEDULES FOR RECLAIMING DISTURBED LANDS	Unimpacted
6.3	PROCEDURES FOR REMOVING AND DISPOSING OF STRUCTURES AND EQUIPMENT	Unimpacted
6.4	EMBANKMENT COVER	Cover design and material quantities affected by smaller embankment are presented.
6.4.1	*Cover Design and Construction*	Unimpacted
6.4.2	*Long Term Radiological Performance of Embankment Cover*	Unimpacted
6.4.3	*Post Closure Containment of Non-Radiological Hazards*	Unimpacted
6.4.4	*Decontamination and Decommissioning*	Unimpacted
6.5	PROCEDURES FOR CONDUCTING POST-RECLAMATION AND DECOMMISSIONING RADIOLOGICAL SURVEYS	Unimpacted

2015 - LICENSE RENEWAL APPLICATION SECTION		AMENDMENT IMPACT
6.6	FINANCIAL ASSESSMENT FOR GROUND-WATER RESTORATION, DECOMMISSIONING, RECLAMATION, WASTE DISPOSAL AND MONITORING	Impacts from premature closure of a smaller embankment are presented.
6.6.1	*Surety*	Unimpacted
SECTION 7. ENVIRONMENTAL EFFECTS		Unimpacted
7.1	SITE PREPARATION AND INITIAL CONSTRUCTION	Unimpacted
7.2	OPERATIONS	Unimpacted
7.2.1	*Radiological Releases During Normal Operation Conditions*	Unimpacted
7.2.2	*Potential Accident Radiological Releases During Operations*	Unimpacted
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8.1	NOTIFICATIONS	Unimpacted
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	2015 - LICENSE RENEWAL APPLICATION SECTION	AMENDMENT IMPACT
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12.2.6	*Office of State Engineer, Utah Division of Water Rights – Approval of Well Plugging*	Unimpacted
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SECTION 3. DESCRIPTION OF FACILITY

Areas utilized for disposal material receiving, unloading, hauling, handling, and placement in the 11e.(2) Embankment are considered a Restricted Area. Any person entering the Restricted Area must check in and out through access control, or through a truck/vehicle entrance gate. Additionally, radiation exposure to persons working within the Restricted Area is monitored using Thermo Luminescent Dosimeters (TLDs), or equivalent monitoring devices. The fences surrounding the areas are conspicuously posted with signs that read "*Caution – Radioactive Materials.*"

3.1 EMBANKMENT

As is illustrated in Engineering Drawing set 20001 (included in Appendix M), the capacity of the 11e.(2) Embankment is 1,629,255 cubic yards and occupies 1,603,136 square feet of land. Energy*Solutions*' 11e.(2) design is a shallow land burial embankment, constructed using materials native to the site or found in close proximity to the site. Engineered features of the Embankment are designed based upon State of Utah regulations, U.S. Nuclear Regulatory Commission (NRC) guidance, U.S. Environmental Protection Agency (EPA) guidance, and Energy*Solutions*' past experience at this location. In order to simplify the information presented in this license amendment reuqest, the following presentation of design criteria, pertinent characteristics, and projected performance is limited to the those features impacted by the reduction in Embankment capacity.

Principle design features of the Embankment include: clay liner, waste placement, final cover, drainage systems, and a buffer zone. Auxiliary systems and facilities include utility systems, operational support facilities, fire protection systems, and water management systems. Of the principle design features and auxiliary systems, only performance of the drainage system is impacted by a reducution in Embankment footprint.

The general design requirements for the licensing of the shallow land burial 11e.(2) Embankment are set forth in Utah Administrative Code (UAC) R313-24 and 10 CFR 40, administered by the Director of the Utah Division of Waste Management and Radiation Control.

1. Site design features are directed toward long-term isolation and avoidance of the need for continuing active maintenance after closure;
2. The disposal site design and operation are 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 is designed to complement and improve, where appropriate, the ability of the disposal site's natural characteristics to assure that the performance objectives are met;
4. Covers are designed to minimize, to the extent practicable, water infiltration, to direct percolating or surface water away from the disposed waste, to resist degradation by surface geologic processes and biotic activity, and to limit the atmospheric release of radon;
5. Surface features direct surface water drainage away from disposal units at velocities and gradients which do not result in erosion that require ongoing active maintenance in the future; and
6. The disposal site is 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.

Long-term stabilization of the site is accomplished through erosion control and flood protection. The controlled areas of the site are fenced both during construction and after operation to prevent public access. Additionally, site custodial maintenance and surveillance are performed to assure continued long-term compliance with applicable regulatory standards. The construction sequence is as follows:

1. Existing terrain is excavated to a depth of approximately eight feet.
2. After the overburden is removed, a two foot clay liner is constructed under all areas where waste material is placed. The clay liner consists of a two foot low permeability clay barrier compacted to 95% of a standard proctor. This clay liner provides a seepage liner/retardant on the bottom of the Embankment.
3. The material for disposal is placed on the liner and compacted in place to a waste column height of approximately 34 feet at the embankment shoulder. At the embankment's highest point, the waste column will be approximately 50 feet thick.
4. When the Embankment is filled to the maximum height, a three and one-half foot thick layer of clay is placed on the side slopes and a four-foot thick layer of clay is placed on top and compacted to form a radon barrier.
5. A twelve-inch filter zone of small diameter rock provides a drainage layer under the rock erosion barrier.
6. An erosion barrier of specification-sized rock covers the surface of the embankment.

In order to evaluate and document stability of the 11e.(2) Embankment, the LLRW and 11e.(2) CQA/QC Manual, work elements "*Temporary Cover Placement and Monitoring*" and "*Settlement Monitoring*" require the placement of settlement monitoring monuments. Within work element "*Temporary Cover Placement and Monitoring*," specification "*Transition to Final Cover*" provides a process for evaluating settlement data to demonstrate stability of the waste column before final cover construction begins. The CQA/QC Manual contains work elements that include construction specifications, including lift bonding, keying-in of segments, prevention of liner drying, and spring start-up. Meeting the CQA/QC Manual's specifications demonstrates that the embankment will meet the regulatory performance requirements.

The Director of the Division of Waste Management and Radiation Control has adopted performance based Best Available Technology (BAT) standards for Energy*Solutions*' disposal facility, requiring that groundwater protection standards will not be exceeded at compliance wells within 200 years for non-radioactive hazardous constituents and within 500 years for radioactive constituents. Where design criteria set forth specific criteria, the 11e.(2) Embankment has been designed to meet that requirement, such as required 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." EPA and NRC, in setting design criteria for disposal facilities for 11e.(2), have addressed the issue of long-term stability. Both agencies have adopted a standard that requires that the facility be designed for 1,000 years, whenever reasonably achievable, but in any case for a minimum of 200 years. Energy*Solutions*' shallow land burial 11e.(2) Embankment design meets the requirement for 1,000 year containment, and follows the direction outlined in "*Guidance for Disposal of Uranium Mill Tailings: Long-Term Stabilization of Earthen Cover Materials.*"

Structural stability has been evaluated in terms of slope stability within the layers that comprise the embankment contents. The Embankment meets global stability requirements for a Sliding Safety factor of 1.5 under static conditions and 1.2 under dynamic (i.e., earthquake) conditions. These minimum factors of safety for static and seismic conditions are found in UAC R655-11-6. These minimum recommended factors of safety are based on reviewing case histories of embankment dams founded on non-liquefiable clay foundations or bedrock, which demonstrated adequate performance under seismic conditions (AMEC, 2011 and AMEC, 2012). This amendment request to license less capacity than is currently licensed does not impact the Director's prior determination that the 11e.(2) Embankment satisfies the structural stability performance objective.

As the basis for License UT2300478, Energy*Solutions* demonstrated that the 11e.(2) Embankment performed as required under normal and abnormal conditions and static conditions. The evaluations compared the calculated safety factor inherent to the Embankment design against the expected peak ground acceleration due to an earthquake that might affect the site. Detailed seismic stability and deformation analyses of the Embankment projected a minimum static factor of safety of 2.1 under saturated conditions and 2.3 under unsaturated condition (AMEC, 2011 and AMEC, 2012), both exceeding the design static factor of safety of 1.5. Abnormal condition evaluated the seismic loading of the Embankment due to a maximum credible earthquake. The calculated minimum seismic factor of safety is 1.3 (AMEC, 2011 and AMEC, 2012). This factor of safety exceeds the minimum design criteria (seismic factor of safety < 1.2). The minimum static factor of safety is 2.1 under saturated conditions and 2.3 under unsaturated conditions; the minimum seismic factor of safety is 1.3. These values exceed the design criteria of static factor of safety < 1.5 and seismic factor of safety < 1.2. The referenced evaluations were performed for the larger and taller Class A West embankment, providing a bounding analysis for a reduction in 11e.(2) Embankment capacity.

3.1.1 Storm-Water Design

During active operations, the 11e.(2) Embankment is surrounded by run-on and run-off berms. Run-on berms prevent stormwater run-on, from ambient precipitation in the vicinity of the facility, into the emplaced waste before final cover is built. Run-on berm design criteria is not impacted by a reduction in 11e.(2) Embankment capacity. The disposal area is surrounded by a perimeter berm that is at least 3 feet above the natural ground. This run-on control berm is designed to protect the disposal operations against the Probable Maximum Flood. The design calculations for the site perimetery berms are located in Appendix E of Energy*Solutions*, (2013). Calculations for the Probable Maximum Precipitation and Probable Maximum Flood are also located in Appendix G of Energy*Solutions*, (2013). The final drainage design is shown on Engineering Drawing 20001-C03.

Run-off berms ensure that precipitation that falls on emplaced waste is collected and does not carry contamination off of the site. Because run-off berm locations necessarily move as new portions of the 11e.(2) Embankment are opened for waste placement, these operational features are not depicted on facility design drawings. The 11e.(2) Embankment drainage systems provide drainage and ensure structural stability, in managing stormwater. In contrast to the embankment, which is designed for a 1,000-year lifetime, the stormwater drainage ditch system is only operational during the active life of the facility. This yields a design life of approximately 25 years for the drainage ditch system. All 11e.(2) Embankment surfaces are contoured to avoid areas of concentrated surface runoff or abrupt or sharp changes in slope gradient. Energy*Solutions* has also designed a drainage ditch to channel flow that originates on the Embankment away from the Embankment. The drainage ditch is designed with rock erosion barrier to limit erosion (as shown on Engineering Drawing 20001-C03). Following completion of the cover for sections of the Embankment, permanent drainage ditches are constructed. Drainage ditches are constructed of filter zone and erosion barrier materials meeting the specifications described in the CQA/QC Manual (Work Element – *Drainage Ditches*). These surface water controls have been successfully utilized at the Clive facility for over 30 years.

3.1.1.1 Facilitate Flow of Precipitation Away from the Embankment

Site drainage is considered in terms of two complementary aspects: (1) facilitating flow of precipitation away from the embankment, and (2) minimizing deep infiltration under flood conditions. As is demonstrated in Appendix L, storm water remains within the 11e.(2) drainage ditch system to a depth of 1.29 feet (2.71 feed of freeboard) under the normal precipitation event and 1.35 feed (2.65 feet of freeboard) under the abnormal precipitation event. This criterion promotes the collection of precipitation as well as promotes flow away from a reduction in 11e.(2) Embankment footprint, thus minimizing standing water adjacent to the Embankment; thereby minimizing potential infiltration into the waste.

During the maximum normal precipitation event, the greatest volume retained in storage within the 11e.(2) Landfill Embankment drainage ditch system occurs approximately 15 minutes into the event and decreases rapidly over the next hour. This volume is well within the four-foot perimeter ditch height specifications. Therefore the 11e.(2) ditch design adequately contains the maximum normal and worst case precipitation events.

Safety factors have been calculated for critical design case of the downstream ditch system. Consideration of the ditch system provides a maximum projected drainage runoff. For the normal condition, the safety factor is calculated as the ratio of projected freeboard to the design criteria for freeboard. The calculated freeboard adjacent to the Embankment during the normal event is 2.71 feet and the design criteria freeboard (from Table 6-1) is 0.5 feed; therefore, the safety factor is 2.71 / 0.5 = 5.42. For the abnormal event, the design criterion is that the ditch be able to contain the flow; no freeboard is necessary. The safety factor during the abnormal event in the drainage system is calculated as the ratio of design ditch depth to calculated flow depth: 4.00 / 2.71 = 2.96.

3.1.1.3 Ensure Ditch Integrity

Ditch Integrity is evaluated in terms of the drainage ditch's ability to prevent internal erosion of the compacted soils beneath the filter rock layer. Runoff water velocity shall not exceed three feet per second on the surface of the compacted soil. NUREG/CR-4620, "*Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments*" provides tables of permissible velocities over different surfaces. The permissible velocity criterion is a velocity that will not erode the underlying material. The erosion potential of the material is determined based on the material properties as well as the degree of compaction that the material has undergone. Table 4.9 of NUREG/CR-4620 provides limiting velocities in cohesive materials. The permissible velocities presented in this table range from 1.05 ft/sec for an uncompacted lean clayey soil to 5.90 ft/sec for "very compact" sandy clay. The drainage ditch sub-grade is comparable to "compact clay" within this table. The permissible velocity for this type of clay is 3.94 ft/sec. Therefore, the specified design criterion of a velocity ≤ 3 ft/sec is conservative.

The normal design condition evaluates performance under the 100-year, 24-hour storm event of 2.4 inches of precipitation. The abnormal condition evaluates impacts of the Probable Maximum Precipitation (one-hour storm of 6.1 inches) as the worst-case extreme erosion event. The one-hour event was selected to maximize velocity of precipitation and, accordingly, flow through the cover drainage system.

The drainage ditch is constructed of compacted natural ground or borrow material covered with Type A filter rock and Type A riprap for erosion control. Drainage ditch slopes range from 0.000474 ft/ft and 0.000484 ft/ft (see Appendix L). Maximum interstitial water velocities in the ditches are calculated in Appendix L at $9.58x10^{-4}$ ft/sec. This velocity is the maximum possible velocity at the interface and is not dependent on the amount of water flow. This velocity is an order of magnitude below the design criteria velocity at which erosion may occur (3 ft/sec). Therefore, significant erosion of the ditch clay surface will not occur.

Abnormal conditions are not applicable for the internal water velocity calculations because the calculated interstitial velocity at the clay/rock interface is a maximum velocity. Any further water will flow in areas above the interface and will not affect erosion of the clay layer. No appropriate accident conditions exist for this design criterion.

The safety factor of the internal water velocity over the compacted soil surface of the ditch is the ratio of the calculated interstitial velocity to the design criteria (minimal erosion) velocity. Use of the top slope interstitial velocity is conservative, since the material is the same but the slope is less for the drainage ditches. Accordingly, the safety factor is approximately 3 / 0.000958 = 3,131.

SECTION 6. GROUND-WATER QUALITY RESTORATION, SURFACE RECLAMATION, PLANT DECOMMISSIONING

11e.(2) Embankment closure and stabilization includes decontamination and decommissioning. However, removal of facilities that have also been used in support of Class A Low-Level Radioactive Waste Management, including roads, rail spurs, railcar rotary, storage pads, wash pads, and administrative buildings is considered as part of Radioactive Material License #UT 2300249 (Energy*Solutions*, 2019b). Any material contaminated solely with 11e.(2) isotopes that do not meet the standards for unrestricted release are placed into the 11e.(2) Embankment. Remediation will then be performed on the decontaminated and decommissioned areas.

Groundwater quality restoration and surface reclamation are discussed further in the 11e.(2) Environmental Assessment (Appendix G of Eergy*Solutions*; 2015). Because groundwater mounding caused by infiltration of non-contact surface water can cause localized areas where the vertical gradient is downward. Energy*Solutions* measured the vertical hydraulic conductivity in core samples and determined the vertical conductivity, on average, is three orders of magnitude less than the horizontal hydraulic conductivity of the shallow water-bearing unit (Energy*Solutions*, 2019a). Given this hydraulic conductivity information, low infiltration rates through the embankment, and the location of shallow water-bearing zone monitoring wells approximately 90 feet from the edge of the embankment. Localized areas of downward gradient will not impact the long-term performance of the embankment. General decommissioning of Section 32 of Energy*Solutions*' facility will be performed to meet site closure requirements of License #UT2300249 and License #UT2300478.

6.4 EMBANKMENT COVER

As shown in Engineering Drawing 20001-C06, the cover design cross section of the 11e.(2) Embankment is unchanged by this capacity reduction amendment request. The cover of the 11e.(2) Embankment is being constructed as follows:

1. When the Embankment is filled to the maximum height, a minimum 3.5-foot thick layer of clay is placed on the top of the side slopes and a 4-foot thick layer of clay is placed on top and compacted to form a radon barrier.
2. 12-inch thick filter zone layer is placed.
3. An erosion barrier consisting of one foot to one and one-half foot thick specification-sized rock is placed. The filter zones and erosion barrier placement and thickness are specified in Engineering Drawing 20001-C06.

Energy*Solutions* is constructing the 11e.(2) Embankment cover in accordance with the cover design and construction procedures and specifications found in the CQA/QC Manual. As they are impacted by precipitation runoff from a reduced the 11e.(2) Embankment, the revised drainage ditch features are summarized in Tables 6-1 through 6-3.

Table 6-1

Design Criteria of the Principle Cover Design Features Impacted by a Reduced 11e.(2) Embankment Capacity

Principal Design Feature	Required Function	Complementary Aspects	Design Criteria	Design Criteria Justification	Conditions	
Drainage Systems	Provide Site Drainage	Facilitate flow away from the embankment	Depth of water < depth of ditch. Promote free flowing conditions. Freeboard ≥ 0.5 foot under normal conditions.	Minimize potential infiltration into the waste.	normal	25 yr. 24 hr. storm
					abnormal	100 yr. 24 hr. storm
					accident	Downstream Blockage
		Minimize Infiltration under flood conditions	Flood water shall dissipate faster than water travels through the cover system.	Ponded flood water promotes infiltration. So long as flood water drains or evaporates faster than the travel time through the cover, increased infiltration will be minimized.	normal	100 year flood (1,300 cfs)
					abnormal	PMF (29,800 cfs)
					accident	Downstream Blockage
	Ensure Ditch Integrity	Prevent Internal Erosion	Water velocity over compacted soil ≤ 3 ft/sec	NUREG/CR-4620 NUREG-1623	normal	25 yr. 24 hr. storm
					abnormal	100 yr. 24 hr. storm
					accident	Not Required

Table 6-2

Pertinent Characteristics of the Principle Cover Design Features Impacted by a Reduced 11e.(2) Embankment Capacity

Principal Design Feature	Principal Design Element	Pertinent Characteristics	References
Drainage Systems	Drainage Ditches	4 feet deep "Irregular quadrilateral" with a 2% bottom slope and 5:1 (H:V) sides slopes Borrow Material = CL or ML soils Natural Ground or Imported Borrow Material Compacted to 95% of a Standard proctor 6 inches of Type A filter material 18 inches of Type A riprap material	Engineering Drawings 20001-C03 and 20001-C05 Borrow Material in CQA/QC Manual, Attachment II-A, Work Element - Drainage Ditch Imported Borrow, Material specification

Table 6-3

Projected Performance of the Principle Cover Design Features Impacted by a Reduced 11e.(2) Embankment Capacity

Principal Design Feature	Required Function	Complementary Aspects	Design Criteria	Projected Performance	Performance Reference	Safety Factor
Drainage System	Provide Site Drainage	Facilitate flow of precipitation away from the embankment	Depth of water < depth of ditch. Freeboard ≥ 0.5 foot under normal conditions.	Design ditch height = 4 feet. Max height of water during normal event = 1.29 feet. Max height of water during abnormal event = 1.35 feet. Downstream blockage improves post-closure performance	Appendix L	Downstream: Normal SF = 5.42 Abnormal SF = 2.96
	Ensure Ditch Integrity	Prevent Internal Erosion	Water velocity over compacted soil ≤ 3 ft/sec	Maximum interstitial water velocities in the ditches = 9.58×10^{-4} ft/sec.	Appendix L	SF = 3,131

6.6 FINANCIAL ASSESSMENT FOR GROUND-WATER RESTORATION, DECOMMISSIONING, RECLAMATION, WASTE DISPOSAL AND MONITORING

Custodial maintenance, such as repair of a damaged perimeter fence, is required at the site. Extreme natural events, intentional intrusion, or other events may occur at a site that may require contingency repair to ensure that the tailings facility continues to function as intended.

The 11e.(2) Embankment is being constructed in a manner that minimizes the need for long-term maintenance. The containment structure is made completely of natural materials. The only item at the facility that is man-made is the chain link fence that surrounds the site. The major items of construction include:

a) a 2-foot clay liner beneath the waste material;
b) the waste material itself;
c) a three and one-half to four foot clay layer over the waste;
d) a filter layer;
e) a rock erosion barrier;
f) a rock-lined perimeter ditch;
g) a twelve foot inspection road; and,
h) a six foot chain link fence.

With the exception of the chain link fence all of the materials incorporated in the final Embankment have been designed to remain intact for 1,000 years. Tthe Embankment is resistant to water erosion, wind erosion, and slope failure for the 1,000 year design life of the facility. There will be no active maintenance required on the Embankment after closure.

Energy*Solutions'* long-term surveillance plan is based on "Guidance for UMTRA Project Surveillance and Maintenance, January 1986" (DOE, 1986). Energy*Solutions* will use that document as a guide during post-closure activities. A summary of the surveillance and maintenance plan is provided in this section.

Prior to completion of remedial action at the Energy *Solutions* site, the final site conditions, including airborne particulate monitoring, will be defined and characterized as the first step in the surveillance and maintenance process. After completion of the remedial action, information will be assembled into a site file that will be reviewed by the Director of the Division of Waste Management and Radiation Control prior to surveillance activities.

This section explains the procedures used by Energy*Solutions* to determine when maintenance or contingency repairs are required at the facility. The Energy*Solutions* site will not require scheduled maintenance. Examples of site conditions that may require maintenance are listed in Table 6-5. Conditions that may trigger contingency repair action are listed in Table 6-6.

When compared with contingency repair, maintenance is generally less costly, smaller in scale, and more frequent in occurrence. In contrast, contingency repairs are unlikely; however, repair costs may be substantial due to the size of the work force and technical skills required for repairs. The inspection report and monitoring results will be reviewed and site conditions compared from year to year so that trends of changing conditions can be identified. Extrapolation of identifiable trends will provide a means of predicting when maintenance or repair is required at the disposal site.

After a decision has been made to initiate maintenance or contingency repair, a statement of work will be prepared for the work performed. The maintenance or repair actions required to correct site problems will be dependent upon the nature of the problem or hazard. Although the details of maintenance or repair actions required cannot be reliably predicted in advance, a range of possible actions are outlined in Table 6-7. A remote possibility exists for failure of a site to adequately contain the waste material. For the Clive site, the only feasible scenario will be release of waste material from a site following a major earthquake, major flood, or other severe natural phenomena.

Energy*Solutions* will identify site failure in at least three ways:

1. Results of Phase I, Phase II, or contingency site inspections.
2. Reports from local government authorities or local residents.
3. Reports from National Oceanic & Atmospheric Administration (NOAA), the Earthquake Early Warning Service, or other agencies.

On the basis of the site contingency plan, appropriate action will be taken to notify individuals who may be affected and advise them of precautions that are necessary. Local law enforcement officials, news media, responsible agency representatives, and/or state representatives may be utilized in contacting affected parties.

After completion of maintenance or contingency repair actions, the responsible agency will certify that all work was completed in accordance with specifications. Copies of the certification statement will be attached to the 11e.(2) License, the site inspection report, and will become part of the site file.

Table 6-5

Examples of Site Conditions That May
Require Custodial Maintenance

1. Damage to site boundary fence, signs, or monuments,

2. Damage or obstruction to primary site access road (e.g., road washout).
or new construction adjacent to the site that obstructs the access road).

3. Growth of deep rooted shrubs on the site cover.

4. Development of animal burrows on the site cover.

Table 6-6

Examples of Site Conditions That May Require Contingency Repair

1. Development of rills or gullies, deeper than six inches with near vertical walls, and no vegetative cover.

2. Surface rupture where the dimensions of the cracks are larger than one inch wide by ten feet long by one feet deep that would indicate severe shrinkage of cover materials or differential settlement of site materials.

3. Instability of slopes to the point where mass wasting or liquifaction has occurred due to earthquakes, differential settlement, or other causes.

4. Encroachment of stream channels onto the disposal site.

5. Flood damage to the disposal site in the form of new channels, or debris deposits.

6. Intrusion by man whereby cover materials have been removed from the site.

Table 6-7

Custodial Maintenance or Repair Action Which Could be Needed at Sites

1. Repair of fences.

2. Replacement of warning signs.

3. Reestablishment of survey control monuments.

4. Removal of deep-rooted shrubs from the embankment cover.

5. Control or eradication of burrowing animals.

6. Placement of fill in gullies or rills.

7. Replacement of erosion barrier rock cover materials.

8. Placement of inclinometers or tilt meters to measure movement on unstable slopes.

9. Reconstruction of embankment slope segments where slumping, mass wasting, liquefaction, or other severe events have occurred.

10. Reconstruction of site cover or other features because of extreme seismic events, extreme flooding, or other events.

AMENDMENT REFERENCES

AMEC, (2012). "Response to Interrogatory CAW R313-25-8(4)-16/3: Seismic Hazard Evaluation/Seismic Stability Analysis Update, EnergySolutions Clive Facility – Class A West Embankment, Clive, Tooele County, Utah." (Job No. 10-817-05290) AMEC Environmental & Infrastructure, Inc., 6 April 2012.

AMEC, (2011). "Geotechnical Update Report, Energy*Solutions* Clive Facility, Class A West Embankment" AMEC Environmental & Infrastructure, Inc. February 15, 2011.

DOE, (1989). Technical Approach Document, Revision II, UMTRA-DOE/Al 050425.0002, 1989.

DOE, (1986). "Guidance for UMTRA Project Surveillance and Maintenance, January 1986" (UMTRA-DOE/AL-350124.0000). January 1986.

Energy*Solutions,* (2019a). "GWQDP UGW450005 – Revised Hydrogeologic Report." Energy*Solutions* Report (submitted via CD19-0008), January 15, 2019.

Energy*Solutions*, (2019b). "Ground Water Quality Discharge Permit Condition I.H.6 – 2019 Annual As-Built Reports", (CD19-0235), November 27, 2019.

Energy*Solutions,* (2015). "Revision 7 of the 11e.(2) Renewal Application for UT2300478; Response to Round 2 Interrogatories." Energy*Solutions* Report (submitted vai CD15-0283), December 11, 2015.

Energy*Solutions*, (2013). "Radioactive Material License UT 2300249: Response to 2012 License Renewal Application Completeness Review (L-2012-178)." Letter (CD13-0066) from Vern Rogers of Energy*Solutions* to Rusty Lundberg, Utah Division of Radiation Control, 15 March 2013.

NRC, (2002). "NUREG-1623: Design of Erosion Protection for Long-Term Stabilization. Final Report." September, 2002.

NRC, (1986). "NUREG/CR-4620: Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments," June 1986.

Appendix C

Proposed 11e.(2) Material License

UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF WASTE MANAGEMENT AND RADIATION CONTROL
RADIOACTIVE MATERIAL LICENSE

Pursuant to the Utah Code Annotated (UCA), Title 19, Chapter 3 and R313 of the Utah Administrative Code 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		)		
		)	3.	License Number: UT 2300478 Amendment #3~~2~~
1.	Name EnergySolutions, LLC	)	**	
		)	4.	Expiration Date November 13, 2027
2.	Address 299 S. Main St., Suite 1700 Salt Lake City, UT 84111	)	**************************************	
		)	5.	License Category 2-c

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6.	Radioactive material (element and mass number)	7.	Chemical and/or physical form	8.	Maximum quantity Licensee may possess at any one time
	11e.(2) Byproduct Material		Packaged or Bulk Radioactive Waste		1,629,255 ~~5,048,965~~ Cubic Yards

****

SECTION 9.0. ADMINISTRATIVE CONDITIONS

9.1 All notices to the Division of Waste Management and Radiation Control required under this license shall be addressed to the Director of the Division of Waste Management and Radiation Control (Director), Department of Environmental Quality, 195 North 1950 West, P.O. Box 144880, Salt Lake City, UT 84114-4880.

9.2 Authorized place for use shall be the Licensee's facility located in Section 32 of Township 1 S, Range 11 W, Tooele County, Utah, near Clive.

9.3 Authorized use is for the receipt, storage and disposal of 11e.(2) byproduct material in accordance with statements, descriptions, and representations contained in the Licensee's application, including appendices.

9.4 In order to ensure that no disturbance of cultural resources occurs, the Licensee shall cease any work resulting in the discovery of previously unknown cultural or historical artifacts and report the discovery, in writing, to the Director and the State Historic Preservation Office (SHPO). The artifacts shall be inventoried and evaluated in accordance with UCA 9-8-404, and no disturbance shall occur until the Licensee has received written authorization from the Director and SHPO to proceed.

9.5 The Licensee shall:

a) Establish, implement and comply with standard operating procedures (SOPs) for all operational activities involving the handling, storing or disposal of radioactive materials. SOPs for operational activities shall enumerate pertinent radiation safety practices to be followed. In addition, SOPs shall be established and implemented for non-operational activities to include environmental monitoring, bioassay analysis and instrument calibration. An up-to-date copy of each written SOP, as controlled under the quality assurance (QA) procedures, shall be kept in each area where it is used.

b) Design, implement and comply with an effective air sampling program in the workplace based on Revision 1 to Nuclear Regulatory Commission (NRC) Regulatory Guide 8.25 (June 1992), "Air Sampling in the Workplace" or an equivalent program.

9.6 The Licensee shall have all written SOPs reviewed and approved by the Radiation Safety Officer (RSO), or designee, qualified by way of specialized radiation protection training equivalent to that required for the RSO as defined in License Condition 9.8, before being implemented and whenever a change in a procedure is proposed. All existing facility SOPs related to operational and non-operational activities shall be reviewed and documented by the RSO on an annual basis in the 11e.(2) Annual Report, to be submitted to the Director by April 30.

9.7 Any change to the Licensee's corporate organizational structure, as presented in the license application, affecting the assignment or reporting responsibility of the radiation staff shall conform to the NRC's Regulatory Guide 8.31, "Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Mills Will Be As Low As Is Reasonably Achievable" as amended.

9.8 The Licensee's staff shall meet the qualifications as described in the currently approved Organization Layout of Condition 32.A of Radioactive Material License UT 2300249. In addition to the responsibilities and qualifications specified in the Licensee's application, the RSO or designee shall be qualified as specified in Sections 1.2 and 2.4 of the NRC Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills will be As Low As Reasonably Achievable," as amended. In addition, the RSO shall also receive 40 hours of related health and safety refresher training every two years.

9.9 For the purposes of this License Condition, reference to "uranium mill" or "milling" in the NRC Regulatory Guide 8.31, as amended, shall mean the Licensee's facility and authorized activities.

9.10 The Licensee shall conduct:

a) Annual training for its facility inspectors that covers all areas included in the daily inspections of the 11e.(2) byproduct material and the disposal area.

b) Annual operational training that covers all aspects of operational safety and emergency procedures for all employees. The SOPs shall be used to conduct operations training to assure consistency and thoroughness.

9.11 The Licensee shall, at all times, maintain a Surety that satisfies the requirements of R313-24-4 (10 CFR 40, Appendix A, Criterion 9 and 10 incorporated by reference), as defined by License Condition 9.13 (a) or 9.13 (b) (or more frequent, at the Licensee's sole discretion) and shall include closure and post-closure costs in all areas subject to the portions of the facility herein licensed.

9.12 Annually, by March 1, the Licensee shall submit proposed closure and post-closure costs in a Surety Report, upon which financial assurance amounts are based, including costs of potential remediation at the licensed facility, as if accomplished by a third party contractor, for completion of a Director-approved reclamation/decommissioning plan of the Licensee's licensed grounds, equipment and facilities including above-ground decommissioning and decontamination, soil and water sample analyses and groundwater restoration associated with the site, as warranted.

9.13 At its election, the Licensee's annual proposed closure and post-closure costs shall be based on either:

a) a proposed 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 9.13A or others mutually agreed to by the Licensee and the Director; or

TABLE 9.13A

Description	Percentage
Working Conditions	5.5%
Mobilization / Demobilization	4.0%
Contingency	11.0%
Engineering and Redesign	2.25%
Overhead and Profit	19.0%
Management Fee and Legal Expenses	4.0%
DEQ Oversight	4.0%

b) an initial financial assurance determination and for each financial assurance determination every five years thereafter, a proposed competitive site-specific estimate for closure and post-closure care of the licensed facility shall be used; and for each year between this financial assurance determination, 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 shall be used.

9.14 The annual Surety Report shall be prepared under the direct supervision of and be certified by a professional with at least five years of construction cost estimation experience, who bears the seal of either a Professional Engineer or Professional Geologist currently licensed by the State of Utah. The Licensee shall provide the Surety Report in both paper and electronic formats. Within 60 days of the Director's approval of the Surety Report, the Licensee shall submit written evidence that the surety instruments have been adequately funded. The currently-approved Surety Report and instrument(s) shall be maintained as a Surety Appendix to the License.

9.15 The combined annual surety is $80,149,535.08 with the 11e.(2) subtotal of $10,870.016.43 as approved in the Director's letter dated October 11, 2019.

9.16 The Licensee shall require a radiation work permit (RWP) for work where the potential for significant exposure to radioactive materials exists and for which no SOP exists. Each RWP shall contain the information specified in Regulatory Guide 8.31, as amended.

9.17 The RSO, or designee, qualified by way of special radiation protection training equivalent to that required for the RSO as defined in License Condition 9.8, shall indicate by signature, the review and approval of each RWP, prior to the initiation of the work.

9.18 The Licensee shall provide SOPs for controlling internal contamination of workers from dust inhalation, which shall include the use of dust suppressants (e.g., magnesium chloride or water) on all operational roads, as necessary.

9.19 The Licensee shall have qualified individuals, designated by the RSO and Manager, Health and Safety, perform quantitative respirator fit tests on all employees required to wear respirators prior to the initial use of a respirator and annually thereafter. During the annual fit test, the qualified individual performing the test shall ensure that the employee is correctly performing negative pressure fit checks and shall instruct the employee that the fit test is to be performed each time a respirator is donned and prior to entering an area where respirators are required. The Licensee shall follow the guidance provided in the NRC Regulatory Guide 8.15 "Acceptable Programs for Respiratory Protection" as amended.

9.20 The Licensee shall complete "as built drawings" of the facility on an annual basis. The as built drawings shall be certified by a professional engineer.

9.21 The Licensee shall provide for an independent internal audit of facility operations to ensure compliance with applicable regulations and license conditions. The independent internal audit shall be conducted annually by a qualified health physicist knowledgeable of operations concerning radiation protection programs at milling/waste disposal facilities. The contractor report shall be submitted to the Director as part of the 11e.(2) Annual Report.

9.22 The operational environmental monitoring program shall be conducted in accordance with the current Environmental Monitoring Plan approved by the Director.

SECTION 10.0. OPERATIONAL CONTROLS, LIMITS AND RESTRICTIONS

10.1 The Licensee shall restrict eating and drinking to the administrative offices and enclosed lunch areas that are separated from the disposal areas. With the exception of drinking from closeable containers, there shall be no eating, drinking, smoking, defecating or urinating in the restricted areas at any time.

10.2 The Licensee shall analyze and adequately characterize all incoming waste to identify any new hazardous constituents not listed in the Waste Characterization Plan referenced in Condition 58 of Radioactive Material License UT 2300249. The Licensee shall develop, implement and comply with methodologies and procedures for systematic characterization and analysis of the incoming waste so that any new hazardous constituents are identified. The Licensee shall assume that the baseline background concentrations for any new constituents are at their detection levels, unless the Licensee demonstrates to the Director's satisfaction that the constituents will not reach the water table in one year and proceeds to establish background based on direct monitoring of these constituents in the Point of Compliance (POC) wells for one full year.

10.3 The following key radon attenuation model parameter values shall be used during placement to verify that the values used in the Licensee's model (see Licensee's correspondence to the NRC dated August 30, 2000 and to the DRC dated October 31, 2007) have been achieved: (1) dry density and (2) moisture content (percent by dry weight) of the placed compacted radon barrier material and the upper ten feet of 11e.(2) byproduct material. Average values for each parameter by lift, for the upper ten feet of the 11e.(2) embankment only, per year shall be calculated and submitted to the Director in the 11e.(2) Annual Report.

10.4 The distribution of the Ra-226 and Th-230 concentrations in the 11e.(2) byproduct material in the upper 3.3 meters (10 feet) of the contaminated material shall be used to verify that the concentration in any lift does not exceed the values used in the radon attenuation model. The Licensee shall measure the Ra-226 and Th-230 concentrations using standard analytical procedures for every 2500 cubic yards of material placed for compaction and at least once per lift for lifts smaller than 2500 cubic yards. This sampling may be performed from the waste container/conveyance at receipt or on the lift during waste placement. In the case where sampling will be performed from the waste container/conveyance, proper tracking shall be performed to accurately identify disposal location (or lift number). In the case where sampling will be performed at the disposal lift, each sample shall be a composite sample consisting of ten aliquots from random locations on the lift. The data shall include the elevation (or lift number) of the sample location. The results shall be presented as average values for each lift and submitted to the Director in the 11e.(2) Annual Report.

10.5 The Licensee shall assume full responsibility for remediation of any groundwater contamination caused by hazardous constituents originating from the 11e.(2) disposal facility that have been detected at the Point of Compliance (POC) wells in concentrations exceeding the limits specified in

Tables 1-C and 1-D of the Groundwater Discharge Quality Permit UGW450005. It shall be assumed that the 11e.(2) disposal facility is the source of all of the hazardous constituents detected in the POC wells, unless it can be demonstrated to the Director's satisfaction that the 11e.(2) facility is not the source of those constituents.

10.6 The Licensee shall undertake corrective action to clean up groundwater contamination if and when required, but no later than 18 months from the date when exceedance of a standard has first been discovered and without taking credit for any delays caused by disagreements as to the source of contamination. The Licensee shall consider and evaluate existing and new groundwater clean-up technologies before selecting and implementing an appropriate clean-up program.

10.7 The Licensee shall continue groundwater and land surface monitoring at all POC locations throughout the post closure period until the disposal facility is transferred to long-term government custody.

10.8 The Licensee shall implement the quality assurance plan as provided in the license application.

10.9 The Licensee shall, prior to managing waste for disposal, determine the presence of free liquids as described in Section IV of the Waste Characterization Plan referenced in Condition 58 of Radioactive Material License UT2300249. Solid waste received for disposal 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.

10.10 The Licensee shall not accept any waste containing free liquid for disposal. Solid waste received and containing unexpected aqueous free liquids in excess of 1% by volume shall have the liquid removed and placed in the evaporation ponds or the liquids shall be solidified prior to its management.

10.11 Unexpected non-aqueous free liquids less than 1% of the volume of the waste within the container shall be solidified prior to disposal.

10.12 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 shipments failed the requirements for acceptance and shall be managed in accordance with the Waste Characterization Plan as referenced in Condition 58 of Radioactive Materials License UT2300249.

10.13 The Licensee shall, upon arrival of waste, perform external exposure rate measurements of the waste conveyances. Any shipment with exposure rates greater than five mrem per hour at a distance of 30 cm from any surface and which cannot be disposed of within 24 hours, shall be posted as a Radiation Area in compliance with R313-15-901, R313-15-902 and R313-15-903 [10 CFR 20.1902(a) incorporated by reference] until disposed.

10.14 The Licensee shall operate the facility in compliance with the following specifications:

a) The maximum bulk mass of waste disposed of annually shall not exceed 4.536 x 10^5 tonnes (5 x 105 tons) or (3.82x 105 m^3) or (4.00 x 10^5 yd^3).

b) The open cell area shall not exceed 78,038.55 m^2, 93,333.33 yd^2, 840,000 ft^2 or 19.28 acres.

c) The total embankment capacity shall not exceed 1,245,655 m^3 (1,629,255 yd^3).

d) The maximum volume of waste that may be stored as in-cell bulk storage on site prior to disposal shall not exceed 10,000 yd^3 or (7,645.55 m^3) at any one time.

e) Waste with an average concentration above 4,000 pCi/g for natural uranium or for any radio nuclide in the radium-226 series; or above 60,000 pCi/g for thorium-230; or above 6,000 pCi/g for any radionuclide in the thorium series in any truckload or railcar shall not be accepted.

10.15 The Licensee shall maintain the detailed documents demonstrating compliance with the specifications in License Condition 10.16 on-site and shall summarize the data in Condition 10.17 and Condition 10.18. This information shall be submitted to the Director in the 11e.(2) Annual Report.

10.16 The minimum compacted radon barrier thickness placed in accordance with the specifications authorized in the LLRW and 11e.(2) Construction Quality Assurance / Quality Control Manual, as revised (CQA/QC Manual) shall be 4.0 ft. on the top and 3.5 ft. on the side of the disposal cell. CLSM shall not be used in the upper ten feet of the 11e.(2) embankment.

10.17 At the end of every calendar year, the Licensee shall ensure that the cumulative average activity concentration of waste placed within the upper three feet of disposed waste does not exceed 300 pCi/g of Ra 226 or 900 pCi/g of Th 230, and within the next seven feet does not exceed 500 pCi/g Ra 226 or 1500 pCi/g of Th 230. When both radionuclides are present, the unity rule defined below shall apply to ensure that the Ra-226 limit is not exceeded within 1000 years.

Activity of Th 230 (pCi/g)/X + Activity of Ra 226 (pCi)/Y < or = 1

Where:

X = 900 pCi/g in the upper three feet and 1500 pCi/g in the next seven feet of waste, and

Y = 300 pCi/g in the upper three feet and 500 pCi/gm in the next seven feet of waste

10.18 The cumulative average densities of the waste in the upper ten feet of the 11e(2) embankment and of the compacted radon barrier placed shall not be less than 1.5 g/cm^3 for either.

SECTION 11. INSPECTION, MONITORING AND RECORDING REQUIREMENTS

11.1 The Licensee shall fulfill and comply with all conditions and all compliance schedules stipulated in the Ground Water Discharge Permit, number UGW 450005, issued by the Director, as amended.

11.2 The Licensee shall require that the RSO and the Engineering Director or designee perform and document joint inspections of all work areas at least quarterly. The Licensee shall correct any deficiency noted during the inspection within seven working days. The results of the inspections and any necessary corrective actions shall be submitted to the Director in the 11e.(2) Annual Report.

11.3 The Licensee is granted an exemption from R313-15-201(4) and R313-15-302(2) and is authorized to use Annual Limit on Intake (ALI) and Derived Air Concentration (DAC) values based on dose coefficients adopted by the International Commission on Radiological Protection (ICRP) and published in ICRP publication No. 68 and adult dose factors published in ICRP publication No. 72, as required to demonstrate compliance with the requirements of Subpart C and Subpart D of 10 CFR 20 (UAC R313-15).

11.4 The Licensee shall conduct an analysis to assess the need to characterize the basal aquifer.

SECTION 12. REPORTING REQUIREMENTS

12.1 The Licensee shall perform an annual ALARA audit of the radiation safety program which shall be led by the RSO or designee, qualified by way of specialized radiation protection training equivalent to that required for the RSO as defined in License Condition 9.8, in accordance with Section 2.3.3 of NRC Regulatory Guide 8.31, as amended. A report of this audit shall be submitted to the Director in the 11e.(2) Annual Report. The report shall include detailed summaries of the analytical results of the radiological surveys. In order to evaluate the ALARA objective, the Licensee shall, at a minimum, review the following records:

a) Bioassay results including any actions taken when the results exceed established action levels as referenced in the NRC Regulatory Guide 8.9, "Acceptable Concepts, Models, Equations, and Assumptions For A Bioassay Program" as amended.

b) Records of external and internal exposure.

c) Safety meeting minutes, attendance records, and training program records.

d) Daily inspection log entries and summary reports of the annual review.

e) Radiological survey and monitoring data, as well as environmental radiological effluent and monitoring data.

f) Surveys required by radiation work permits.

g) Reports on overexposure submitted to the Director and previously submitted to the NRC.

h) Reviews of operating and monitoring procedures completed during the period.

12.2 The ALARA audit shall also address any statistically significant trends in personnel exposures for identifiable categories of workers and types of activities, any trends in radiological effluent data and the performance of exposure and effluent control equipment as well as its utilization, maintenance and inspection history. Any recommendations to further reduce personnel exposures or environmental releases of uranium or radon and radon progeny shall be included in the report.

12.3 The Licensee shall conduct an annual land use survey for a five km radius around the site. The purpose is to assess population growth or industry growth in the immediate vicinity of the Clive facility and provide an inventory of domestic and agricultural wells within the survey area. The Licensee shall document this survey in the 11e.(2) Annual Report submitted to the Director.

12.4 The Licensee shall orally notify the Director within 24 hours and by submitting a letter within seven days of any waste shipment where a violation of applicable regulations or license conditions occurs. For example:

a) Free liquids and leaking shipment discrepancy notifications made in accordance with applicable provisions of the Waste Characterization Plan as referenced in Condition 58 of Radioactive Materials License UT2300249.

12.5 Shipment discrepancies not addressed by the Waste Characterization Plan shall be noted on the manifest and the manifest retained on site for Division review.

12.6 The Licensee shall, unless otherwise specified, include in 11e.(2) the Annual Report submitted to the Director:

a) The annual reporting requirements as specified in the license conditions;

b) The results of calibration of equipment;

c) Reports on audits and inspections completed during the year;

d) The results of all meetings and training courses required by this license; and

e) Any other significant subsequent information, reviews, investigations and corrective actions. Unless otherwise specified by rule, all such documentation shall be maintained at the site and corporate headquarters for a period of at least five years.

12.7 The Licensee shall, at least three months prior to license termination, submit to the Director a report which demonstrates the site has met all applicable provisions for license termination and transfer of the facility to the government for long-term custody in accordance with R313-24-4 (10 CFR Part 40, Appendix A, Criterion 11 incorporated by reference). Specifically, the Licensee shall document that:

a) The concentrations of all of the listed hazardous constituents at the POC are within their designated concentration limits (standards);

b) If a corrective action program was implemented, that the hazardous constituents contaminating the groundwater were returned to their designated limits; and

c) The facility has been properly decontaminated and decommissioned in accordance with the decontamination and decommissioning plan proposed by the applicant in the license application and approved by the Director. The license termination shall not occur until the Licensee has demonstrated that these actions have been completed.

12.8 The Licensee shall immediately report to the Director:

a) Any failure of the 11e.(2) byproduct material disposal cell that results in a release of waste into unrestricted areas; or

b) Any unusual conditions that, if not corrected, could indicate the potential or lead to the failure of the system and result in a release of waste into an unrestricted area.

DIVISION OF WASTE MANAGEMENT AND RADIATION CONTROL

______________________________	______________________________
Ty L. Howard, Director	Date

Appendix L

Revised Drainage Ditch Calculations

PERIMETER DITCH CALCULATIONS FOR THE 11e.(2) EMBANKMENT

The following calculations are performed to justify the perimeter ditch design proposed in drawing set 20001; specific design information is provided in Engineering Drawings 20001-C03 and 20001-C05.

1.0 Perimeter Ditch Flow Capacity Evaluation

The drainage area contained by the 11e.(2) embankment perimeter drainage ditch includes the landfill embankment, the ditch itself, and the perimeter inspection road surrounding the facility. Engineering Drawing 20001-C03 provides centerline drainage ditch locations and elevations around the 11e.(2) landfill embankment. From Engineering Drawing 20001-C03, the following ditch centerline distances may be estimated:

North Side = South Side = 971 feet
East Side = West Side = 1,860 feet

From these dimensions, an estimate of the total drainage area is calculated:

Drainage Area = (971 ft)(1,860 ft) = 1,806,060 ft^2

From the ditch lengths and centerline elevations in Drawing 20001-C03, the following ditch slopes are determined:

North Side = 971 feet in length with an elevation change of 0.46 feet; this yields a slope of (0.46 ft / 971 ft) = 4.74×10^{-4} ft/ft

South Side = 970 feet in length with an elevation change of 0.46 feet; this yields a slope of (0.46 ft / 970 ft) = 4.74×10^{-4} ft/ft

East Side = 1,859 feet in length with an elevation change of 0.9 feet; this yields a slope of (0.9 ft / 1,859 ft) = 4.84×10^{-4} ft/ft

West Side = 1,859 feet in length with an elevation change of 0.9 feet; this yields a slope of (0.9 ft / 1,859 ft) = 4.84×10^{-4} ft/ft

As marked, the south side slope present the least amount of slope and are therefore the limiting slopes for the analysis.

Based on the ditch slopes and factoring in a triangular geometry for the ditch shape, Manning's Formula can be used to determine the maximum flow rate for each side of the cell. The ditch depth is 4 feet with a total ditch width of 40 feet, a ditch side-slope ratio of 1V:5H is produced.

Manning's Formula is:

$$Q = \frac{1.486}{n} AR^{2/3} S^{1/2}. \tag{1}$$

where,

Q = Flow in ft^3/sec;
A = Cross sectional area of flow in ft^2;
R = The hydraulic radius, the area of flow divided by the wetted perimeter, in feet; and,
S = Slope in ft/ft.
n = Manning's coefficient of roughness, calculated as:

$$n = 0.0456\left(D_{50} S\right)^{0.159}. \tag{2}$$

D_{50} is equal to 4.5 inches for the rock in the ditch.
$n_{(east)}$ = 0.017208;
$n_{(west)}$ = 0.017208;
$n_{(north)}$ = 0.017150;
$n_{(south)}$ = 0.017152;

The cross sectional area of the ditch is determined by multiplying the height of the ditch squared by 5, and the wetted perimeter is determined by multiplying two times the height of the water in the ditch by the square root of one plus five squared; or:

$$\text{WP} = 2h\sqrt{1+5^2}. \tag{3}$$

The Manning calculations for flow around the embankment perimeter yields the following tables:

Table 1 - East Side Ditch (S = 0.000484 ft/ft)

Height of Water in Ditch (feet)	Flow Cross-Section Area in Ditch (ft^2)	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Flow Rate (ft^3/sec)	Flow Rate (ft^3/min)
0.5	1.25	5.1	0.25	0.93	55.82
1.0	5.00	10.2	0.49	5.91	354.41
1.5	11.25	15.3	0.74	17.42	1,044.91
2.0	20.00	20.4	0.98	37.51	2,250.34
2.5	31.25	25.5	1.23	68.00	4,080.13
3.0	45.00	30.6	1.47	110.58	6,634.75
3.5	61.25	35.7	1.72	166.80	10,008.04
4.0	80.00	40.8	1.96	238.15	14,288.75

Table 2 - West Side Ditch (S = 0.000484 ft/ft)

Height of Water in Ditch (feet)	Flow Cross-Section Area in Ditch (ft^2)	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Flow Rate (ft^3/sec)	Flow Rate (ft^3/min)
0.5	1.25	5.1	0.25	0.93	55.82
1.0	5.00	10.2	0.49	5.91	354.41
1.5	11.25	15.3	0.74	17.42	1,044.90
2.0	20.00	20.4	0.98	37.51	2,250.33
2.5	31.25	25.5	1.23	68.00	4,080.12
3.0	45.00	30.6	1.47	110.58	6,634.73
3.5	61.25	35.7	1.72	166.80	10,008.02
4.0	80.00	40.8	1.96	238.15	14,288.72

Table 3 - North Side Ditch (S = 0.000474 ft/ft)

Height of Water in Ditch (feet)	Flow Cross-Section Area in Ditch (ft^2)	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Flow Rate (ft^3/sec)	Flow Rate (ft^3/min)
0.5	1.25	5.1	0.25	0.92	55.42
1.0	5.00	10.2	0.49	5.86	351.87
1.5	11.25	15.3	0.74	17.29	1,037.42
2.0	20.00	20.4	0.98	37.24	2,234.22
2.5	31.25	25.5	1.23	67.52	4,050.91
3.0	45.00	30.6	1.47	109.79	6,587.22
3.5	61.25	35.7	1.72	165.61	9,936.35
4.0	80.00	40.8	1.96	236.44	14,186.40

Table 4 - South Side Ditch (S = 0.000474 ft/ft)

Height of Water in Ditch (feet)	Flow Cross-Section Area in Ditch (ft^2)	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Flow Rate (ft^3/sec)	Flow Rate (ft^3/min)
0.5	1.25	5.1	0.25	0.92	55.43
1.0	5.00	10.2	0.49	5.87	351.93
1.5	11.25	15.3	0.74	17.29	1,037.62
2.0	20.00	20.4	0.98	37.24	2,234.63
2.5	31.25	25.5	1.23	67.53	4,051.66
3.0	45.00	30.6	1.47	109.81	6,588.45
3.5	61.25	35.7	1.72	165.64	9,938.20
4.0	80.00	40.8	1.96	236.48	14,189.04

The calculations in Tables 1 through 4 show the amount of runoff that can be successfully collected in each section of the 11e.(2) embankment perimeter drainage ditch system.

2.0 Erosion Evaluation

The geotechnical literature (NUREG/CR-4620, "Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments") indicates that an acceptable velocity of water traveling over a compacted clay surface without significant erosion is no greater than 3 ft/sec. Water velocity may be calculated using the simple equation:

$$v = \frac{Q}{A}. \tag{4}$$

In order to calculate the interstitial velocities associated with the ditch flow, the dimensions of the rock inside the ditch is required. Engineering Drawing 20001-C03 notes that the perimeter ditch is lined with Type A rock which has a D_{15} of 2 to 4 inches. A conservative value of 4 inches (yielding the fastest water velocity) is selected for the following equation to calculate the interstitial velocity:

$$v_f = \frac{1.4Ki}{n}. \tag{5}$$

where,

K is the coefficient of permeability = $0.35(D_{15})^2$ = 5.6 in/sec = 0.467 ft/sec
i is the slope
n is the porosity = 0.33
tortuosity factor = 1.4.

The tortuosity factor describes the extra length that a flow must travel to eventually reach the outflow area. This is calculated as the length of actual flow (L_c) to the total length of the porous media (L). Typical ranges for this factor can be calculated from ranges provided by Bear ("Dynamics of Fluids in Porous Media," Dover Publications, Inc., 1972) for a similar tortuosity factor. The typical range provided by Bear converts to a range of 1.12 – 1.34 for the tortuosity factor used in this equation. Therefore, a tortuosity factor of 1.4 is conservatively selected.

Water velocities and interstitial velocities are calculated for a conservative maximum potential centerline height of 4 feet of water in each drainage ditch. The calculated velocities are presented in Table 5, which demonstrate all velocities are well below 3 ft/sec.

Table 5 - Water Velocities

Location	**Area (ft^2)**	**Flow Rate (ft^3/sec)**	**Water Velocity (ft/sec)**	**Interstitial Velocity (ft/sec)**
North	80	236.44	2.96	9.38×10^{-4}
South	80	236.48	2.96	9.39×10^{-4}
East	80	238.15	2.98	9.58×10^{-4}
West	80	238.15	2.98	9.58×10^{-4}

3.0 Storm Events

The performance of the drainage ditches to contain runoff is only important for the active life of the facility (estimated as 25 years). Upon closure, the drainage ditches will be removed or eventually become silted in to allow sheet flow across the site over the natural grade of the area. Therefore, a reasonable maximum storm event over the active life of the facility is the 25-year, 24-hour storm event (1.9 inches). A reasonable potential worst-case event during the active life of the facility is the 100-year, 24-hour storm event (2.4 inches). Both of these storm events are depicted in the isopluvial maps of the National Oceanic and Atmospheric Administration (NOAA) Atlas 2, Volume VI (1973).

The rainfall amount at one hour during the 100 and 25-year events is calculated using the equations provided in NOAA, Atlas 2. For the Clive region , the equation is:

$$1-hr = 0.322 + 0.789\left[(6-hour)\left(\frac{6-hour}{24-hour}\right)\right]. \tag{6}$$

Where the (6-hr) and (24-hr) are the precipitation amounts displayed on the isopluvial maps.

Empirical equations are developed for the 15-min, 30-min, 2-hour and 3-hour events, based upon the 1-hour and 6-hour events:

15-min = 0.57 x (1-hr). (7)

30-min = 0.79 x (1-hr). (8)

2-hr = 0.299 x (6-hour) + 0.701 x (1-hr). (9)

3-hr = 0.526 x (6-hour) + 0.474 x (1-hr). (10)

As is described in the NOAA text, the 12-hour distribution is estimated using graphical methods, based upon the 6-hour and 24-hour events. Using the equations and methods described above, the following storm distributions is estimated for the design storm events.

Table 6 - Storm Distributions

Time (min)	Maximum Normal Event (inches)	Potential Worst Case Event (inches)
15	0.65	0.73
30	0.9	1.00
60	1.14	1.27
120	1.21	1.40
180	1.27	1.50
360	1.4	1.70
720	1.65	2.05
1,440	1.9	2.40

Over the short active life span of the drainage ditches, it is unreasonable to assume larger storm events such as the Probable Maximum Precipitation (PMP). These larger storm events are more appropriately utilized in the longer life elements of the embankment design such as the rock cover over the embankment.

4.0 Drainage Calculations

Drainage calculations for the 11e.(2) embankment ditch system are determined from a mass balance over the system itself, where

(flow in) – (flow out) = Accumulated water (required storage space)

The total accumulated flow into the system is calculated by multiplying the accumulated rainfall by the weighted total drainage area. The calculated drainage area is equal to 1,806,060 ft^2. The run-off coefficient is equal to 0.5 (for earth with stone surface). Therefore, the total weighted drainage area is equal to (1,806,060 ft^2)(0.5) = 903,030 ft^2.

Flow out of the system is calculated by multiplying the flow rate at specific depths (as presented in Tables 1 through 4) by the elapsed time of rainfall. The volume of the ditch at a specific depth is calculated by multiplying the cross-sectional flow area in the ditch at a given depth by the length of the ditch. The volume associated with a given depth is compared to the required storage volume calculated by subtracting the available discharge from the accumulated flow into the system. The volume associated with a given depth is equated the required storage volume by iterating over the depth of water in the ditch to estimate a maximum flow within the ditch for a particular storm event.

The total length of the drainage ditch, calculated from the ditch centerline coordinates provided in Engineering Drawing 20001-C03 is approximately 5,662 ft. The cross-sectional flow areas of the ditch varies with depth (as shown in Tables 1 through 4). Conservatively assuming that the discharge rate from the perimeter berm is dependent on the least sloped ditch (south side ditch = 4.74 x 10^{-4} ft/ft). Using the maximum normal storm event described in Table 6, an iterative method is used to equate the required storage with the available storage volume at a specific water depth. Using the lowest ditch slope (4.74x10^{-4} ft/ft), the discharge flow rate and volume of required ditch storage is calculated.

Table 7 - Drainage Flows and Storage for the Maximum Normal Storm Event

Rainfall Duration (min)	Rainfall Depth (in)	Flow Into Ditch System (ft^3)	Flow Out of Ditch System (ft^3)	Required Storage (ft^3)
15	0.65	48,914	10,377	38,537
30	0.9	67,727	20,754	46,974
60	1.14	85,788	41,507	44,281
120	1.21	91,056	83,015	8,041
180	1.27	95,571	124,522	0
360	1.4	105,354	249,044	0
720	1.65	124,167	498,088	0
1440	1.9	142,980	996,175	0

5.0 Conclusions

During the maximum normal precipitation event, the greatest volume retained in storage within the 11e.(2) Landfill Embankment drainage ditch system is approximately 46,974 ft^3. This occurs approximately 30 minutes into the event and decreases over the next couple of hours. This volume equates to a depth of water within the ditch of approximately 1.29 feet, which is well within the four-foot perimeter ditch height specifications. Therefore the 11e.(2) ditch design adequately contains the maximum normal precipitation event. Similarly, Table 8 reports the discharge and water perimeter elevations for the worst-case storm event.

Table 8 - Drainage Flows and Storage for the Worst Case Storm Event

Rainfall Duration (min)	Rainfall Depth (in)	Flow Into Ditch System (ft^3)	Flow Out of Ditch System (ft^3)	Required Storage (ft^3)
15	0.73	54,934	11,786	43,148
30	1.0	75,253	23,572	51,681
60	1.27	95,571	47,144	48,427
120	1.4	105,354	95,571	11,066
180	1.5	112,879	141,431	0
360	1.7	127,929	282,862	0
720	2.05	154,268	565,725	0
1440	2.4	180,606	1,131,449	0

During the potential worst-case scenario, the maximum volume retained in storage within the 11e.(2) ditch system is approximately 51,681 ft^3, occurring roughly 30 minutes into the event and decreasing over the couple of next hours. This volume equates to a water height within the ditch slightly higher than 1.35 feet (well within the four-foot design height of the ditches). It is therefore concluded that the 11e.(2) embankment is capable of adequately containing the worst-case storm precipitation event.

6.0 Peak Run-Off Rate for Small Watersheds

The maximum length for the travel of water to the discharge point is down the sloped corner of the 11e.(2) embankment, from the crest to the northeast corner of the drainage ditch, then west down the northern drainage ditch and finally south toward the discharge point in the southwest corner. Engineering Drawing 20001-C03 illustrates this travel distance at approximately distance down the corner slope from the crest to the shoulder at roughly 784 feet with a slope of 16.71 / 784 = 0.021 ft/ft. From that point, the distance down the corner slope from the shoulder to the northeast corner is approximately 272 feet with a slope of 25.5 / 272 = 0.094 ft/ft. Flow across the northern drainage ditch is approximately 971 feet with a slope of 0.000474 ft/ft. Flow across the western drainage ditch is approximately 1,860 feet with a slope of 0.000484 ft/ft.

Rainfall intensity (i) is estimated by determining the time of concentration, T_c, or time required for water to travel from the most distant location in the watershed to the watershed discharge point. The formula for determining T_c is:

$$T_c = 0.00013L^{0.77}S^{-0.385} \qquad (11)$$

The cumulative T_c over the path length of water travel, yields the following:

Table 9 - Travel Time

Path Length (ft)	Slope (ft/ft)	T_c (hr)
784	0.021	0.097
272	0.094	0.024
971	0.000474	0.494
1860	0.000484	0.809
	Cummulative	**1.424**

Therefore, the total time required for water to travel the farthest distance within the watershed is roughly one hour and twenty-five minutes.

As it is a boundary condition, only the estimate of peak runoff flow rates during the potential worst-case condition is necessary. If the flow rates for the worst-case scenario are within tolerance, then the normal conditions will also be within tolerance. From Table 6, the most applicable storm intensity data for the above abnormal event is 1.27 inches over a one-hour time period. This equates to a rainfall intensity (i) of 1.76×10^{-3} feet/minute. Using this intensity, the drainage area and runoff coefficient values herein described, the estimated peak runoff during the abnormal event is:

$$Q = CiA = (0.5)(1.76 \times 10^{-3} \text{ ft/min})(1{,}806{,}060 \text{ ft}^2) = 1{,}589.3 \text{ ft}^3/\text{min} \qquad (12)$$

This value is less than the lowest design flow rates for the 2.5-foot deep ditch described in Tables 1 through 4 (ranging between 4,051 ft^3/min and 4,080 ft^3/min).

Using the calculations of Tables 1 through 4 as maximum flow, this calculated flow results in depths of approximately 1.76 feet in all of the ditches (all allowing a freeboard of more than 2 feet). Therefore, the 11e.(2) Embankment ditches are sufficiently designed to contain the peak runoff flow from the potential worst case (and subsequently normal) storm events.

Calculations were performed by Vern C. Rogers and reviewed by Timothy L. Orton, P.E.

Reviewed by:

____
Timothy L. Orton, P.E.
Environmental Engineer and Manager

References

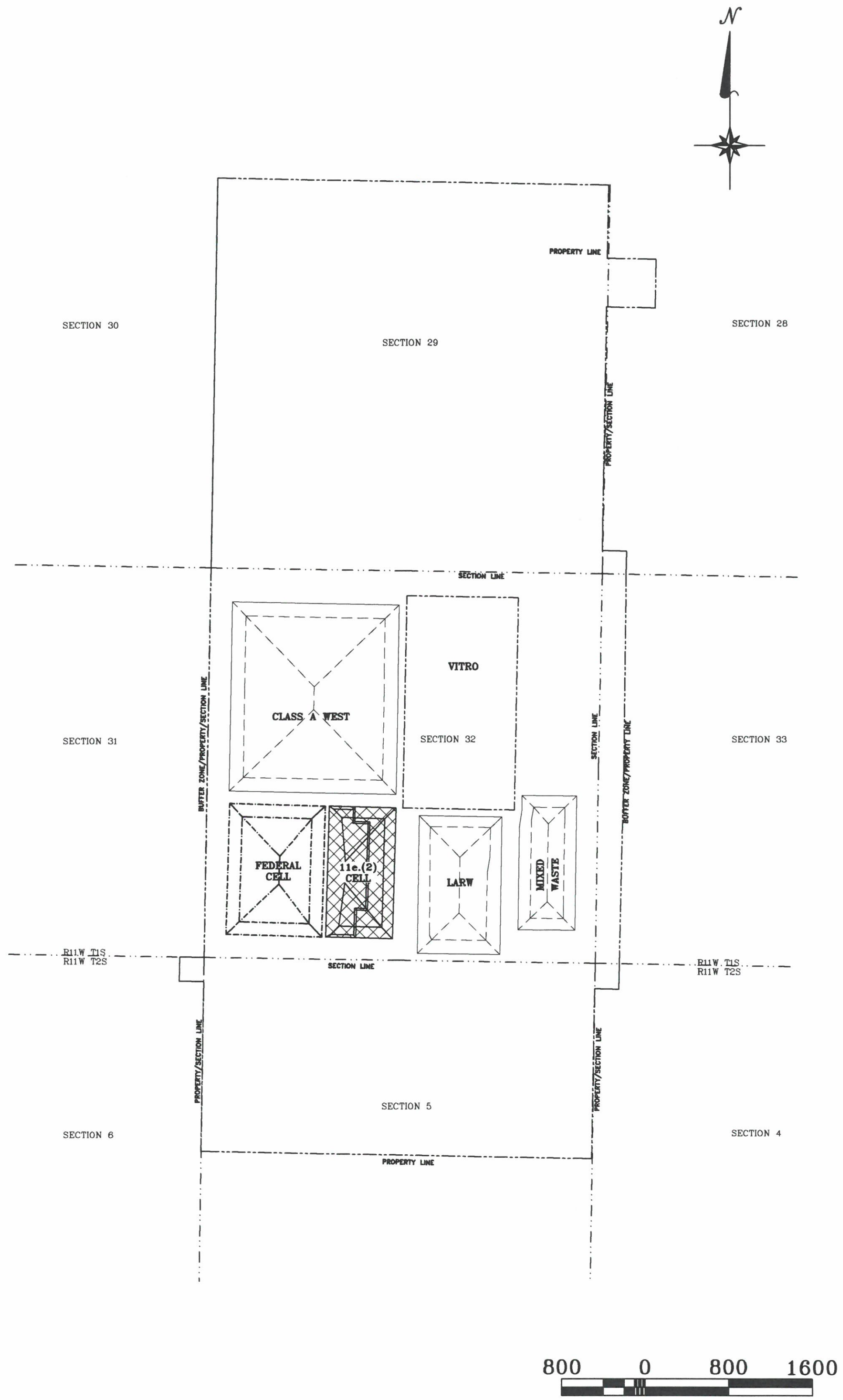
Bear. J, (1972). Dynamics of Fluids in Porous Media, Dover Publications, Inc., 1972

NOAA, (2012). "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.

NRC, (1986). "NUREG/CR-4620: Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments," June 1986.

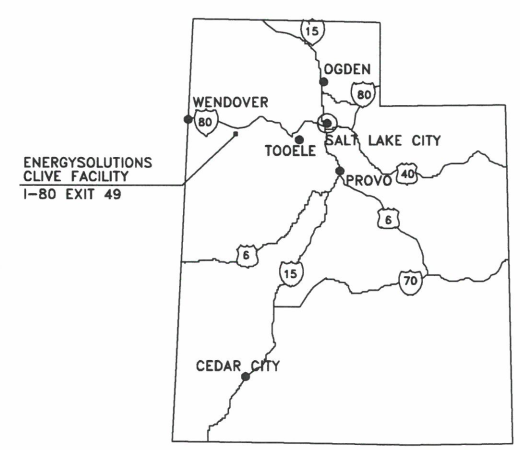
Appendix M

Revised Engineering Drawing Set



11e.(2) DISPOSAL CELL

DWG. NO.	DESCRIPTION
20001–G01	PROJECT TITLE SHEET
20001–C01	REVISED CELL GENERAL PLAN
20001–C02	CELL CROSS SECTIONS, 1 OF 2
20001–C03	REVISED CELL FEATURES AND CONTROLS
20001–C04	CELL CROSS SECTIONS, 2 OF 2
20001–C05	CELL CONSTRUCTION DETAILS, 1 OF 2
20001–C06	CELL CONSTRUCTION DETAILS, 2 OF 2
20001–U01	DISPOSAL CELL BUFFER ZONE
20001–U02	DISPOSAL CELL WASTE LIMITS–LATITUDES & LONGITUDES



UTAH VICINITY MAP

LICENSED PROFESSIONAL ENGINEER
No. 189500
DAVID F BOOTH
STATE OF UTAH
10/5/2020

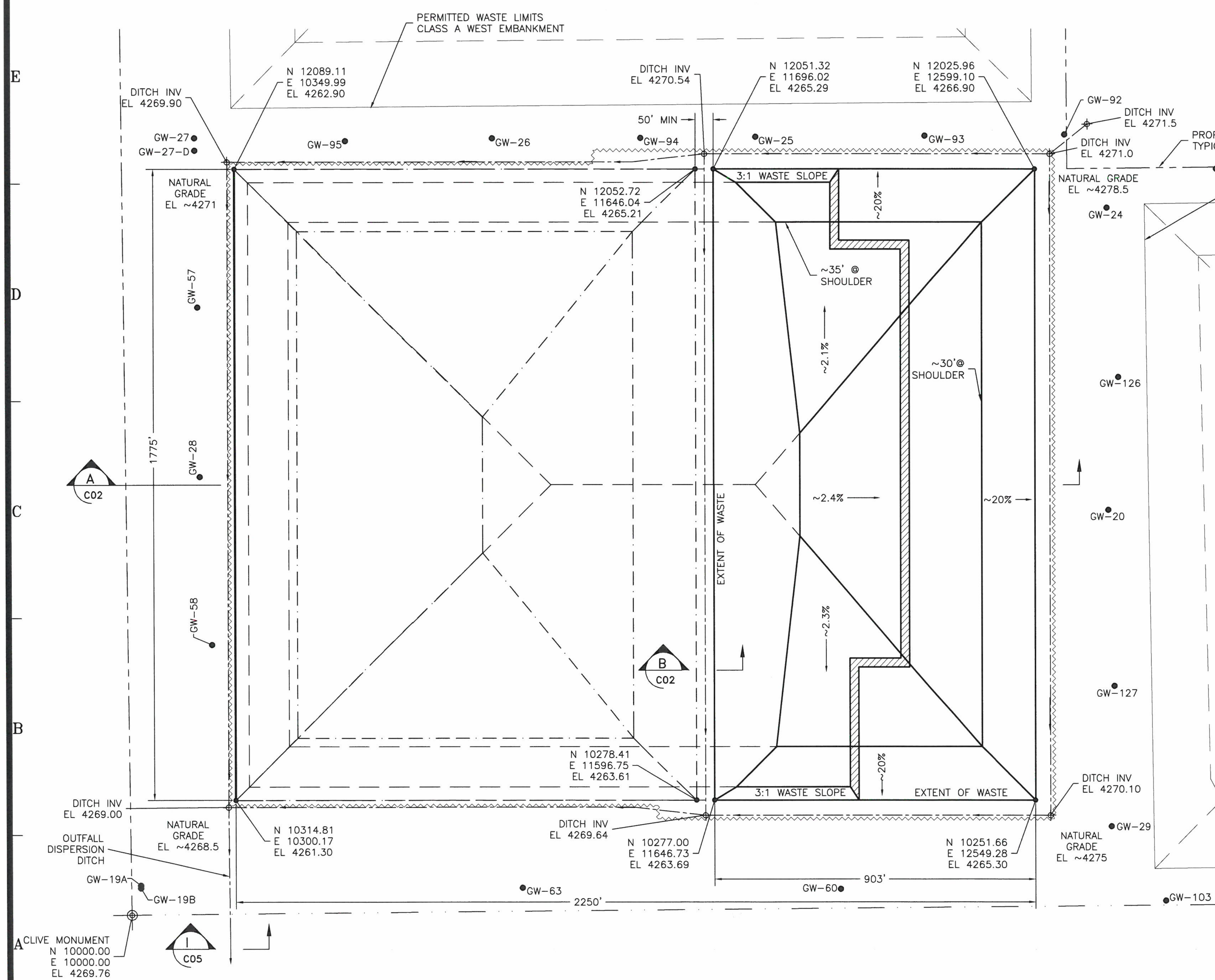
△	10/5/20	DFB	FOR LICENSE AMMENDMENT
	DATE	BY	DESCRIPTION OF CHANGE

ENERGYSOLUTIONS

CLIVE FACILITY
11e.(2) DISPOSAL CELL
PROJECT TITLE SHEET
CLIVE, UTAH

FINAL DRAWING

DRAWN BY D. BOOTH
REVIEWED BY T. ORTON
APPROVED BY D. BOOTH
SCALE AS NOTED
DATE 09/23/20
REV. △
DRAWING NO. 20001 G01



LEGEND

- SECTION LINE
- PROPERTY LINE
- REVISED 11e.(2) CELL BREAK LINES
- ORIGINAL 11e.(2) CELL BREAK LINES
- PROPOSED FEDERAL CELL BREAK LINES
- LINER LIMITS (MINIMUM)
- DRAINAGE DITCH CENTERLINE
- COVER TRANSITION ZONE (CLAY WEDGE)

150 0 150 300

NOTES

1. ALL ELEVATIONS SHOWN ARE FOR TOP OF LINER UNLESS OTHERWISE NOTED.
2. COORDINATES ARE BASED ON THE CLIVE MONUMENT.
3. THE CALCULATED VOLUME OF THE REVISED 11e.(2) EMBANKMENT IS 1,629,255 YD³.
4. REFER TO THE LLRW AND 11e.(2) CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL (CQA/QC) MANUAL FOR MATERIAL AND CONSTRUCTION SPECIFICATIONS.

LICENSED PROFESSIONAL ENGINEER
No. 189500
DAVID F BOOTH
STATE OF UTAH
10/19/2020

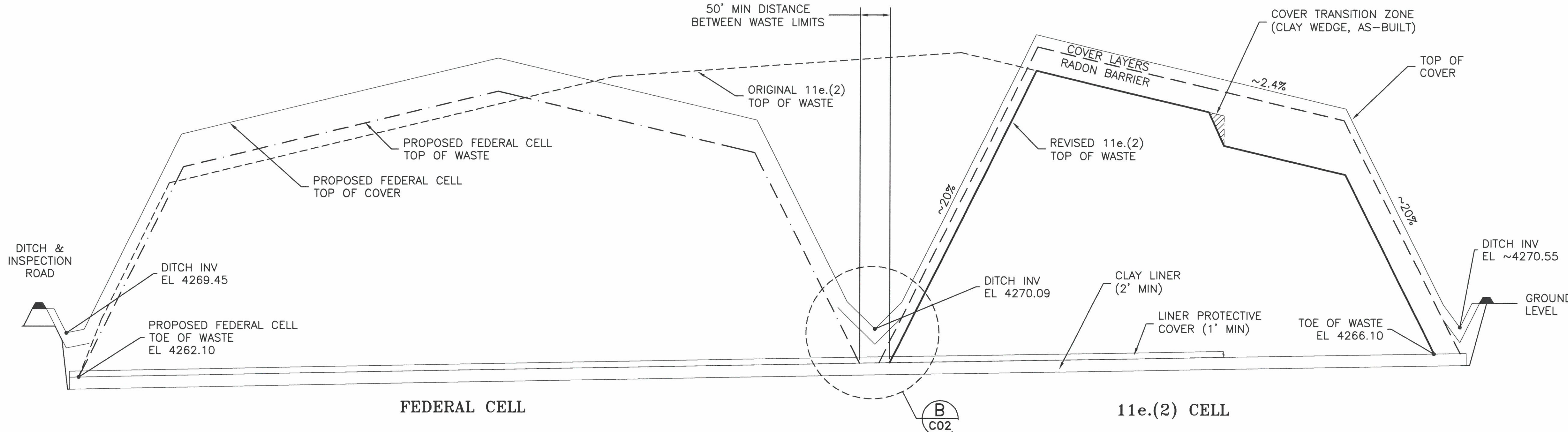
	DATE	BY	DESCRIPTION OF CHANGE
1	10/19/20	DFB	FOR LICENSE AMENDMENT

ENERGYSOLUTIONS

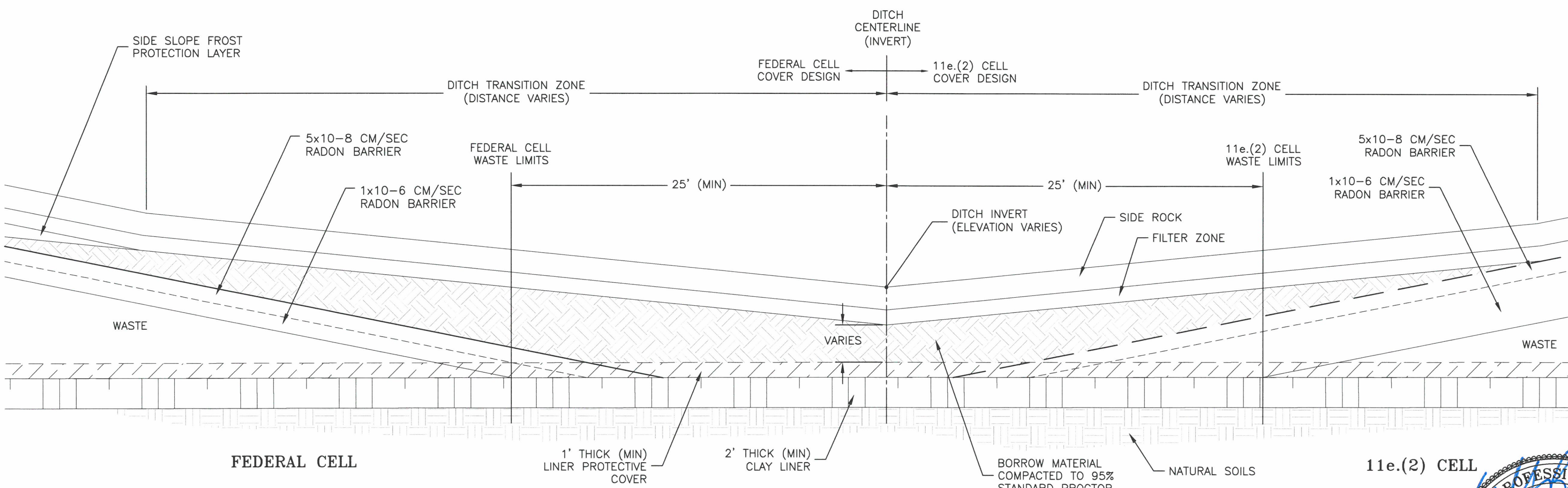
CLIVE FACILITY
11e.(2) DISPOSAL CELL
REVISED CELL GENERAL PLAN
CLIVE, UTAH

FINAL DRAWING

DRAWN BY: D. BOOTH
REVIEWED BY: T. ORTON
APPROVED BY: D. BOOTH
SCALE: AS NOTED
DATE: 09/04/20
REV: 1
DRAWING NO. 20001 C01



A
C01
WEST-EAST CROSS SECTION
HORIZONATAL SCALE: 1" =200'
VERTICAL SCALE: 1" = 20'



B
C01,C02
DITCH BETWEEN CELLS - DETAIL
SCALE: 1" =8'

LICENSED PROFESSIONAL ENGINEER
No. 189500
DAVID F BOOTH
10/5/2020
STATE OF UTAH

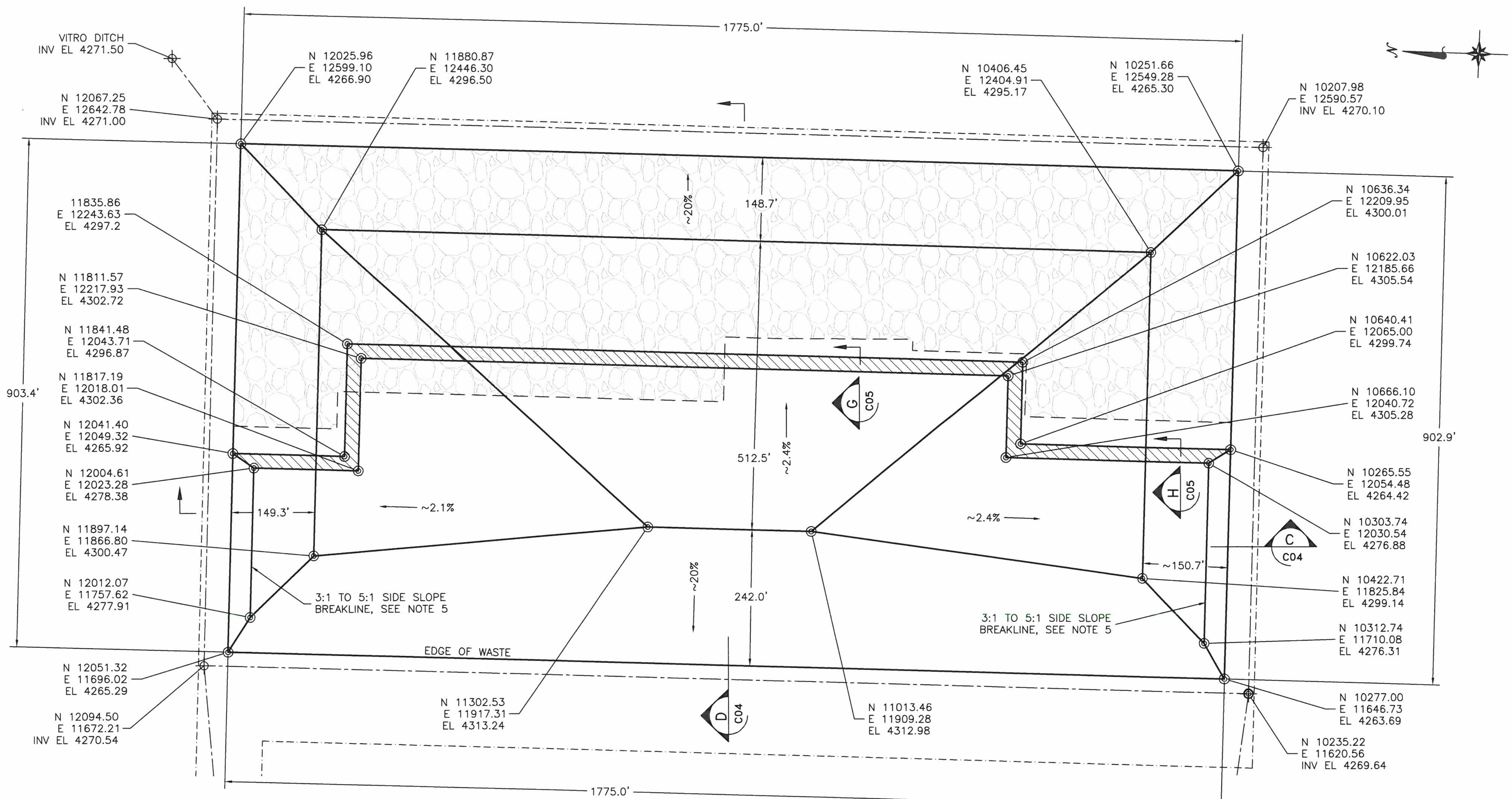
1	10/5/20	DFB	FOR LICENSE AMENDMENT
	DATE	BY	DESCRIPTION OF CHANGE

ENERGYSOLUTIONS

CLIVE FACILITY
11e.(2) DISPOSAL CELL
CELL CROSS SECTIONS, 1 OF 2
CLIVE, UTAH

FINAL DRAWING

DRAFTED BY D. BOOTH
REVIEWED BY T. ORTON
APPROVED BY D. BOOTH
SCALE AS NOTED | DATE 09/11/20 | REV. 1
DRAWING NO. 20001 C02



LEGEND

- REVISED ECELL BREAK LINES
- COMPLETED LINER LIMITS (AS-BUILT)
- DRAINAGE DITCH CENTERLINE
- COVER TRANSITION ZONE, CLAY WEDGE (AS-BUILT, REFER TO NOTE 6)
- WASTE FOOTPRINT WITH FINAL COVER (AS-BUILT)

100 0 100 200

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 REVISED 11e.(2) EMBANKMENT IS 1,629,255 YD³.
4. REFER TO THE LLRW AND 11e.(2) CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL (CQA/QC) MANUAL FOR MATERIAL AND CONSTRUCTION SPECIFICATIONS.
5. THE COVER DESIGN CHANGE REDUCED THE RADON BARRIER THICKNESS BY 5 FT WHILE MAINTAINING THE ORIGINAL TOP OF COVER LIMITS. THE 5 FEET OF RADON BARRIER IS "REPLACED" WITH WASTE AND TEMPORARY COVER. TO MAINTAIN THE ORIGINAL WASTE FOOTPRINT, WASTE ALONG THE BOTTOM OF NORTH AND SOUTH SIDE SLOPES IS PLACED AT A 3:1 SLOPE UNTIL IT INTERCEPTS THE BOTTOM OF RADON BARRIER SURFACE. THAT INTERCEPT OCCURS AT ROUGHLY 37.5 FT IN FROM THE TOE OF WASTE.
6. THE CLAY WEDGE AND THE RADON BARRIER THE EAST OF THE CLAY WEDGE HAVE BEEN CONSTRUCTED.

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10/19/2020
STATE OF UTAH

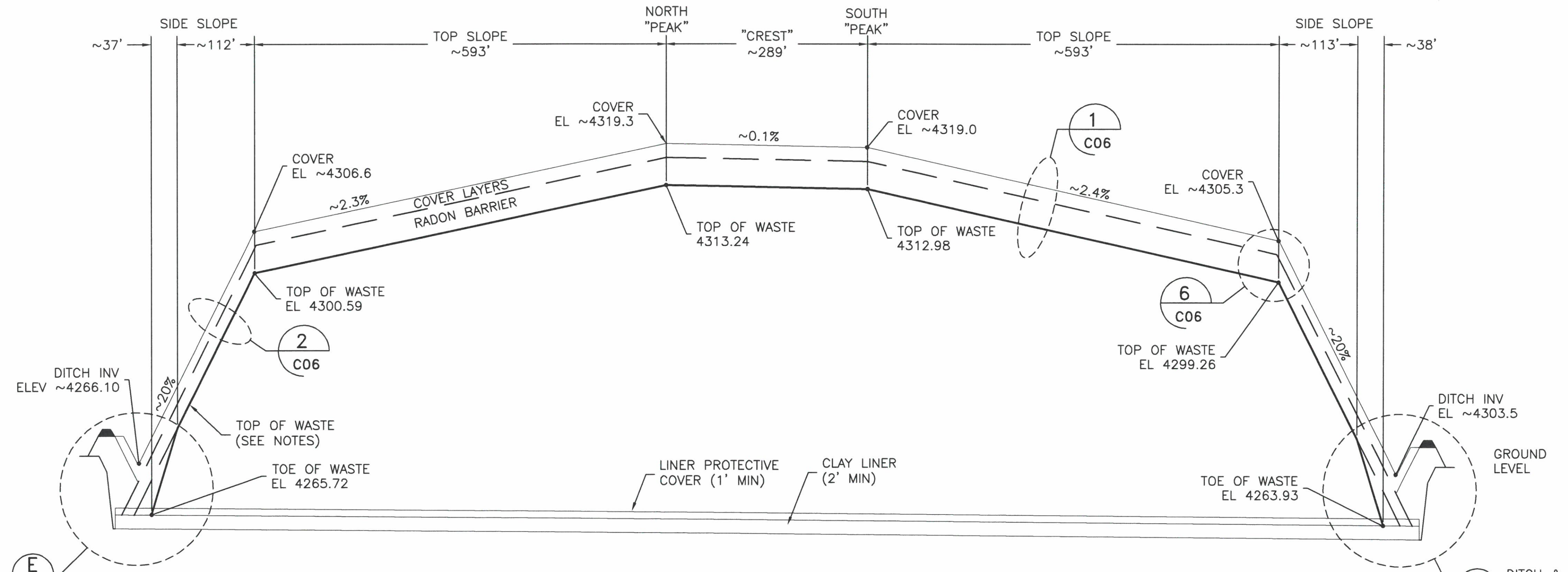
REV	DATE	BY	DESCRIPTION OF CHANGE
1	10/19/20	DFB	FOR LICENSE AMMENDMENT

ENERGYSOLUTIONS

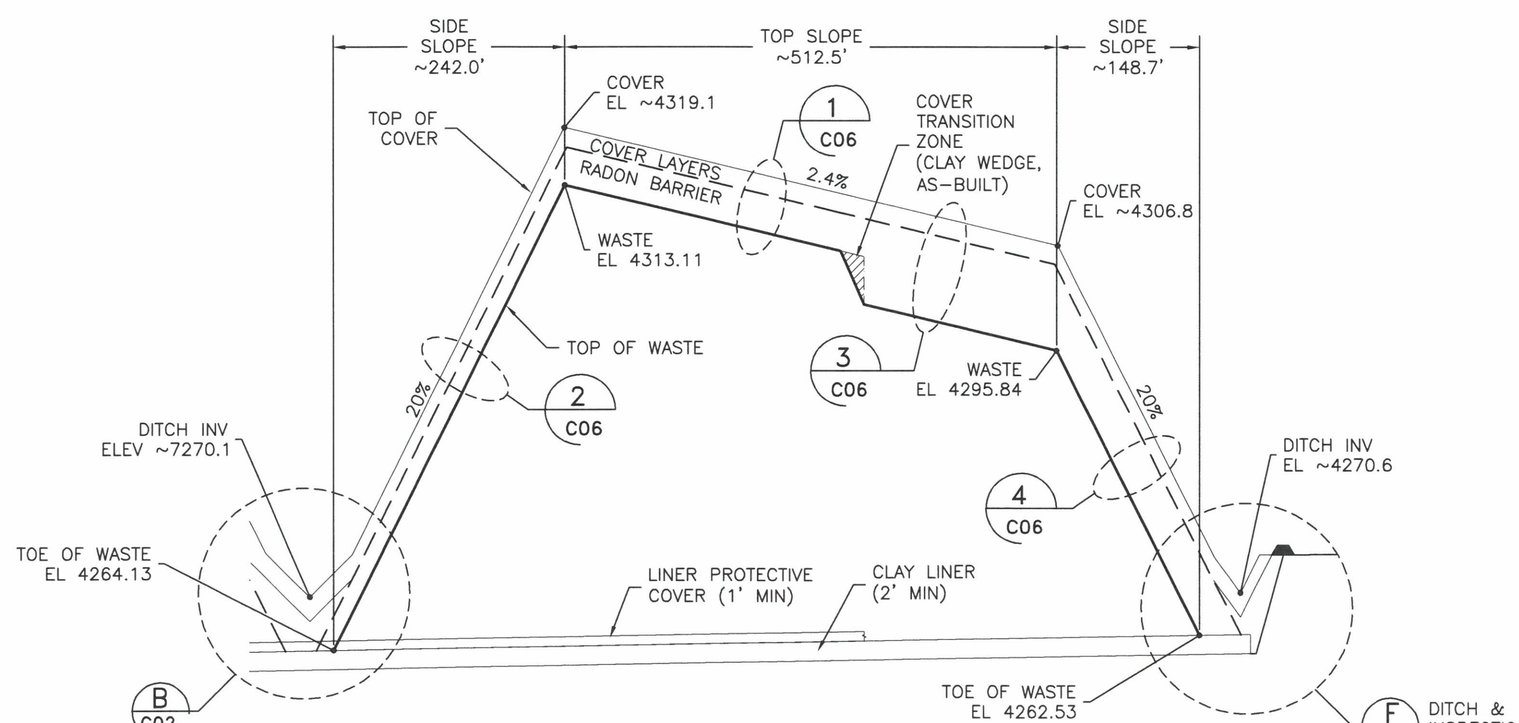
CLIVE FACILITY
11e.(2) DISPOSAL CELL
REVISED CELL FEATURES AND CONTROLS
CLIVE, UTAH

FINAL DRAWING

DRAFTED BY: D. BOOTH
REVIEWED BY: T. ORTON
APPROVED BY: D. BOOTH
SCALE: AS NOTED DATE: 09/04/20 REV: 1
DRAWING NO. 20001 C03



C C03 NORTH-SOUTH
HORIZONATAL SCALE: 1" =100'
VERTICAL SCALE: 1" = 10'



D C03 WEST-EAST CROSS SECTION
HORIZONTAL SCALE: 1" =100'
VERTICAL SCALE: 1" = 10'

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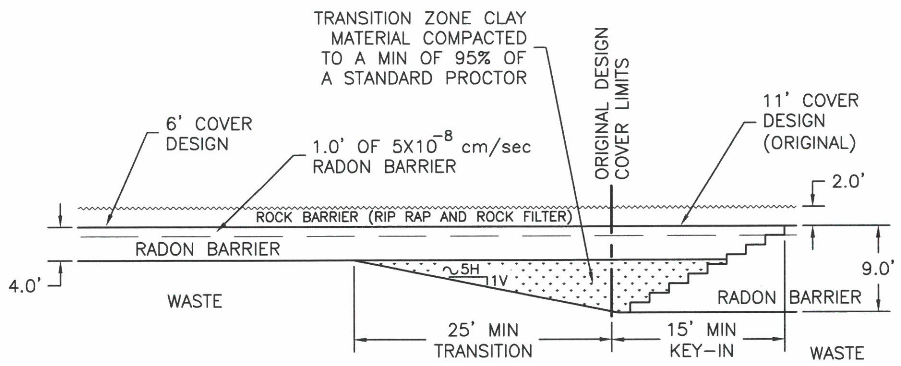
ENERGYSOLUTIONS

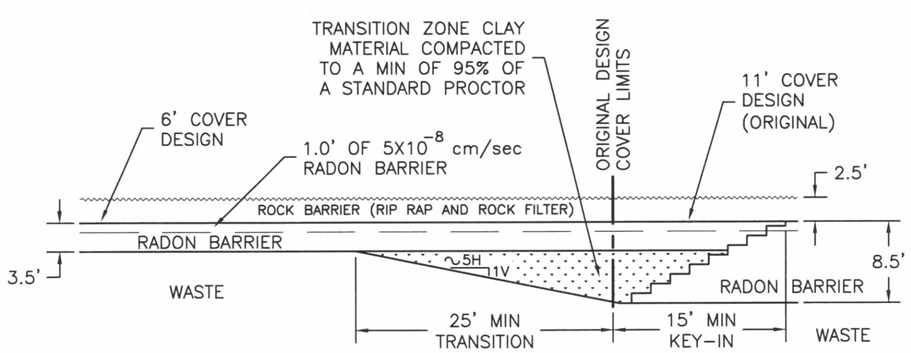
CLIVE FACILITY
11e.(2) DISPOSAL CELL
CELL CROSS SECTIONS, 2 OF 2
CLIVE, UTAH

FINAL DRAWING

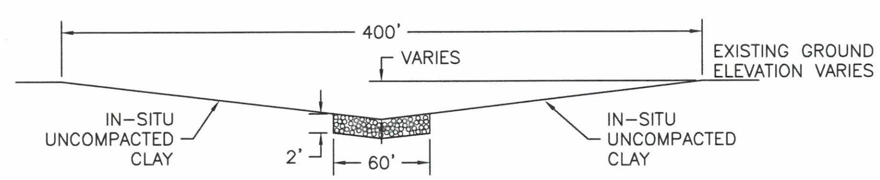
DRAFTED BY D. BOOTH
REVIEWED BY T. ORTON
APPROVED BY D. BOOTH
SCALE AS NOTED
DATE 9/10/20
REV. 1
DRAWING NO. 14004 C04



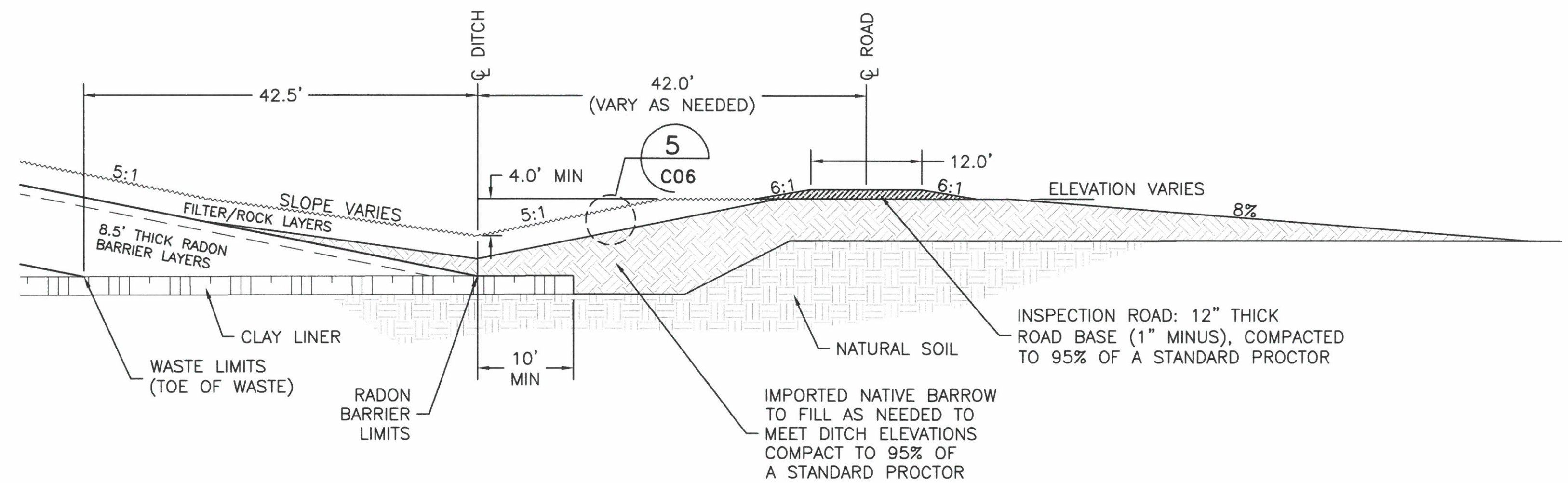
G
C03
11e.(2) TOP SLOPE COVER TRANSITION
NOT TO SCALE



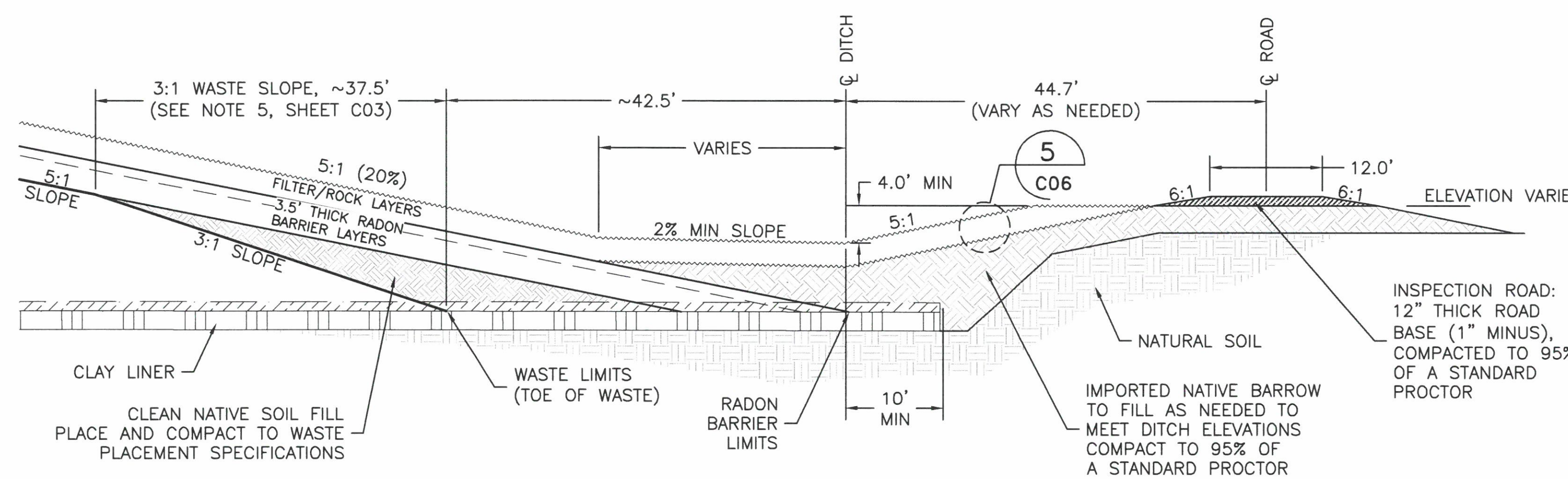
H
C03
11e.(2) SIDE SLOPE COVER TRANSITION
NOT TO SCALE



I
C01
DISPERSION DITCH CROSS SECTION
HORIZONTAL SCALE: 1" = 120'
VERTICAL SCALE: 1" = 20'



F
C04
ORIGINAL DITCH CROSS SECTION
10 0 10 20



E
C04
DITCH CROSS SECTION
10 0 10 20

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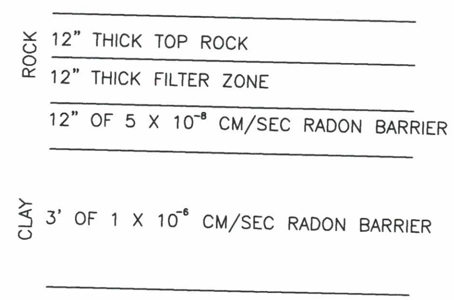
ENERGYSOLUTIONS

CLIVE FACILITY
11e.(2) DISPOSAL CELL
CELL CONSTRUCTION DETAILS, 1 OF 2
CLIVE, UTAH

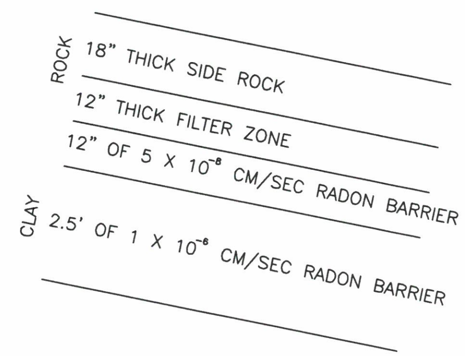
FINAL DRAWING

DRAFTED BY D. BOOTH
REVIEWED BY T. ORTON
APPROVED BY D. BOOTH
SCALE NTS
DATE 09/22/20
REV. 1
DRAWING NO. 20001 C05

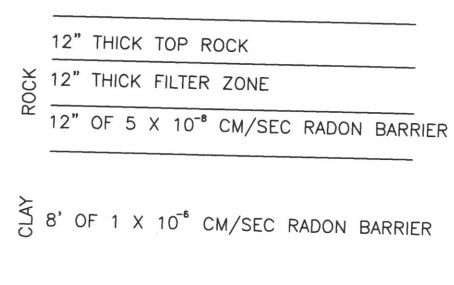
11e.(2) CELL COVER DESIGNS



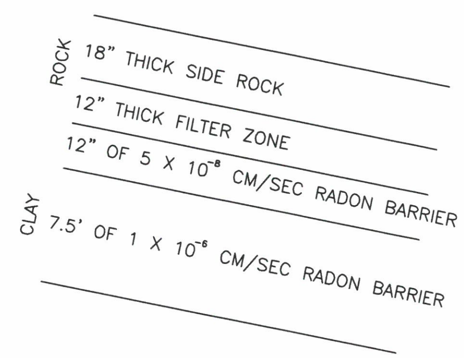
1 C04 11e.(2) TOP SLOPES



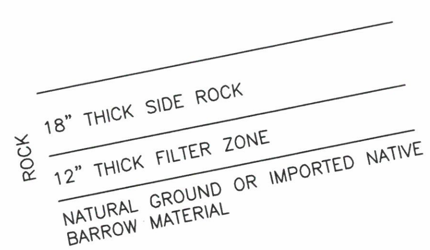
2 C04 11e.(2) SIDE SLOPES



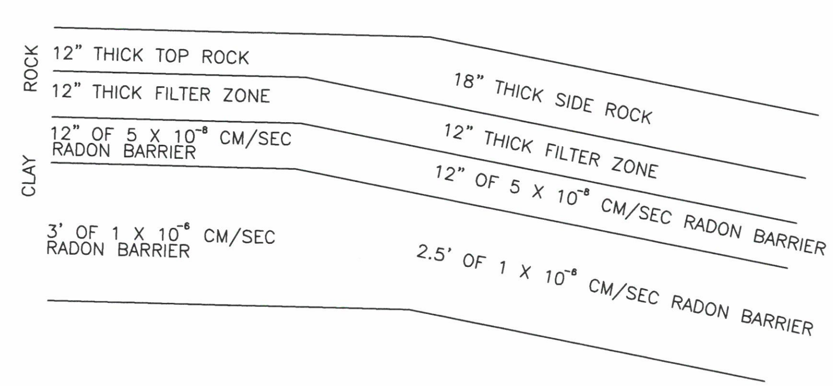
3 C04 11e.(2) TOP SLOPES
ORIGINAL DESIGN



4 C04 11e.(2) SIDE SLOPES
ORIGINAL DESIGN



5 C05 PERIMETER DITCH
OUTSIDE SLOPE ONLY



6 C05 TOP SLOPE/SIDE SLOPE BREAKOVER

GRADATIONS – ASTM C-136

TOP ROCK

- D_{100} 2-1/2 TO 4-1/2 INCHES
- D_{50} 1-1/8 TO 3 INCHES
- D_{15} 3/4 TO 1-1/2 INCHES

SIDE ROCK

- D_{100} 12 TO 16 INCHES
- D_{95} 8 5TO 12 INCHES
- D_{50} 4-1/2 TO 8 INCHES
- D_{15} 2 TO 4 INCHES

FILTER ZONE

- D_{100} = 1.5 TO 3. 0 INCHES
- D_{85} = 1.0 TO 2.5 INCHES
- D_{50} = 0.75 TO 2.0 INCHES
- D_{15} = 0.3.125 TO 0.625 INCHES
- D_{10} >= #10 SIEVE (2.0 mm)
- D >= #200 SEIVE (0.074 mm)

REFER TO THE LLRW AND 11e.(2) CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL (CQA/QC) MANUAL FOR MATERIAL AND CONSTRUCTION SPECIFICATIONS.

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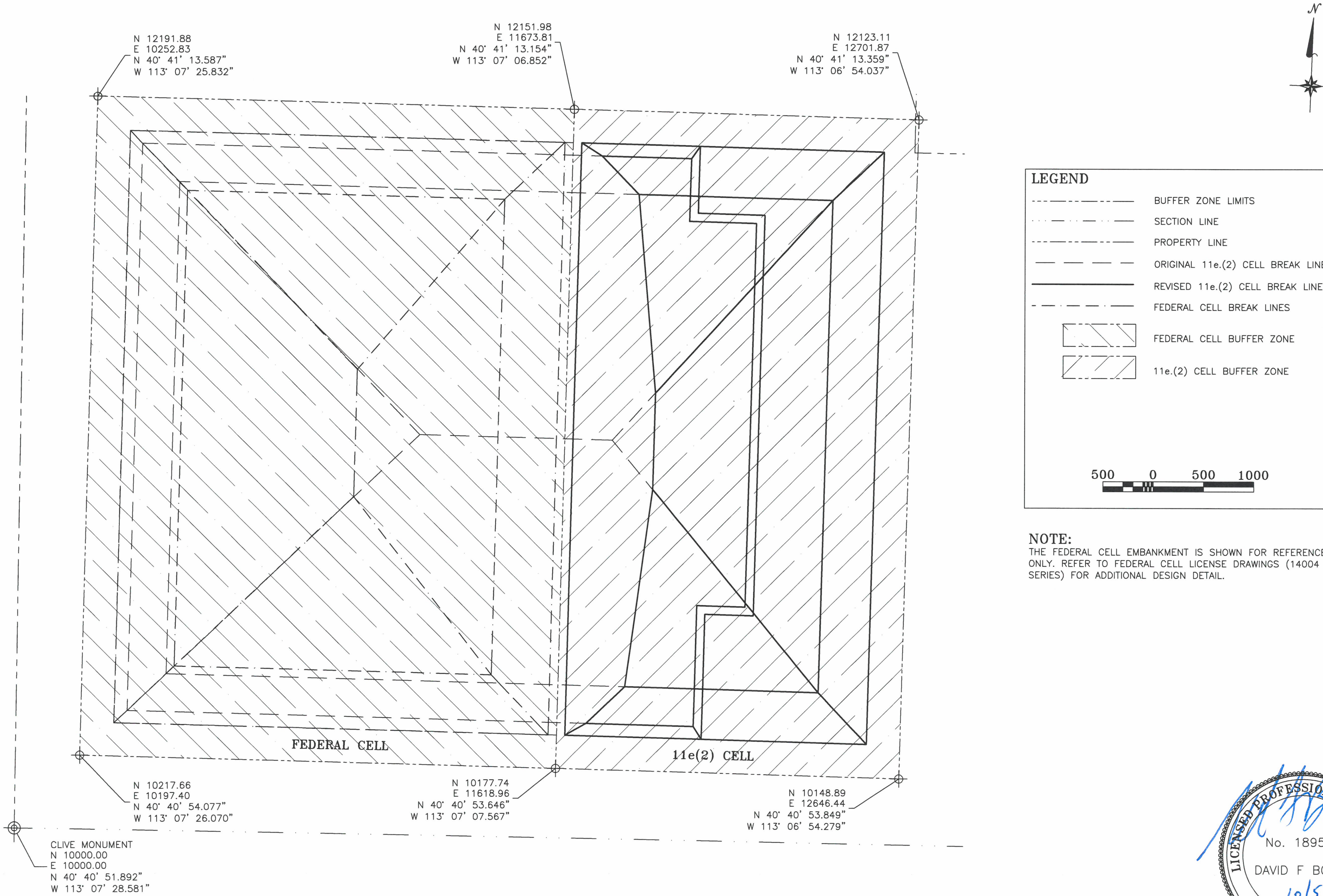
ENERGYSOLUTIONS

CLIVE FACILITY
11e.(2) DISPOSAL CELL
CELL CONSTRUCTION DETAILS, 2 OF 2
CLIVE, UTAH

FINAL DRAWING

DRAFTED BY D. BOOTH
REVIEWED BY T. ORTON
APPROVED BY D. BOOTH
SCALE NTS
DATE 09/22/20
DRAWING NO. 20001 C06



LEGEND

- BUFFER ZONE LIMITS
- SECTION LINE
- PROPERTY LINE
- ORIGINAL 11e.(2) CELL BREAK LINES
- REVISED 11e.(2) CELL BREAK LINES
- FEDERAL CELL BREAK LINES
- FEDERAL CELL BUFFER ZONE
- 11e.(2) CELL BUFFER ZONE

500 0 500 1000

NOTE:
THE FEDERAL CELL EMBANKMENT IS SHOWN FOR REFERENCE ONLY. REFER TO FEDERAL CELL LICENSE DRAWINGS (14004 SERIES) FOR ADDITIONAL DESIGN DETAIL.

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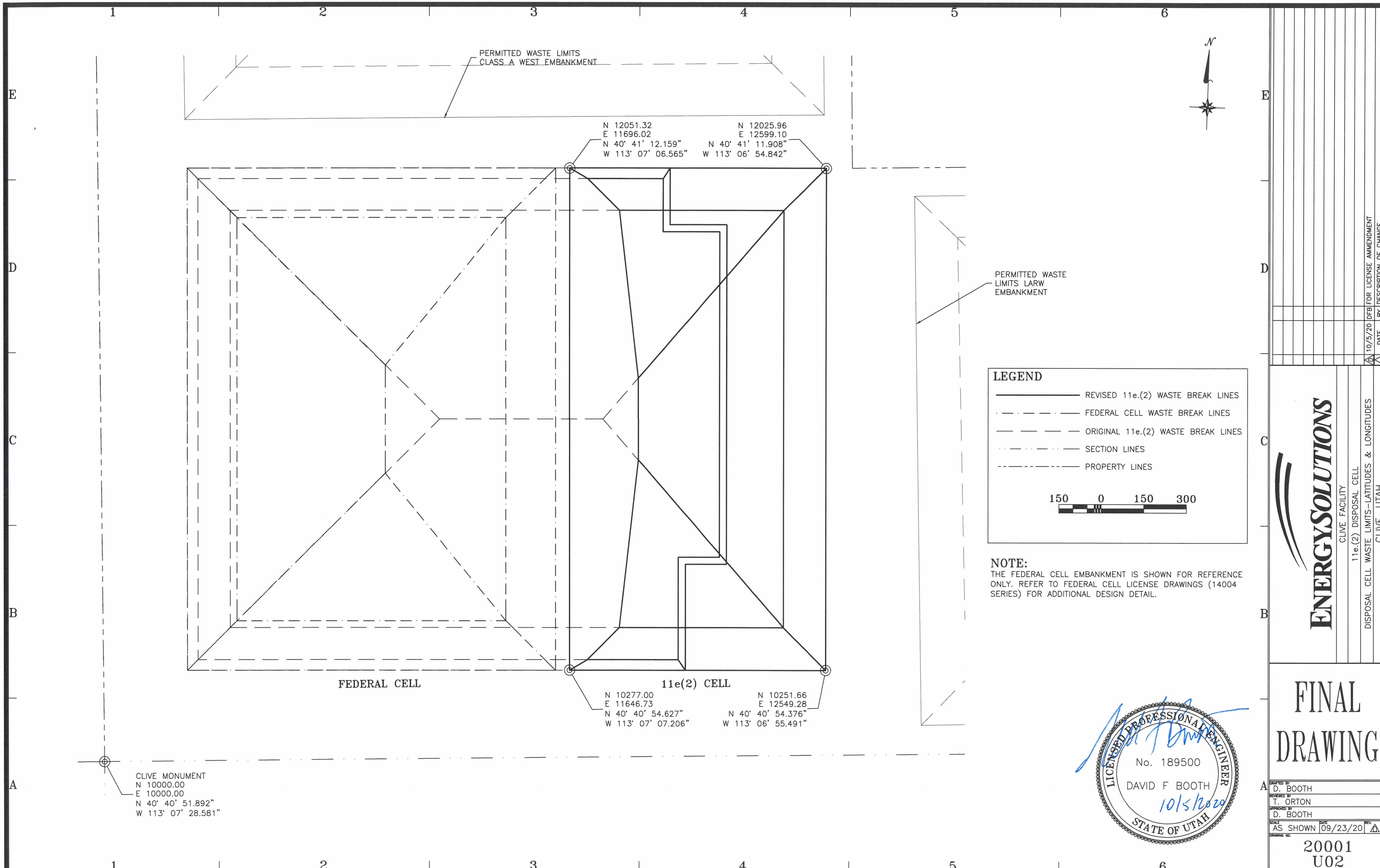
ENERGYSOLUTIONS

CLIVE FACILITY
11e.(2) DISPOSAL CELL
DISPOSAL CELL BUFFER ZONE
CLIVE, UTAH

FINAL DRAWING

DRAFTED BY: D. BOOTH
REVIEWED BY: T. ORTON
APPROVED BY: D. BOOTH
SCALE: AS NOTED
DATE: 09/23/20
REV: 1
DRAWING NO.: 20001 U01



PERMITTED WASTE LIMITS CLASS A WEST EMBANKMENT
N 12051.32
E 11696.02
N 40° 41' 12.159"
W 113° 07' 06.565"
N 12025.96
E 12599.10
N 40° 41' 11.908"
W 113° 06' 54.842"
PERMITTED WASTE LIMITS LARW EMBANKMENT
LEGEND
REVISED 11e.(2) WASTE BREAK LINES
FEDERAL CELL WASTE BREAK LINES
ORIGINAL 11e.(2) WASTE BREAK LINES
SECTION LINES
PROPERTY LINES
150 0 150 300
NOTE:
THE FEDERAL CELL EMBANKMENT IS SHOWN FOR REFERENCE ONLY. REFER TO FEDERAL CELL LICENSE DRAWINGS (14004 SERIES) FOR ADDITIONAL DESIGN DETAIL.
FEDERAL CELL
11e(2) CELL
N 10277.00
E 11646.73
N 40° 40' 54.627"
W 113° 07' 07.206"
N 10251.66
E 12549.28
N 40° 40' 54.376"
W 113° 06' 55.491"
CLIVE MONUMENT
N 10000.00
E 10000.00
N 40° 40' 51.892"
W 113° 07' 28.581"
LICENSED PROFESSIONAL ENGINEER
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10/5/20 DFB FOR LICENSE AMMENDMENT
DATE BY DESCRIPTION OF CHANGE
ENERGYSOLUTIONS
CLIVE FACILITY
11e.(2) DISPOSAL CELL
DISPOSAL CELL WASTE LIMITS-LATITUDES & LONGITUDES
CLIVE, UTAH
FINAL DRAWING
D. BOOTH
T. ORTON
D. BOOTH
AS SHOWN 09/23/20
20001
U02