STATE OF UTAH 11e.(2) BYPRODUCT MATERIAL LICENSE RENEWAL APPLICATION (UT 2300478)

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SECTION 1. PROPOSED ACTION

"*In addition to the requirements of Rules R313-19, R313-21 or R313-22, all licensees are subject to the requirements of Rules R313-12, R313-15, and R313-18. Licensees authorized to use sealed sources containing radioactive materials in panoramic irradiators with dry or wet storage of radioactive sealed sources, underwater irradiators, or irradiators with high dose rates from radioactive sealed sources are subject to the requirements of Rule R313-34, licensees engaged in industrial radiographic operations are subject to the requirements of Rule R313-36, licensees using radionuclides in the healing arts are subject to the requirements of Rule R313-32, licensees engaged in land disposal of radioactive material are subject to the requirements of Rule R313-25, and licensees engaged in wireline and subsurface tracer studies are subject to the requirements of Rule R313-38. Licensees engaged in source material milling operations, authorized to possess byproduct material, as defined in Section R313-12-3 (see definition (b)) from source material milling operations, authorized to possess and maintain a source material milling facility in standby mode, authorized to receive byproduct material from other persons for disposal, or authorized to possess and dispose of byproduct material generated by source material milling operations are subject to the requirements of Rule R313-24.*" – **R313-19-2(2).**

"the applicant's facilities are permanently located in Utah, otherwise the applicant shall seek reciprocal recognition as required by Section R313-19-30;" – **R313-22-33(c).**

"*Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100.*" – **R313-24-4, 10 CFR 40.41(c).**

In 2005, Energy*Solutions*, LLC (Energy*Solutions*) submitted an application to the Utah Division of Radiation Control (the Division) for renewal of its 11e.(2) Radioactive Material License (UT 2300478) (Energy*Solutions*, 2005b). In response, the Division requested from Energy*Solutions* clarification of certain components of the License Renewal Application through a first round of interrogatories, received 29 June 2005 (Finerfrock, 2005). Energy*Solutions* provided the Division with responses to this first round of interrogatories and a revised License Renewal Application on 28 February 2006 (Shrum, 2006). Following this revised submittal, Energy*Solutions* received a second round of interrogatories from the Division, on 16 October 2007 (Cook, 2007).

Energy*Solutions* requests that the Division review and approve this revised License Renewal Application for its 11e.(2) Disposal Embankment (which includes responses to the second round of interrogatories). Engineering and construction practices with respect to waste placement will continue as specified in Energy*Solutions*' LLRW and 11e.(2) Construction Quality Assurance and Quality Control Manual, currently approved as revision 25d (CQA/QC Manual).

On January 31, 2005, Envirocare of Utah, Inc. was sold and became Envirocare of Utah, LLC. On February 2, 2006, Envirocare of Utah, LLC became Energy*Solutions*, LLC. Therefore, all references and appendices to this revised License Renewal Application that were performed for, or in support of, Envirocare of Utah, Inc. or Envirocare of Utah, LLC, are pertinent to this Energy*Solutions* 11e.(2) License Renewal Application.

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Energy*Solutions*, LLC is a subsidiary of Energy*Solutions*, Inc., a publicly held corporation. Energy*Solutions*, LLC is a Utah limited liability corporation with corporate headquarters located at 423 West 300 South, Suite 200, Salt Lake City, UT 84101. Detailed requirements and qualifications for significant organizational positions are described in the facility Organization Chart approved under Radioactive Material License #UT 2300249, condition 32.A (currently approved as revision 23 as of May 3, 2012). There will be no changes to the organization for purposes of renewal of the 11e.(2) License.

To the extent practicable, the information presented in this revised License Renewal Application conforms to the format and outline specified by the Division (Rauen, 2012). A complete list of NRC Regulatory Guides applied to the 11e.(2) facility design is included in Section 12. Energy*Solutions* requests that the Division renew the issued License for the continued operation of the 11e.(2) Embankment. Proposed revisions to the 11e.(2) Radioactive Material License are provided in redline/strikeout format in Appendix D. The proposed changes to the 11e.(2) Radioactive Material License include the following:

1. Recipient for required notices changed from the Executive Secretary of the Utah Radiation Control Board to the Director of the Utah Division of Radiation Control. This change is in compliance with changes incorporated into statute through Utah Governor's signature of Senate Bill 21, "Department of Environmental Quality Boards Revisions."
2. Format for listing License Conditions amended more than once changed. It is observed that there was an inconsistent use in notation of multiple amendments for License sections. In some cases, amendments were listed separately, (e.g., [UDRC Amendment 5] [UDRC Amendment 6] [UDRC Amendment 7]), while in other cases they were combined into a single list (e.g. [UDRC Amendments 5, 6, and 7]). In all cases, it is proposed that the format to be used for listing multiple approved license amendments is a combined single list (e.g., [UDRC Amendments 5, 6, and 7]).
3. Correction in notation that indirect cost multipliers should be applied to "applicable" direct construction costs.
4. Replacement of the requirement for use of the Environmental Protection Agency's Paint Filter Liquids Test with management consistent with that approved in Radioactive Material License #UT 2300249.
5. Acceptance of compliance with field-tested density requirements through use of Computer-Aided Earthmoving Systems (CAES)-equipment compactors.
6. Revision to allow ALARA audits to use "statistically-significance" for trends in personnel exposures for identifiable categories of workers and types of activities.

SECTION 2. SITE CHARACTERIZATION

"*Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100.*" **– R313-24-4, 10 CFR 40.41(c).**

As a facility, the Energy*Solutions'* Clive site has 25 years of experience with the design, construction, management, engineering, and operation of radioactive waste disposal embankments. Since receiving its first radioactive material license in 1988, Energy*Solutions* has constructed a low-activity radioactive waste (LARW) Disposal Embankment, a RCRA mixed radioactive and hazardous waste (Mixed Waste) Disposal Embankment, the Class A and Class A North Disposal Embankments, and a uranium- and thorium-mill radioactive tailings 11e.(2) Disposal Embankment. Energy*Solutions*' 11e.(2) License allows for the disposal of specified radioactive wastes in accordance with specified conditions and restrictions.

Since first licensed, the broad objective of the 11e.(2) disposal siting and design decisions has been permanent isolation of tailings and associated contaminants. These decisions have been focused on minimizing disturbance and dispersion by natural forces, without the need of ongoing maintenance. For practical reasons, specific siting decisions and design standards have involved finite times. The following site features have been considered in selecting among alternative tailings disposal sites or judging the adequacy of the existing Energy*Solutions*' 11e.(2) Embankment:

a. Remoteness from populated areas;
b. Hydrologic and other natural conditions as they contribute to continued immobilization and isolation of contaminants from groundwater sources; and
c. Potential for minimizing erosion, disturbance, and dispersion by natural forces over the long term.
d. The site selection process must be an optimization to the maximum extent reasonably achievable in terms of these features.

In the selection of the 11e.(2) Embankment, primary emphasis was given to isolation of tailings or wastes, a matter having long-term impacts, as opposed to consideration only of short-term convenience or benefits, such as minimization of transportation or land acquisition costs. While isolation of tailings is a function of both site and engineering design, overriding consideration has been given to siting features of the long-term nature of the tailings hazards.

The 11e.(2) Embankment is located in the semi-arid west desert of Utah. A meteorological report prepared by Meteorological Solutions Inc. (MSI), and taken from data collected at the Clive site from July 1992 to December 2011, shows an annual average precipitation of 8.62 inches per year, with evaporation averaging 52.73 inches annually (MSI, 2012). This report was provided to the Division on 23 February 2012 (McCandless, 2012). Low precipitation coupled with high evaporation at Clive is beneficial in waste immobilization.

The 11e.(2) Embankment is situated in a remote area of Tooele County in the western portion of Utah. The nearest resident is a person acting as caretaker at a rest stop along I-80, roughly 7 miles to the Northeast, with the nearest community being approximately 35 miles from the site. Strict access control and security also provide additional assurance of protection to the public. The 11e.(2) Embankment is designed to minimize dispersion of the waste. The Embankment has been designed to resist water erosion, wind erosion, biointrusion, geotechnical instability and other natural events. All features are designed to promote embankment stability for NRC's 1,000-year Embankment design life requirement of NUREG-1476 (NRC, 1993c).

The location of the 11e.(2) Disposal Embankment has been studied extensively to establish the natural conditions that contribute to the isolation of waste. The site is located on Quaternary lakebed deposits. Wells indicate that lacustrine deposits extend to at least 500 feet underneath the Site. Additionally, the groundwater is of low yield and poor quality at the Clive site. In fact, the groundwater is classified by the State of Utah as a Class IV aquifer (unpotable), meaning that the Total Dissolved Solids (TDS) exceed 10,000 mg/L. The water is generally very brackish and has no uses other than for dust suppression. The site-wide average horizontal velocity of the groundwater in the shallow aquifer is 1.1 feet/year. The average site-wide vertical groundwater velocity is calculated at 0.1 feet/year in the upward direction in the saturated aquifer zones. The low production and poor quality of the groundwater contributes to long-term immobilization of the waste and isolation of the facility by discouraging industrial and residential developments.

After closure of the 11e.(2) Embankment there will be no active maintenance required to preserve isolation. The above-grade design of the Embankment meets the design standards for water and wind erosion, as well as being geotechnically stable. All materials used in the construction of the Embankment are natural and from the area of the site. The site has been designed to contain the waste properly for 1,000 years. Furthermore, waste disposal procedures have been designed to promote long-term stability by limiting total and differential settlement within the waste.

2.1 SITE LOCATION AND LAYOUT

"*A license application shall be approved if the Executive Secretary determines that:(c) the applicant's facilities are permanently located in Utah, otherwise the applicant shall seek reciprocal recognition as required by Section R313-19-30;*" **– R313-22-33(c).**

"*Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100.*" **– R313-24-4, 10 CFR 40.41(c).**

Energy*Solutions'* Utah-based operations are conducted in Section 32, Township 1 South, Range 11 West, SLB&M, Tooele County, Utah. This location is known as Clive, Utah. Most of the land within a 10-mile radius of the Site is public domain administered by the U.S. Department of Interior's Bureau of Land

Management (BLM). Land use in the immediate vicinity of the Site is not affected by the renewal of the 11e.(2) License, since the Embankment is located entirely within the licensed area of Section 32.

The Clive site is on the eastern edge of the Great Salt Lake Desert, three miles west of the Cedar Mountains, 2.5 miles south of Interstate 80, and 1 mile south of a switch point called Clive on the tracks of the Union Pacific system. Figure 2-1 shows the location of the site in relation to Salt Lake City and surrounding towns. The disposal site is a parcel of land, consisting of one square mile in Tooele County, Utah. The land was owned by the State of Utah, and, with the exception of approximately 100 acres used in the Vitro Remedial Action project, has been purchased by Energy*Solutions*. DOE owns the 100 acres used in the Vitro Remedial Action project. The licensed property owned by Energy*Solutions*, is Utah SLB&M, Section 32, Township 1 South, Range 11 West, Tooele County, Utah, except for the following legal description of the Vitro site:

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

While Energy*Solutions* also owns property adjacent to the licensed area as shown on Figure 2-2, properties outside of Section 32 are not currently used for radioactive waste management. The south portion of the site contains Energy*Solutions'* LARW, and Mixed Waste landfill cell. The 11e.(2) Embankment is being constructed west of the LARW Embankment. Energy*Solutions*' Class A Embankment is located to the north of the 11e.(2) Embankment. Energy*Solutions*' Class A North Embankment is being constructed to the north of the Class A Embankment. A current drawing of the facility layout is provided as Figure 2-3.

All Restricted/Controlled Areas are fenced. The fence is conspicuously posted with "Caution -- Radioactive Materials" signs bearing the standard radiation symbol. Other signs are also posted as appropriate. The Restricted Area boundary may change as waste placement proceeds in the 11e.(2) Embankment. However, there are not any changes to the requirements for control of the Restricted Areas, as a result of the 11e.(2) Embankment, nor is there expected to be any added waste handling facilities as a result of continued disposal at the 11e.(2) Embankment.

Upon eventual completion of each waste embankment, a minimum 94-foot buffer zone between the edge of the embankment and the fence will remain (with the edge of the embankment defined as the toe of the contaminated material). The buffer zone allows room inside of the fence for an inspection roadway and for sample collection from monitoring wells located within the boundary.

A buffer zone of at least 90.9 feet is maintained between the closest waste placement of the 11e.(2) Embankment and the Vitro property line. Although previous submittals reported the buffer zone to the Vitro property line as being a minimum of 100 feet, it was discovered in preparation of the design drawings for the Class A West Embankment that the northeast corner of waste placement for the 11e.(2) Embankment is 90.9 feet from the Vitro property line. This slight reduction in the buffer zone size does not compromise the ability to construct the final inspection roadway in this area. Furthermore, in accordance with 42 USC §2113(b), the Department of Energy is required to assume ownership of the 11e.(2) Embankment following satisfactory closure. Therefore, long-term ownership and custodial care for the 11e.(2) and Vitro Embankments will be with the same U.S. government agency.

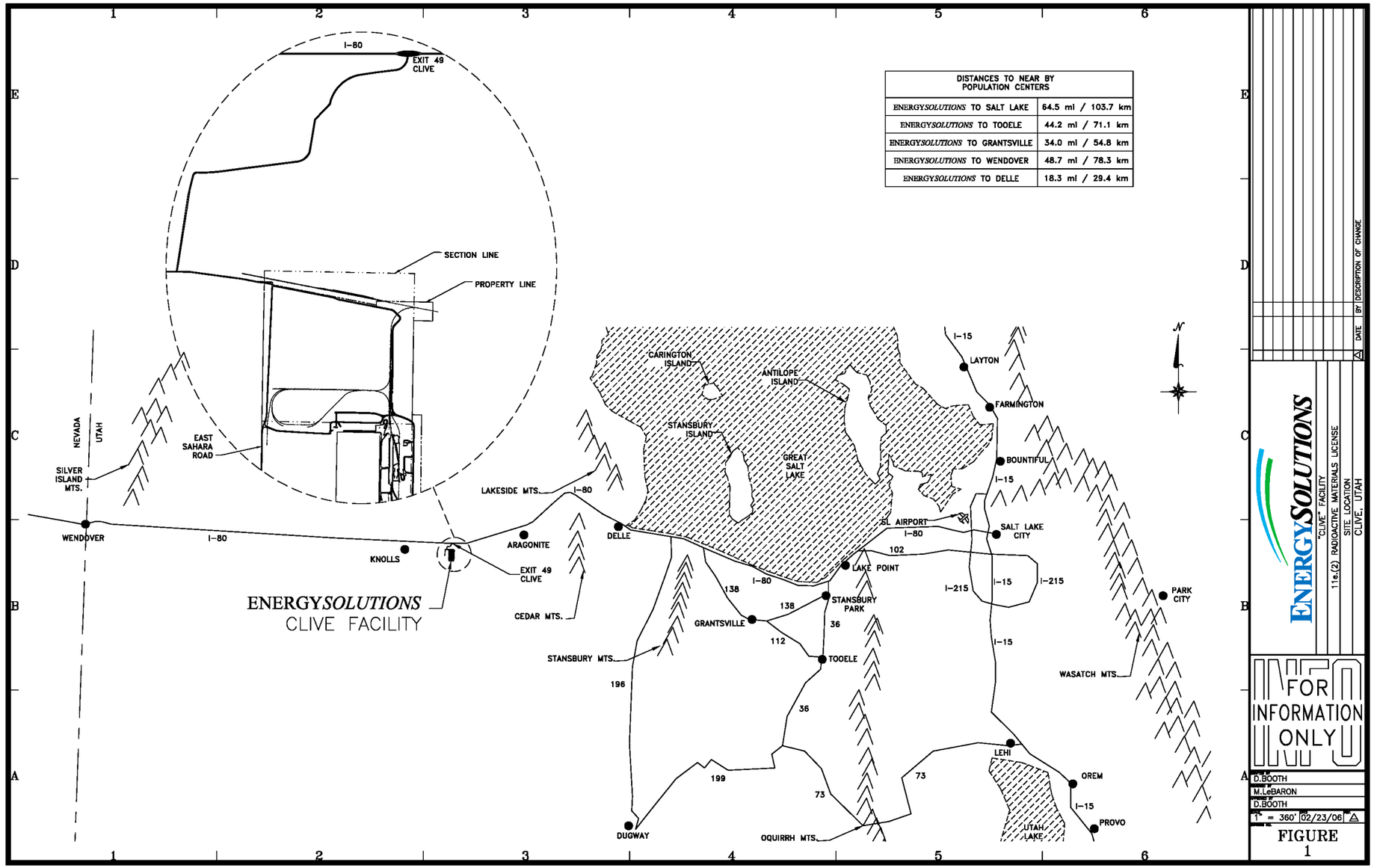

Figure 2-1. Energy*Solutions* Site Location

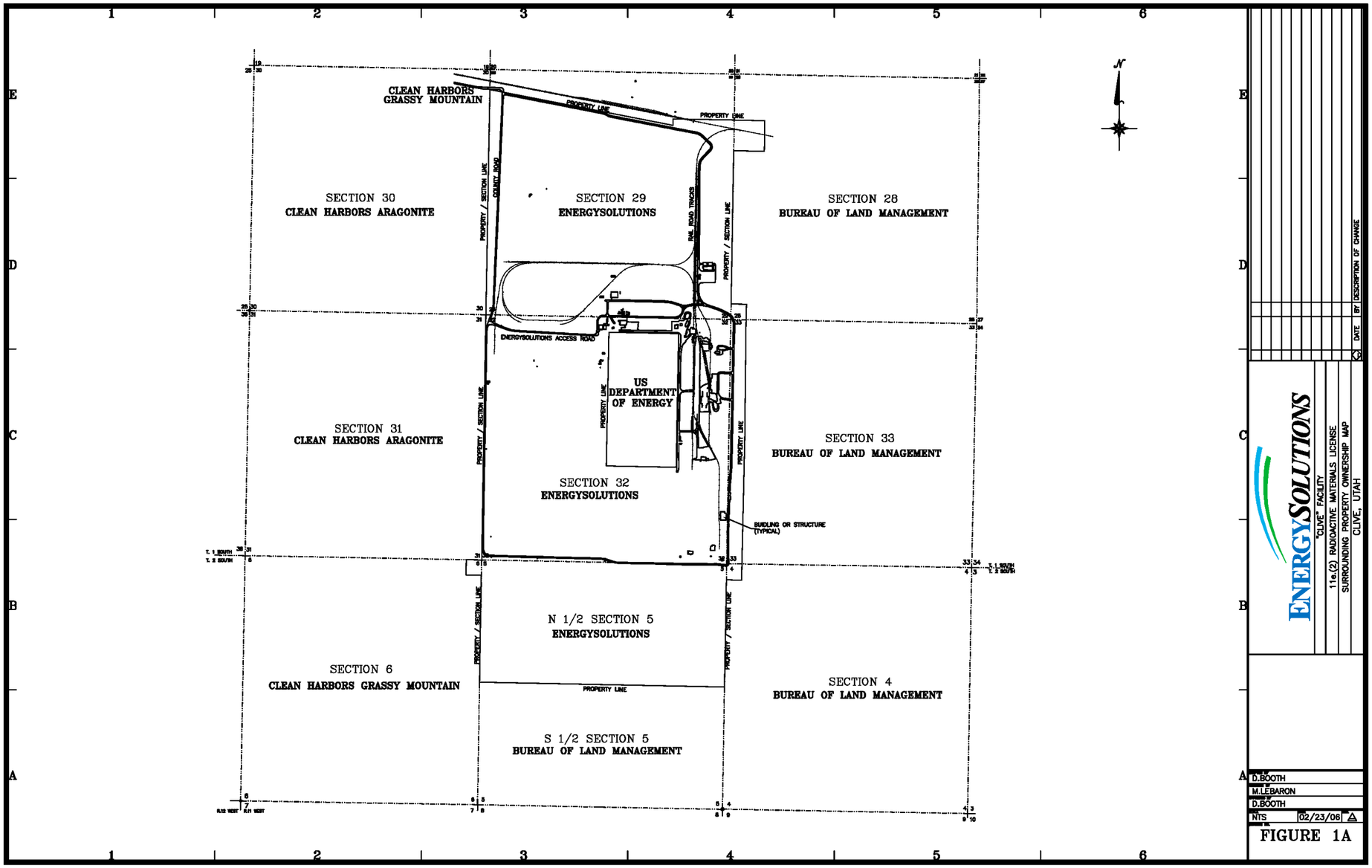

Figure 2-2. Energy*Solutions* Property Ownership

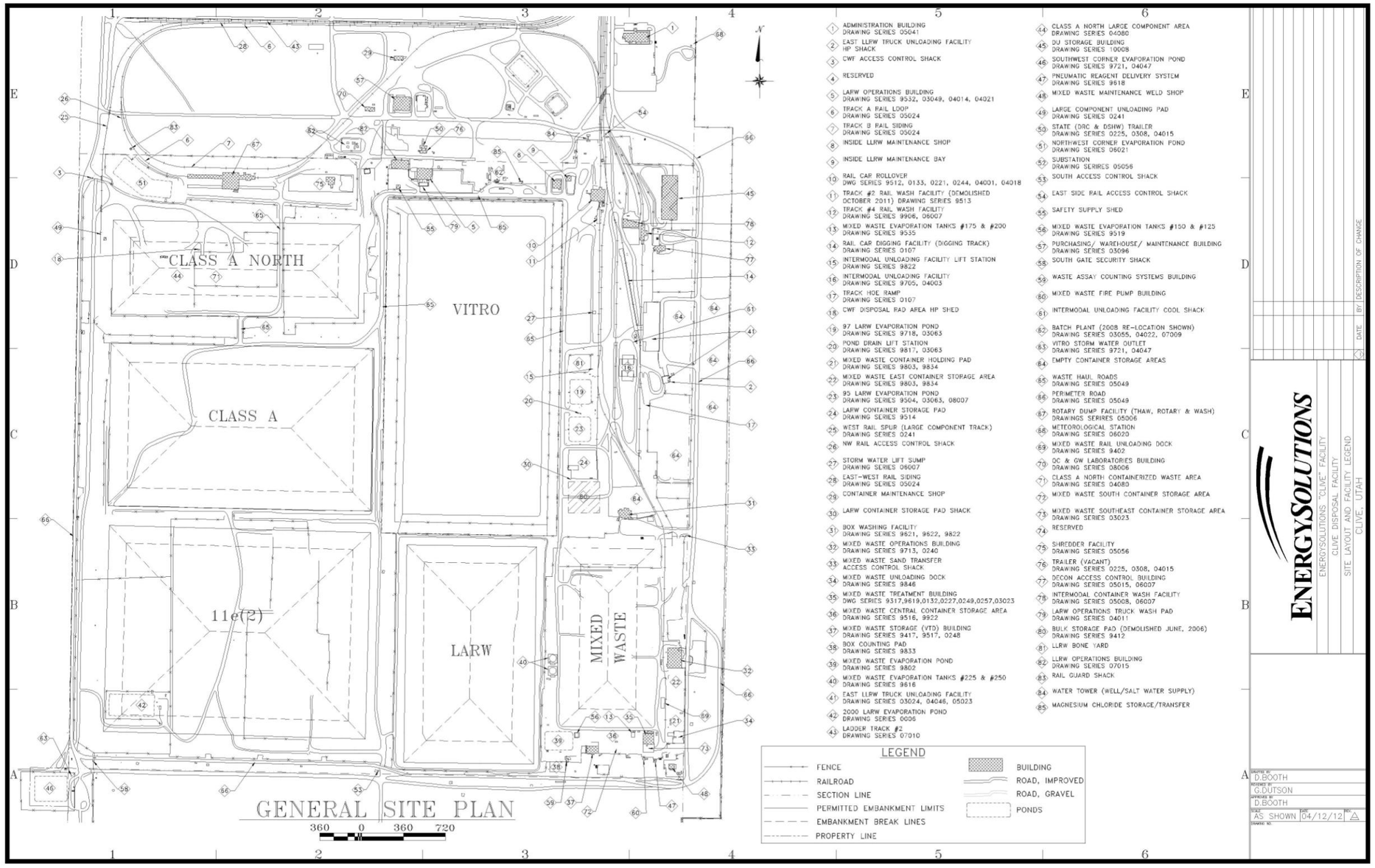

Figure 2-3. Energy*Solutions*' Clive Facility General Site Plan

With the exception of the Vitro-Energy*Solutions* property line, a buffer zone of at least 300 feet is maintained between the closest edge of any embankment (i.e., toe of waste) and the outside site boundary or property line. This 300 foot buffer zone is a requirement of the facility's Conditional Use Permit issued by Tooele County, reported here for informational purposes.

The permanent site boundary markers are United States Geological Survey (USGS) quadrant "brass cap" markers, which provide adequate documentation of the exact location of the disposal embankment(s). Licensed surveyors have verified the design locations of all embankments. All locations have been tied into the USGS survey control stations. Permanent markers will be placed at the head and toe of each completed embankment.

Many of the Clive facilities, buildings, and infrastructure are common to the operating areas of the facility and support Energy*Solutions*' 11e.(2) disposal operations. Key facilities and buildings utilized to support 11e.(2) disposal operations include (as identified on Figure 2-3):

- Administration Building (1): The Administration Building houses office space for Security, Shipping and Receiving, Health Physics, Engineering and Quality Assurance.
- Rail Car Rollover (10): The Rail Car Rollover is the older of the two such facilities and is used to unload bulk rail shipments received in gondola type railcars.
- Track #4 Rail Wash Facility (12): A railcar decontamination facility used on Track #4.
- Intermodal Unloading Facility (16): This facility is used for unloading bulk intermodal containers.
- 97 LARW Evaporation Pond (19) and 95 LARW Evaporation Pond (23): Storm water collected from LLRW and 11e.(2) waste management and disposal facilities is contained and evaporated in these ponds.
- LARW Container Storage Pad (24): This facility is used for the short term storage of waste filled containers (boxes, drums, etc.).
- Box Washing Facility (31): Facility is used to decontaminate containers used to ship waste to the facility and to wash waste handling and disposal equipment.
- East LLRW Truck Unloading Facility (41): Trucks carrying containers of waste can be unloaded without bringing the truck into the restricted area.
- 2000 LARW Evaporation Pond (42) and Northwest Corner Evaporation Pond (51): Storm water collected from LLRW and 11e.(2) waste management and disposal facilities is contained and evaporated in these ponds.
- State Trailer (50): Offices for the Division of Radiation Control and the Division of Solid and Hazardous Waste.
- Batch Plant (62): The batch plant produces concrete and CLSM for construction and waste disposal operations.
- Waste Haul Roads (65): Waste haul roads are used to haul waste from receiving areas to final placement within the embankments. Also used for general operations within the facility.
- Perimeter Road (66): The perimeter road provides general site access.
- Rotary Dump Facility (Thaw, Rotary & Wash) (67): This facility is used to thaw and offload bulk rail shipments received in gondola type railcars. It is also used for the decontamination of railcars after waste is offloaded.
- Meteorological Station (68): Weather station equipment is used to gather wind, temperature, evaporation, and precipitation data.

- QC & GW Laboratories Building (70): Offices and laboratories for quality control (QC) and groundwater/environmental monitoring.
- Shredder Facility (75): The shredder facility is utilized to size reduce waste debris.
- Decontamination Access Control Building (77): Houses office, lunchroom, locker room and access control facilities.
- Intermodal Container Wash Facility (78): Supports decontamination of waste shipping containers.
- LLRW Operations Building (82): This building houses administrative offices, laboratories, and locker rooms; as well as the principal access control point to the Restricted Area for Class A, LLRW, and 11e.(2) operations.

2.2 USE OF ADJACENT LANDS AND WATERS

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (a) An assessment of the radiological and non-radiological impacts to the public health from the activities to be conducted pursuant to the license or amendment;" **– R313-24-3(1)(a).**

"*Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100.*" **– R313-24-4, 10 CFR 40.41(c).**

"The licensee shall conduct an annual land use survey for a 5 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 annual report." **– License Condition 12.4**

Most of the land within a 10-mile radius of the site is public domain administered by BLM. This dry and arid desert area limits other viable uses of the land. Previous to the Vitro project, there were no industrial, residential, or municipal activities near the site. The only land use was for sheep grazing, jackrabbit hunting, and occasional off-road recreational driving. Since that time, three hazardous waste facilities have located in the Clive area:

- Clean Harbors' Grassy Mountain facility, a commercial, hazardous waste, treatment, storage and disposal facility located greater than ten miles north-northwest of Energy*Solutions'* Clive facility. This facility was issued its original permit to operate on June 30, 1988;
- Clean Harbors' Aragonite facility a 140 million Btu slagging rotary kiln with a vertical afterburner chamber located approximately 8 miles east-northeast of Energy*Solutions'* Clive facility. This facility applied for its original permit to operate on July 22, 1987; and,
- Clean Harbors Clive facility, a defunct incinerator site currently permitted for transfer and storage of hazardous waste located one mile west of Energy*Solutions'* Clive facility. This facility applied for its original permit to operate on February 14, 1988.

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

As is illustrated in Figure 2-4, the area around the Clive facility has been designated as a Hazardous Industrial District MG-H by Tooele County, further reducing the potential for population encroachment near Energy*Solutions*' Clive facility. This designation limits, through zoning, the future uses of land in the area of the disposal facility to heavy industrial processes (General Industrial District M-G type uses) and to industries dealing with hazardous wastes, by the issuance of conditional use permits. The Hazardous Industrial District MG-H designation does not authorize any other types of land use.

While BLM has several sheep and cattle grazing allotments near Clive, the remoteness of the site from the urbanized areas of Tooele County makes the surrounding area an improbable location for any other significant industrial use which might be impacted by the disposal project. Additionally, the low precipitation and high evaporation rates are not conducive to any sustainable crop yields. Further, the groundwater contained in the shallow aquifer is saline with TDS concentrations ranging from 32,000 mg/L to 74,000 mg/L. It is impossible to support a permanent, residential population center in this area as the groundwater exceeds EPA primary and secondary drinking water standards, often by significant amounts.

Closure of the 11e.(2) Embankment is taking place during normal operations. Closure activities include a settlement monitoring program prior to cover construction as provided in the CQA/QC Manual, work element - Temporary Cover Placement and Monitoring. The settlement monitoring program includes a requirement that temporary cover be placed and monitored for at least one year prior to final cover construction, with evaluation of differential settlement. If differential settlement exceeds or is projected to exceed the established criteria, surcharging of affected areas is required.

2.2.1 Land Ownership

The disposal site is a parcel of land, consisting of one square mile in Tooele County, Utah. The land was owned by the State of Utah, and, with the exception of approximately 100 acres used in the Vitro Remedial Action project, has been purchased by Energy*Solutions*. DOE owns the 100 acres used in the Vitro Remedial Action project. The licensed property owned by Energy*Solutions*, is Utah SLB&M, Section 32, Township 1 South, Range 11 West, Tooele County, Utah.

Until completion of the 11e.(2) Embankment, Energy*Solutions* will retain ownership of the land and will be responsible for site closure, as well as the long-term maintenance and monitoring of the disposal site. In accordance with the requirements of 10 CFR Part 40.28, the ownership of the 11e.(2) Embankment will eventually be transferred to DOE, another Federal Agency designated by the President, or the State of Utah. The land will be transferred at no cost to DOE. DOE or other designated agency will be responsible under the general license for custody of and long-term care of the site, including monitoring, maintenance, and emergency measures necessary to protect the public health and safety and other actions necessary to comply with the standards. It is anticipated that the State of Utah will retain a function in the post-closure activities at the site in an oversight role.

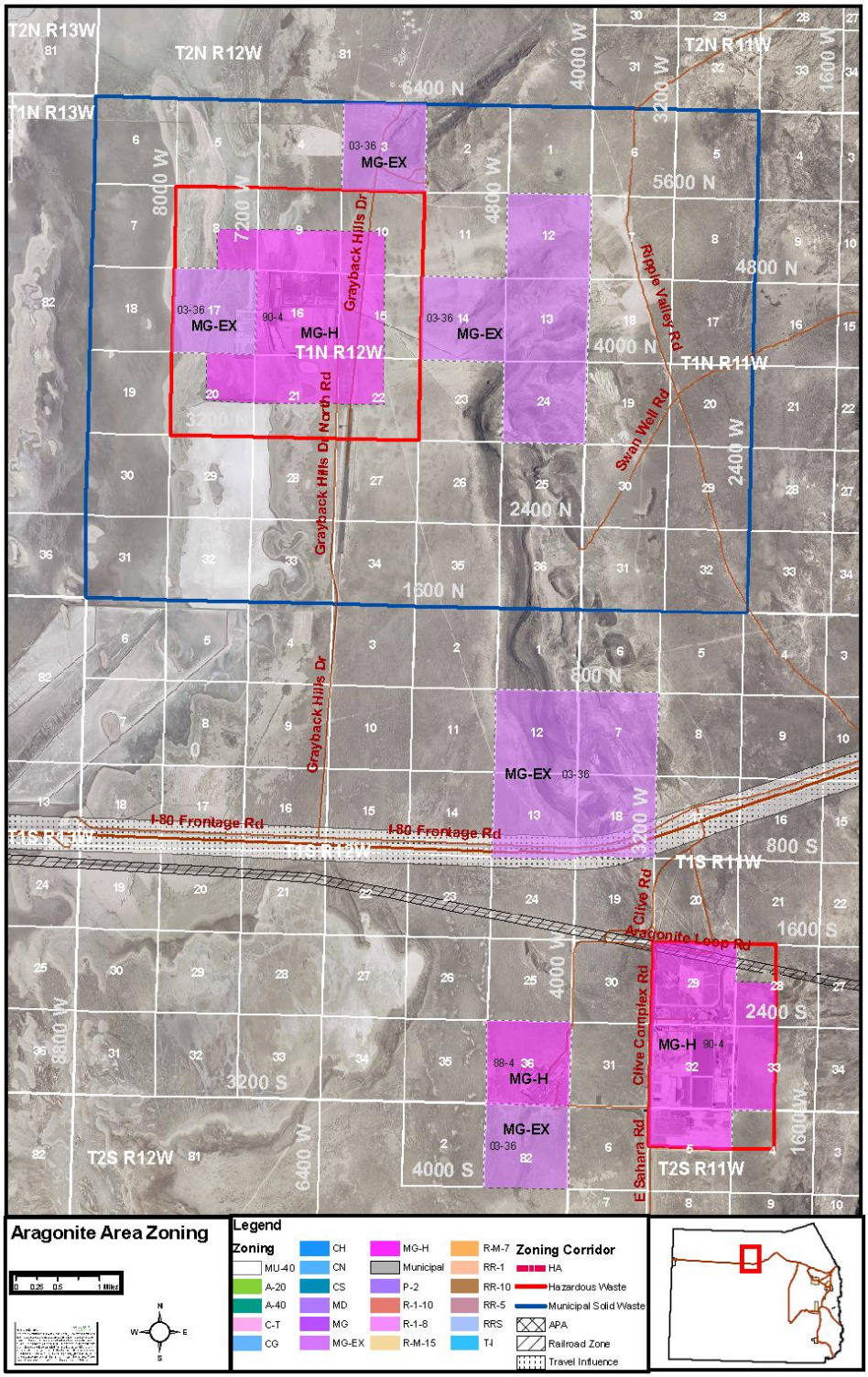

Figure 2-4. Tooele County Hazardous Industrial District Zoning.

2.2.2 Subsurface Interests

In response to a request made by the Division, Energy*Solutions* requested that the Division of Water Rights place a restricted groundwater-rights area designation around the Clive facility. The purpose of this request was to ensure that water rights and groundwater withdraws from Energy*Solutions*' facility would be prohibited. As part of the request, Energy*Solutions* submitted a comprehensive Groundwater Institutional Control Plan that proposed both restricted water rights and determined appropriate horizontal and vertical zones around the facility that would effectively isolate it. However, on January 6, 2006 this request was denied. Because groundwater is controlled by the State and not individual entities, the Division of Water Rights could not grant Energy*Solutions'* request. As such, Energy*Solutions* has dropped its request to restrict the groundwater rights in the area. No other efforts have been undertaken regarding ownership or protection of subsurface interests.

2.2.3 Land Records

An affidavit discussing operations at Clive was filed with Energy*Solutions*' land ownership records at the Tooele County office, on April 6, 1989. The affidavit states that the land at Clive has been or may be used to manage radioactive and hazardous waste and that the post-closure use of such land is restricted under 40 CFR 264 117(c).

2.2.4 Cost of Land Transfer

Funds for the closure, remediation and long-term surveillance of the 11e.(2) Embankment are discussed in Section 6.6.1 of this License Renewal Application. Upon State of Utah request to draw upon the irrevocable letter of credit established at Zions First National Bank, funds are maintained in trust for the benefit of the State of Utah with Wells Fargo Bank. Furthermore, the State of Utah has established a Perpetual Care Fund for the entire Clive site with a target initial minimum balance of $100 million at the conclusion of the post-closure monitoring period (i.e., year 101 after site closure). The Perpetual Care Fund is funded by an annual payment and earnings accrued to the fund cash balance with an irrevocable letter of credit bringing the current total value to $13 million. Any land transfer costs are covered under administrative and legal fees accounted for in Energy*Solutions*' 11e.(2) Surety. In accordance with the requirements of 10 CFR Part 40.28, the ownership of the 11e.(2) Embankment will eventually be transferred to DOE, another Federal Agency designated by the President, or the State of Utah. The land will be transferred at no cost to DOE.

2.3 POPULATION DISTRIBUTION

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (a) An assessment of the radiological and non-radiological impacts to the public health from the activities to be conducted pursuant to the license or amendment;" **– R313-24-3(1)(a).**

"The licensee shall conduct an annual land use survey for a 5 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 annual report." **– License Condition 12.4**

While an estimated 41,000 people resided within 50 miles of the Clive site at the time of the 2010 Census, most of the immediate area is uninhabited. The closest resident lives roughly seven miles to the northeast of the site, and acts as a caretaker for the rest stop just off I-80. As is illustrated in Table 2-1, the largest group of people live 48 - 80.5 miles to the east and southeast of the site in the Tooele-Grantsville area.

Table 2-2 summarizes a study projecting that Tooele County will increase its population at an annual rate of 5 percent until the year 2020 (with a projected 2010 Tooele County population of 62,364), (Thomas Consultants, Inc, 2002). In this study, it is projected that Tooele City and Grantsville would continue to be the areas of greatest growth, with growth rates of roughly five percent to six percent per year, through the year 2020. Since the 2010 U.S. Census (released after completion of the Thomas Consultants, Inc, 2002 study) documents the Tooele County population as 58,218 (6.6% lower than that estimated by the Assessment), the 2002 Tooele Valley Demographic and Market Assessment is considered conservative.

The remoteness of the site from the urbanized area of Tooele County makes the surrounding area an improbable location for any other significant industrial use. This was one of the chief reasons for its selection as a disposal site in the Vitro project. Additionally, the Tooele County Commission has designated the area around the Clive site as a hazardous industries zone by Tooele County. This designation prohibits all residential housing in the vicinity of the Clive site. Also, NRC identified the absence of any culinary water sources at the Clive Facility as a major deterrent to any potential population growth within a 12-kilometer radius (NRC, 1993c). Although the NRC projection is nearly 20 years old, it remains reasonable as evidenced by the lack of development in the intervening years.

2.4 HISTORIC, SCENIC, AND CULTURAL RESOURCES

"In order to assure 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 Executive Secretary and the Utah State Historic Preservation Office (SHPO). The artifacts shall be inventoried and evaluated in accordance with UCA Section 404, and no disturbance shall occur until the licensee has received written authorization from the Executive Secretary and SHPO to proceed." **– License Condition 9.5**

In order to assure that no disturbance of cultural resources occurs, Condition 9.5 of the current 11e.(2) Radioactive Material License requires Energy*Solutions* to cease any work resulting in the discovery of previously unknown cultural or historical artifacts and report the discovery, in writing, to the Division's Director and the Utah State Historic Preservation Office (SHPO). In such a case, Energy*Solutions* and SHPO will ensure that the artifacts are inventoried and evaluated in accordance with UCA Section 404, and no further disturbance will occur until Energy*Solutions* receives written authorization from the Division Director and SHPO to proceed. Protection of historic, scenic, and cultural resources is discussed further in the 11e.(2) Environmental Assessment (Appendix H).

Table 2-1

12-Kilometer Population Wheel

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

Table 2-2

Tooele County Growth Projection: 2005-2020

Area	Pop. 2002	Annual Growth Rate 2001-2005	Pop 2005	Annual Growth Rate 2005-2010	Pop 2010*	Annual Growth Rate 2010-2015	Pop 2015	Annual Growth Rate 2015-2020	Pop 2020
Tooele City	23,493	2.40%	25,225	6.34%	34,301	4.49%	42,724	5.47%	55,763
Grantsville	6,307	2.40%	6,772	6.34%	9,209	4.98%	11,742	4.98%	14,971
Lake Point/ Stansbury Park	6,093	0.47%	6,179	0.30%	6,273	0.35%	6,384	0.33%	6,490
Stockton	465	2.39%	499	6.32%	678	4.99%	865	4.98%	1,103
[redacted]									
Tooele County	42,714	2.40%	45,864	6.34%	62,364	4.98%	79,516	4.98%	101,386

Information prepared by Thomas Consultants Inc., 2002 & Source: Tooele County Engineering Department 2002,

* By comparison, the 2010 U.S. Census reported a total population for Tooele County of 58,218 (Census, 2010)

2.5 METEOROLOGY AND CLIMATOLOGY

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (a) An assessment of the radiological and non-radiological impacts to the public health from the activities to be conducted pursuant to the license or amendment;" **– R313-24-3(1)(a).**

"*Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100.*" **– R313-24-4, 10 CFR 40.41(c).**

"*Each licensee authorized to possess and use source material in uranium milling, in production of uranium hexafluoride, or in a uranium enrichment facility shall: (1) Within 60 days after January 1, 1976 and July 1, 1976, and within 60 days after January 1 and July 1 of each year thereafter, submit a report to the Executive Secretary, Division of Radiation Control, using an appropriate method listed in §40.5; the report must specify the quantity of each of the principal radionuclides released to unrestricted areas in liquid and in gaseous effluents during the previous six months of operation, and such other information as the Executive Secretary may require to estimate maximum potential annual radiation doses to the public resulting from effluent releases. If quantities of radioactive materials released during the reporting period are significantly above the licensee's design objectives previously reviewed as part of the licensing action, the report shall cover this specifically. On the basis of such reports and any additional information the Executive Secretary may obtain from the licensee or others, the Executive Secretary may from time to time require the licensee to take such action as the Executive Secretary deems appropriate."* **– 10 CFR 40.65(a)(1).**

Energy*Solutions* has operated a weather station at Clive since July 1992. The station monitors wind speed and direction, 2-m and 10-m temperatures, precipitation, pan evaporation and solar radiation. A 19-year Summary Report from January 1, 1993 through December 31, 2011 was provided to the Division on February 23, 2012 (McCandless, 2012). Since the 11e.(2) Embankment is located entirely within Section 32, this information adequately characterizes the site. Furthermore, the 11e.(2) Embankment has no significant effects upon the meteorological conditions or air quality of the region.

2.5.1 Weather Patterns

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

Mountain ranges tend to restrict the movement of weather systems into the area, but it is occasionally affected by well-developed storms in the prevailing regional westerlies. The mountains act as a barrier to frequent invasions of cold continental air. Precipitation is generally light during the summer and early fall

and reaches a maximum in spring when storms from the Pacific Ocean are strong enough to move over the mountains. During the late fall and winter months, high pressure systems tend to settle in the area for as long as several weeks at a time.

2.5.2 Winds

In the 19-year period of time (July 1992 through December 2011) the most frequent (and predominant) winds were from the south-southwest direction, with the second most frequent direction being the east-northeast, followed by the south. Wind Rose data summarized in Figure 2-5 has been obtained from the on-site weather station and checked for accuracy by a certified meteorologist (MSI, 2012).

2.5.3 Temperature

Temperatures at Clive range from an hourly minimum to hourly maximum of -25.5 to 41.3 degrees C. Monthly mean temperatures have been found to range from -2.5 degrees C in December to 26.4 degrees C in July. According to the data generated over the last 19 years, the coldest month of the year at the Clive site is December, while the warmest month of the year is July.

2.5.4 Precipitation

The Clive site receives an average of 8.62 inches of precipitation per year. Measurements taken at the Clive site showed that the lowest monthly precipitation recorded was 0 inches in May 2001. The highest recorded monthly precipitation was 4.28 inches, in May 2011.

2.5.5 Evaporation

Pan evaporation measurements are taken from April through October when ambient temperatures remain above freezing. Maximum hourly evaporation values usually occur in July. The 17-year average annual evaporation at the Clive site is 52.73 inches (excluding 2 years of reported instrument malfunction).

2.5.6 Severe Weather Phenomena

Severe weather phenomena in the west desert-region of Utah is likely to take one of four forms: tornadoes, severe thunderstorms, damaging hail, or dust devils. Tornadoes are rare phenomena in the State of Utah primarily due to the lack of atmospheric moisture and the presence of mountainous terrain. Utah tornadoes tend to be much weaker and smaller than their central U.S. counterparts. Utah tornadoes stay on the ground for an average of only a few minutes and their path widths are usually one-eighth of a mile or less. Five tornadoes were observed in Tooele County for the period 1847–2010 (Brough, et.al; 2010). Based on this historic record, the probability of a tornado strike at any one point in Tooele County is extremely low. Although tornadoes are very rare and not statistically likely to strike the Clive site, they are amongst weather phenomena that can occur in the State of Utah. A safety assessment for this meteorological occurrence is discussed in Section 7.5.4 of this License Renewal Application.

While thunderstorms are fairly common over Utah, especially in the late summer months, typically these storms are not severe. The Dugway, Utah station records an average of 20 thunderstorm-days per year. Assuming that 10% of these thunderstorms develop into the severe category, this equates to two high-speed wind events (50 knots or greater) at the Clive site per year. A safety assessment of accidental releases due to high winds is discussed in Section 7.5.4 of this License Renewal Application.

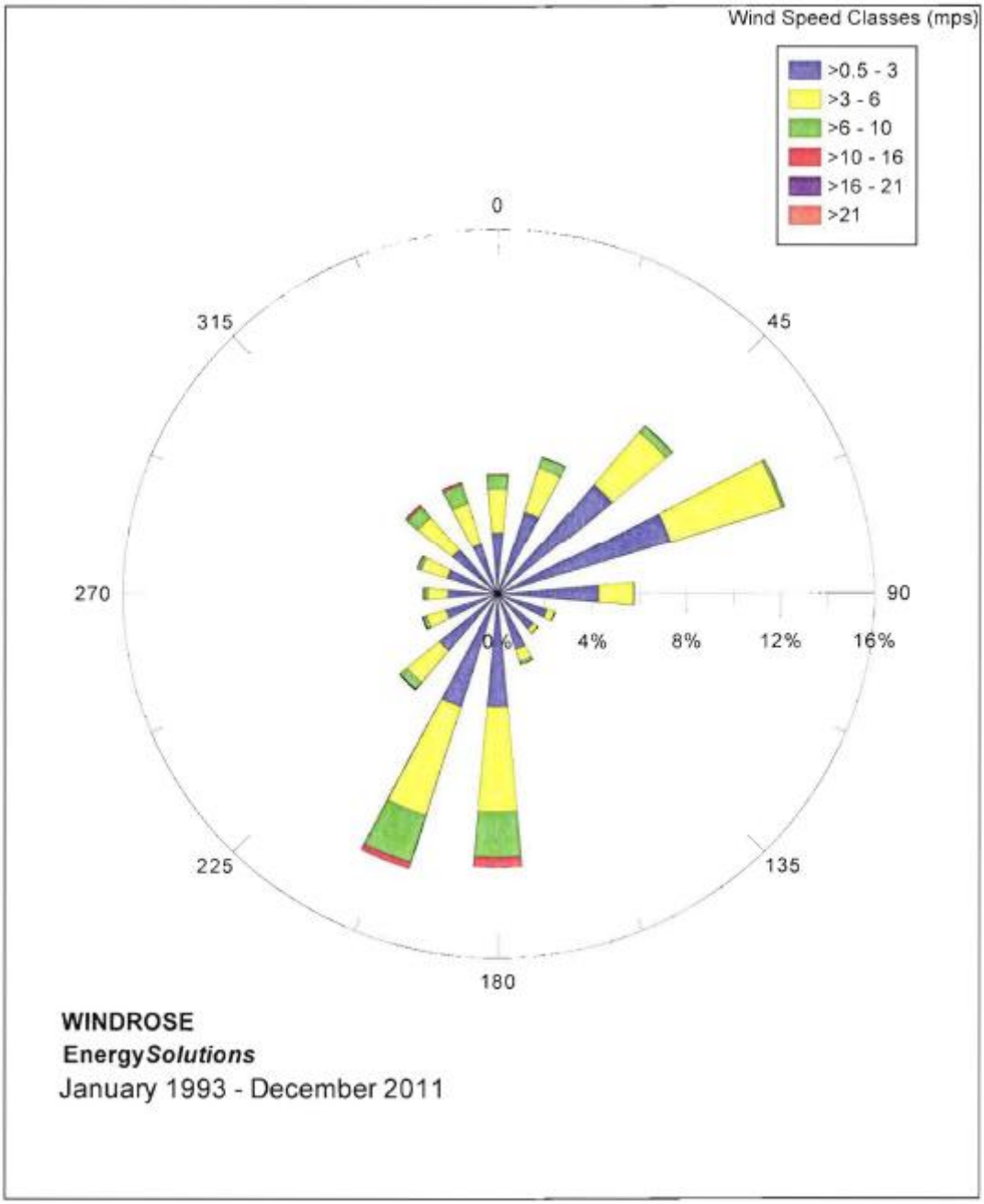

Figure 2-5. Energy*Solutions* Wind Rose July 1992 – December 2011 (MSI, 2012).

Large damaging hail is a rare phenomenon in the State of Utah, primarily due to the lack of atmospheric moisture needed to develop strong thunderstorms and related hail. During the last 60 years, there have been four severe thunderstorm events in Tooele County with reported hail damage (Brough, et.al; 2010). Two of these reports indicated hail with a diameter of one inch or greater. A return interval of 10–15 years for a storm with potential damaging hail is possible for the Energy*Solutions* site. A safety assessment for this meteorological occurrence is discussed in Section 7.5.4 of this License Renewal Application.

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

2.6 GEOLOGY AND SEISMOLOGY

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (a) An assessment of the radiological and non-radiological impacts to the public health from the activities to be conducted pursuant to the license or amendment;" **– R313-24-3(1)(a).**

"*Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100.*" **– R313-24-4, 10 CFR 40.41(c).**

The Energy*Solutions* Clive site is located on the eastern fringe of the Great Salt Lake Desert. Geophysical surveys performed in the region included (1) a regional gravity survey conducted over a study area that included the eastern half of the Great Salt Lake Desert - performed by the University of Utah Geophysics Department between 1957 and 1961 (Cook et. al, 1964); and (2) an earth resistivity survey (Bisdorf and Zohdy, 1980) conducted in the Fish Springs area, about 50 miles south of the site to delineate faults and their influence on springs in the area. Energy*Solutions* has relied upon geologic mapping and existing geophysical survey information. The gravity data was used to determine regional geologic conditions (Cook et. al, 1964). Many basin and range faults, grabens and horsts are indicated in Cook's report on the Great Salt Lake Desert study area.

The Utah Department of Natural Resources has prepared two hydrologic reports for the Great Salt Lake Desert area (Stephens, 1974; UDNR, 1981). These reports provide a description of physiographic conditions, regional characteristics, groundwater aquifers, flow characteristics and water quality. In addition to these studies and reports, the U.S. Geological Survey has prepared geologic and surface water resources maps (Moore, 1979; Bucknam, 1977). The most recent characterization of the site geology and hydrogeology is reported in the Revised Hydrogeologic Report prepared by Energy*Solutions* in August, 2004 (Envirocare, 2004).

2.6.1 Regional Geology

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

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

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

2.6.2 Site Geology

The site rests on Quaternary lakebed deposits of Lake Bonneville. Site subsurface logs indicate that lacustrine deposits extend to at least 500 feet underneath the site. The underlying Tertiary and Quaternary age valley fill is composed of semi-consolidated clays, sands, and gravel where it comes in contact with bedrock. Although the exact depth to and relationships of various bedrock units are unknown, the presence of nearby outcrops and the regional block-faulted basins suggest that the valley-fill deposits are relatively thin within the area of the site. Estimated down-dip projections from bedrock outcrop on the southwest corner of Section 31 and bedrock found at depth in Clean Harbors wells suggest that the contact may dip to the east about three degrees.

The Energy*Solutions* site is located in, and is bounded by, the Great Salt Lake Desert to the west at approximate elevations of 4,250 to 4,300 feet above mean sea level (amsl). Also to the west, low-lying hills rise 50 to 100 feet from the desert floor. To the east and southeast, the site is bounded by the north-south trending Lone Mountains, which rise to a height of 5,362 feet amsl. At the base of the Lone Mountains alluvial fans slope gently toward the west at a gradient of approximately 40 feet per mile. The site has topographic relief of approximately 11 feet, sloping in a southwest direction at a gradient of approximately 0.0019.

To the north of the site are the Grayback Hills, composed of limestone and quartzite mapped as Permian-Pennsylvanian Oquirrh Formation, which is as much as 10,000 feet thick in western Utah. Igneous extrusives form a resistant cap on the Grayback Hills, and are mapped as Pliocene-age basalt/rhyolite, (Montgomery Watson, 2007).

Geomorphic processes at the site are limited to micro processes that occur in the soil. For example the Great Salt Lake Desert is located in a semiarid to arid region where precipitation is less than evaporation. The soil moisture is available by infiltration and lateral flow as groundwater from adjacent mountain slopes and the water is drawn upward through the soil by capillarity and evaporates either in the soil profile or at the ground surface. When the soil water evaporates, dissolved mineral matter is precipitated and form calcium carbonate, gypsum and alkali (sodium and potassium carbonates) in the soil. Macro geomorphic processes are almost nonexistent where the general rate of weathering is very slow. This is due to the low amounts of precipitation, the lack of fluvial activities and the lack of relief at the site.

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

2.6.3 Seismicity

In a study conducted for a separate licensing effort by Energy*Solutions*, AMEC presented an updated assessment of the seismic hazard for the Clive Facility consistent with the requirements of the Utah Code of Regulations R313-25-8(5) (AMEC, 2012). The seismic hazard assessment is based on an assessment of the peak ground acceleration (PGA) associated with the Maximum Credible Earthquake (MCE) for known active or potentially active faults in the site region (shown in Figure 2-6), and the PGA obtained from a probabilistic seismic hazard analysis (PSHA) to assess the seismic hazard for earthquakes that may occur on unknown faults in the area surrounding the project site (i.e., background seismicity). For fault sources, the PGA is calculated at the 84th percentile level and is based on the maximum rupture length and rupture area for each fault. The return period for ground motions resulting from a background earthquake is identified as 5,000 years (equal to a one percent probability of exceedance in 50 years). The approach to select a MCE PGA from the larger of the values associated with the deterministic MCE for faults or the PSHA result for background earthquakes at a 5,000 year return period is consistent with requirements of the Utah Division of Water Rights (Dam Safety Section) for assessment of dams.

For the Stansbury fault, the maximum magnitude was assessed as MW 7.3 based on consideration of the maximum rupture length, fault width, and maximum fault displacement. The maximum of the 84th percentile PGA values calculated for the M_{max} events on the fault sources is equal to 0.24g, as obtained for the Stansbury and the Skull Valley faults.

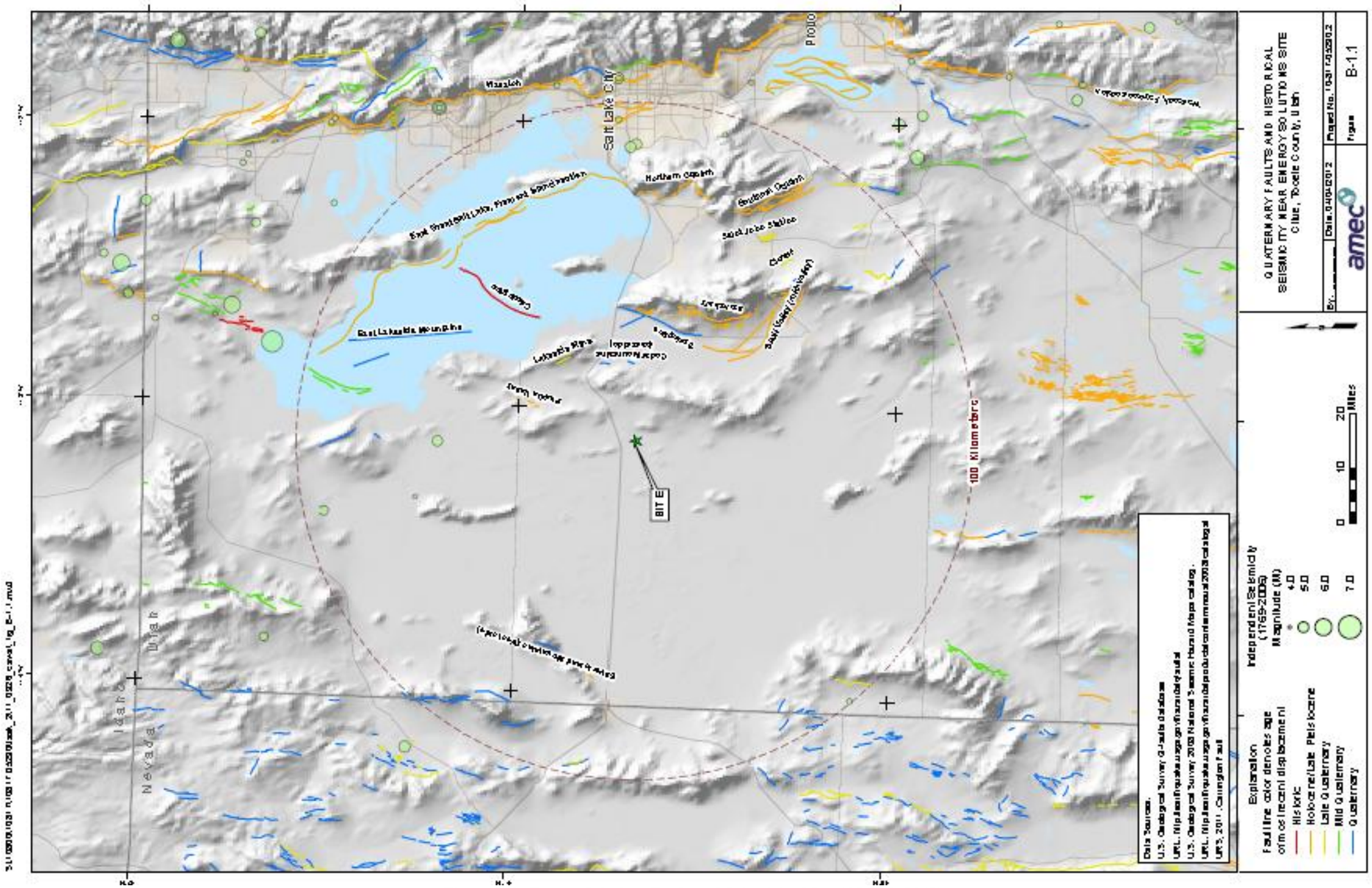

Figure 2-6. Energy*Solutions* Fault and Seismicity Map (AMEC, 2012).

Liquefaction is a soil behavior phenomenon in which saturated, medium dense to loose, sand-type soils experience losses of shear strength and stiffness associated with accumulation of excess pore-pressures that develops during seismic shaking. The liquefaction potential was considered for each of Clive's four subsurface geologic units. Unit 4 and the majority of Unit 3 is in an unsaturated state and are considered non-liquefiable, due to lack of saturation because the water table depth is 22 feet below site grade. The remainder of Unit 3 is typically too dense to liquefy. Also, a factor of safety for Unit 3 was calculated to be above 1. However, a liquefiable layer from 25.3 to 26.9 feet was encountered. This layer had an average factor of safety of 0.61.

Unit 2 is primarily clay-like in nature consisting of clay and silt with seams of sand. Sand seams are generally less than 1 foot, but range up to 3 feet. These sand layers are generally dense and have corresponding factors of safety greater than 1. Liquefaction analyses within Unit 2 indicate cumulative liquefiable thicknesses ranging from 2 to 14 inches with no individual liquefiable layer exceeding 6 inches. Several of the individual layers are confined by soft clays. Based upon low liquefaction potential due to thin liquefiable layers and the predominantly clay-like soils within this unit, a cyclic shear softening analysis was applied to Unit 2, in lieu of a liquefaction analysis appropriate for sand-like soils.

Unit 1 is characterized as interbedded sand, silt and clay. Generally, soil intervals demonstrating sand-like behavior within this unit are dense. The data indicates that approximately 98 percent of soils in this unit, exhibiting sand-like characteristics, have a factor of safety greater than 1. These soils were classified as not susceptible to liquefaction-type behavior.

The density profile of sand-like soils is laterally and vertically variable, but is generally dense. Thin liquefiable layers are encountered in the soil profile, but they tend to be discontinuous and are generally not encountered in adjacent tests or borings. The lack of a continuous liquefiable layer beneath the site reduces the likelihood of lateral spread due to the resistance of non-liquefiable material between discontinuous layers. Due to site topography, thin discontinuous liquefiable layers, and a generally dense profile with significant density variability across short distances and at variable depths, AMEC projected the likelihood of liquefaction-induced lateral spread occurring at the Clive Facility to be very low.

In addition to the liquefaction evaluation of the "sand-like" soils, AMEC evaluated the potential for cyclic softening in "clay-like" soils underlying the Clive Facility. Based on their analysis, the factors of safety against cyclic softening within Units 2 and 4 are greater than 1.0 and therefore cyclic softening of the clay-like soils at the site is considered to be negligible.

2.7 HYDROLOGY AND HYDROGEOLOGY

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (b) An assessment of any impact on waterways and groundwater resulting from the activities conducted pursuant to the license or amendment;" **– R313-24-3(1)(b).**

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall

carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." – **R313-24-4, 10 CFR 40.41(c).**

DOE performed initial detailed hydrogeologic investigations within Section 32 in the 1980s. Since Energy*Solutions*' operations began in 1988, many additional studies have been performed at the site in order to more accurately characterize the hydrogeology. In August 2004, Energy*Solutions* prepared a Revised Hydrogeologic Report that summarizes the hydrogeology of the site based upon historical data and prior hydrogeologic reports (Envirocare, 2004). An updated hydrogeologic report is under preparation in advance of renewal of the Ground Water Quality Discharge Permit. This update is scheduled for submittal to the Division by December, 2012.

2.7.1 Hydrogeology

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

Four hydrostratigraphic units have been delineated in the unsaturated zone and shallow aquifer system at the Clive Facility, consisting of an upper silty clay/clayey silt (Unit 4), an upper silty sand (Unit 3), a middle silty clay (Unit 2), and a lower sand/silty sand (Unit 1). The site aquifer system consists of a shallow unconfined aquifer that extends through the upper 40 feet of lacustrine deposits. A confined aquifer begins around 40 to 45 feet below the ground surface and continues through the valley fill. Due to the low precipitation and relatively high evapotranspiration, little or no precipitation reaches the upper unconfined aquifer as direct vertical infiltration. Groundwater recharge is primarily due to infiltration at bedrock and alluvial fan deposits which then travels laterally and vertically through the unconfined and confined aquifers. Groundwater flow in this area is generally directed northeasterly to northwesterly.

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

2.7.2 Groundwater Flow Regime

The groundwater flow regime at the Energy*Solutions* Clive Facility has been evaluated and defined based on (1) information collected from water level measurements, (2) the aquifer hydraulic properties which were calculated from slug out tests and laboratory testing, (3) isotope dating of groundwater, and (4) hydraulic testing performed for wells in the shallow and deep aquifers. Water levels obtained from monitoring wells between 1991 and 2004 were used to develop contour maps and flow nets to define the direction of groundwater flow and hydraulic gradients within the aquifers. These data were then combined with measured hydraulic conductivities to develop estimates of groundwater velocities.

Aquifer tests performed within Section 32 include pumping and slug tests performed as part of DOE's investigations for disposal of the Vitro tailings (DOE, 1984). Energy*Solutions* has supplemented these data

by performing more recent slug extraction tests in monitor wells or piezometers (Whetstone, 2001). The pumping tests and slug tests performed for DOE are summarized in Disposal Site Characterization Report for the Uranium Mill Tailings Site (DOE, 1985b). Pumping tests were performed with observation wells utilized to obtain drawdown and recovery measurements. Review of the drill hole logs and well construction details indicates that the pumping wells were installed in Unit 1, which is the upper part of the confined aquifer at the site. However, some of the pumping wells and observations wells were screened over Unit 1 and part of Unit 2. Therefore these tests are representative of the aquifer properties of Unit 1. Based on an assumed saturated thickness of 12 feet and a transmissivity of 40 ft^2/day, the horizontal hydraulic conductivity is estimated to be on the order of $1.0x10^{-4}$ cm/sec.

In January and February of 1997, Adrian Brown Consultants performed slug tests of 44 wells at the site to reduce uncertainty associated with previous slug test results (Adrian Brown Consultants, 1997). These more recent data was used in the development of revised groundwater modeling for the site. These slug tests were performed on wells screened within Unit 2 and/or Units 2 and 3. Adrian Brown Consultants reported a site-wide Unit 2 clay hydraulic conductivity of $2.98x10^{-4}$ cm/sec; with minimum and maximum values of $2.23x10^{-6}$ cm/sec and $4.30x10^{-3}$ cm/sec, respectively. The Unit 2, clayey material exhibits a vertical saturated hydraulic conductivity of $5.95x10^{-4}$ cm/sec. The Unit 3 sandy material exhibits a saturated hydraulic conductivity of $3.19x10^{-4}$ cm/sec.

The vertical hydraulic conductivity of Unit 1 was measured in the laboratory using soil core samples collected during the installation of deep well GW-139D located near the northeast corner of the Class A North Embankment (Energy*Solutions*, 2010). The samples were obtained from 43 to 60 feet below ground surface in Unit 1. Vertical conductivities ranged from $2.2x10^{-8}$ to $1.6x10^{-6}$ cm/sec, with an arithmetic mean of $2.9x10^{-7}$ cm/sec.

2.7.2.1 Groundwater Levels

Characterization of the shallow, unconfined groundwater surface was based on numerous sets of groundwater levels measured between February 1991 and August 2004. The data were previously provided to the Division in the Semi-Annual Groundwater Quality Reports and summarized in the Revised Hydrogeologic Report (Appendix E of Energy*Solutions*, 2005b). Review of the groundwater level data indicates that water level fluctuations are generally on the order of 2 to 3 feet, with the exception of localized groundwater mounds discussed further below. Recent wells installed by Energy*Solutions* indicate much smaller groundwater fluctuations (ranging on the order of one-half to one foot over the past few years). The groundwater surface is relatively flat in Section 32, with elevations varying about two feet per mile.

Water level measurements from deeper monitor wells screened in Unit 1 between 70 and 100 feet below the ground surface have also been obtained and analyzed. When comparing water levels within deep and shallow monitor well clusters, the deep wells exhibit higher piezometric levels than the shallow wells, indicating an upward vertical gradient of approximately one foot based on fresh water equivalent heads. While this is offset somewhat by the downward density gradient of 0.2 feet, overall groundwater flow is from the confined to the unconfined aquifer. Based on the historic minimum depth to groundwater, groundwater levels would need to rise some 18 feet below the 11e.(2) Embankment to begin to threaten contact with disposed waste The historic minimum depth for this area is roughly 24 feet below original contour. The 11e.(2) Embankment is constructed by excavating approximately eight feet below the ground surface, then constructing a two-foot thick liner of compacted low-permeability clay. Therefore, the groundwater would need to rise 18 feet and pass through the liner to threaten disposed waste.

Residual effects of three groundwater mounds that developed within or in the vicinity of the 11e.(2) Embankment are apparent in piezometric surface maps derived from monthly water level measurements at the facility. All three mounds were created by focused infiltration of non-contact (i.e., uncontaminated) surface water resulting from precipitation events.

A mound was first noticed in monitoring wells GW-36, GW-37, and GW-38 in the spring of 1993 when groundwater elevations increased over 5 feet in GW-37, 2.5 feet in GW-38, and 1 foot in GW-36. Groundwater elevation increases also occurred during the summer of 1995 with highest elevations occurring during this time. The cause of groundwater mounding in this area was the ponding of run-off water shed from the Vitro Embankment into the center of the 11e.(2) footprint. This area formed a catchment basin that accumulated run-off water as much as two feet deep over an area of at least one acre. This depression was formed in the 11e.(2) Embankment footprint where clay material was removed during the construction and completion of the Vitro Embankment by the State of Utah. Vitro run-off is currently being diverted into a drainage ditch that transports run-off water away from the 11e.(2) area and into a collection pond located in the northeast portion of Section 6 (the Southwest Evaporation Pond). In addition, Energy*Solutions* isolated the Vitro borrow area as well as current borrow areas to prevent surface water flow into these depressions.

A second mound formed in the area of monitoring well GW-19A during the summer of 1998. Groundwater elevations in GW-19A went from 4251.15 ft amsl on February 19, 1998, to 4,252.69 ft amsl on August 20, 1998. Groundwater elevation in GW-19A peaked on June 18, 1999, at 4,254.61 ft amsl. Increased groundwater elevations in GW-19A were due to mounding resulting from leakage from the Southwest Evaporation Pond. This pond is located up gradient of GW-19A. Subsequently, pond contents were removed and the pond was retrofitted for two liners and a leak detection system. Piezometer PZ-1 was installed down gradient of the pond and is monitored monthly to verify proper operation of the pond. Subsequently, the pond has overflowed from the outlet in response to periods of elevated precipitation, and the overflowing water has infiltrated and reached the groundwater table. Energy*Solutions* is currently extracting groundwater near the pond to reduce the mound. Energy*Solutions* is also actively removing water from the pond for dust suppression to reduce the potential for overflow.

A third area of groundwater mounding is located near monitoring wells GW-29 and GW-60. Although the extent is less than that associated with the mounds discussed above, this mounding may affect water levels in the southeast corner of the 11e.(2) Embankment. In April 2006, a groundwater mound formed near GW-29 in response to infiltration of surface water in an area where the LARW drainage joined the 11e.(2) drainage ditch. The culvert between LARW and 11e.(2) was replaced in May 2006, and the groundwater elevation at GW-29 rapidly decreased for the next several months and has been on a slow decline since. Water elevations at GW-60 have fluctuated from 2003 to present due to localized recharge associated with the embankment runoff drainage system. Elevations have increased rapidly following large precipitation events and have decreased rapidly. Peak elevations of 3 to 9 feet above static have been observed. Since construction of a runoff lift station immediately south of the south access road in late summer 2009, Energy*Solutions* has actively removed water collecting in the station to reduce infiltration.

2.7.2.2 Groundwater Gradients and Velocities

Horizontal ground water gradients in the shallow aquifer range from 6.77×10^{-6} to 4.49×10^{-3}. The site-wide average gradient is 5.78×10^{-4}. Using these gradients and a hydraulic conductivity of 0.09 ft/day, an average horizontal velocity of 1.48×10^{-6} ft/day is calculated (Envirocare, 2004).

Vertical groundwater gradient and velocity were estimated by comparing the potential head between monitor wells completed in the shallow and deep aquifers: (1) at the midpoint of the saturated filter packs, and (2) the midpoint of intervening Unit 2. Both methods resulted in a downward vertical gradient near well pair GW-19A/GW-19B, located in the southwest corner of the facility, and an upward gradient near wells I-3-30/I-3-100, north of the Mixed Waste Landfill cell. However, the magnitude of the downward gradient near the GW-19A/GW-19B well pair is artificially enhanced by the infiltration of overflow from the Southwest Evaporation Pond in the southwest corner of the site (Section 2.7.2.1). The low magnitude of the upward vertical gradient elsewhere beneath the facility may indicate that the two aquifers are likely subsets of a continuous aquifer system separated by low conductivity clay strata, and that vertical flow is not significant either upward or downward.

2.7.3 Groundwater Aquifer System

The aquifer system investigated in the area of the Energy*Solutions* Clive Facility consists of unconsolidated basin-fill and alluvial-fan aquifers which extend to depths on the order of 500 feet below Section 32. The lacustrine deposits, which comprise the majority of the aquifer system below the Clive Facility, are somewhat variable in depth and thickness, and this makes the exact delineation of aquifers and aquitards difficult. Characterization of the aquifer system as a whole is based on subsurface stratigraphy and potentiometric data. A shallow, unconfined aquifer has been identified in the upper 20 to 40 feet separated from a deeper, confined aquifer by layers of primarily silty clay material (Unit 2) occurring between 30 and 45 feet deep. Low, vertical hydraulic conductivity characterize both the aquifers and aquitards, but the water-bearing zones exhibit relatively high horizontal hydraulic conductivity in relation to the aquitard.

2.7.3.1 Shallow Unconfined Aquifer

The shallow, unconfined aquifer typically consists of the upper 40 feet of lacustrine deposits, and the groundwater surface ranges from 19 to 31 feet below the ground surface (with a historic minimum depth of approximately 24 feet). The unsaturated zone consists of an upper 8 to 15 foot thick silty clay and clayey silt (Unit 4) that overlies a 10 to 20 foot thick silty sand layer (Unit 3). Groundwater occurs within the lower part of Unit 3 below the majority of the 11e.(2) area and the primary movement of groundwater is assumed to be in the silty sand lenses and layer of the shallow, unconfined aquifer.

Below this silty sand layer, a silty clay deposit (Unit 2) is present at variable depths and thickness. It appears that this silty clay layer is continuous based on exploratory boreholes and monitoring well installations. The top of Unit 2 generally slopes down from east to west across Section 32.

There are two possible groundwater flow mechanisms for leachate beneath the Energy*Solutions* Clive facility – one is vertical movement through the unsaturated zone to the saturated zone, the other is vertical movement to the boundary between Unit 3 and Unit 2, then along the top of Unit 2 sloping to the west until the top of Unit 2 meets the groundwater table. If leachate moved through this second mechanism, depending on the irregularity of the top of Unit 2 and on the localized slope and the permeability of the clay, potential leachate may also migrate through Unit 2 until it reaches the shallow groundwater surface.

Unit 1, which consists of a relatively thick silty sand layer, is present below the silty clay (Unit 2) at depths ranging from 40 to 45 feet below the ground surface. Wells and piezometers, which penetrate into Unit 1, typically exhibit higher freshwater equivalent heads than wells screened shallower in Units 2 and/or 3.

The shallow aquifer contains saline water with TDS concentrations ranging from 32,000 mg/L in monitoring wells GW-26 and GW-63, to 74,000 mg/L in monitoring well GW-19A, and is classified as

Class IV groundwater based on the criteria of TDS greater than 10,000 mg/l of the Utah Ground Water Quality Protection Regulations. The saline water typically exhibits a specific gravity averaging 1.033.

The majority of the recharge to the shallow aquifer appears to occur as vertical leakage from the deeper confined aquifer. In addition, a small amount of vertical infiltration from the surface and some lateral movement of water from the recharge zone to the east probably occurs. Movement in the shallow aquifer is primarily laterally to the north, northeast and/or northwest.

2.7.3.2 Confined Aquifer

The confined aquifer consists primarily of lacustrine deposits in Unit 1, which occurs below a depth of 40 to 45 feet. This deeper aquifer primarily consists of silty sand deposits with occasional silty clay layers and is overlain by one or more silty clay layers. Wells completed with screened intervals located at least 70 to 100 feet below the ground surface have static fresh water equivalent levels ranging from 3 to 18 inches above wells screened in the shallow, unconfined aquifer.

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

2.7.4 Groundwater Quality

Available groundwater quality data indicates that the shallow, unconfined aquifer exhibits variable quality within both the 11e.(2) area and more generally within Section 32. Seasonal variations in water quality appear to be relatively small. However, spatial variations appear to be significant. One indicator parameter, TDS, had concentrations ranging from 24,000 to 53,000 mg/L, in monitoring wells GW-26 and GW-63, to 74,000 mg/l in well GW-19A, in and adjacent to the 11e.(2) area with no apparent pattern or trend to the variations. Deeper screened wells below 70 feet appear to exhibit lower TDS values than the shallow screened wells. There are significant water quality variations in the shallow, unconfined aquifer possibly due to the variations in subsurface soils that leach salts to the groundwater and the small gradients and corresponding velocities in the shallow groundwater system, which limit the mixing of the groundwater. Variations may also be related to groundwater mounding, which may dilute concentrations (e.g., GW-60) or may increase some concentrations (e.g., GW-19A).

The deeper confined aquifer exhibits slightly better water quality. However, it is still saline with TDS on the order of 20,000 mg/l. The groundwater aquifer classification system established in the State of Utah Groundwater Quality Protection Regulations designates both the shallow and deeper aquifers as Class IV aquifers, based on TDS above 10,000 mg/l; a classification equivalent to the EPA's Class III.

The major effects of locally increased water elevations in the 11e.(2) area have been changes in groundwater chemistries and local gradients. Mounding has caused increases in TDS, some metals, and total uranium. These increases are the result of re-dissolution of naturally occurring constituents of the lake sediments underlying the Clive facility. The increased water levels have also caused a downward switch in gradients at the southwest corner of the site, as evidenced by data collected at the GW-19A/B well nest. It has been observed that as the mound decreases, and the site conditions return to normal, the vertical gradient in GW-19A/B has decreased. It is anticipated that the gradient in this area will eventually return to regional conditions.

A significant amount of water quality data has been collected for groundwater from Section 32. This includes laboratory analyses for organic, inorganic and radionuclide constituents. Recent groundwater quality data from Section 32 has been summarized in the Revised Hydrogeologic Report (Envirocare, 2004) and is reported in annual monitoring reports to the Division.

The inorganic parameters analyzed previously indicate that many naturally-present concentrations are above the Criterion 5C limits for groundwater. Sulfate, chloride, and TDS concentrations in all wells also exceeded the EPA secondary drinking water standards. Analytical results for the radionuclide parameters also indicate that gross alpha, gross beta, and total uranium exceeded EPA's drinking water standards in two or more of the wells. Because of this, it is concluded there would be a minimal potential for degradation of water quality in the vicinity of the Clive site. The groundwater at the site is already characterized as a brine. The water is suitable for limited industrial uses, without prior extensive treatment. The nearest current use of groundwater is located over three miles from the site and up-gradient.

The 11e.(2) Embankment design minimizes the potential for transport of contaminants away from the tailings. The cover reduces the potential for infiltration, which is already believed to be minimal in the area due to the low incident precipitation and high potential evapotranspiration. Additionally, seepage is not expected to reach the groundwater as a result of moisture redistribution within the disposal materials. The impact of this seepage on the groundwater is expected to be minimal for several reasons:

1. Waste must not exhibit free liquids at the time of disposal.
2. The volume of seepage would be expected to be small, and should occur over a long period of time.
3. The existing poor quality of the groundwater makes it difficult to significantly degrade it.
4. The hydraulic head gradient in the groundwater is small, limiting the velocity of groundwater movement away from the site to a maximum of 1.1 feet per year.
5. Modeling analyses (Appendix E of Energy*Solutions*, 2005b) indicate that it would take approximately 400 to 600 years for leachate to move through the unsaturated zone and then another 800 years to travel to the nearest off-site groundwater well.

2.7.5 Surface Water Hydrology

The Energy*Solutions* 11e.(2) Embankment is located in the semi-arid desert of western Utah. The area containing the Energy*Solutions* 11e.(2) Embankment lies within the Great Basin drainage, a closed basin having no outlet. The site drains into the normally-dry Ripple Valley depression on the eastern fringe of the Great Salt Lake Desert.

The nearest usable body of water east of the Clive site is 28.1 miles away. At this location, a perennial stream flows from Big Spring (1,000 feet south of I-80) to the Timpie Springs Waterfowl Management Area, about 2,000 feet north of I-80. Activities at the Energy*Solutions* Clive Facility have no effect on surface-water quantities or quality at the Clive site. There are no perennial surface-water systems associated with the Clive site. Water necessary for construction is provided by existing wells in the vicinity, or impounded water.

No surface water bodies are present on the Clive site. The nearest stream channel ends about two miles east of the site and is typical of all drainages along the transportation corridors within 20 miles of the site. Stream flows from higher elevations evaporate and infiltrate into the ground before reaching lower, flatter land. The stream channel reduces until there is no evidence of a stream. The watershed up-gradient of the site covers approximately 46 square miles.

Although there is no data indicating that historical floods have impacted the Clive site, HEC-1 and HEC-2 analyses that have been prepared to model the Probable Maximum Precipitation and Probable Maximum Flood for the Clive site (Appendix J of Energy*Solutions*, 2005b; Bingham, 1996). The largest "instantaneous" value of runoff from the watershed was 48,512 cubic feet per second (cfs) and was associated with the six-hour Probable Maximum Precipitation. The HEC modeling shows a Probable Maximum Precipitation of 10.08 inches for the six-hour storm and 6.1 in. for a 1-hour storm. The Probable Maximum Flood expected at the site from a six-hour Probable Maximum Precipitation event is 48,512 cfs; compared to an estimated 100-year flood of 3,802 cfs (Utah Geological Survey Special Study 96 reports that Energy*Solutions* waste disposal operations do not take place in a 100-year flood plain (UGS, 1999). The Probable Maximum Flood would most likely flow into the south and east borders of the site with the fringes of the flow encroaching on Energy*Solutions*' Clive Facility. The maximum depth of flow at the site was calculated to be approximately one foot and last for 6 hours. Thus, the Probable Maximum Flood would not infiltrate into groundwater beneath the facility. These events demonstrate that for post-closure, a short-term flood of any depth is likely to have no impact on the embankment's performance. Additionally, short-term flooding of any depth on the order of days or even weeks can intuitively be seen to have minimal impact on long-term performance.

Runoff from such a hypothetical event as the Probable Maximum Precipitation or Probable Maximum Flood (the heaviest reported rainfall in the area is 1.3 inches over a 24-hour period) will be diverted from encroaching into the embankment by using a berm surrounding the disposal area. Flow would be diverted around the site to the south and through the areas between the embankments, which are designed to channel runoff flow to the south and west.

2.8 ECOLOGY

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (a) An assessment of the radiological and non-radiological impacts to the public health from the activities to be conducted pursuant to the license or amendment;" **– R313-24-3(1)(a).**

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

In August 1993, NRC concluded an Environmental Impact Study and generated a report detailing the potential impacts associated with the siting of Energy*Solutions*' 11e.(2) disposal facility in Utah's West Desert (NRC, 1993c). In the process of creating this Environmental Impact Study, extensive research was performed into the vegetative and terrestrial populations in and around Section 32. This analysis was supplemented by a secondary study, conducted in support of a separate licensing effort (SWCA, 2011)

2.8.1 Vegetation

The Clive site occurs in the Desert Alkali range site, which is rated by BLM as being poor for grazing or forage production. However, the vegetation forms an important ground cover and deterrent to soil erosion and provides habitat for wildlife species. Annual production of the three community types ranged from 152 to 517 pounds per acre, air dry. Annual production for the range site is given as 50 to 200 and 500 to 1,500 pounds per acre during unfavorable and favorable years respectively. Livestock carrying capacity with such production would range from 3 to 80 acres per animal-unit month.

The vegetation of the Clive site is a homogeneous, semi-desert low shrub-land, primarily composed of shadscale (Atriplex confertifolia). The shrubland is part of the Northern Desert Shrub Biome of the Cold Desert Formation and is described as a Saltbush (Shadscale)-Greasewood Shrub complex. Plant communities identified on the site are Shadscale-Gray Molly (Kochia americana var. vestita), a transitional community type of Shadscale-Gray Molly-Black Greasewood (Sarcobatus vermiculatus), and Black Greasewood-Gardner Saltbush (Atriplex nuttallii). Representative of the desert shrub/saltbush community are low widely spaced shrubs, totaling approximately 10 percent ground cover (Cronquist et. al, 1972).

Dominant shrubs on the Clive site include shadscale, Nuttall's saltbush, and winterfat (SCS 1987; Kidd 1989). Vegetation patterns of the Clive site are correlated with soil salinity and corresponding shifts in presence or abundance of species. All three communities are low in species diversity. Seep-weed or inkweed (Suaeda torreyana) and scattered perfoliate pepperweek (Lepidium perfoliatum) are the only prominent understory species of the Shadscale-Gray Molly community. This community occurs over most of the Clive site, although black greasewood becomes prominent enough in the eastern quarter to form a Shadscale-Black Greasewood-Gray Molly community. Except for black greasewood and occasional stands of halogeton (Halogeton glomeratus), the composition is similar to the more prominent Shadscale-Gray Molly community. Maximum root depth of the late successional shadscale species is reported to be 39 inches, while fourwing saltbush roots generally extend to a maximum depth of 20 inches (DOE, 1995).

Black greasewood may have tap roots that extend beyond 11 feet beneath the surface. Root penetrations of these depths may be expected to reach into the upper part of the 7-foot thick clay radon barrier, but will not penetrate through it. The Black Greasewood-Gardner Saltbush community type is floristically the most diverse, but only occurs in the extreme northeast corner and eastern edge of the Clive site. In addition to Gardner saltbush, the flora is composed of all species found in the other communities except halogeton.

In the SWCA Study (2011), forty-one plant species were identified. However, because many desert forbs are spring ephemerals and field sampling was conducted at the end of a growing season, the plant species diversity and cover, particularly for herbaceous forbs, was underrepresented. Of the few forb species that were detected, all were dead or senesced, with the exception of Halogeton (Halogeton glomeratus), a late-season invasive annual weed.

Biological soil crusts are a dominant feature of vegetation communities throughout the Great Salt Lake basin. Soil crusts were present in all vegetation associations sampled, but were more prevalent in the low desert vegetation associations (e.g., black greasewood, haltogeton-disturbed, and shadscale-gray molly) present on and adjacent to the Clive Site.

In the first SWCA sample plot, a mix of native and non-native grass species with a few scattered shrubs and forbs was observed. The ground cover was dominated by biological soil crust (52%). Twenty plant species were recorded. Eleven species of grass, dominated by needle-and-thread grass (Hesperostipa comata),

comprised approximately 25% of total cover. The mixture of primarily desirable non-native grass species present in SWCA Plot 1 and surrounding grasslands were determined to be the result of recent fire disturbance and subsequent seeding with a mixture of needle-and-thread, intermediate wheatgrass (Thinopyrum intermedium), bluegrass (Poa spp.), crested wheatgrass (Agropyron cristatum), tall wheatgrass (Thinopyrum ponticum), slender wheatgrass (Elymus trachycaulus), western wheatgrass (Pascopyrum smithii), and other species. The reseeded area covers a large portion of uplands surrounding the Clive Facility, and these desirable non-native grass species have become established in the area and are likely to persist.

The second SWCA sample plot comprised an overstory of Utah juniper (Juniperus osteosperma; 6.2%) with a multilayered midlevel canopy of big sagebrush (Artemisia tridentata ssp. wyomingensis; 17.1%), and a subcanopy of broom snakeweed (Gutierrezia sarothrae; 1.0%), grasses (9.8%), and forbs (1.4%). This plot was the most diverse of the five field plots with 25 plant species recorded. The ground cover was dominated by biological soil crust (44.9%) and plant litter (23.5%), with some bare ground (9.9%) where game and livestock trails pass through the plot.

The third SWCA plot comprised primarily black greasewood (Sarcobatus vermiculatus; 4.5%) and halogeton (0.7%). The ground cover was dominated by biological soil crust (84.8%). Six plant species were recorded within the sample quadrats. Total cover was greater than 100% in some areas due to the presence of a shrub overstory.

The fourth SWCA sample plot comprised scattered native shrubs (5.2%) and halogeton (3.3%). The ground cover was dominated by biological soil crust (85.6%). Nine plant species were recorded. Crested wheatgrass and squirreltail (Elymus elymoides) were detected at trace levels (less than 0.005%).

The fifth SWCA sample plot included native shrubs (13.3%) and scattered weeds (1.1%). The ground cover was dominated by biological soil crust (70.7%) and plant litter (11.7%). Fifteen plant species were recorded.

SWCA also examined the root density and maximum rooting depth of dominant plant species on the Clive Facility. Excavations were performed at the third and fourth SWCA Sample Plots (black greasewood and halogeton-disturbed). Three excavation locations were selected in each plot and excavated using a backhoe. Six locations were excavated.

The focus of the excavations was to obtain cross-sections of the rooting mass of dominant plant species in each field plot. The roots were carefully exposed by gradual removal of vertical layers of soil with the backhoe and hand tools. Root density measurements were collected by measuring the width of the rooting mass and by counting visible roots across a set of sample widths or for the entire width of the root mass. Root density measurements were taken at the soil surface and at 10 cm increments until no roots could be detected. Roots were continuous at just below the soil surface in all excavated soil profiles.

Observed root densities were higher near the surface of the soil, where roots were mostly fibrous with few woody structures. A few large, woody roots were encountered in deeper soils. Rooting depths were shallower than expected, with the maximum rooting depth of dominant woody plant species ranging from 40 to 70 cm. Woody plant species maximum rooting depths were proportional to aboveground plant mass with an above-ground height root depth ratio of 1:1 and an above-ground width root depth ratio of approximately 1.4:1. The herbaceous dominant in the fourth SWCA Sample Plot, halogeton, had higher

ratios of plant height and width to maximum rooting depth (1.4:1 and 1.7:1, respectively). The low proportion of roots to above-ground biomass is expected for annual plants, which invest the bulk of their energy in reproduction and little energy in root systems.

2.8.2 Terrestrial Life

Two habitat types (shadscale flats and greasewood) occur on the Clive site. Animal species typical of the site include black-tailed jackrabbit (Lepus californicus), deer mouse (Peromyscus maniculatus), horned lark (Eremophila alpestris), and desert horned lizard (Phrynosoma platyrhinos); species diversity is low. All of these animal species could use the site for breeding or nesting. Jackrabbits, deer mice, and grasshopper mice (Onychomys leucogaster) were the only mammals collected during field surveys for the Environmental Impact Study.

The Clive site is located within the year-long range of the pronghorn antelope. The West Desert Herd Unit 2A occurs south of I-80 and includes the Clive site (BLM, 1988). Pronghorn are rare in the project area south of Interstate-80. The area is considered poor pronghorn habitat (Nelson, 1989). Interstate-80 acts as a pseudo-barrier to most pronghorn movement south from the Puddle Valley Herd Unit (Ekins, 1989).

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

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

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

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

2.8.3 Aquatic Biota

Aquatic ecosystems do not occur on or near the Clive site.

2.8.4 Endangered and Threatened Species

No important plant or animal species, as defined by NRC (1980), are known to occur on the Clive site and no known important habitats have been identified in the area. Furthermore, no threatened or endangered

plant species are known to occur in the vicinity of the Clive site. However, the Utah Division of Wildlife Resources reports that the area is used for foraging by bald eagles (Haliaeetus leucocephalus) during the winter. The Great Basin fishhook cactus (Sclerocactus pubispinus) is currently under review for threatened status. This species is associated with gravelly beach terraces of Pleistocene Lake Bonneville in western Tooele County and is not expected to occur in the Clive area.

The bald eagle and American peregrine falcon are federally listed endangered species that could occur within the project area (USFWS 1987). The bald eagle is a winter resident from late November to mid-March in the project vicinity. The majority of wintering eagles are found in Rush Valley with others occurring in Skull and Cedar Valleys. No bald eagle roosts are located within the proposed project area. However, the black-tailed jackrabbit is the primary food source utilized by bald eagles in Tooele County (BLM 1988), and eagles potentially hunt within this area.

One historical aerie of the American peregrine falcon was located near Timpie Springs Wildlife Management Area in the northern end of the Stansbury Mountains. The nest site became inactive following the construction of Interstate-80 in the late 1960s (BLM 1988). In an attempt to re-establish a breeding pair of peregrines, the Utah Division of Wildlife Resources, in cooperation with the U.S. Fish and Wildlife Service (USFWS), erected a hack site at the Timpie Springs Wildlife Management Area, approximately 26 miles from the Clive site. The hack site became active in 1983 and 1984, and a peregrine pair was observed using the site in the Spring of 1987. The hack site was occupied in 1989 by a nesting pair of peregrines (Benton 1989). Peregrines are known to arrive in the area in March and, if nesting, may remain until September (Benton 1989). Due to the distance between the Clive site and the aerie, it is unlikely any peregrines utilize the project area.

It should be noted that since 2001, Energy*Solutions* has been annually monitoring a nest (Nest 1379) located near the Northeast corner of Section 29, just north of and adjacent to the Union Pacific railroad tracks. Tooele County required this monitoring in accordance with a Conditional Use Permit (CUP) (CUP No. 2700-87) as the nest is large, and appears capable of housing larger birds, such as raptors.

Since monitoring activities began in 2001, the nest has largely been unoccupied. However, EnergySolutions personnel did observe and report sightings of the Common Raven (Corvus Corax) in the Spring of 2001, 2002, and 2007. Energy*Solutions* will continue to monitor this nest for as long as required by the CUP.

The Cedar Mountains contain a wild horse herd protected under the Wild and Free Roaming Horse and Burro Act of 1971. The Cedar Mountain herd presently contains an estimated 360 horses and extends from four miles north of Eight Mile Spring to the southern portion of the Cedar Mountain range (BLM, 2003). Wild horses are seldom encountered on the Clive site (Kidd 1989), and are monitored so that the herd population does not exceed 309 horses, or more than the environment could sustain (BLM, 2003). The state sensitive kit fox may occur throughout the West Desert Hazardous Industry Area (Johnston, 1989; USPCI, 1990).

2.9 SOILS

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (a) An assessment of the radiological and non-radiological impacts to the public health from the activities to be conducted pursuant to the license or amendment;" **– R313-24-3(1)(a).**

"*Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100.*" **– R313-24-4, 10 CFR 40.41(c).**

A significant amount of field and laboratory information has been developed for the site and surrounding area, as a result of studies and investigations conducted in and adjacent to Section 32. Available geotechnical data adequately characterizes the subsurface soil conditions below the 11e.(2) Embankment and Section 32. DOE collected geotechnical and hydrogeologic information to locate and dispose of the Vitro uranium tailings in the north central part of Section 32. Dames & Moore, Jacobs Engineering Group and CSU collected information for the DOE between 1982 and 1984 (DOE, 1985b). Additionally, Delta Geotechnical collected geotechnical and hydrogeologic information for Energy*Solutions* between 1988 and 1990 as part of the permitting process for the Mixed Waste landfill cell. Energy*Solutions* has further updated and revised the data collected. Results have been summarized in the Revised Hydrogeologic Report (Envirocare, 2004).

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

The clayey soils, typically encountered from the surface down to a depth of 10 feet and between depths of 30 to 45 feet, typically are medium stiff, to stiff and moderately compressible. The majority of these clayey soils exhibit low to moderate plasticity and moisture contents ranging from 20 to 40 percent by weight. The clayey material exhibits a saturated hydraulic conductivity on the order of 1.41×10^{-3} cm/sec. Unsaturated moisture retention and hydraulic conductivity were obtained from laboratory tests.

The silty sand and sand layers, typically encountered between a depth of 10 and 30 feet and below a depth of 45 feet, are medium dense and low to moderately compressible. Moisture contents of the silty sands above the water table typically range from 5 to 15 percent by weight.

2.10 MINIMIZATION OF EROSION AND DISPERSION

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

The natural characteristics of the site as well as the facility design provide the necessary protection to minimize the potential of erosion and dispersion. The following administrative controls provide additional protection:

- Energy*Solutions*' Control of Fugitive Dust procedure (CL-LD-PR-103);
- 11e.(2) cover design's long-term ability to protect from water erosion (CQA/QC Manual);
- 11e.(2) cover design's ability to protect from wind erosion (CQA/QC Manual);
- 11e.(2) cover design's ability to minimize water infiltration (CQA/QC Manual);
- Energy*Solutions*' operational-phase management plan to contain hazardous constituents (CQA/QC Manual);
- Energy*Solutions*' Stormwater Management Plan (CL-LD-PR-704).

2.11 CONSOLIDATION OF WASTE FACILITIES

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

To avoid proliferation of small waste disposal sites and thereby reduce perpetual surveillance obligations, byproduct material from in situ extraction operations, such as residues from solution evaporation or contaminated control processes, and wastes from small remote above ground extraction operations is currently being disposed of at Energy*Solutions*' existing 11e.(2) Embankment. Considering the nature of the wastes, such as their volume and specific activity, and the costs and environmental impacts of transporting the wastes to Energy*Solutions*' existing 11e.(2) Embankment, off-site byproduct transport to Energy*Solutions*' Clive facility is demonstrated to be practical and advantageous over on-site burial at existing byproduct storage locations. For example, centralizing byproduct disposal significantly reduces a generator's perpetual surveillance obligation.

In determining whether the Energy*Solutions* facility meets this requirement, the following items are established:

1. **That the current operations at the Clive site constitute the equivalent of an existing large mill tailings disposal site.** The Clive site was initially developed by DOE for the disposal of 2.5 million cubic yards of uranium mill tailings. The site is currently being used by Energy*Solutions* for the disposal of Class A, 11e.(2), and Class A/Mixed Waste. The site is part of the Tooele

County Hazardous Waste Zone. Since the site has already been set aside by DOE for the disposal of uranium mill tailings and since the site is already the disposal location of millions of cubic yards of uranium mill tailings, the site is an optimum location for the disposal of additional 11e.(2) waste material.

2. **That Energy*Solutions'* Clive site helps to reduce the number of small disposal sites throughout the country.** The Clive site allows the avoidance of the proliferation of small disposal sites and thereby reduces perpetual surveillance obligations and other negative aspects of establishing numerous disposal facilities. The Clive facility consists of 540 acres. The land was originally purchased and studied as a square-mile (640 acre) section of land. The first 100 acres were used for the disposal of the UMTRA Vitro waste, and is in possession of DOE. The remaining 540 acres are owned by Energy*Solutions* and are licensed for the operation of the current facility. If the 11e.(2) License is renewed, the Clive Site will continue to provide the opportunity to eliminate many small disposal sites from throughout the country. Furthermore, the Clive facility is designed and constructed to contain a large capacity of waste allowing for the consolidation of many sites throughout the country.
3. **That Energy*Solutions'* Clive facility must reduce the potential for radiological releases to the environment.** Potential dose rates, indoor radon concentrations and risks have been calculated for several disposal alternatives. The highest calculated doses and risks result from leaving the waste in place and are attributable to the food grown on-site and indoor radon inhalation pathways. The calculated doses and risks related to transport and disposal alternatives are significantly lower than those associated with leaving the waste in place, with disposal at Clive exhibiting the lowest. Even though the likelihood of a train accident occurring during transport of the waste to either of the disposal facilities is low, a simulated derailment accident was assessed. The radiological risk assessment of the train accident revealed that the doses and risks were negligible. The main contributors to the doses and risks are the long-lived daughters (Pb-210 and Po-210) of Ra-226. Therefore, modeling shows that by properly cleaning up many small, contaminated sites, transporting the waste to Utah, and properly disposing of the material the potential for radiologic release is reduced.
4. **That Energy*Solutions'* Clive facility continues to reduce the potential number of persons exposed to radiological releases from disposed waste.** Modeling shows that by properly cleaning up many small, contaminated sites, transporting the waste to Utah and properly disposing of the material that the number of persons exposed to radiological releases is reduced.
5. **That Energy*Solutions'* Clive facility continues to reduce perpetual surveillance obligations** The long-term surveillance that are incorporated at the Clive site, including physical inspection, air monitoring, soil, and groundwater monitoring, as well as other important surveillance activities are catalogued in the procedures listed in Appendices B and E . This type of long-term surveillance is required at any properly licensed disposal facility in the country, regardless of its size. If contaminated sites should dispose onsite, some type of long-term surveillance program should also be incorporated at each of those sites. By reducing the number of sites the overall perpetual surveillance required is reduced.

An NRC analysis of viable alternatives for 11e.(2) management concluded that the most cost-effective and least hazardous of the alternatives considered for management of 11e.(2) byproduct material is to excavate the waste and transport by rail and truck to the Energy*Solutions* facility for disposal (NRC, 1993c). Factors that contribute to this conclusion include:

1. Lower doses and risks than the other alterative.
2. Ability to accept this type of waste in bulk by railroad transport.
3. Very arid dry climate conditions.
4. Area not suitable for residential or agricultural development.
5. Sparsely populated.
6. Sufficient capacity to accept this quantity of waste.
7. Lower estimated disposal costs than other southeast disposal facilities (including transportation costs).
8. Limited capacity of other southeast disposal facilities.

2.12 BACKGROUND RADIOLOGICAL CHARACTERISTICS

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (a) An assessment of the radiological and non-radiological impacts to the public health from the activities to be conducted pursuant to the license or amendment;" **– R313-24-3(1)(a).**

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

Energy*Solutions* collected radiological preoperational environmental samples before starting major construction of the disposal facility, and continues operational sampling according to the requirements of the license. Preoperational and operational radiological environmental results are reported annually to the Division. In addition to the currently licensed 11e.(2) Embankment, Energy*Solutions* also operates an adjacent low-level radioactive waste disposal facility under an Agreement-State license issued by the Division. Because of the facilities' close proximity, some locations are used for monitoring both facilities. Subsequently, the results of environmental monitoring performed at those locations that are common to both facilities are reported to the Division as applicable (McCandless, 2012; NRC, 1993c).

2.13 BACKGROUND NON-RADIOLOGICAL CHARACTERISTICS

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (a) An assessment of the radiological and non-radiological impacts to the public health from the activities to be conducted pursuant to the license or amendment;" **– R313-24-3(1)(a).**

Energy*Solutions* collected non-radiological preoperational environmental samples before starting major construction of the disposal facility, and continues operational sampling according to the requirements of the license. Preoperational and operational non-radiological environmental results are reported annually to the Division. In addition to the currently licensed 11e.(2) Embankment, Energy*Solutions* also operates an adjacent low-level radioactive waste disposal facility under an Agreement-State license issued by the Division. Because of the facilities' close proximity, some locations are used for monitoring both facilities. Subsequently, the results of environmental monitoring performed at those locations that are common to both facilities are reported to the Division as applicable (McCandless, 2012; NRC, 1993c).

SECTION 3. DESCRIPTION OF FACILITY

"A license application shall be approved if the Executive Secretary determines that (b) the applicant's proposed equipment, facilities, and procedures are adequate to minimize danger to public health and safety or the environment;" **– R313-22-33(1)(b).**

"*Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100.*" **– R313-24-4, 10 CFR 40.41(c).**

Figure 2-3 illustrates the current layout of the site with disposal embankments, staging area, office area(s), train track, train car rollover, ditches, etc. The construction drawings also include the site topography (included in Appendix I).

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

As required by Criterion 3 of 10 CFR 40-Appendix A, the above-grade 11e.(2) Embankment design documented in this application and utilized by Energy*Solutions* since it began 11e.(2) material disposal operations has been compared to two below-grade embankment designs and found to be the alternative that best isolates the tailings from the environment (NUREG-1476). A cross sectional drawing of the embankment is provided in Appendix I (Drawing Number 9420-05).

3.1 EMBANKMENT DESIGN, CONSTRUCTION AND PERFORMANCE

"A license application shall be approved if the Executive Secretary determines that (b) the applicant's proposed equipment, facilities, and procedures are adequate to minimize danger to public health and safety or the environment;" **– R313-22-33(1)(b).**

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

"The minimum compacted radon barrier thickness placed after December 1, 2001, will be 4.0 ft. on the top and 3.5 ft. on the side of the disposal cell.

a) The placed radon barrier material will be compacted to not less than 95 percent of maximum dry density in accordance with Standard Proctor Method ASTM-698, field-tested for compliance. At least one density test shall be performed for every 200 cubic yards (compacted) and at least one test shall be conducted on each lift. All lifts shall be field-tested for density and moisture content. At least one moisture content test shall be performed for every 200 cubic yards (compacted) and at least one test shall be conducted on each lift.

b) The waste in the upper ten feet of the 11e(2) embankment shall be placed and compacted to not less than 90 percent of the maximum dry density in accordance with Standard Proctor Method ASTM D-698, field-tested for compliance. At least one density test shall be performed for every 1000 cubic yards (compacted) and at least one test shall be conducted on each lift. All lifts in the upper ten feet of the 11e.(2) embankment shall be field-tested for moisture content. CLSM shall not be used in the upper ten feet of the 11e.(2) embankment.

c) At the end of every calendar year starting with 2001, the licensee shall ensure that the cumulative average activity concentration of waste placed after Jan. 1, 2001, within the upper 3 feet of disposed waste does not exceed 300 pCi/g of Ra 226 or 900 pCi/g of Th 230, and within the next 7 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 will 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 3 feet and 1500 pCi/g in the next 7 feet of waste, and
Y = 300 pCi/g in the upper 3 feet and 500 pCi/gm in the next 7 feet of waste

d) The cumulative average densities of the waste in the upper ten feet of the 11e(2) embankment and of the compacted radon barrier placed since January 1, 2001, shall not be less than 1.5 g/cm3 for either.

e) These cumulative average values of 10.9(d) will be provided in the 4th quarter effluent and environmental monitoring report, starting with the 2008 report, and in the construction completion report." **– LICENSE CONDITION 10.9.**

This Section presents the principle design features of the Clive 11e.(2) Embankment that provide long-term isolation of disposed waste, minimize the need for continued active maintenance after site closure, and improve the site's natural characteristics in order to protect public health and safety. The principal objective of the 11e.(2) Embankment design is to provide control measures that meet applicable regulatory standards and the requirements of the Division. These standards include specific limitations on the release of radon, along with contaminants, including limitations on the release of radiation from radium and radon-daughter products. To comply with the requirements for long term stabilization, Energy*Solutions* has designed the facilities to effectively control any radioactive release for up to 1,000 years.

The environment, site personnel, and the public are protected both during and after the operation of the 11e.(2) disposal activities from unsafe levels of radiation. 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 11e.(2) Embankment is being constructed in a continuous "cut and cover" operation:

1. Existing terrain has been excavated to a depth of approximately eight feet, with this overburden stockpiled for future use in capping the embankment.
2. After the overburden was removed, a two foot clay liner was constructed under all areas where waste material is to be 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 being placed on the liner and compacted in place to a waste column height of approximately 35 feet at the embankment shoulder. At the embankment's highest point, the waste column is approximately 52 feet thick.
4. When the embankment is filled to the maximum height, a three and one-half foot thick layer of clay will be placed on the side slopes and a four-foot thick layer of clay will be placed on top and compacted to form a radon barrier.
5. An erosion barrier of specification-sized rock will cover the twelve-inch filter zone of small diameter rock that will underlay the rock erosion barrier.

Energy*Solutions*' above-grade 11e.(2) Embankment provides better protection against water infiltration by minimizing the amount of time that precipitation is in contact with the cover. The above-grade 11e.(2) Embankment has slopes that are designed to shed water. Also, the above-grade embankment provides better protection against potential water infiltration from the Probable Maximum Flood and other large storms.

An NRC analysis of viable alternatives for 11e.(2) management concluded that the above-grade 11e.(2) Embankment design is economically feasible and provides the best use of land (NRC, 1993c). The cost, per cubic yard of waste, for disposal in the deep below-grade design is three times as expensive as disposal in the design currently employed by Energy*Solutions*. The cost, per cubic yard of waste, for disposal in the shallow below-grade design is four times as expensive as disposal in the above grade design. This is due in large part to the fact that both below grade designs require more excavation, clay liner, radon barrier, rock ditch, inspection roads, perimeter fence and land. The capacity of the above-grade 11e.(2) Embankment design employed by Energy*Solutions* is 5,050,000 cubic yards and will occupy approximately 92 acres of land. This design provides adequate capacity for Energy*Solutions* and efficient use of land space (NRC, 1993c).

Energy*Solutions*' above-grade 11e.(2) Embankment design is designed to meet the standards of protection from water erosion, wind erosion, geotechnical instability, embankment settlement, roots and burrowing animals. It provides the best protection for groundwater contamination. Energy*Solutions*' above-grade 11e.(2) Embankment design also 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."

The above-grade 11e.(2) Embankment cover is designed to protect the embankment from the Probable Maximum Precipitation and the Probable Maximum Flood for the Clive area. This cover design maintains sheet flow and resists erosion and gully formation during the 1,000-year life of the embankment and has been designed in accordance with NRC Staff Technical Position (STP) "Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites."

To protect the 11e.(2) Embankment from the effects of water erosion, the above-grade 11e.(2) Embankment will be covered with a graded rock erosion barrier (refer to drawings 9420-4 and 9420-6 of Appendix I). The slopes of the 11e.(2) Embankment are limited to 20 percent maximum. The top of the 11e.(2) Embankment is convex with gentle, two percent slopes to promote drainage. The above-grade 11e.(2) Embankment with its 2 to 20 percent slopes is designed to shed water quickly -- thus, minimizing the time water has to infiltrate into the Embankment. Additionally, the infiltration into the above-grade 11e.(2) Embankment has been studied in detail. Discussions of these studies are found in Section 6.3.1.

The rock layer used to protect against water erosion in the above-grade 11e.(2) Embankment design also provides protection against wind erosion. Because the Probable Maximum Precipitation is the event that could occur as a result of the most severe meteorological conditions, the erosion barrier designed to withstand the Probable Maximum Precipitation also withstands any winds at the Clive site. The ditch around the perimeter of the embankment encourages precipitation from small and large storms to drain away from the embankment (Appendix G of Energy*Solutions*, 2005b).

As previously mentioned, the above-grade 11e.(2) Embankment design employed by Energy*Solutions* provides better groundwater protection in two ways. First, the above-grade 11e.(2) Embankment provides a greater distance from the waste to the groundwater. Second, the above-grade 11e.(2) Embankment provides less of a chance that the groundwater level will rise above the bottom of the waste.

Because a portion of the above-grade 11e.(2) Embankment is below the ground surface, fluctuations in groundwater elevation demonstrate a minimum distance of 5 feet from the Embankment liner to the highest recorded groundwater elevation for the last 20 years. This distance increases to the northeast, peaking at 16.3 feet in the northeast corner. At least two feet of this distance is comprised of low-permeability clays. This layer of low-permeability clays provides additional protection against fluid migration from the embankment into the groundwater.

The above-grade 11e.(2) Embankment design is geometrically stable and not readily mobilized by any natural force. Geotechnical and hydrogeologic data from the site indicate that the most favorable foundation soils occur in clay deposits found just below the surface (Envirocare, 2004). Deeper excavations could place the waste within reach of the groundwater high water mark (Envirocare, 2004). Refer to Section 6.3.5 for a discussion of embankment settlement.

Energy*Solutions*' above-grade 11e.(2) Embankment design employs a thick rock erosion barrier. This extensive use of larger rock allows the above-grade 11e.(2) Embankment design to provide protection from roots and burrowing animals.

The prime considerations for rejecting a shallow or deep below-grade 11e.(2) Embankment design in favor of the above-grade 11e.(2) Embankment design are the proximity of the waste to the groundwater, and the lack of low-permeability clays between the bottom of the Embankment and the groundwater. These factors are also the prime considerations for determining the maximum depth of excavation.

The distance between the bottom of the waste and the groundwater acts as a buffer zone and is necessary for two reasons. First, it increases the time for water to infiltrate through the 11e.(2) Embankment and into the groundwater. Second, it protects against fluctuations in the level of the groundwater, allowing the water to rise without encroaching on the 11e.(2) Embankment. The layers of low-permeability clay also increase the time it takes water to travel from the bottom of the 11e.(2) Embankment to the groundwater. Below the

11e.(2) Embankment, these clays are not found directly above the groundwater. Also, the geotechnical and hydrogeologic data from the site indicate that favorable foundation soils occur in the zones near the surface, just below the surface clay deposits.

The slopes of the approved above-grade 11e.(2) Embankment design meet the requirement outlined in 10 CFR 40, Appendix A, Criterion 4(c) which states that "slopes should not be steeper than 5h:1v." The slopes on the side of the embankment are 5h:1v while the slopes on the top of the pile are approximately 2 percent.

3.1.1 Storm-Water Design

"A license application shall be approved if the Executive Secretary determines that (b) the applicant's proposed equipment, facilities, and procedures are adequate to minimize danger to public health and safety or the environment;" **– R313-22-33(1)(b).**

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

There are no surface water features within 5 miles of Section 32. Therefore, site drainage is addressed in terms of direct precipitation runoff and sheet flow associated with the Probable Maximum Flood event. The post-closure drainage system surrounding the 11e.(2) Embankment has been designed to direct water from precipitation or sheet flow away from the disposal unit. Drainage system design for the 11e.(2) Embankment are included in Appendix I.

The lack of surface water bodies, the sparse precipitation and the high evaporation rate make it unlikely that any condition creating a permanent body of standing water will occur. Standing water at the Clive Site is managed during the operational life of the facility according to Condition I.E.7 of the Ground Water Quality Discharge Permit "Run-on and Run-off Control Requirements" and "Waste Water, Runoff, and Storm Water Management Requirements." Standing water in depressions outside waste management areas is not actively managed. Disposal site areas are managed to remove any intermediate standing water when necessary. Energy*Solutions* uses mobile pumping trucks and other equipment as needed to access and remove water from disposal site areas which are not designed to free-drain into an evaporation pond or equipped with permanent pumps. Other areas of the property are channeled to the southwest. Short-term bodies of standing water on the surface in other areas of the property do not affect the performance of the facility. This water dissipates primarily through evaporation due to the climatic features of the site rather than percolation, having no impact on groundwater horizontal gradients.

Surface water controls have been successfully utilized at the Clive facility for over 25 years. During operation, the 11e.(2) Embankment is surrounded by run-on and run-off berms, designed to prevent storm-water run-on from ambient precipitation in the vicinity of the facility into the emplaced waste (before final cover is built). Run-off berms are also used during operation to ensure that precipitation that falls on emplaced 11e.(2) waste is collected and does not carry contamination off of the Embankment. Run-off berm locations necessarily move as new portions of the 11e.(2) Embankment are opened for waste placement.

Appendix J of Energy*Solutions*, (2005b) presents the HEC-1 and HEC-2 analyses that have been prepared to model the Probable Maximum Precipitation and Probable Maximum Flood for the Clive site (Bingham, 1996). The largest "instantaneous" value of runoff from the watershed was 48,512 cubic feet per second (cfs) and was associated with the six-hour Probable Maximum Precipitation. The HEC modeling shows a Probable Maximum Precipitation of 10.08 inches for the six-hour storm and 6.1 in. for a 1-hour storm. The Probable Maximum Flood expected at the site from a six-hour Probable Maximum Precipitation event is 48,512 cfs; compared to an estimated 100-year flood of 3,802 cfs (Utah Geological Survey Special Study 96 reports that Energy*Solutions* waste disposal operations do not take place in a 100-year flood plain (UGS, 1999). The Probable Maximum Flood would most likely flow into the south and east borders of the site with the fringes of the flow encroaching on Energy*Solutions*' Clive Facility. The maximum depth of flow at the site was calculated to be approximately one foot and last for 6 hours. Thus, the Probable Maximum Flood would not infiltrate into groundwater beneath the facility. These events demonstrate that for post-closure, a short-term flood of any depth is likely to have no impact on the embankment's performance.

Runoff from such a hypothetical event as the Probable Maximum Precipitation or Probable Maximum Flood (the heaviest reported rainfall in the area is 1.3 inches over a 24-hour period) will be diverted from encroaching into the embankment by using a berm surrounding the disposal area. Flow would be diverted around the site to the south and through the areas between the embankments, which are designed to channel runoff flow to the south and west.

Energy*Solutions* designed a rock erosion barrier to prevent water and wind erosion of the embankment. In the design of this barrier Energy*Solutions* ensured that dense, sound, and abrasion resistant rock was used. The rock that is used on the embankment has been tested to ensure quality so that it meets all of the NRC requirements, (NRC, 1999b).

During operation, Energy*Solutions*' disposal facilities are managed to prevent precipitation from flowing into the 11e.(2) Embankment. This is accomplished by construction of a run-on berm around the perimeter of the disposal embankment. Therefore, there are no design features to promote deposition during operations since there is no "…runoff which flows into the impoundment area…". Energy*Solutions*' final embankment is designed to maintain sheet flow for all precipitation that falls on it. By maintaining sheet flow, the turbulence and velocity of the water are minimized; thus improving the deposition of sediment and minimizing the erosion of the cover.

The drainage of the Clive embankment area, along with general site grading, ensures long-term stability. The disposal area is surrounded by a perimeter berm that is at least 3 feet above the natural ground. This perimeter berm is designed to store the 100-year 24-hour storm and protect the disposal operations against the Probable Maximum Flood. The design calculations for the berm are located in Appendix G-1 of Energy*Solutions*, (2005b). Calculations for the Probable Maximum Precipitation and Probable Maximum Flood are also located in Appendix J of Energy*Solutions*, (2005b). A discussion of the erosion barrier is located in Section 6. During the construction of the 11e.(2) Embankment, drainage from the adjacent Vitro embankment was diverted into a diversion ditch east of the 11e.(2) Embankment. The final drainage design is as shown on Figure 9420-4, Appendix L of Energy*Solutions*, (2005b).

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. This ditch is shown on Figure 9420-06, Appendix L of Energy*Solutions*, (2005b). The ditch is also designed with rock erosion barrier to limit erosion.

3.1.2 Waste Disposal Operations and Procedures

"(1) A licensee or registrant shall dispose of licensed or registered material only:

a) By transfer to an authorized recipient as provided in Section R313-15-1006 or in Rules R313-21, R313-22, R313-24, or R313-25, or to the U.S. Department of Energy; or

b) By decay in storage; or

c) By release in effluents within the limits in Section R313-15-301; or

d) As authorized pursuant to Sections R313-15-1002, R313-15-1003, R313-15-1004, R313-15-1005, or R313-15-1008.

(2) A person shall be specifically licensed or registered to receive waste containing licensed or registered material from other persons for:

a) Treatment prior to disposal; or

b) Treatment or disposal by incineration; or

c) Decay in storage; or

d) Disposal at a land disposal facility licensed pursuant to Rule R313-25; or

e) Storage until transferred to a storage or disposal facility authorized to receive the waste.;" **– R313-15-1001.**

"A licensee or registrant or applicant for a license or registration may apply to the Executive Secretary for approval of proposed procedures, not otherwise authorized in these rules, to dispose of licensed or registered material generated in the licensee's or registrant's operations. Each application shall include:

(1) A description of the waste containing licensed or registered material to be disposed of, including the physical and chemical properties that have an impact on risk evaluation, and the proposed manner and conditions of waste disposal; and

(2) An analysis and evaluation of pertinent information on the nature of the environment; and

(3) The nature and location of other potentially affected facilities; and

(4) Analyses and procedures to ensure that doses are maintained ALARA and within the dose limits in Rule R313-15." **– R313-15-1002.**

"(1) The requirements of Section R313-15-1006 and Appendix G of 10 CFR 20.1001 to 20.2402, (2010), which are incorporated into these rules by reference, are designed to:

a) control transfers of low-level radioactive waste by any waste generator, waste collector, or waste processor licensee, as defined in Appendix G in 10 CFR 20.1001 to 20.2402, (2010), who ships low-level waste either directly, or indirectly through a waste collector or waste processor, to a licensed low-level waste land disposal facility as defined in Section R313-25-2;

b) establish a manifest tracking system; and

c) supplement existing requirements concerning transfers and recordkeeping for those wastes.

(2) Any licensee shipping radioactive waste intended for ultimate disposal at a licensed land disposal facility must document the information required on the U.S. Nuclear Regulatory Commission's Uniform Low-Level Radioactive Waste Manifest and transfer this recorded manifest information to the intended consignee in accordance with Appendix G to 10 CFR 20.1001 to 20.2402, (2010), which is incorporated into these rules by reference.

(3) Each shipment manifest shall include a certification by the waste generator as specified in Section II of Appendix G to 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference.
(4) Each person involved in the transfer of waste for disposal or in the disposal of waste, including the waste generator, waste collector, waste processor, and disposal facility operator, shall comply with the requirements specified in Section III of Appendix G to 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference.
(5) A licensee shipping byproduct material as defined in paragraphs (c) and (d) of the Section R313- 12-3 definition of byproduct material intended for ultimate disposal at a land disposal facility licensed under Rule R313-25 must document the information required on the NRC's Uniform Low-Level Radioactive Waste Manifest and transfer the recorded manifest information to the intended consignee in accordance with Appendix G to 10 CFR Part 20 (2010 edition)." **– R313-15-1006.**

"(1) Licensed material defined in Section R313-12-3, byproduct material definition, paragraphs (c) and (d), may be disposed in accordance with Rule R313-25, even though it is not defined as low-level radioactive waste. Therefore, licensed byproduct material being disposed of at a facility, or transferred for ultimate disposal at a facility licensed under Rule R313-25, must meet the requirements of Section R313-15-1006.
(2) A licensee may dispose of licensed material defined in Section R313-12-3, byproduct material definition, paragraphs (c) and (d), at a disposal facility authorized to dispose of such material in accordance with Federal or State solid or hazardous waste law, including the Solid Waste Disposal Act, as authorized under the Energy Policy Act of 2005." **– R313-15-1008.**

Waste Disposal Operations and Procedures are catalogued in Appendix A. In addition to these procedures, the CQA/QC Manual includes procedures for site preparation, use of appropriate construction equipment, requirements for excavation of natural materials, construction requirements for the clay liner, waste placement requirements, and temporary and permanent cover construction requirements.

3.1.2.1 Site Preparation

A construction staging area, site drainage system, fences, access roads and other such facilities have been constructed in accordance with applicable CQA/QC procedures, for the current operations (see the construction drawings in Appendix I).

3.1.2.2 Construction Equipment

Table 3-1 lists examples of the types of heavy construction equipment utilized at the site, in support of construction and operation of the 11e.(2) Embankment. Energy*Solutions* may provide this construction equipment through a construction contractor. With the exception of compactors used for waste placement in accordance with the CQA/QC Manual (Work Element – Waste Placement with Compactor), there are no specific requirements or specifications other than the ability to carry and/or move dirt as in any routine dirt-moving construction project. Energy*Solutions* requires equipment operators to use respirators when operating equipment that works in areas where contaminated dust is a concern.

Table 3-1

Equipment List

Types of Equipment		
Shredder	Water Truck	Water Tank Trailer
Rock Truck	Farm Tractor	Crusher
Forklift	Hydroseeder	Mixer Barrell
Extending Forklift	Light Truck	Heaters
Loader	Tool Truck	Air Compressors
Dozer	18-Wheel Tractor	Light Plants
Boom Lift or Crane	Water Truck Trailer	Locomotive
Track Hoe	Flat Trailer	Roll-Off Truck
Cement Truck (Mixer)	Man Lifts	Pin Trailer & Transport
Grader	Welders	Compactor

Energy*Solutions* requires that construction and operation equipment are routinely maintained, repaired, or replaced as needed to ensure safe and effective operation. Energy*Solutions* maintains maintenance records on equipment at the site. Equipment that can no longer be used for site operations is removed from service.

3.1.2.3 Excavation of Natural Materials

Energy*Solutions* is constructing the 11e.(2) Embankment as a partially below-grade facility. This requires that the natural material be excavated to the specified elevations. The material excavated is used for the construction of liner or radon barrier, and/or used during waste disposal operations as fill materials, temporary cover, etc.

3.1.2.4 Construction of Clay Liner

After excavation to the specified depth, the excavated area is scarified and compacted to provide an adequate foundation for the clay liner. A two foot low permeability clay liner is then placed and compacted to 95 percent of a standard proctor (ASTM, 2003). At the time of compaction, the moisture of the 11e.(2) Embankment clay liner material is between optimum and five percent above optimum moisture content. The compacted material is tested to ensure that the required compaction has been achieved. The Division must approve completed liner before waste may be placed on the liner.

The bottom clay liner is constructed such that the saturated hydraulic conductivity is no more than 1.0×10^{-6} cm/sec. Based on operational experience in constructing clay liners and radon barriers for the 11e.(2) and Class A Embankments, it has been demonstrated that the site soils can meet the permeability performance specifications. The CQA/QC Manual outlines field control procedures designed to ensure that the bottom liner is constructed with a hydraulic conductivity that is greater than or equal to the radon barrier.

The bottom liner clay consists of brown and whitish silty clay that exhibits relatively low hydraulic conductivity characteristics. A mineralogical analysis of the clay was performed by x-ray diffraction and the results are summarized in Table 3-2. The cation exchange capacity of the clay was determined to be 13.4 MEQ/100 g, which is relatively low for clay materials. Permeability tests performed on the clay material indicate that when compacted, the saturated hydraulic conductivity ranges from 5×10^{-7} to 5×10^{-8} cm/sec.

Compatibility of the clay liner with the leachate from 11e.(2) materials was evaluated by obtaining data from Kerr McGee where permeability tests were performed on clayey soil (referred to as F-Stratum soil) using leachate from tailing. Energy*Solutions* is currently disposing of Kerr McGee's tailing, therefore these results are considered applicable. The F-Stratum soil was composed of 38 percent quartz, 17 percent calcite, 14 percent smectite, 18 percent mica, 7 percent kaolinite and other small percentages of miscellaneous minerals. The percentage of smectite and calcite are similar to the Energy*Solutions* Unit 4 clay with the major difference being the high percentage of quartz in the F-Stratum soil and the high percentage of aragonite in the Unit 4 clay.

The conclusions of F-Stratum liner compatibility tests (Hazen, 1989) were that the clay exhibits no degradation in saturated hydraulic permeability due to the tailing leachate. This is an indication that the Unit 4 clay is compatible with the tailing leachate.

Table 3-2
Summary of Mineralogical Analysis
Unit 4 Clay

Mineral	Wt. %
Quartz	12
Plagioclase	2
K-Feldspar	3
Dolomite	4
Calcite	8
Aragonite	53
Kaolinite	2
Illite/Mica	1
Smectite	15

3.1.2.5 Placement of Waste Material

Energy*Solutions* is placing waste in accordance with the CQA/QC Manual. The disposal material is placed in the 11e.(2) Embankment in lifts and is compacted before the next lift is placed. Effective spreading equipment is used on each lift to obtain uniform distribution of the waste. Leveling and manipulating of the waste is required to assure uniform density is achieved.

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

Each lift is compacted to not less than 90 percent maximum density as determined by the Standard Proctor Method (ASTM, 2003), or as otherwise approved in the CQA/QC Manual. No fill is placed upon the 11e.(2) Embankment until that area of the Embankment has been approved by Engineering Quality Control personnel. All lift approvals are documented.

The liner is protected from damage during operations by a minimum 1 ft thick liner of clean native material (referred to as liner protective cover). Similarly, the last one foot of the embankment below the radon barrier is constructed with clean native material to protect the radon barrier from waste debris and to facilitate cover construction (referred to as temporary cover). The construction of both the liner protective cover and temporary cover is specified in the CQA/QC Manual. Debris placement is subject to additional controls on size and percentage (by volume) of each lift in accordance with the CQA/QC Manual.

Debris is defined as any radioactive waste for disposal other than compactable soils. Compactable soil is defined as:

a. Having a graded material that passes through a four-inch grizzly; or,
b. As having a density greater than seventy pounds per cubic foot dry weight in accordance with ASTM D-698 (ASTM, 2003); and,
c. Having soil-like properties (i.e., standard tests in accordance with waste placement procedures can be performed).

Drums and metal containers that are to be disposed of in the 11e.(2) Embankment are emptied before being crushed and placed in the lift to minimize the void space. After the drums and metal containers have been emptied and mixed with soil, the entire lift is compacted to the required density.

Energy*Solutions* is committed to minimizing void spaces. Energy *Solutions* takes the following measures to minimize void spaces:

a. Debris is distributed throughout the lift. This prevents void containing material or materials that may degrade and leave void spaces from concentrating in one area of the embankment. This also minimizes the voids that may occur between two pieces of debris by distributing the debris throughout the lift.
b. All debris is than ten inches (10”) in at least one (1) dimension. This minimizes the possibility that a significant void space extends vertically through multiple lifts.
c. Drums and metal containers that are to be disposed of in the embankment are emptied before being crushed. This eliminates potential void spaces between containers when the waste is disposed of in the container.

Large pieces of concrete and other debris may be broken into manageable pieces, or disposed in Controlled Low-Strength Material (CLSM) in accordance with the CQA/QC Manual.

3.1.2.6 Radon Barrier

A clay barrier with a minimum depth of three and one-half feet on the side slopes and four feet on top is placed over the waste to act as a radon barrier. The radon barrier consists of select native clays obtained from the excavation and the clay is constructed to exhibit a saturated hydraulic conductivity of 5.0×10^{-8} cm/sec or less for the top one foot of the radon barrier and at a saturated hydraulic conductivity of 1.0×10^{-6} cm/sec or less for the remainder of the radon barrier. A 2 to 2.5 foot, thick rock erosion barrier with filter zones is then placed on top of the radon barrier.

3.1.2.7 Erosion Barrier

A 2 to 2.5 foot thick erosion barrier with filter zones is placed on top of the radon barrier. Energy*Solutions* designed a rock erosion barrier to prevent water and wind erosion of the embankment. In the design of this barrier, Energy*Solutions* ensured that dense, sound, and abrasion resistant rock was used. The rock that is used on the embankment has been tested to ensure quality so that it meets all of the requirements of NRC, 1999b.

3.2 UNLOADING FACILITIES

"A license application shall be approved if the Executive Secretary determines that (b) the applicant's proposed equipment, facilities, and procedures are adequate to minimize danger to public health and safety or the environment;" **– R313-22-33(1)(b).**

This section describes the procedures for accepting, inspecting, receiving, handling, and disposing of incoming 11e.(2) waste at the Energy*Solutions* Clive facility. A list of procedures discussed in this section is provided in Appendix A (and have been previously provided to the Division). Administrative, Access Control, Engineering, Environmental Monitoring, Bulk Waste Handling, and Training procedures listed in Appendix B assist Energy*Solutions*' employees keep their doses as low as reasonably achievable (ALARA).

3.2.1 Procedures For Receiving and Opening Shipments

"For purposes of Section R313-19-100, 10 CFR 71.0(c), 71.1(a), 71.3, 71.4, 71.13, 71.14(a), 71.15, 71.17, 71.19(a), 71.19(b), 71.19(c), 71.20 through 71.23, 71.47, 71.83 through 71.89, 71.97, 71.101(a), 71.101(b), 71.101(c)(1), 71.101(g), 71.105, 71.127 through 71.137, and Appendix A to Part 71 (2010) are incorporated by reference;" **– R313-19-100.**

"(1) Each licensee or registrant who expects to receive a package containing quantities of radioactive material in excess of a Type A quantity, as used in Section R313-19-100, which incorporates 10 CFR 71.4 by reference, shall make arrangements to receive:

a) The package when the carrier offers it for delivery; or

b) The notification of the arrival of the package at the carrier's terminal and to take possession of the package expeditiously.

(2) Each licensee or registrant shall:

a) Monitor the external surfaces of a labeled package for radioactive contamination unless the package contains only radioactive material in the form of gas or in special form as defined in Section R313-12-3; and

b) Monitor the external surfaces of a labeled package for radiation levels unless the package contains quantities of radioactive material that are less than or equal to the Type A quantity, as used in Section R313-19- 100, which incorporates 10 CFR 71.4 by reference; and

c) Monitor all packages known to contain radioactive material for radioactive contamination and radiation levels if there is evidence of degradation of package integrity, such as packages that are crushed, wet, or damaged.

(3) The licensee or registrant shall perform the monitoring required by Subsection R313-15-906(2) as soon as practical after receipt of the package, but not later than three hours after the package is received at the licensee's or registrant's facility if it is received during the licensee's or registrant's normal working hours or if there is evidence of degradation of package integrity, such as a package that is crushed, wet, or damaged. If a package is received after working hours, and has no evidence of degradation of package integrity, the package shall be monitored no later than three hours from the beginning of the next working day.

(4) The licensee or registrant shall immediately notify the final delivery carrier and, by telephone and telegram, mailgram, or facsimile, the Executive Secretary when:

a) Removable radioactive surface contamination exceeds the limits of Section R313-19-100 which incorporates 10 CFR 71.87(i) by reference; or

b) External radiation levels exceed the limits of Section R313-19-100 which incorporates 10 CFR 71.47 by reference.

(5) Each licensee or registrant shall:

a) Establish, maintain, and retain written procedures for safely opening packages in which radioactive material is received; and

b) Ensure that the procedures are followed and that due consideration is given to special instructions for the type of package being opened.

(6) Licensees or registrants transferring special form sources in vehicles owned or operated by the licensee or registrant to and from a work site are exempt from the contamination monitoring requirements of Subsection R313- 15-906(2), but are not exempt from the monitoring requirement in Subsection R313-15-906(2) for measuring radiation levels that ensures that the source is still properly lodged in its shield." – **R313-15-906.**

"The licensee shall analyze and adequately characterize:

a) All incoming waste to identify any new hazardous constituents not listed in License Condition 11.1. The licensee shall develop and implement methodologies and procedures for systematic characterization and analysis of the incoming waste, so that any new hazardous constituents are identified. Furthermore, the licensee shall assume that the baseline background concentrations for any new constituents are below their detection levels, unless the licensee demonstrates to the Executive Secretary'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." – **LICENSE CONDITION 10.2(a).**

"The licensee shall upon arrival of waste, perform external exposure rate measurements of the waste conveyances. Any shipment with exposure rates greater than 5 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 UAC R313-15-901, R313-15-902, and R313-15-903 [10 CFR 20.1902(a) incorporated by reference] until disposed." – **LICENSE CONDITION 10.7.**

This section outlines the procedures for incoming shipments of 11e.(2) byproduct materials from before the time that Energy*Solutions* contracts to dispose of a radioactive waste to the time that the waste is accepted or rejected for disposal upon arrival at the Clive facility. Three critical steps are taken during the incoming shipment procedures:

1. The first is a pre-shipment waste characterization. This is a determination that the radioactive characteristics of the material are within those limits outlined in the license. This includes a review of appropriate licenses, generator statements, and laboratory analyses to confirm that the material to be disposed of is actually 11e.(2) byproduct material. This determination is made by the Director of LLRW Operations, assisted by the Radiation Safety Officer and Environmental Engineer, and takes place before Energy*Solutions* receives any shipments from the generator or the owner of the radioactive material.
2. The second step is the sampling of incoming shipments for radiological analysis of the waste. The sampling is performed by qualified site personnel.
3. The third step is the completion of the incoming shipment acceptance procedures followed by a decision to accept or reject the material for disposal upon its arrival at the Clive site.

Acceptance criteria for incoming shipments are:

1. Each conveyance must be properly manifested according to 10 CFR 20.1001-20 2401, Appendix G.
2. Each conveyance must meet all conditions for a shipment of low specific activity material.
3. Each conveyance and any containers must meet Department of Transportation (DOT) requirements for marking, labeling and placarding.
4. Each shipment must meet the condition that the material shipped is only 11e.(2) and that it contains no RCRA hazardous materials.
5. The weighted average concentration of radioactivity in each delivery, i.e., individual truck or railcar must not exceed 4,000 pCi/g of natural uranium or any radionuclide in the Ra-226 series; 60,000 pCi/g of Th-230, or 6,000 pCi/g of Th-232, although they may be present at those concentrations together.

3.2.1.1 Pre-shipment Waste Characterization Procedures

Prior to shipment, Energy*Solutions* must obtain from the generator a description of the material in each waste stream to be managed at the Clive facility. This description must be made by the generator (or such entity desiring to dispose of the material). The generator's description must include a statement declaring that the generator has determined that the material is within the parameters of the license, that it is 11e.(2) material, and that the material is not a hazardous waste as defined by 40 CFR 261. The generator's descriptions must also include all of the nuclides that are present in the waste, with supporting laboratory documentation. These descriptions and information may include documents and certifications provided by the generator or the generator's agent(s).

Unless the generator is shipping waste from a stockpile which is well-characterized and relatively homogenous, each shipment must be sampled and radiologically analyzed in order to properly manifest the shipment as required by 10 CFR 20, Appendix G. This analysis may be performed by the generator using on-site equipment rather than using a third-party laboratory, and generally consists of gamma spectral analysis.

3.2.1.2 Acceptance Sampling and Analysis

During the acceptance procedures for a waste shipment, Energy*Solutions* must obtain samples of the waste in accordance with approved sampling procedures. These samples must be submitted to the laboratory for analysis to confirm that the waste has been properly manifested and is within the parameters of the license. Energy*Solutions* must receive laboratory results within 90 days of the applicable shipment's arrival (unless additional time is approved by the Division Director). If results from the laboratory show that the waste is beyond the limits of the license, and if the waste has been placed and disposed of in the 11e.(2) Embankment, Energy*Solutions* must notify the Division Director and respond in accordance with the Waste Characterization Plan (currently approved as the October 8, 2009 revision under Radioactive Material License #UT 2300249, condition 58). Generally, this means that Energy*Solutions* will follow the procedure below.

1. Within 24 hours of discovering nonconforming material had been disposed; Energy*Solutions* must notify the Division's Director of the situation.
2. Within fourteen (14) calendar days of the notice, Energy*Solutions* must provide the Division's Director with a written description of the situation. The following information must be included in the written description:
   a. Name of generator;
   b. Name of nonconforming waste stream;
   c. Amount of nonconforming disposed waste;
   d. Location of nonconforming waste in the disposal cell;
   e. Date nonconforming waste was accepted;
   f. Date nonconforming waste was placed in disposal cell; and,
   g. Description of waste placed on and around non-conforming waste.
3. Provide a written plan to the Division's Director for managing the non-conforming material.
4. Resample the shipment, by means of core sampling or removal of portions of subsequent lifts, as necessary, to confirm the initial findings.
5. Obtain approval from the Division's Director for the plan to manage the non-compliant waste. This approval may require Energy*Solutions* to modify the initial plan.
6. Carry out the approved management plan.

The minimum frequencies for laboratory sampling are provided in the Waste Characterization Plan (currently approved as the October 8, 2009 revision under Radioactive Material License #UT 2300249, condition 58).

3.2.1.3 Sampling Requirements for Laboratory Analysis

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

1. Hold a current certification from the generator's state; or
2. Meet the requirements of the generator's state for chemical or radiological laboratories; or
3. Hold a current certification for the applicable chemical or radiological analytes from the Utah Bureau of Laboratory Improvement, insofar as such official certifications are given; or
4. Be a laboratory approved by the Division.

For each waste stream, the minimum number of samples to be analyzed is:

1. One sample for each of the first ten (10) shipments (rail or highway); or,
2. One sample for each of the first 100 cubic yards (yd^3) up to 1,000 yd^3; thereafter,
3. One sample for each additional 500 yd^3 following the first ten (10) shipments or following the first 1,000 yd^3.

For ease in counting, one rail car (any type) may represent a nominal 100 cubic yards and one highway shipment (any type) may represent a nominal 20 cubic yards. The laboratory performs gamma spectrometry on all samples to identify and quantify the gamma emitting radionuclides present. Sample collection and analysis are performed in accordance with the Standard Operating Procedures catalogued in Appendices A, B, E, and F.

3.2.1.4 Incoming-Shipment Acceptance Procedures

When an 11e.(2) shipment arrives at the Clive site, it is not considered to be accepted to the Energy*Solutions* facility until the acceptance procedures have been completed and the material has been accepted for disposal. A transportation vehicle may be physically located on the Clive site property and may still not be considered "accepted" for disposal at Energy*Solutions*. Energy*Solutions* does not direct that containers of non-accepted materials be unloaded or that railcars of non-accepted material be dumped or unloaded. Should non-accepted material be dumped or unloaded without direction or permission from Energy*Solutions*, the Division's Director is contacted within 24 hours of discovery. Incoming waste shipments are accepted for disposal in accordance with the Standard Operating Procedures catalogued in Appendices A, B, E, and F.

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

a. Complies with the requirements of a manifest as outlined in 10 CFR 20, Appendix G.
b. Describes container types, volumes, number.
c. Provides estimated weights, activities, isotopes of material.
d. Documents generator's certification of packaging, classification, markings, labels, condition of containers, and compliance with the applicable regulations and Energy *Solutions*' 11e.(2) License.
e. Documents generator's certification as to RCRA or non-RCRA status of material (non-RCRA status is the default).
f. Documents generator's certification that the waste is 11e.(2).
g. Documents generator's warranty that the information provided in the radioactive waste manifest is true and correct.
h. Provides a checklist for Energy*Solutions* for inspection of the incoming material and for possible violations.
i. Documents Energy*Solutions*' acceptance or rejection of the shipment for disposal.
j. Alert receiving staff to probable concentrations and gamma exposure rates to be expected.

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

The freight container is externally surveyed for gamma radiation readings with a micro-R meter or equivalent, to assure compliance with DOT regulations. Other portable instruments appropriate to measure the radionuclides expected in the shipment are used as necessary to measure for external surface contamination. Container surveys are performed in accordance with the Standard Operating Procedures catalogued in Appendices A, B, E, and F. Each incoming freight container is smear tested for removable

contamination for comparison to the standards of 49 CFR 173.443, in accordance with the Standard Operating Procedures catalogued in Appendices A, B, E, and F.

In accordance with 10 CFR 20.1906(d), Energy*Solutions* immediately notifies the final delivery carrier and the Division's Director by telephone, when:

1. Removable radioactive surface contamination exceeds the limits of part 71.87(i) of this chapter; or
2. External radiation levels exceed the limits of part 71.47 of this chapter.

Upon arrival at the site, each incoming shipment is visually inspected for the following items in compliance with the shipment inspection requirements of 10 CFR 61.80(f) and the Standard Operating Procedures catalogued in Appendices A, B, E, and F:

1. To ensure accuracy of information submitted on the radioactive waste manifest (the container/car ID numbers, number of cars or containers) and to ensure that the material has arrived packaged, marked, labeled, and placarded according to DOT regulations in 49 CFR. Should Energy*Solutions* discover any discrepancies in the documentation, certification, or shipment, the discrepancies must be resolved with the generator or shipper prior to acceptance of the material by Energy*Solutions*. Energy*Solutions* does not unload/dispose of a shipment until such discrepancies have been settled, either through a generator visit to the disposal site or through written documentation that reflects the necessary changes in the manifest.
2. To verify whether there is any evidence of physical damage to the container that might jeopardize its integrity. This will be accomplished by visually examining the containers for any appearance of packaging breach or any such potential problem.

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

As a result of these steps, Energy*Solutions* either accepts or rejects a shipment for disposal. If a shipment meets all acceptance criteria except for possible noncompliance with license conditions, it is placed into an approved management area until additional testing can determine its status. In accordance with the Standard Operating Procedures catalogued in Appendices A, B, E, and F, waste is not accepted from a Generator when one or more of the following conditions apply:

- The shipping and disposal documents do not agree with the waste profile record;
- The waste is prohibited from land disposal;
- The shipment contains PCB's and has liquid not approved by the Environmental Engineer;
- Generator sends a shipment to the Clive facility prior to receiving a notice to transport from Energy*Solutions*.

If the shipment is rejected for disposal, Energy*Solutions* documents the rejection in accordance with the Standard Operating Procedures catalogued in Appendices A, B, E, and F, and notifies the Division's Director. If the shipment is accepted, the material is placed in an approved management area or in the embankment.

Shipments that are not found acceptable or approvable are sent back to the Generator in accordance with the Standard Operating Procedures catalogued in Appendices A, B, E, and F. A shipment which has been found

to be in violation of DOT shipping regulations, but which is otherwise acceptable, is not accepted for disposal until:

1. The Division's Director has been notified of the shipment discrepancy; and
2. The generator or generator's agent has made necessary corrections to bring the shipment into compliance with DOT regulations, if possible.

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

In accordance with NRC requirements (NRC, 1995a), Energy*Solutions* requires a Uniform-Low Level Radioactive Waste Manifest (radioactive waste manifest), or equivalent documentation, for shipments received at the Energy*Solutions* Clive facility. The radioactive waste manifest meets the requirements of 10 CFR 20, Appendix G, to certify that the shipment is 11e.(2) byproduct material and to certify that the material does not contain hazardous material under 40 CFR 261.

3.2.1.5 Requirements of Manifests

Within one week of receipt of any shipment at the facility, Energy*Solutions* acknowledges the receipt by returning a signed copy of the radioactive waste manifest to the generator. Any discrepancies in the material received and the manifest are indicated on the returned manifest.

If Energy*Solutions* receives a completed radioactive waste manifest but the entire load described on the manifest does not arrive within 60 days of that manifest receipt, Energy*Solutions* will notify the generator and the Division's Director. Energy*Solutions* will maintain verified electronic copies of all completed radioactive waste manifests until license termination.

3.2.1.6 Review of Manifest at Waste Acceptance

The procedures for accepting incoming waste shipments included in the Standard Operating Procedures catalogued in Appendices A, B, E, and F. During the incoming shipment review, each shipment is checked for the following items:

a) The condition of the packages received,
b) Radiation dose rates for the package(s) and conveyance,
b) Any discrepancies between materials and the manifests, and
c) Any leaking or damaged packages.

A complete radioactive waste manifest must be received by Energy*Solutions* before a shipment may be accepted for management. The radioactive waste manifest accompanies the shipment and may also be received by Energy*Solutions* prior to the time that the shipment is received. After a review of the radioactive waste manifest and completion of the other incoming shipment acceptance requirements each shipment will either be accepted or rejected for disposal.

3.2.1.7 Waste Tracking

Energy*Solutions* has implemented an electronic database called the Electronic Waste Information System (EWIS) to track the location of all waste at the facility. The tracking program is based on details of site operations. Waste storage is tracked as shipping containers move from acceptance through unloading. Bulk

waste material is assigned storage or disposal locations depending on how it is managed. Final disposal is identified with a Lift ID that is assigned during the quality control lift approval process.

3.2.1.8 Records at License Termination

Upon 11e.(2) License termination, Energy*Solutions* will provide records of the location and quantity of the radioactive waste disposed at the facility to each of the following:

a) Mayor of Grantsville;
b) Tooele County Commissioners;
c) Tooele County Planning Commissioners;
d) Governor of the State of Utah; and,
e) Utah Radiation Control Board.

The permanent site boundary markers are USGS quadrant "brass cap" markers. Qualified engineering contractors will survey the embankment to document its location. All locations will be tied into the USGS survey control stations. Permanent markers will also be placed at the head and toe of each completed embankment.

3.2.1.9 Annual Reports

On an annual basis, Energy*Solutions* will submit to the Division's Director the following information:

a) An as-built report and drawings, including the annual survey;
b) A summary of activities and quantities of radionuclides disposed of;
c) Any instances in which observed site characteristics were significantly different from those described in this application;
d) Environmental monitoring results; and,
e) Weather monitoring results.

If there are any unusual circumstances substantiated in the annual report they must be discussed specifically.

3.2.1.10 Division Inspections

Energy*Solutions* will allow the Division to conduct routine inspections, including unannounced inspections, of the Clive Facility including all radioactive waste, equipment and the associated facilities. Such inspections will typically be conducted during normal working hours. Energy*Solutions* will make available during any inspections all records as requested by the Division. In the past, the Division has performed various waste placement inspections on 11e.(2) facility operations. The results of these inspections are communicated to Energy*Solutions* via closeout meetings and then documented via letter.

3.3 DECONTAMINATION FACILITIES

"A license application shall be approved if the Executive Secretary determines that (b) the applicant's proposed equipment, facilities, and procedures are adequate to minimize danger to public health and safety or the environment;" **– R313-22-33(1)(b).**

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment

and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

"The minimum compacted radon barrier thickness placed after December 1, 2001, will be 4.0 ft. on the top and 3.5 ft. on the side of the disposal cell.

a) The placed radon barrier material will be compacted to not less than 95 percent of maximum dry density in accordance with Standard Proctor Method ASTM-698, field-tested for compliance. At least one density test shall be performed for every 200 cubic yards (compacted) and at least one test shall be conducted on each lift. All lifts shall be field-tested for density and moisture content. At least one moisture content test shall be performed for every 200 cubic yards (compacted) and at least one test shall be conducted on each lift.

b) The waste in the upper ten feet of the 11e(2) embankment shall be placed and compacted to not less than 90 percent of the maximum dry density in accordance with Standard Proctor Method ASTM D 698, field-tested for compliance. At least one density test shall be performed for every 1000 cubic yards (compacted) and at least one test shall be conducted on each lift. All lifts in the upper ten feet of the 11e.(2) embankment shall be field-tested for moisture content. CLSM shall not be used in the upper ten feet of the 11e.(2) embankment.

c) At the end of every calendar year starting with 2001, the licensee shall ensure that the cumulative average activity concentration of waste placed after Jan. 1, 2001, within the upper 3 feet of disposed waste does not exceed 300 pCi/g of Ra 226 or 900 pCi/g of Th 230, and within the next 7 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 will 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 3 feet and 1500 pCi/g in the next 7 feet of waste, and
Y = 300 pCi/g in the upper 3 feet and 500 pCi/gm in the next 7 feet of waste

d) The cumulative average densities of the waste in the upper ten feet of the 11e(2) embankment and of the compacted radon barrier placed since January 1, 2001, shall not be less than 1.5 g/cm3 for either.

e) These cumulative average values of 10.9(d) will be provided in the 4th quarter effluent and environmental monitoring report, starting with the 2008 report, and in the construction completion report." **– LICENSE CONDITION 10.9.**

"Table 9—Non-Fixed External Radioactive Contamination Limits for Packages

Contaminant	*Maximum permissible limits*		
	Bq/cm²	*uCi/cm²*	*dpm/cm²*
1. Beta and gamma emitters and low toxicity alpha emitters	*4*	*10^{-4}*	*220*
2. All other alpha emitting radionuclides	*0.4*	*10^{-5}*	*22"* **– 40CFR173.443.**

Ground Water Quality Protection - Rule R317-6.

Energy*Solutions* has developed an extensive set of decontamination facilities in support of its 11e.(2) Embankment and waste disposal operations (as outlined in the procedures catalogued in Appendix A, the 11e.(2) Embankment drawings of Appendix I, and the Decontamination Plan of Appendix C). These procedures address decontamination activities necessary for equipment and tools used in shipping, receiving, managing, and disposal of 11e.(2) material. Decontamination procedures have also been developed to address release of the various shipping containers from the Restricted Area.

The 11e.(2) Embankment, being one of several active disposal facilities at the Energy*Solutions* Clive site, will be closed according to the general plan outlined in Appendix C. At the time of closure, a detailed decommissioning plan will be prepared for Division approval consistent with the Applicable Regulations and Requirements. Currently, it is assumed that additional support facilities will not be required beyond that specified in this License Renewal Application. It is also assumed that these support facilities will be decontaminated and decommissioned upon closure. The decontamination and decommissioning activities include:

a. Decontaminating off-site soils and rail road spur, if necessary, by removing all surface materials contaminated with 11e.(2) materials such that the contamination in the residual soil or rail road ballast is ALARA and below the respective cleanup limits. Soil will be disposed of at an Energy*Solutions* Class A Embankment using disposal methods approved in the CQA/QC Manual.
b. Decontaminating on-site soils within the Energy*Solutions*' property but excluding the disposal embankments, by removing all surface soils contaminated with 11e.(2) materials such that the contamination in the residual soils is ALARA and below the respective cleanup limits. Soils will be disposed of at an Energy*Solutions*' Class A Embankment using disposal methods approved in the CQA/QC Manual.
c. Decontaminating on-site structures such as the rollover facility, geotechnical laboratory, and rail spur to meet the unconditional release criteria or, remove and place structures in a Class A Embankment.
d. Decontaminating the on-site support structures and contents including the change and laboratory facilities within the administration building to meet the unrestricted release criteria, or remove and dispose of contents and structures in a Class A Embankment.
e. Implementing of a corrective action plan to remove groundwater contamination at the site per license condition based on guidelines in 10 CFR 40, Appendix A, Criterion 5.

Clive waste handling facilities are used for both Class A and 11e.(2) waste management activities. Since 11e.(2) radionuclides represent a subset of the potential contaminants in Class A waste, it is appropriate to place decommissioning waste from these facilities into a Class A Embankment. In fact, the Ground Water Quality Discharge Permit requires that sludge and other wastes from eventual decommissioning of the 2000 Evaporation Pond be disposed as Class A, rather than 11e.(2), waste.

3.3.1 Waste-Water Facilities

"A license application shall be approved if the Executive Secretary determines that (b) the applicant's proposed equipment, facilities, and procedures are adequate to minimize danger to public health and safety or the environment;" **– R313-22-33(1)(b).**

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall

carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

During operation, Energy*Solutions*' disposal facilities are managed to prevent precipitation from flowing into the 11e.(2) Embankment. This is accomplished by construction of a run-on berm around the perimeter of the disposal embankment. Therefore, there are no design features to promote deposition during operations since there is no "…runoff which flows into the impoundment area…". Energy*Solutions*' final embankment is designed to maintain sheet flow for all precipitation that falls on it. By maintaining sheet flow, the turbulence and velocity of the water are minimized; thus improving the deposition of sediment and minimizing the erosion of the cover.

The post-closure drainage system surrounding the 11e.(2) Embankment has been designed to direct water from precipitation or sheet flow away from the disposal unit. Drainage system design for the 11e.(2) Embankment are included in Appendix I. Potentially-contaminated standing water at the Clive Site is managed during the operational life of the facility according to Condition I.E.7 of the Ground Water Discharge Permit "Run-on and Run-off Control Requirements" and "Waste Water, Runoff, and Storm Water Management Requirements." 11e.(2) Embankment areas are managed to remove any intermediate standing water when necessary. Energy*Solutions* uses mobile pumping trucks and other equipment as needed to access and remove water from disposal site areas which are not designed to free-drain into an evaporation pond or equipped with permanent pumps. Other areas of the property are channeled to the southwest. Short-term bodies of standing water on the surface in other areas of the property will not affect the performance of the facility. This water dissipates primarily through evaporation due to the climatic features of the site rather than percolation; and thus will have no impact on groundwater horizontal gradients.

3.4 WASTE HANDLING FACILITIES

"A license application shall be approved if the Executive Secretary determines that (b) the applicant's proposed equipment, facilities, and procedures are adequate to minimize danger to public health and safety or the environment;" **– R313-22-33(1)(b).**

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

Energy*Solutions*' waste handling procedures and associated facilities, included in the Standard Operating Procedures catalogued in Appendices A, B, E, and F and Embankment drawings of Appendix I, ensure that other wastes are not co-mingled with 11e.(2) wastes. These procedures discuss the necessary precautions required to ensure that vehicle, facility and equipment cleaning occurs prior to hauling or handling 11e.(2) material at the intermodal unloading facility. They also address signage requirements for vehicles, facilities and equipment handling 11e.(2) waste. The Standard Operating Procedures catalogued in Appendices A, B,

E, and F detail how waste streams are reviewed, assigned a Bates Number used for tracking purposes, and finally accepted for disposal.

3.4.1 Procedures for Waste Handling

"A license application shall be approved if the Executive Secretary determines that (b) the applicant's proposed equipment, facilities, and procedures are adequate to minimize danger to public health and safety or the environment;" **– R313-22-33(1)(b).**

"The licensee shall operate the facility in compliance with the following specifications:

a) The maximum bulk mass of waste disposed of annually will not exceed 4.536 x 105 tonnes (5 x 105 tons) or (3.82x 105 m 3) or (4.00 x 105 yd3).

b) The open cell area will not exceed 69,955.41 m2, 83,666.67 yd2, 753,000 ft2 or 17.29 acres.

c) Deleted by NRC Amendment 1

d) The total embankment capacity will not exceed 4.20 x 106 m3 (5.50 x 106 yd3)

e) The maximum volume of waste that may be stored as in-cell bulk storage on site prior to disposal will not exceed 75,000yd3 or (5.735 x 104m3) at any one time.

f) Waste with an average concentration above 4,000 pCi/g for natural uranium or for any radio nuclide in the radium-226 series; 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 will not be accepted.

The licensee shall maintain the detailed documents demonstrating compliance with the above specifications on-site and summarize the data in paragraphs a) and b) of this License Condition in the annual As-built report that is required in the Groundwater Quality Discharge Permit UGW450005." **– LICENSE CONDITION 10.8**

Once the Incoming Shipment form has been completed to indicate that a shipment has been accepted for disposal, the shipment will be unloaded in accordance with approved site operating procedures. Procedures address incoming waste transferring, and handling at the LLRW truck unloading facility, intermodal unloading facility, rail operations, and container return inspection.

3.4.1.1 Management of Shipments with External Gamma Rates in Excess of 5mR/hr

For purposes of reducing radiation doses to workers handling shipments containing higher-than-usual concentrations of radioactivity, the following procedures will be followed. Rail cars or trucks which are found on the arrival survey to have external gamma exposure rates of greater than 5 mR/h at 30 cm from any surface will be identified as Radiation Areas by placing a "Caution, Radiation Area" sign, as described in 10 CFR 20.1902, on each of the two sides. If there will be a delay of more than 24 hours in emptying the load, it will be roped off to control access to the radiation area around the shipment.

All workers will be required to wear appropriate respiratory protection while managing waste from shipments identified as Radiation Areas. For those tasks determined to require the use of respirators, half-face respirators will provide a factor of 10-protection against airborne particulate radioactivity. Energy*Solutions* also provides full-face respirators that provide a factor of 50-protection, if needed. All respirator use is conducted as prescribed in Regulatory Guide 8.15, (NRC, 1999a).

Wastes placed in the embankment from shipments identified as Radiation Areas will be covered with lower activity wastes or six inches of clean fill after final compaction, if that portion of the lift will be inactive for more than 10 working days. Wastes placed within the upper three feet of disposed waste must not exceed the cumulative average activity of 300 pCi/g Ra-226 or 900 pCi/g Th-230. The cumulative average activity

of wastes placed within the next seven feet of disposed waste must not exceed 500 pCi/g Ra-226 or 1500 pCi/g of Th-230. Wastes placed below the ten feet outlined above must not exceed a cumulative average concentration above 4,000 pCi/g for natural uranium or for any radionuclide in the Ra-226 series, above 60,000 pCi/g for Th-230, or above 6,000 pCi/g for any radionuclide in the thorium series. These requirements will prevent radon emissions at the surface of the radon barrier from exceeding 20 pCi/m^2/s. For wastes containing more than one limited nuclide, the Sum of Fractions Rule will apply.

In order to ensure that wastes are disposed of in the proper embankment location, Quality Control personnel supply Lift ID numbers for wastes placed in the top ten feet of the embankment to Health Physics upon completion of a lift. Health Physics personnel use the Lift ID numbers to obtain shipment volumes and Bates Numbers for the wastes that went into the lift. Upon obtaining these data, a request is made to the lab to provide sample results for the wastes identified in the lifts in question. When results are received, radiological personnel then calculate the radon emanation values to ensure that they are within the guidelines specified by License Condition 10.9(c), as discussed in the previous paragraph. The radon emanation values are reported to the Division annually in the 11e.(2) Environmental Monitoring Report.

In the past, annual average Ra-226 and Th-230 concentrations have always been well below the maximum permitted license concentrations for the top 3 feet of the cell (found in License Condition 10.9c) so Energy*Solutions* demonstrates compliance by taking the averaging concentrations in the top 10 feet of the cell and comparing it against the more restrictive 3 feet limit. Energy*Solutions* identifies the lifts in the top 10 feet of the 11e.(2) cell completed during the year. The shipments disposed in these lifts are compiled into a list. The gamma spectrometry analysis from the receipt samples for the listed shipments are collected and the average Ra-226 and Th-230 is calculated and submitted to demonstrate compliance. If average concentrations in the lifts exceed the top 3 feet limit in any given year, the calculation may need to separate waste placed in the top 3 feet from the waste placed "within the next 7 feet," or the average concentration may need to include previous years.

Gamma exposures at the surface of the clay cover are not affected by burial of wastes at ten feet below the top of the waste placed in the embankment. Schleien, Bernard, 1989 reports a tenth-value layer for attenuation of gamma rays from Ra-226 in sand and concrete at 23.4 centimeters. Ten feet of waste and three and one-half feet of clay provide approximately 17 tenth-value thicknesses for Ra-226 or a reduction to background in gamma exposure rates.

3.4.1.2 Quality Assurance and Quality Control During Disposal Operations

Waste disposal in the 11e.(2) Embankment occurs in accordance with Energy*Solutions*' CQA/QC Manual. Standard Operating Procedures catalogued in Appendix A are generated using the CQA/QC Manual as a guideline for approved disposal methods. As disposal of varying waste types are discussed, the governing CQA/QC Manual reference and the Standard Operating Procedures are provided.

3.4.1.3 In-cell Bulk Management (Stockpiling) and Disposal

When bulk materials are to be stockpiled or unloaded and managed prior to emplacement, they are placed in accordance with Part I.E.9 of Energy*Solutions'* Ground Water Quality Discharge Permit. A dust suppressant is used on the storage piles to prevent wind dispersal. Bulk waste soil material is place in accordance with the CQA/QC Manual (Work Element – Waste Placement, In-Cell Bulk Disposal). The procedures generated from the CQA/QC manual are outlined in the Standard Operating Procedures catalogued in Appendices A, B, E, and F. These procedures delineate general safety, compliance and precautionary instructions that should be followed when disposing of 11e.(2) waste soils.

3.4.1.4 Container Management and Disposal

Containers approved for storage in accordance with Condition I.F.9 of Energy*Solutions*' Ground Water Quality Discharge Permit are visually inspected to ensure that the containers have structural integrity. Drums and barrels of material are placed on pallets and stacked a maximum of two (2) high. Storage areas are inspected daily in accordance with the Ground Water Quality Discharge Permit, Appendix J. Containers which are found to be deteriorating are re-containerized or over-packed, i.e., placed inside another, larger container of assured structural integrity.

Disposal of 11e.(2) debris takes place in accordance with the CQA/QC Manual (Work Element – Waste Placement, Debris Placement). The quality assurance procedures catalogued in Appendix F delineate general safety, compliance and precautionary instructions that should be followed when disposing of 11e.(2) waste soils.

3.4.1.5 Locating Disposal Units and Boundary Markers

Four permanent survey monuments currently exist at the outside corners of Section 32. These monuments are USGS "brass caps" and are tied into the USGS and National Geodetic Survey control networks and the State Plane Coordinate System. Energy*Solutions* maintains lines of sight from each monument to adjacent monuments for surveying purposes. The monuments are located in positions that are easy to see. The monuments are not likely to be disturbed by natural or human action and are convenient for surveys from all portions of the site by use of short-range distance measuring equipment.

Records maintained by the Engineering Office in compliance with the disposal record-keeping requirements of 10 CFR 61.80(f) detail the location of the disposal material within the 11e.(2) Embankment. The records contain: the generator, truck or railcar, the Grid Location (North/South & East/West & Depth coordinates), and the approximate location. During construction, horizontal and vertical controls are identified by survey lathe and stakes; or by GPS. In compliance with the requirements of 10 CFR 61.80(e), Energy*Solutions* will transfer these records upon license termination to the chief executive of the city of Tooele, Utah; the chief executive of Tooele County; the Tooele County zoning board, the Governor of the State of Utah, and any other State, local, and Federal agencies as designated by the Division's Director at the time of 11e.(2) License termination. The USGS survey monuments also delineate the boundaries of Section 32. No site markers are necessary during the operational phase of embankment construction on the site. However, upon completion of the 11e.(2) Embankment, the site is marked as follows:

1. One site marker is placed at the entrance to the site, and one marker is placed near the center of the crest of the embankment.
2. The site markers identifies the site and the general location of the disposal material on the site, and show the dates of construction opening and embankment closure, the volume, mass or tonnage of disposal material, the number of kilograms of source material, the number of grams of special nuclear material, and the total activity of radioactive material in curies.
3. The markers are unpolished granite with minimum dimensions of 36 inches in length, 24 inches in width, and 18 to 24 inches in depth. Lettering and other markings will be incised 1/4 to 1/2 inch.
4. The site markers at the entrance to the site are set in a bed of reinforced concrete that extends below the frost line. The incised face of both markers are approximately horizontal, but with sufficient slope to prevent the accumulation of water, ice, or soil. The site markers are slightly above ground (18 to 24 inches).
5. The elevation and position of the site markers are determined by a survey using site survey markers as reference.

3.5 INSTRUMENTATION AND CONTROL

"A license application shall be approved if the Executive Secretary determines that (b) the applicant's proposed equipment, facilities, and procedures are adequate to minimize danger to public health and safety or the environment;" **– R313-22-33(1)(b).**

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

Health Physics instrumentation selected for this program includes the portable and laboratory equipment described below. Equivalent instrumentation may be selected for use if approved by the Health Physics Department.

a. Ludlum Model 19 Micro-R Survey Meters - Selected as the basic survey meter for gamma exposure rates for area surveys and incoming shipments. Due to the low exposure rates encountered, a scintillation survey meter capable of performing accurate measurements in the range of background is required. The selected meters are rugged, dependable, easy to use, and feature a range of 0 to 5,000 mR/h over 5 ranges.

c. Berthold Model 122 contamination survey meter - This meter measures alpha and beta surface contamination independently and provides a direct readout of area contamination levels. It operates over a wider range of temperature conditions than other survey meters and is well-suited for field use in meeting the release standards presented in Section 17.4.7.1.

d. Ludlum Model 177 Rate meter with Model 44-9 Pancake G-M Detector - Selected as a portal frisker for personnel surveys due to the high sensitivity of the pancake detector and alarm-rate meter capability of the rate meter. The thin-window GM detector is sensitive to alpha, beta, and gamma radiation. The radiation types can be determined by selective use of shielding.

e. Ludlum Model 9 Ion Chamber Survey Meter - Selected to provide a wide range of exposure rate measurements with little dependence on gamma energy. This instrument is rugged and reliable, and has a range of 0 - 5 R/h over 4 ranges.

f. Self-Reading Dosimeters (Victoreen 541R or equivalent or Bicron Model PDM-207 or equivalent) - Selected to provide detection capability of approximately 1 mR over a scale of 0 - 200 mR. Used to record exposures to visitors and temporary employees while in the controlled area.

g. Ludlum Model 1000 Scalar-Timer with Model 43-10 Alpha Scintillation Detector - Selected as a reliable, easy-to-use instrument for the counting of gross alpha activity on air samples and swipes.

h. Ludlum Model 2200 Scalar/Rate meter with Model 43-10 Alpha Scintillation Detector - Selected as a reliable, easy-to-use instrument for the counting of gross alpha activity on air samples and swipes.

i. Ludlum Model 2200 Scalar-Timer with Model 120 Gas Proportional Detector - Selected as a reliable, easy-to-use instrument for the counting of gross alpha or gross beta activity on air samples and swipes.

j. Packard Tri-Carb Liquid Scintillation Counter.

The calibration and management of monitoring equipment is based on applicable guidance in NRC Regulatory Guides, 4.14, 8.25, and DG-80030. All equipment used in measurement of radiation is periodically calibrated by persons licensed to perform such calibrations. The calibration facilities currently used by Energy*Solutions* calibrate exposure rate survey meters and dosimeters against Cs-137 standards. All survey equipment will be calibrated at least annually or after each repair. All personal dosimeters will be calibrated annually.

All instruments will be efficiency checked or source checked prior to use on a daily basis. Alpha and beta laboratory counters will be efficiency checked each day that they are in use. Portal monitors will be source checked at the beginning of each day using a source that is adequate to indicate an alarm. The response of hand-held radiation detection instruments will be compared to known sources prior to each use.

The respiratory protection equipment and protective clothing are located in the change rooms at the various controlled access points. Portable radiation instruments and laboratory instruments are located in the radiological laboratory in the Operations Building.

SECTION 4. EFFLUENT CONTROL SYSTEMS

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

"Each licensee authorized to possess and use source material in uranium milling, in production of uranium hexafluoride, or in a uranium enrichment facility shall:
(1) Within 60 days after January 1, 1976 and July 1, 1976, and within 60 days after January 1 and July 1 of each year thereafter, submit a report to the Director, Office of Federal and State Materials and Environmental Management Programs, using an appropriate method listed in § 40.5, with a copy to the appropriate NRC Regional Office shown in appendix D to part 20 of this chapter; the report must specify the quantity of each of the principal radionuclides released to unrestricted areas in liquid and in gaseous effluents during the previous six months of operation, and such other information as the Commission may require to estimate maximum potential annual radiation doses to the public resulting from effluent releases. If quantities of radioactive materials released during the reporting period are significantly above the licensee's design objectives previously reviewed as part of the licensing action, the report shall cover this specifically. On the basis of such reports and any additional information the Commission may obtain from the licensee or others, the Commission may from time to time require the licensee to take such action as the Commission deems appropriate." **– 10 CFR 40.65(a)(1)**

"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." **– LICENSE CONDITION 9.14**

The above-grade disposal embankment is the most environmentally sound approach for disposal. Although it was demonstrated that deep and shallow below-grade embankments were designed to meet the same standards of effluent protection from water erosion, wind erosion, geotechnical instability, settlement of embankment, roots and burrowing animals, the above-grade embankment utilized by Energy*Solutions* provides the best protection for the groundwater. It was also found that both below-grade embankment designs have a higher potential for water infiltration than the above-grade 11e.(2) Embankment design due to their closer proximity to the upper boundary of the unconfined aquifer (NUREG-1476).

4.1 GASEOUS AND AIRBORNE PARTICULATES

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

"Each licensee authorized to possess and use source material in uranium milling, in production of uranium hexafluoride, or in a uranium enrichment facility shall:
(1) Within 60 days after January 1, 1976 and July 1, 1976, and within 60 days after January 1 and July 1 of each year thereafter, submit a report to the Director, Office of Federal and State Materials and Environmental Management Programs, using an appropriate method listed in § 40.5, with a copy to the appropriate NRC Regional Office shown in appendix D to part 20 of this chapter; the report must specify the quantity of each of the principal radionuclides released to unrestricted areas in liquid and in gaseous effluents during the previous six months of operation, and such other information as the Commission may require to estimate maximum potential annual radiation doses to the public resulting from effluent releases. If quantities of radioactive materials released during the reporting period are significantly above the licensee's design objectives previously reviewed as part of the licensing action, the report shall cover this specifically. On the basis of such reports and any additional information the Commission may obtain from the licensee or others, the Commission may from time to time require the licensee to take such action as the Commission deems appropriate." **– 10 CFR 40.65(a)(1)**

Air is continuously sampled at multiple locations surrounding the 11e.(2) Embankment, Restricted Area, and the Clive Facility. The stations located around the Restricted Area perimeter are used to determine the airborne concentration of radioactive particulates from disposal operations. Station A-16, located west of the Site, at the Clean Harbors Clive facility, is used to determine background.

Radioactive airborne particulate samples are collected using a constant-flow air sampler to draw air through a glass fiber filter, or a functionally similar particulate sampling media. The particulate air sampling apparatus maintains a flow rate of approximately 60 liters per minute through the filter media. The airborne particulate sampling filters are changed twice weekly under most circumstances.

All particulate filters are analyzed for alpha and beta activity at least 7 days but not more than 14 days after collection. The delay of 7 days is needed to allow for the decay of short-lived radon progeny that could potentially interfere with detecting the long-lived contaminants of concern. The time limit of 14 days is to ensure that samples are analyzed in a timely manner. The background alpha and beta concentrations measured at Station A-16 are subtracted from the concentrations measured at the other stations. If for some reason the data from A-16 are not available or are indeterminate, no background is subtracted for the samples collected during the sampling period (e.g., gross concentrations are reported, instead of the net concentrations).

Any individual sample filters with a net alpha or net beta concentration above the applicable Particulate Air Sample Action Level are analyzed by gamma spectroscopy within 3 working days of the alpha/beta analysis. Gamma spectroscopy analysis results are reviewed to determine if any additional actions need to be taken.

When an individual filter has a net alpha concentration above $3x10^{-12}$ μCi/ml or net beta concentration above $5x10^{-11}$ μCi/ml (approximately 25 times the Particulate Air Sample Action Level, based on 25 or 26 filters per quarter per location), additional radiochemical analyses are performed on that filter according to the requirements for quarterly composite filters, unless gamma spectroscopy associates at least 50 percent of the net alpha or net beta activity present on the filter with gamma-emitting radionuclides.

All particulate air sample filters collected during the quarter are gathered into a composite sample for each air monitoring station. Each composite sample is analyzed by gamma spectroscopy using either the on-site instruments or one of the qualified contractor laboratories. The composite samples are also analyzed specifically for U-238, U-234, U-235, Th-228, Th-230, Th-232, Ra-226, Pb-210, and Po-210. The specific analytical methods are determined by the accredited laboratories doing the analysis.

In order to maximize the detection sensitivity for the important radionuclides, any additional radiochemical analyses are limited to those radionuclides that could reasonably be expected to contribute more than five percent of the aggregate Committed Effective Dose Equivalent over the quarter. The potential relative dose fraction for each radionuclide is determined each quarter by weighting its effective inhalation dose coefficient according to its relative abundance in the waste disposed during the quarter.

Air is also continuously sampled for radon and thoron, using Landauer RadTrak® Dosimeters. Stations B-2, A-27, and A-16 sample results are used to determine background.

Tritium is monitored by collecting water vapor in a desiccant material, at a flow rate of approximately 200-300 ml/min. The samples are analyzed at the end of each quarter (with an H-3 ECL of $1x10^{-7}$ µCi/ml used to calculate dose). These facilities are operated in accordance with Energy*Solutions* Air Approval Order.

4.2 LIQUIDS AND SOLIDS

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

"Each licensee authorized to possess and use source material in uranium milling, in production of uranium hexafluoride, or in a uranium enrichment facility shall:
(1) Within 60 days after January 1, 1976 and July 1, 1976, and within 60 days after January 1 and July 1 of each year thereafter, submit a report to the Director, Office of Federal and State Materials and Environmental Management Programs, using an appropriate method listed in § 40.5, with a copy to the appropriate NRC Regional Office shown in appendix D to part 20 of this chapter; the report must specify the quantity of each of the principal radionuclides released to unrestricted areas in liquid and in gaseous effluents during the previous six months of operation, and such other information as the Commission may require to estimate maximum potential annual radiation doses to the public resulting from effluent releases. If quantities of radioactive materials released during the reporting period are significantly above the licensee's design objectives previously reviewed as part of the licensing action, the report shall cover this specifically. On the basis of such reports and any additional information the Commission may obtain from the licensee or others, the Commission may from time to time require the licensee to take such action as the Commission deems appropriate." **– 10 CFR 40.65(a)(1)**

Compliance is demonstrated by analysis of groundwater sampling from compliance monitoring wells and soil sampling (for analytes listed in Table 4-1). All 11e.(2) groundwater sampling is performed in accordance with the 11e.(2) License and the Ground Water Quality Discharge Permit. Soil sampling is conducted in accordance with the Environmental Monitoring Plan, as controlled by condition 20 of Radioactive Material License No. UT2300249.

Environmental soil samples are analyzed by gamma spectroscopy. In order to facilitate the accurate measurement of radionuclides, the samples are collected from the top one inch of soil. Routine soil samples that exceed the Soil Action Levels are analyzed for isotopic thorium. The locations of any quarterly or annual soil sample above action levels is further characterized by additional sampling to verify the initial finding, and to subsequently determine the nature, extent, and cause of any problem once the initial finding is verified. Areas with confirmed radioactivity above the Soil Action Level are remediated.

Soil samples are also collected annually to assess potential windblown contamination from the 11e.(2) Embankment. Surface soil samples are taken at 300 meter intervals along the 8 compass directions centered near the center of Section 32. The first sample is taken just outside the site boundary and additional samples are taken at 300 meter intervals extending out to 1,500 meters. All 48 samples are analyzed by gamma spectroscopy.

Radioactivity concentrations in the soil near rail gates and gates that directly access Non-contaminated Restricted Areas are also monitored. A soil sample is taken near rail gates used to exit the Restricted Area during the quarter. A soil sample is also taken at gates that directly access Non-contaminated Restricted Areas; where vehicles, personnel, or materials were permitted to exit during the quarter without a radiological release. The sample is taken where the soil is most likely to be affected by contamination that may be present on vehicles exiting the Restricted Area. All soil samples are analyzed by gamma spectroscopy.

Groundwater sampling is performed for all compliance monitoring wells which are required by the Ground Water Quality Discharge Permit. Water samples collected from monitoring wells are analyzed for all monitoring parameters required by the Ground Water Quality Discharge Permit. All groundwater sampling and analysis results are reviewed by the Groundwater Manager or qualified designee.

Groundwater samples are taken from the compliance monitoring wells on an annual basis. The annual sampling events are conducted at least six months later than the previous year's sampling event. Groundwater compliance is determined by a comparison of the results of sampling to the established groundwater protection levels specified in the Ground Water Quality Discharge Permit.

In conjunction with the annual sampling event, the compliance monitoring wells are inspected for security of the surface casing, mechanical integrity, condition of inside casing and well depth to assure the well's screens are free and open to the formation. If any conditions requiring corrective actions are observed, these actions are taken within 10 working days.

Table 4-1

Groundwater and Soil Sampling Program: List of Analytes (Table 1C of the GWQDP)

Parameter	GWPL [1]	Parameter	GWPL [1]
Field and Inorganic Parameters [2] (mg/l)		*Organic Parameters – Specific to 11e.(2) (mg/l)*	
Cyanide	0.2	Acetone [5]	0.7
Fluoride	4.0	2-Butanone [11]	4.0
Total Nitrate/Nitrite (as N)	10.0	Carbon Disulfide [5]	0.7
pH (units)	6.5 – 8.5	Chloroform [6]	0.08
Dissolved Metals [2] (mg/l)		1,2-Dichloroethane	0.005
Antimony	0.006	Methylene Chloride [7]	0.005
Arsenic	NA [3]	Naphthalene [8]	0.02
Barium	2.0	Diethyl Phthalate [9]	5.0
Beryllium [4]	0.004	2-Methylnaphthalene [10]	0.004
Cadmium	0.005	Benzo(a)anthrancene	0.01
Chromium	0.1	Benzo(a)pyrene	0.01
Copper	1.3	Benzo(k)fluoranthene	0.01
Lead	0.015	Chlordane	0.002
Mercury	0.002	Chrysene	0.01
Molybdenum	NA [3]		
Nickel [4]	0.10		
Selenium	0.05		
Silver	0.1		
Thallium	0.002		
Uranium – total	0.03		
Zinc	5.0		
Combined Radiologic Parameters (pC/l)			
Radium-226+radium-228	5		
Radiologic Parameters (pC/l)			
Thorium-230	83		
Thorium-232	92		

1. All field, inorganic, dissolved metals, and organic indicator organic parameters and corresponding GWPLs for the 11e.(2) wells are equivalent to those for the LARW wells in Table 1A, above.
2. All ground water protection levels (GWPL) derived from Ground Water Quality Standards (GWQS, see UAC R317-6-2), except as noted.
3. Due to naturally elevated concentrations of arsenic and molybdenum in the Class IV saline aquifer at Clive, Utah, these constituents are poor indicators of cell leakage and therefore will not be used as compliance parameters with ground water protection levels. However, the Permittee will continue to sample, analyze, and report arsenic and molybdenum data in all compliance monitoring wells at Permit and License renewal as a best management practice.
4. Beryllium and Nickel GWQS derived from EPA drinking water Maximum Contaminant Levels (MCL), as published in the July 17, 1992 Federal Register, Vol. 57, No. 138, pp. 31776 – 31849, Table 1.

5. GWQS for acetone, and carbon disulfide determined by DWQ staff from reference doses available in the technical literature, see August 8, 1994 DWQ Staff Report: Ground Water Quality Conditions and Proposed Revision to Ground Water Protection Levels, Envirocare of Utah Inc., Low-Level Radioactive Waste and 11e.(2) Waste Disposal Facility, near Clive, Tooele County, Utah, p. 3.
6. GWQS for chloroform derived from a 1998 EPA final drinking water MCL for total trihalomethane compounds in "Drinking Water Standards and Health Advisories", EPA 822-B-00-001, Summer 2000.
7. GWQS for methylene chloride derived from EPA drinking water MCL (ibid.).
8. Naphthalene GWQS derived from final EPA drinking water LHA (ibid.).
9. GWQS for diethyl phthalate based on draft EPA drinking water LHA (ibid.).
10. GWQS for 2-methylnaphthalene could not be located or determined, thanks to a lack of reference dosage information in the technical literature. Consequently, a detection monitoring approach has been taken and the GWPL set equal to the minimum achievable detection limit for the compound as a result of matrix interferences from high TDS content of Clive ground water. As health-based risk or other reference dosage information becomes available, the Executive Secretary may modify the Permit and set a GWQS for 2-methlynaphthalene.
11. GWQS for 2-Butanone (methyl ethyl ketone) derived from Life-time health advisory value in "2006 Edition of the Drinking Water Standards and Health Advisories", EPA 822-R-06-013, August 2006

In addition to any other corrective action that may be required under the Ground Water Quality Discharge Permit, the need for corrective action is evaluated in the event that monitoring detects migration of constituents to the groundwater, or any other situation which indicates a compromise of the Embankment's integrity. The Division Director is notified within five days of discovery of a need for corrective action, for conditions governed by Parts 1.G.1 through 1.G.3 of the Ground Water Quality Discharge Permit. Within ten days of notifying the Division Director, Energy*Solutions* submits a plan and compliance schedule to complete any necessary corrective action.

4.3 CONTAMINATED EQUIPMENT

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

"Each licensee authorized to possess and use source material in uranium milling, in production of uranium hexafluoride, or in a uranium enrichment facility shall:
(1) Within 60 days after January 1, 1976 and July 1, 1976, and within 60 days after January 1 and July 1 of each year thereafter, submit a report to the Director, Office of Federal and State Materials and Environmental Management Programs, using an appropriate method listed in § 40.5, with a copy to the appropriate NRC Regional Office shown in appendix D to part 20 of this chapter; the report must specify the quantity of each of the principal radionuclides released to unrestricted areas in liquid and in gaseous effluents during the previous six months of operation, and such other information as the Commission may require to estimate maximum potential annual radiation doses to the public resulting from effluent releases. If quantities of radioactive materials released during the reporting period are significantly above the licensee's design objectives previously reviewed as part of the licensing action, the report shall cover this specifically. On the basis of such reports and any additional information the Commission may obtain from the licensee or others, the Commission may from time to time require the licensee to take such action as the Commission deems appropriate." **– 10 CFR 40.65(a)(1)**

The decontamination and release procedures applicable for equipment in use within the Restricted Area are catalogued in Appendices A, B, E, and F. Any equipment, rail cars or vehicles exiting the Restricted Area must be monitored, decontaminated if necessary, and released before leaving the Restricted Area. Designated Commercial transports for the exclusive use of waste transport may be released from a Restricted Area as long as the 49 CFR criteria are met. Entrances into parts of the Restricted Area that are not expected to be contaminated under routine conditions may not require equipment (vehicles, cement trucks, haul trucks, etc.), personnel or personal item decontamination. These areas include but are not limited to areas of new construction inside the Restricted Area, unloading dock and areas in which embankment closure is being performed inside the Restricted Area.

Depending on individual circumstances, vehicles or equipment leaving the site are surveyed in accordance with the unrestricted use of release criteria or to the standards of the DOT release. Unrestricted use release entails decontamination and release to the standards of 49 CFR 173.443. All vehicles, packages, equipment, or other items leaving the Restricted Area, except conveyances used for commercial transport of radioactive waste material, are unrestricted use released.

Closed trucks and rail cars used exclusively for transport of radioactive materials will be released as described in Table 4-2, measuring the removable contamination on the exterior surfaces only. Transport vehicles that are being released from exclusive use service will be released as described above, measuring removable contamination on both exterior and interior surfaces. Closed containers used solely for the transportation of radioactive materials may be released as described in Table 4-2, provided that the radiation level at any point on the external surface of the container does not exceed 0.5 millirem per hour:

a. The non-fixed (removable) radioactive surface contamination on the external surface of the container does not exceed the limits of Table 4-2;
b. The container does not contain more than 15 grams of U-235, the container is in unimpaired condition and is securely closed so that there will be no leakage of radioactive material under conditions normally incident to transportation;
c. Internal contamination does not exceed 100 times the limits of the table above;
d. Any labels previously applied are removed, obliterated, or covered and the "Empty" label prescribed in 49 CFR 172.450 and the notices are affixed to the container.

Regardless of the type of release, the basic requirement is that all items must be visibly clean. Visibly clean means that all potentially contaminated material that can be removed by a broom, shovel or other tool must be removed. Typical road dust and grime that is on a vehicle as it arrives and is not part of the radioactive waste material being carried does not have to be removed. Trucks, rail cars or reusable containers hauling waste to Energy*Solutions* will be released to the DOT standards of 49 CFR 173.443, as set forth in Table 4-2, below.

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

Contaminated equipment or vehicles may be decontaminated using brooms, shovels, high pressure water, or other effective means. The waste water is allowed to drain into tanks and transferred to permitted evaporation ponds. In accordance with the Ground Water Quality Discharge Permit, wastewater may also be used for dust suppression on a Class A Embankment.

Table 4-3 summarizes surface contamination levels of equipment, clothing, and personnel to be released without restriction from the Restricted Area

TABLE 4-2

REMOVABLE EXTERNAL

RADIOACTIVE CONTAMINATION - WIPE LIMITS

Contaminant	**Maximum permissible limits**	
	µCi/cm^2	**dpm/cm^2**
Beta-gamma emitting radionuclides; all radionuclides with half-lives less than ten days; natural uranium; natural thorium; uranium-235; uranium-238; thorium-232; thorium-228 and thorium-230 when contained in ores or physical concentrates.....	10^{-5}	22
All other alpha emitting radionuclides.....	10^{-6}	2.2

Each transport vehicle used for transporting radioactive materials as an exclusive-use shipment... shall be surveyed with appropriate radiation detection instruments after each use. A vehicle shall not be returned to service until the radiation dose rate at each accessible surface is 0.5 millirem per hour or less, and there is no significant removable (non-fixed) radioactive surface contamination as specified in the above table.

Table 4-3

Surface Contamination Levels of Equipment, Clothing, and Personnel

to be Released Without Restriction From the Restricted Area

Column I	**Column II**	**Column III**	
Nuclide [a]	**Average [b,d,f]**	**Maximum [b,d,f]**	**Removable [b,e,f]**
U-nat, U-235, U-238, and associated decay	5,000 dpm alpha/100 cm^2	15,000 dpm/100 cm^2	1,000 dpm/100 cm^2 products
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emissions or spontaneous fission) except Sr-90 and others noted above	5,000 dpm beta-gamma/100 cm^2	15,000 dpm beta-gamma/100 cm^2	1,000 dpm beta-gamma/100 cm^2

a. Where surface contamination by both alpha and beta-gamma emitting nuclides exist, the limits established for alpha and beta-gamma emitting nuclides should apply independently.

b. As used in this Table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

c. Measurements of average contaminant should not be averaged over more than one square meter. For objects of less surface area, the average should be derived for each object.

d. The maximum contamination level applies to an area of not more than 100 cm^2.

e. The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping the area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

f. The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters shall not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

SECTION 5. OPERATIONS

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

"An application for a license to receive, possess, and use source material for uranium or thorium milling or byproduct material, as defined in this part, at sites formerly associated with such milling shall contain proposed written specifications relating to milling operations and the disposition of the byproduct material to achieve the requirements and objectives set forth in appendix A of this part. Each application must clearly demonstrate how the requirements and objectives set forth in appendix A of this part have been addressed. Failure to clearly demonstrate how the requirements and objectives in appendix A have been addressed shall be grounds for refusing to accept an application." **– 10 CFR 40.31(h)**

Among the byproduct materials being disposed at the 11e.(2) Embankment are:

1. Waste soils and building debris, with limited amounts of scrap metal, glass, wood and masonry rubble, contaminated with Uranium, Thorium, and Ra-226 concentrations to 2,000 pCi/g; Th-232 concentrations to 6,000 pCi/g. Weighted average Ra-226 activity for all soil is about 300 pCi/g. However, approximately 86 percent of the soil has a radium activity below 200 pCi/g, with an average value of 40 pCi/g. A similar range of concentrations for Th-232, resulting in a weighted average concentration of about 900 pCi/g, but with most of the waste at about 50 pCi/g.
2. Waste expected from the cleanup of 11e.(2) Embankment and supporting facilities licensed by the Division. This waste is anticipated to contain Th-230 and Ra-226 to 2,000 pCi/g, plus daughters in equilibrium, Th-232 to 6,000 pCi/g, plus daughters in equilibrium. The weighted average concentrations are expected to be one-third of the maximum, or about 700 pCi/g for Ra-226 and Th-230 and 2,000 pCi/g for Th-232.
3. Waste that is licensed uranium mill or mine tailings. Th-230 and Ra-226 concentrations to 2,000 pCi/g, plus daughters in equilibrium. The average concentrations are about 700 pCi/g.

The weighted average radioactivity concentrations are about 340 pCi/g for Th-230 and for Ra-226 in equilibrium with its daughters, and about 910 pCi/g for Th-232 in equilibrium with its daughters, plus small amounts of natural uranium.

These wastes also include those constituents found in mill tailings in general, regardless of the source. EPA has reported the following upper ranges of elements in mill tailings from several sources (see Table 5-1). In some cases, these are not significantly different from "normal" soils.

Table 5-1

Upper Range of Elements in Mill Tailings

Element	Concentration (ppm)	Average Crustal Concentration (ppm)
Aluminium	72,000	81,300
Aresenic	2030[1,2]	1.5
Barium	4080[1,2]	250
Bromine	6	2
Calcium	87,000	36,300
Chlorine	6820 [1]	314
Chromium	7250[1,2]	200
Cobalt	138 [1]	23
Copper	1160 [1]	70
Iron	316,000	50,000
Lead	3100[1,2]	16
Magnesium	17,000	20,900
Manganese	10000 [1]	1,000
Mercury	34[1,2]	0.5
Molybdenum	550 [1]	15
Nickel	1070 [1]	80
Potassium	25,000	25,900
Rubidium	560	310
Selenium	233[1,2]	0.1
Silver	10[1,2]	0.1
Sodium	47,000	28,300
Strontium	4130 [1]	300
Terbium	5	0.9
Thallium	10 [1]	0.6
Tin	6200 [1]	40
Titanium	5,660	4,400
Tungsten	570 [1]	69
Vandium	4440 [1]	150
Zinc	2,200	132

1. Observed concentrations substantially greater than average.
2. Hazardous constituents from 10 CFR 40, App. Z, Criterion 5C.

11e.(2) License limitations for radioactive constituents are as follows:

1. Uranium and Ra-226: 4,000 pCi/g.
2. Th-230: 60,000 pCi/g.
3. Thorium: 6,000 pCi/g.

These 11e.(2) License limitations allow Energy*Solutions* to accept 11e.(2) wastes that vary beyond expected ranges. At these concentrations it is expected that arsenic, barium and lead would fail TCLP (Toxicity Characteristic Leachate Procedure) and those wastes would be classified as exempt wastes. However, Energy*Solutions* anticipates that the majority of the waste received for disposal will be as described in Table 5-2. This will be primarily soil with typical crustal rock concentrations of the elements listed above. This would result in weighted average concentrations of those elements listed as hazardous constituents as shown below.

Upon termination of disposal activities at the site, contaminated soil around the perimeter of the site will be recovered and placed in the embankment. Data from the Vitro Remedial Action project indicates that some windblown contamination existed at the time of that project's conclusion, as well as other contamination from wash-down activities. Spread of contamination through airborne and mechanical means is much more rigorously controlled by Energy*Solutions'* approach to handling and disposal (as is catalogued in Appendix A).

5.1 CORPORATE ORGANIZATION AND ADMINISTRATIVE PROCEDURES

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

"An application for a license to receive, possess, and use source material for uranium or thorium milling or byproduct material, as defined in this part, at sites formerly associated with such milling shall contain proposed written specifications relating to milling operations and the disposition of the byproduct material to achieve the requirements and objectives set forth in appendix A of this part. Each application must clearly demonstrate how the requirements and objectives set forth in appendix A of this part have been addressed. Failure to clearly demonstrate how the requirements and objectives in appendix A have been addressed shall be grounds for refusing to accept an application." **– 10 CFR 40.31(h)**

Energy*Solutions*' organizational structure is shown in Radioactive Material License #UT 2300249, which lists responsibilities for positions and required qualifications for individuals holding those positions. Additionally, applicable administrative procedures are catalogued in Appendices A, B, E, and F.

Table 5-2

Average Concentrations of 11e.(2) Waste Received for Disposal

Element	Average Concentration (ppm)
Arsenic	210
Barium	630
Chromium	900
Lead	320
Mercury	4
Selenium	20
Silver	1

5.1.1 Standard Operating Procedures

"(1) Each licensee or registrant shall develop, document, and implement a radiation protection program sufficient to ensure compliance with the provisions of Rule R313-15. See Section R313-15-1102 for recordkeeping requirements relating to these programs.
(2) The licensee or registrant shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA).
(3) The licensee or registrant shall, at intervals not to exceed 12 months, review the radiation protection program content and implementation.
(4) To implement the ALARA requirements of Subsection R313-15-101(2), and notwithstanding the requirements in Section R313-15-301, a constraint on air emissions of radioactive material to the environment, excluding radon-222 and its decay products, shall be established by licensees or registrants such that the individual member of the public likely to receive the highest dose will not be expected to receive a total effective dose equivalent in excess of 0.1 mSv (0.01 rem) per year from these emissions. If a licensee or registrant subject to this requirement exceeds this dose constraint, the licensee or registrant shall report the exceedance as provided in Section R313-15-1203 and promptly take appropriate corrective action to ensure against recurrence." **– R313-15-101**

"*Prior to the initial receipt and storage of any 11e.(2) byproduct material at the site, the licensee shall:*

a) Establish and implement standard operating procedures (SOPs) for all operational activities involving the handling, storing or disposing 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) Deleted by NRC Amendment 1

c) Deleted by NRC Amendment 1

d) Deleted by NRC Amendment 1

e) Modify the Quality Control/Quality Assurance Plan to provide quality controls for waste sampling and characterization. The plan must also be modified to provide controls for the quality of the protective equipment (e.g., anticontamination clothing and equipment that meets the ANSI Z-88.2 guidance (ANSI, 1989)) and respiratory protection equipment;

f) Design and implement an effective air sampling program in the workplace based on Revision 1 to NRC Regulatory Guide 8.25 (June 1992) entitled "Air Sampling in the Workplace," or an equivalent program." **– LICENSE CONDITION 9.6**

"*The licensee shall have all written SOPs reviewed and approved by the Director of Health Physics (DHP), or designate, qualified by way of specialized radiation protection training equivalent to that required for the DHP as defined in License Condition 9.10, 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 DHP on an annual basis.*" **– LICENSE CONDITION 9.8**

"*The licensee shall conduct:*

b) Annual operational training that covers all aspects of operational safety and emergency procedures for all employees. The SOPs will be used to conduct operations training to assure consistency and thoroughness." **– LICENSE CONDITION 9.11(b)**

Energy*Solutions* has established procedures for its employees, contractor employees, truck drivers, and visitors. Basic health and safety requirements are specified including access requirements and limitations, personnel protection equipment, dosimetry requirements, and work area rules and restrictions. These regulations are included in the Operating Procedures (Appendix A).

5.2 MANAGEMENT CONTROL PROGRAM

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

"An application for a license to receive, possess, and use source material for uranium or thorium milling or byproduct material, as defined in this part, at sites formerly associated with such milling shall contain proposed written specifications relating to milling operations and the disposition of the byproduct material to achieve the requirements and objectives set forth in appendix A of this part. Each application must clearly demonstrate how the requirements and objectives set forth in appendix A of this part have been addressed. Failure to clearly demonstrate how the requirements and objectives in appendix A have been addressed shall be grounds for refusing to accept an application." **– 10 CFR 40.31(h)**

Energy*Solutions* has established management control procedures for oversight of its employees, contractor employees, truck drivers, and visitors. Management roles and responsibilities and included in the Operating Procedures (Appendix A), Site Radiological Security Procedure Catalogue (Appendix B), Safety and Health Procedure Catalogue (Appendix E), Quality Assurance Procedure Catalogue (Appendix F), and the facility Organization Requirements approved under Radioactive Material License #UT 2300249.

5.3 MANAGEMENT AUDIT, INSPECTION, AND RECORDKEEPING PROGRAM

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

"An application for a license to receive, possess, and use source material for uranium or thorium milling or byproduct material, as defined in this part, at sites formerly associated with such milling shall contain proposed written specifications relating to milling operations and the disposition of the byproduct material to achieve the requirements and objectives set forth in appendix A of this part. Each application must

clearly demonstrate how the requirements and objectives set forth in appendix A of this part have been addressed. Failure to clearly demonstrate how the requirements and objectives in appendix A have been addressed shall be grounds for refusing to accept an application." **– 10 CFR 40.31(h)**

"(1) Each licensee or registrant shall develop, document, and implement a radiation protection program sufficient to ensure compliance with the provisions of Rule R313-15. See Section R313-15-1102 for recordkeeping requirements relating to these programs.
(2) The licensee or registrant shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA).
(3) The licensee or registrant shall, at intervals not to exceed 12 months, review the radiation protection program content and implementation.
(4) To implement the ALARA requirements of Subsection R313-15-101(2), and notwithstanding the requirements in Section R313-15-301, a constraint on air emissions of radioactive material to the environment, excluding radon-222 and its decay products, shall be established by licensees or registrants such that the individual member of the public likely to receive the highest dose will not be expected to receive a total effective dose equivalent in excess of 0.1 mSv (0.01 rem) per year from these emissions. If a licensee or registrant subject to this requirement exceeds this dose constraint, the licensee or registrant shall report the exceedance as provided in Section R313-15-1203 and promptly take appropriate corrective action to ensure against recurrence." **– R313-15-101**

Energy*Solutions* is required by Appendix J of its Ground Water Quality Discharge Permit to perform Best Available Technology inspections of all facilities that could, if not functioning properly, have a negative impact on the groundwater. Appendix J of the Ground Water Quality Discharge Permit is the Best Available Technology performance monitoring plan while Appendix K of the Ground Water Quality Discharge Permit discusses contingency plans related to Best Available Technology failures at those facilities that require this type of monitoring. Best Available Technology inspectors are trained in accordance with Energy*Solutions*' internal training procedures. Facility inspections are also performed in accordance with approved procedures. Should a problem be discovered during any inspection, it will be documented and reported to the Director of LLRW Operations and Quality Assurance Manager. If the problem represents a radiological hazard, the Director of Health Physics will be notified.

5.3.1 Management Audit, and Internal Inspection Program

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

"An application for a license to receive, possess, and use source material for uranium or thorium milling or byproduct material, as defined in this part, at sites formerly associated with such milling shall contain proposed written specifications relating to milling operations and the disposition of the byproduct material to achieve the requirements and objectives set forth in appendix A of this part. Each application must clearly demonstrate how the requirements and objectives set forth in appendix A of this part have been addressed. Failure to clearly demonstrate how the requirements and objectives in appendix A have been addressed shall be grounds for refusing to accept an application." **– 10 CFR 40.31(h)**

"(3) The licensee or registrant shall, at intervals not to exceed 12 months, review the radiation protection program content and implementation." **– R313-15-101(3)**

One of the Energy*Solutions'* Director of Health Physics' responsibilities is to conduct monthly inspections in accordance with 11e.(2) License condition 11.3. These inspections encompass all 11e.(2) work areas at least monthly. Deficiencies noted during these inspections are corrected within 7 working days. The results of the inspections and any necessary corrective actions are reported in the annual report.

Additionally, the Director of Health Physics performs an annual ALARA audit of the radiation safety program, in accordance with Section 2.3.3 of NRC Regulatory Guide 8.31, as amended. A report of this audit is submitted annually to corporate headquarters and the Division Director. The report includes detailed summaries of the analytical results of the radiological surveys.

In order to evaluate the ALARA objective, the Director of Health Physics reviews 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 monthly reviews.
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 Division Director and previously submitted to the NRC.
h) Reviews of operating and monitoring procedures completed during the period.

The audit also addresses any noticeable 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 are included in the report.

5.3.1.1 Daily, Weekly and Monthly Inspections

"The licensee shall require that the DHP and the Site Engineer perform and document joint inspections of all work areas at least monthly. The licensee shall correct any deficiency noted during the inspection within 7 working days. The results of the inspections and any necessary corrective actions should be reported in the annual report." **– LICENSE CONDITION 11.3**

"An application for a license to receive, possess, and use source material for uranium or thorium milling or byproduct material, as defined in this part, at sites formerly associated with such milling shall contain proposed written specifications relating to milling operations and the disposition of the byproduct material to achieve the requirements and objectives set forth in appendix A of this part. Each application must clearly demonstrate how the requirements and objectives set forth in appendix A of this part have been addressed. Failure to clearly demonstrate how the requirements and objectives in appendix A have been addressed shall be grounds for refusing to accept an application." **– 10 CFR 40.31(h)**

"(3) The licensee or registrant shall, at intervals not to exceed 12 months, review the radiation protection program content and implementation." **– R313-15-101(3)**

Daily inspections are to be performed each day that the facility is in operation. Examples of some of the items inspected are provided in Table 5-3. Problems are corrected according to the schedule outlined below:

- Problems that pose an imminent threat to human health or the environment are corrected as soon as possible but no later than 24 hours from the time of discovery.
- Problems that do not pose an imminent threat to human health or the environment are corrected within 72 hours of discovery.
- If a longer time period is required to correct the problem, Energy*Solutions* will notify the Division prior to the end of the 72-hour period. At the time of notification, Energy*Solutions* will propose a time schedule for correcting the problem. The Division must approve the correction schedule.

The daily security inspection includes at least the following:

- **Check fences**. The inspector must inspect the site security devices (fences, gates, doors, and locks) to check for items such as proper functioning, breaks, gaps, erosion, vandalism or damage to the fence fabric, fence posts, gates, etc. The inspector must also check the gates and doors to ensure that the gates and doors are locked or attended by a person assigned to control entry.
- **Check communication systems**. The inspector performs an audio test on the external communication system (telephone) by ensuring that dial tone exists and that the phone is operational. This test may be conducted by placing and completing a telephone call. The inspector tests the internal communication system (two-way radios, intercom, etc.) by operating the system and achieving communication through the system.

The following items are to be checked each operating day. The facility is considered to be in operation in the following instances:

- When off-site shipments have been received to the facility;
- When waste is being added to or removed from an 11e.(2) embankment; or,
- When 11e.(2) containers are being added to or removed from the storage area.

The daily BAT inspection includes the following:

- **Check roads**. The inspector must drive the access and facility roads to visually inspect them for deterioration, erosion and evidence of spills.
- **Loading and Unloading Areas**. Visually inspect the loading and unloading areas. Note stains, residues, and any evidence of a spill or leak.
- **Container storage area**. The container storage area must be inspected for evidence of a spill.
- **Inspect containers.** The inspector visually inspects the exterior surface area for evidence of leaks, corrosion, deterioration, holes, bulges, and poorly fitting lids.

The following items are to be inspected each week, (see Table 5-4).

- **Signs.** The inspector must visually check the site warning signs to determine that the signs are present, visible and legible.
- **Verify personal protection equipment.** The inspector will verify the supply of personal protection equipment to ensure that each employee has a proper supply or access to gloves, boots, coveralls, hard-hat, goggles, and respiratory protection.

Table 5-3

Daily BAT Inspection Items

Is the facility in operation?
Check facility roads for deterioration, erosion and evidence of spills.
Check the truck sampling area for evidence of waste material releases.
Check loading and unloading areas for evidence of waste material releases.
Check the container storage area for evidence of waste material releases.
Inspect the containers in storage for evidence of leaks, corrosion, deterioration, holes, bulges, and poorly fitting lids.

Daily Security Inspection Items

Check internal and external communication systems for proper operation.
Check doors, gates, locks, and fences for proper security.

Table 5-4

Weekly Inspection Items

Check facility signs for legibility, presence.
Verify personal protection equipment supply.

The following items are to be inspected each month (see Table 5-5).

- **Inventory first aid stations**. The inspector ensures that the list of items for each first aid station is present. The inspector inventories the contents of the first aid stations to verify that the items are complete and in good condition and repair.
- **Inspect safety showers**. The inspector will operate the safety showers to verify water supply. The inspector will also visually inspect the showers for general condition looking for damage and general repair.
- **Inspect fire extinguishers**. The inspector visually inspects each fire extinguisher to ensure that the fire extinguisher's pressure gauge registers a pressure within the acceptable range on the gauge. The inspector verifies that each extinguisher has a current inspection tag.

5.3.2 Recordkeeping and Record Retention

"(1) Each licensee or registrant shall use the SI units becquerel, gray, sievert and coulomb per kilogram, or the special units, curie, rad, rem, and roentgen, including multiples and subdivisions, and shall clearly indicate the units of all quantities on records required by Rule R313-15.
(2) Notwithstanding the requirements of Subsection R313-15-1101(1), when recording information on shipment manifests, as required in Subsection R313-15-1006(2), information must be recorded in SI units or in SI units and the special units specified in Subsection R313-15-1101(1).
(3) The licensee or registrant shall make a clear distinction among the quantities entered on the records required by Rule R313-15, such as, total effective dose equivalent, total organ dose equivalent, shallow dose equivalent, lens dose equivalent, deep dose equivalent, or committed effective dose" **– R313-15-1101**

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

"An application for a license to receive, possess, and use source material for uranium or thorium milling or byproduct material, as defined in this part, at sites formerly associated with such milling shall contain proposed written specifications relating to milling operations and the disposition of the byproduct material to achieve the requirements and objectives set forth in appendix A of this part. Each application must clearly demonstrate how the requirements and objectives set forth in appendix A of this part have been addressed. Failure to clearly demonstrate how the requirements and objectives in appendix A have been addressed shall be grounds for refusing to accept an application." **– 10 CFR 40.31(h)**

Table 5-5

Monthly Inspection Items

Inventory first aid stations.
Check fire extinguishers for adequate pressure and presence of a current inspection tag.
Check safety showers for water supplies.

"The licensee shall, unless otherwise specified, submit an annual report documenting: 1) the annual reporting requirements as specified in the license conditions; 2) the results of calibration of equipment; 3) reports on audits and inspections completed during the year; 4) the results of all meetings and training courses required by this license; and 5) any other significant subsequent information, reviews, investigations, and corrective actions. This report, covering the calendar year, shall be submitted to the Executive Secretary by March 1 following the first full year after receipt of this license, and by April 30 every year thereafter. Unless otherwise specified in the UAC rules, all such documentation shall be maintained at the site and corporate headquarters for a period of at least five (5) years." **– LICENSE CONDITION 12.6**

Documentation of completed operational inspections will be maintained electronically in the site operating record for a minimum of three years from the date of the inspection. Hardcopy records are retained in accordance with the prescribed retention policy.

Retention of radiation safety records demonstrates the effectiveness of the Clive Facility Radiation Protection Program (Energy*Solutions*, 2012a). The work force and management are required to use records to document radiation safety afforded to personnel on-site. Records of Radiation Safety programs are required to support worker health studies and future disputes or claims. Therefore, these electronic records are high quality, readily retrievable and managed until license termination. Hardcopy records are retained in accordance with the prescribed retention policy. Records are handled such that personal privacy is protected.

The following information is maintained and electronic records retained until the Division terminates the 11e.(2) License:

- Results of surveys, measurements, and calculations used to determine individual occupational dose from external and internal sources.
- Results of air sampling, surveys, and bioassays.
- Records or the results of measurements and calculations used to release material and equipment from restricted areas or evaluate the release of effluents to the environment.
- NRC Form 4 or equivalent.
- Personal dose records.
- Dose records to members of the public required to demonstrate compliance.
- Provisions of the Radiation Safety Program.
- Records of the disposal of licensed or registered materials.

Hardcopy records will be maintained and retained in accordance with the prescribed retention policy.

The following electronic records are maintained until license termination. Hardcopy records are retained in accordance with the prescribed retention policy:

- Results of equipment calibrations and receipt of radioactive material;
- Results of audits and other reviews of program content and implementation.
- Records used in preparing NRC Form 4.

Hardcopy records will be maintained and retained in accordance with the prescribed retention policy.

Radiation Safety records are accurate and legible. The records include the following:

- Company name, specific location, function and process
- Signature or other identifying code of the preparer and date
- Legible entries in black/blue ink
- Corrections identified by a single lineout, initialed and dated

Health Physics maintains a file of names, signatures and initials for future identification of the person who signed or initialed a record. Radiation Safety records do not include:

- Opaque substances for corrections
- Non-standardized terms or shorthand

Units are clearly indicated for all quantities entered in records. Units used to denote radiological dose, exposure or contamination include curie, rad, becquerels, rem (including multiples of subdivisions of these units) and dpm. Working Level concentration units are presented in units of some multiple of curie per (multiple of) grams or liters.

A clear distinction is made among the quantities entered on the records required by Clive's Facility Radiation Protection Program (catalogued in Appendix B) (e.g. TEDE, SDE, DDE).

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

- Determines the occupational radiation dose received during the current year.
- Attempts to obtain the records of lifetime cumulative occupational radiation dose.

Clive management may also:

- Accept as a record of the occupational dose that the individual received during the current year, a written signed statement from the individual, or from the individual's most recent employer for work involving radiation exposure that discloses the nature and the amount of any occupational dose that the individual may have received during the current year;
- Accept, as the record of lifetime cumulative radiation dose, an up-to-date NRC Form 4, or equivalent signed by the individual and countersigned by an appropriate official of the most recent employer for work involving radiation exposure, or the individual's current employer (if the individual is not employed by Energy*Solutions*).
- Obtain reports of the individual's dose equivalent(s) from the most recent employer for work involving radiation exposure, or the individual's current employer (if the individual is not employed by Energy*Solutions* by telephone, electronic media, or letter. Energy*Solutions* may request a written verification of the dose data if the authenticity of the transmitted report cannot be established.

Clive management records the dose history, as required on NRC Form 4 or other clear and legible record, of all the information required on the form. The form or record shows each period in which the individual received occupational dose to radiation or radioactive material and must be signed by the individual who received the dose. For each period for which Clive management obtains reports, Clive management uses the dose shown in the report in preparing NRC Form 4. For any period in which Clive management does not obtain a report, Clive management places a notation on NRC Form 4 indicating the periods of time for which data are not available.

If the current year's occupational dose record is incomplete, Clive management limits the individual to a Total Effective Dose Equivalent of 100 mrem (1.0 mSv) per year. Records of all employees whom monitoring was required and records of doses received during planned special exposures, accidents, and emergency conditions include, when applicable:

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

Personal dose records are updated at least annually. Personal dose records are maintained on NRC Form 5 or in clear and legible records containing all the information required by NRC Form 5. Electronic records are maintained until license termination. Hardcopy records are maintained in accordance with the prescribed retention policy.

Required personal dose records are protected from public disclosure. Records of dose to an embryo/fetus are maintained with the dose to the declared pregnant woman. Declarations of pregnancy, including the estimated date of conception, are also kept on file. Radiation dose records contain information sufficient to identify each person, or employee number. Planned Special Exposures are not authorized for the Clive Facility.

Pre-employment medical records, if available, and reports of periodic medical examinations are maintained. Physical examination reports and fit testing results for respirator are maintained for respirator users. Medical evaluations and treatment performed in support of the Radiation Safety program are documented. Maintenance of employee non-occupational radiation dose records for therapeutic or large amounts of diagnostic radiation doses for medical purposes is also included in Clive's Facility Radiation Protection Program (Appendix B).

Records of training and qualification are electronically maintained until license termination to demonstrate that a person received appropriate information to perform the work assignment in a safe manner. Hardcopy records are retained in accordance with the prescribed retention policy. Qualification standard records are retained for classroom, on-the-job, and practical factor training. Formal records of training and qualification are readily available to first-line supervision and management of involved personnel to aid in making work assignments. At a minimum, these records include the following:

- Course title
- Attendance sheets with instructor's name
- Employee's name and signature
- Date of training
- Documentation related to exceptions for training requirements and extensions of qualification
- Quizzes, tests, responses and acknowledgments of training, with the date and signature of the person trained
- Special instructions to female workers concerning prenatal radiation dose acknowledged by the worker's signature.

Records are retained for the following types of training:

- Visitor Orientation
- Radiation Worker Safety Training
- Health Physics Technician Training
- Periodic retraining
- Respiratory Protection Training
- Hazardous Waste and OSHA training
- Instructor training
- Qualifications for special tests or operations
- Training of emergency response personnel
- ALARA Training
- General Employee Training

The following instructional materials are maintained:

- Course name, with revision and approval date
- Instructor's manuals, course content, handouts, or lesson plans containing topical outlines
- Video and audio instructional materials, include the dates and lessons for which they were used
- Job-specific training documents

Terminating employees are provided a report that summarizes radiation dose for the total monitoring period at the reporting facility either:

1) upon receipt of a signed request at the time of termination, or
2) upon receipt of a signed request from the Director of Health Physics, or
3) on or before April 30 of the year following termination.

The most recent monitoring result estimate of dose is also provided at the time of termination, with a clear indication that it is an estimate with a formal record to follow within 30 days after final dose determination. If a written request has been received and all doses are final, a record is provided to the affected individual or requesting facility within 30 days of receipt.

For visitors and temporary radiation workers entering an area where radiation monitoring is required, the following records are maintained:

- Documented completion of Visitor or Temporary Radiation Worker Orientation.
- Any additional training given by Clive management to gain access into the Restricted Area.
- Radiation dose records, including zero dose.

Electronic records are retained until license termination. Hardcopy records are maintained in accordance with the prescribed retention policy.

Records are maintained sufficient to demonstrate compliance with the dose limit for individual members of the public. Policies, Procedures and Radiation Work Permits should be maintained in a chronological sequence that allows correlation with the corresponding support information.

Electronic records of ALARA plans and goals are maintained until license termination to demonstrate the adequacy of the ALARA Program. Hardcopy records are maintained in accordance with the prescribed retention policy.

Records of quality assurance reviews and audits developed for Radiation Safety functions are electronically retained until license termination if dosimetry related and a minimum of five years for all others to ensure that sufficient records are specified, prepared, reviewed, approved and maintained to accurately reflect completed work. Hardcopy records will be maintained in accordance with the prescribed retention policy.

The Radiation Safety program requires the performance of radiation, airborne radioactivity, and contamination surveys to determine existing conditions in a given location. Maps with sufficient detail to permit identification of original survey and sampling locations are maintained. Records should contain sufficient detail to be meaningful even after the originator is no longer available. Radiological surveys are recorded on standard forms and include the following common elements:

- Date and purpose of the survey.
- General and specific location of the survey.
- Name and signature of the surveyor and analyst.
- Pertinent information needed to interpret the survey results.
- Reference to a specific Radiation Work Permit if the survey is performed to support the permit.

Radiation surveys also include, at a minimum:

- Instrument model, calibration date, and serial number.
- Results of the measurements of area dose rates.

Records of airborne radioactivity measurements include, at a minimum:

- Sampler location identifier and laboratory counting instrument model, serial number, calibration date, and efficiency;
- Airborne radioactivity concentrations in general airborne areas and breathing zones; and
- Supporting parameters, flow rate, duration of sampling, correction factors and filter medium.

Records of contamination surveys include, at a minimum:

- Model and serial number of counting equipment.
- Contamination levels (using appropriate units) and supporting parameters including counting efficiency, counting time, correction factors, type of radiation, and whether the contamination was fixed plus removable or removable.
- Location of areas found to contain hot particles or high concentrations of localized contamination.
- Follow up survey results for decontamination processes cross-referenced to the original survey.

Electronic records of calibration and periodic operational checks of fixed, portable, and laboratory radiation measuring equipment are maintained until license termination and include frequencies, method, dates, person performing calibration and calibration sources numbers. Only National Institute of Science and Technology or other acceptable standards are used for calibration. Hardcopy records are maintained in accordance with the prescribed retention policy. Calibration records are maintained for the following equipment:

- Portable survey instruments
- Bioassay measurement equipment
- Laboratory, counting room and fixed radiation measuring equipment
- Process and effluent monitors and sampling equipment
- Radiation area monitors

- Portal monitors and other personnel contamination monitors
- Electronic Dosimeters
- Air sampling equipment
- Tool and waste monitoring equipment
- Protective clothing and equipment monitors.

Maintenance histories, including the nature of any defects and corrective actions taken, and calibration results for each instrument are created and retained. Records of additional tests and checks of instrumentation used in conjunction with a suspected overexposure, questionable indication or unusual occurrence are retained. In addition, records of special instrument calibrations and modifications made are retained. Electronic records are maintained until license termination. Hardcopy records are maintained in accordance with the prescribed retention policy.

Records required to be retained by UAC R313-15 are kept legible throughout the specified retention period and meet either of the following conditions. Records may be the original or a reproduced copy or a microfilm provided that the copy or microfilm is authenticated by authorized personnel and that the microfilm is capable of producing a clear copy throughout the required retention period. Records may be stored in electronic media with the capability for producing legible, accurate, and complete records during the required retention period. Records such as letters, drawings, and specifications must include all pertinent information, such as, stamps, initials, and signatures. Adequate safeguards are taken to prevent tampering with and loss of records.

Reports to the Division are required for the following events (refer to UAC R313-15-1202):
Immediate reporting is required for:

- Loss, stolen or missing licensed material in an aggregate quantity equal to or greater than 1000 times the quantity specified in Appendix C to 10 CFR 20 (UAC R313-15-1201).
- Any event involving byproduct, source or special nuclear material possessed by the Clive Facility that may have caused or threatens to cause an individual to receive:
  1) A TEDE of 25 rems or more.
  2) An EDE of 75 rems or more.
  3) A SDE to the skin or extremities of 250 rads or more.
  4) A release of radioactive material so that had an individual been present for 24 hours, the individual could have received an intake five times the occupational annual limit on intake.

A written notification is required within 24 hours after the following events:

- The loss of control of licensed material possessed by Clive Facility that may have caused or threatens to cause an individual to receive in a period of 24 hours any of the following conditions:
  1) A TEDE of 5 rems; or
  2) An EDE of 15 rems; or
  3) A SDE to the skin or extremities exceeding 50 rems; or the release of radioactive material inside or outside of the Restricted Area, so that had an individual been present for 24 hours, the individual could have received an intake in excess of one occupational annual limit on intake.
  4) Make reports to the Division Director by telephone, telegram, mailgram or facsimile.

A written report is required within 30 days after the following events:

- Loss, stolen or missing licensed material in an aggregate quantity equal to or greater than 10 times the quantity specified in appendix C to 10 CFR 20 (UAC R313-15-1201).
- Any incident for which notification is required
- Doses in excess of any of the following:
  1) The occupational dose limits for adults in Section R313-15-201; or
  2) The occupational dose limits for a minor in section 2.1.6; or
  3) The limits for an embryo/fetus of a declared pregnant women in section 2.1.2; or
  4) The limits for an individual member of the public in section 2.1.3; or
  5) Any applicable limit of the license; or
  6) The ALARA constraints for air emissions established under Subsection R313-1 5-101 (4); or
- Levels of radiation or concentrations of radioactive material in:
  1) A restricted area in excess of any applicable limit in the license.
  2) An unrestricted area in excess of 10 times any applicable limit set forth in this manual or in the license (whether or not it involved exposure to any individual in excess of the limits in section 2.1.3) or releases of radiation or radioactive material in excess of 40 CFR 190 levels or licensed material related to those standards.

Each report describes the extent of exposure of individuals to radiation and radioactive material, including, as appropriate:

1) Estimates of each individual's dose; and
2) The levels of radiation and concentrations of radioactive material involved; and
3) The cause of the elevated doses, dose rates or concentrations; and
4) Corrective steps taken or planned to ensure against a recurrence, including the schedule for achieving conformance with applicable limits, ALARA constraints, generally applicable environmental standards and associated license conditions.

Each report includes for each occupationally overexposed individual the name, Social Security account number and date of birth. With respect to the limit for the embryo/fetus, the identifiers are those of the declared pregnant female. A copy of the report also is submitted to the overexposed individual. This report is transmitted at a time no later than the transmittal to the Division Director.

Any report pursuant to this section are prepared and filed with the Division Director so that names of individuals who have received exposure to sources of radiation are stated in a separate and detachable portion of the report.

5.4 QUALIFICATIONS FOR PERSONNEL

"(1) A license application shall be approved if the Executive Secretary determines that:

a) the applicant and all personnel who will be handling the radioactive material are qualified by reason of training and experience to use the material in question for the purpose requested in accordance with these rules in a manner as to minimize danger to public health and safety or the environment;." **– R313-22-33(1)(a).**

"Filing Application for Specific Licenses." **- R313-22-32.**

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

"An application for a license to receive, possess, and use source material for uranium or thorium milling or byproduct material, as defined in this part, at sites formerly associated with such milling shall contain proposed written specifications relating to milling operations and the disposition of the byproduct material to achieve the requirements and objectives set forth in appendix A of this part. Each application must clearly demonstrate how the requirements and objectives set forth in appendix A of this part have been addressed. Failure to clearly demonstrate how the requirements and objectives in appendix A have been addressed shall be grounds for refusing to accept an application." **– 10 CFR 40.31(h)**

"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." **– LICENSE CONDITION 9.9**

Energy*Solutions* Organization Chart is included as Figures 1 through 7 of Condition 32.A of Energy*Solutions*, (2012b). A summary of the responsibilities for significant positions entities is included in this Section.

5.4.1 Director of Health Physics

"(1) A license application shall be approved if the Executive Secretary determines that:

a) the applicant and all personnel who will be handling the radioactive material are qualified by reason of training and experience to use the material in question for the purpose requested in accordance with these rules in a manner as to minimize danger to public health and safety or the environment;." **– R313-22-33(1)(a).**

The Director of Health Physics reports to the Vice President of Clive for day to day activities and indirectly reports to the Corporate Director of Radiation Safety for ALARA and Radiation Safety Program issues. The Director of Health Physics meets the position of Radiation Safety Officer as defined in UAC R313-12 and is responsible for implementation of and compliance with protocols and procedures of the Radioactive Material Licenses. The Director of Health Physics supervises the Health Physics support staff and works very closely with the Director of LLRW Operations, and Director of Mixed Waste Operations. The Director of Health Physics is responsible for on-site radiation safety including implementation of, and compliance with the Corporate Radiation Protection Program and associated procedures. The Director of Health Physics determines whether adequate radiation instrumentation and equipment are used and whether adequate measurements are made to ensure that all applicable standards for personnel protection against exposure to radiation and radioactive materials are satisfied.

5.4.2 Radiation Safety Staff

"(1) A license application shall be approved if the Executive Secretary determines that:

a) the applicant and all personnel who will be handling the radioactive material are qualified by reason of training and experience to use the material in question for the purpose requested in accordance with these rules in a manner as to minimize danger to public health and safety or the environment;." **– R313-22-33(1)(a).**

The Director of Health Physics is responsible for assuring that the environmental health and safety requirements at the site are being met and, in particular, the operations at the site are in compliance with License Requirements. All health and safety related procedural changes are approved by the Director of Health Physics. Assisting the Director of Health Physics are Access Control Technicians, Health Physics Technicians, and an Environmental Manager. The Environmental Manager is responsible for conducting the routine environmental monitoring program and performing certain laboratory analyses.

5.4.2.1 Certification for Access Control Technician and Health Physics Technician

All personnel must be certified before they can be classified as either an Access Control Technician or a Health Physics Technicians. This certification will include training and testing beyond that given in the restricted-area training program. Specific training and experience requirements for the Health Physics positions are further discussed in Condition 32.A of Energy*Solutions*, (2012b). The following is a summary of requirements for certification in those areas:

Access Control Technician

1. 20 hours of training in areas of physics, radiation safety, construction safety, operation of equipment and site operations.
2. Pass a written exam designed specifically for Access Control Technician.
3. Pass, to the satisfaction of the Director of Health Physics, a practical test designed to assure that the candidate possesses knowledge for all equipment being handled and all duties can be performed effectively.
4. Demonstration to the Director of Health Physics of satisfactory understanding and training under the Non-Contaminated Restricted Area Gate Guard Monitor qualification.

Health Physics Technician

1. 40 hours of training in areas of chemistry, physics, radiation safety, construction safety, operation of equipment and site operations.
2. Pass a written exam designed specifically for Health Physics Technician.
3. Pass a laboratory test designed to assure that all equipment is being handled properly and all duties can be performed effectively.
4. Demonstration to the Director of Health Physics of satisfactory understanding and training under the Non-Contaminated Restricted Area Gate Guard Monitor qualification.
5. Demonstration to the Director of Health Physics of satisfactory understanding and training under the Access Control Procedure (as catalogued in Appendix A).

5.5 RADIATION SAFETY TRAINING

"(1) Each licensee or registrant shall develop, document, and implement a radiation protection program sufficient to ensure compliance with the provisions of Rule R313-15. See Section R313-15-1102 for recordkeeping requirements relating to these programs.
(2) The licensee or registrant shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA).
(3) The licensee or registrant shall, at intervals not to exceed 12 months, review the radiation protection program content and implementation.
(4) To implement the ALARA requirements of Subsection R313-15-101(2), and notwithstanding the requirements in Section R313-15-301, a constraint on air emissions of radioactive material to the environment, excluding radon-222 and its decay products, shall be established by licensees or registrants such that the individual member of the public likely to receive the highest dose will not be expected to receive a total effective dose equivalent in excess of 0.1 mSv (0.01 rem) per year from these emissions. If a licensee or registrant subject to this requirement exceeds this dose constraint, the licensee or registrant shall report the exceedance as provided in Section R313-15-1203 and promptly take appropriate corrective action to ensure against recurrence." **– R313-15-101.**

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

"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 will be used to conduct operations training to assure consistency and thoroughness." **– LICENSE CONDITION 9.11.**

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

1. Permanent Employee. A "*Permanent Employee*" is an employee of Energy*Solutions* hired for a period longer than 20 days, or a long-term employee of a contractor to Energy*Solutions*.
2. Temporary Worker. A "*Temporary Worker*" is a service contractor (electrician, welder, consultant, surveyor, driller, sampler, engineer, fence installer, forklift operator, laborer, mechanic, liner installer, excavator, etc.) who works inside the Restricted Area under a contract or service order but who is not an employee on the payroll of Energy*Solutions* or a long-term contractor performing work inside the Restricted Area.
3. Visitor. A "*Visitor*" is a person whose main interest inside the Restricted Area is to communicate with personnel in the Restricted Area, to observe and/or inspect the operations, facilities, programs,

location and compliance at the site. Examples of visitors are compliance inspectors, visiting dignitaries, representatives of organizations and corporations, tour groups, and associates of the above. Most visitors will be required to be in the presence of a qualified escort while in the Restricted Area. Certain visitors, such as compliance inspectors or auditors will not require escorts.

Training requirements have been established for each of the categories listed above. Refresher training is provided to review and update training information. Radiation Safety training is directed by the Director of Health Physics. The training includes the following items and topics:

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

Records of training attendance and a copy of the examination provided are maintained by Energy*Solutions*. As is reflected in Table 5-6, training is meant to educate the employees in the fundamentals of handling radioactive materials, to provide information on the ways and means of minimizing exposure, and to inform employees of practices and programs aimed at preventing possible spread of contamination. The annual refresher sessions for permanent employees are provided to keep the employees aware of the nature of the material with which they have daily contact.

The content of the Radiation Worker Safety training is authorized by the Director of Health Physics. During this training, procedures and precautions are explained and the trainees are required to complete a written or computer based examination. The training records are maintained by the training group. In addition to the above training, all Energy*Solutions* site employees receive periodic refresher training. This training is tailored to the specific employee needs and duties and cover such topics as general occupational safety, radiological safety, and training on any specific items such as new procedures or safety deficiencies.

5.6 SECURITY

"(1) The licensee or registrant shall secure licensed or registered radioactive material from unauthorized removal or access.
(2) The licensee or registrant shall maintain constant surveillance, and use devices or administrative procedures to prevent unauthorized use of licensed or registered radioactive material that is in an unrestricted area and that is not in storage.
(3) The registrant shall secure registered radiation machines from unauthorized removal.
(4) The registrant shall use devices or administrative procedures to prevent unauthorized use of registered radiation machines." **– R313-15-801.**

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license.

Table 5-6

Training Requirements

Category	Restricted Area Safety Training	Read/Sign Site Regulations Overview	Radiation Worker Safety Training	Radiation Worker Refresher
Unescorted Rad Worker	Yes	Yes	Yes	Annually*
Temporary Rad Worker	No	Yes	Yes	N/A
Visitor	No	Yes	No	N/A

*Unescorted Radiation Workers also receive an Initial Training Refresher and/or HAZWOPER Refresher annually. Training may be provided using a computer based format.

Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

The procedures to accomplish site security are provided in Energy*Solutions'* Site Radiological Security Plan, as controlled by Condition 54 of LLRW Radioactive Material License #UT 2300249 (Energy*Solutions*, 2012b). The entire restricted area of the project is fenced to ensure intruders do not gain access to the site inadvertently. The fences are posted with appropriate warning signs, and all entrances into the work areas are locked or guarded by personnel when unlocked. All fences are chain link. Temporary fencing will be constructed with "T" posts located at least every 12 feet. Permanent fencing will be built with permanent posts cemented in concrete and will be topped with three (3) strands of barbed wire. Personnel will enter the Restricted Area through designated access control points. Traffic will be allowed to enter the site through one of the approved access gates.

A six-foot chain link fence will eliminate intrusion by grazing sheep, cattle, or other large animals. A two-foot thick erosion barrier will severely limit, if not eliminate, intrusion and burrowing by small animals into the completed disposal embankment. All areas utilized for disposal material receiving, unloading, hauling/handling, and placement in the embankment will be considered a restricted (or controlled) area as defined in 10 CFR 20.1003. Additionally, any person working within the Restricted Area will be assigned, and must wear, a personnel monitoring badge to measure the individual's exposure to radiation.

The Clive site includes adjacent controlled and Restricted Areas. Various access control points are located on the boundary between the two. The Restricted Area is a fenced area consisting of the materials handling facilities and disposal areas. All licensed waste handling and disposal activities will be conducted within the fenced Restricted Areas. Other activities such as off-site environmental monitoring and laboratory analysis of environmental samples are conducted in the controlled area. In keeping with 10 CFR 20.1301, Energy*Solutions* will limit the exposure to employees restricted to the controlled (but unrestricted) areas of the site to the limits for individual members of the public.

5.6.1 Access Control

"(1) The licensee or registrant shall secure licensed or registered radioactive material from unauthorized removal or access.
(2) The licensee or registrant shall maintain constant surveillance, and use devices or administrative procedures to prevent unauthorized use of licensed or registered radioactive material that is in an unrestricted area and that is not in storage.
(3) The registrant shall secure registered radiation machines from unauthorized removal.
(4) The registrant shall use devices or administrative procedures to prevent unauthorized use of registered radiation machines." **– R313-15-801.**

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

All personnel working in the Restricted Area are required to enter and exit through an access control gate. All persons entering the area are required to enter their name in an access control log. Access to the site without prior training and deviation of dosimeter policy must have prior approval from the Director of Health Physics.

Each person entering the Restricted Area who are or may receive in one year a radiation exposure in excess of 10 percent of the limits in 10 CFR 20.1201, 10 CFR 20.1207, or 10 CFR 20.1208 are required to disclose in a written, signed statement, either: (1) that the individual had no prior occupational dose during the current calendar quarter, or (2) the nature and amount of any occupational dose that the individual may have received during that specifically-identified current calendar year from sources of radiation possessed or controlled by other persons.

The access control points are equipped with a facility to allow employees access in and out of the restricted area. Personal Protection Equipment is issued as required by the Radiation Work Permits. Either cloth or disposable coveralls will be provided for all employees working, or visitors, in the contaminated areas. It is required that this protective clothing be worn at all times by employees while working. Permanent employees at the site will be issued dedicated work boots that are to be worn in the controlled area. These boots are not to leave the controlled area. Temporary workers will be issued boots or will be required to wear shoe covers. Each employee shall be responsible to keep contaminated material inside the Restricted Area.

5.6.2 Signs and Postings

"(1) Standard Radiation Symbol. Unless otherwise authorized by the Executive Secretary, the symbol prescribed by 10 CFR 20.1901, (2010), which is incorporated by reference, shall use the colors magenta, or purple, or black on yellow background. The symbol prescribed is the three-bladed design as follows:
(a) Cross-hatched area is to be magenta, or purple, or black, and
(b) The background is to be yellow.
(2) Exception to Color Requirements for Standard Radiation Symbol. Notwithstanding the requirements of 10 CFR 20.1901(a), (2010), which is incorporated by reference, licensees or registrants are authorized to label sources, source holders, or device components containing sources of radiation that are subjected to high temperatures, with conspicuously etched or stamped radiation caution symbols and without a color requirement.
(3) Additional Information on Signs and Labels. In addition to the contents of signs and labels prescribed in Rule R313-15, the licensee or registrant shall provide, on or near the required signs and labels, additional information, as appropriate, to make individuals aware of potential radiation exposures and to minimize the exposures." **– R313-15-901.**

"(1) Posting of Radiation Areas. The licensee or registrant shall post each radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIATION AREA."
(2) Posting of High Radiation Areas. The licensee or registrant shall post each high radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, HIGH RADIATION AREA" or "DANGER, HIGH RADIATION AREA."
(3) Posting of Very High Radiation Areas. The licensee or registrant shall post each very high radiation area with a conspicuous sign or signs bearing the radiation symbol and words "GRAVE DANGER, VERY HIGH RADIATION AREA."

(4) Posting of Airborne Radioactivity Areas. The licensee or registrant shall post each airborne radioactivity area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, AIRBORNE RADIOACTIVITY AREA" or "DANGER, AIRBORNE RADIOACTIVITY AREA."
(5) Posting of Areas or Rooms in which Licensed or Registered Material is Used or Stored. The licensee or registrant shall post each area or room in which there is used or stored an amount of licensed or registered material exceeding ten times the quantity of such material specified in Appendix C of 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference, with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL." **– R313-15-902.**

"(1) A licensee or registrant is not required to post caution signs in areas or rooms containing sources of radiation for periods of less than eight hours, if each of the following conditions is met:
(a) The sources of radiation are constantly attended during these periods by an individual who takes the precautions necessary to prevent the exposure of individuals to sources of radiation in excess of the limits established in Rule R313-15; and
(b) The area or room is subject to the licensee's or registrant's control.
(2) Rooms or other areas in hospitals that are occupied by patients are not required to be posted with caution signs pursuant to Section R313-15-902 provided that the patient could be released from licensee control pursuant to Rule R313-32.
(3) A room or area is not required to be posted with a caution sign because of the presence of a sealed source provided the radiation level at 30 centimeters from the surface of the sealed source container or housing does not exceed 0.05 mSv (0.005 rem) per hour.
(4) A room or area is not required to be posted with a caution sign because of the presence of radiation machines used solely for diagnosis in the healing arts.
(5) Rooms in hospitals or clinics that are used for teletherapy are exempt from the requirement to post caution signs under Section R313-15-902 if:
(a) Access to the room is controlled pursuant to Section R313-32; and
(b) Personnel in attendance take necessary precautions to prevent the inadvertent exposure of workers, other patients, and members of the public to radiation in excess of the limits established in Rule R313-15." **– R313-15-903.**

A fence was constructed around the 11e.(2) Embankment before any waste was brought into the area. It is conspicuously posted with "Caution -- Radioactive Materials" signs bearing the standard radiation symbol, and other signs as appropriate. Other sign and posting requirements are included in the procedures catalogued in Appendices E and F.

5.7 RADIATION SAFETY CONTROLS AND MONITORING

"(1) Each licensee or registrant shall develop, document, and implement a radiation protection program sufficient to ensure compliance with the provisions of Rule R313-15. See Section R313-15-1102 for recordkeeping requirements relating to these programs.
(2) The licensee or registrant shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA).
(3) The licensee or registrant shall, at intervals not to exceed 12 months, review the radiation protection program content and implementation.

(4) To implement the ALARA requirements of Subsection R313-15-101(2), and notwithstanding the requirements in Section R313-15-301, a constraint on air emissions of radioactive material to the environment, excluding radon-222 and its decay products, shall be established by licensees or registrants such that the individual member of the public likely to receive the highest dose will not be expected to receive a total effective dose equivalent in excess of 0.1 mSv (0.01 rem) per year from these emissions. If a licensee or registrant subject to this requirement exceeds this dose constraint, the licensee or registrant shall report the exceedance as provided in Section R313-15-1203 and promptly take appropriate corrective action to ensure against recurrence." **– R313-15-101.**

Energy*Solutions* has implemented health and safety procedures that cover both Energy*Solutions* and contractor employees (Appendix E). While any site contractor is responsible for developing its own safety and health procedures, Energy*Solutions* performs safety inspections of the contractor's on-site operations to assure compliance with Utah's Occupational Safety and Health Administration and Energy*Solutions* regulations.

Any contractor that performs work for Energy*Solutions* on this project must formally take responsibility to obey all site rules. Any contractor who is to work for an extended period of time at the site must submit their own Health and Safety Procedures or commit to comply with Clive procedures.

All OSHA regulations will be under the jurisdiction of Utah's Occupational Safety and Health Administration. The Safety and Health Manager is responsible for overall development, direction, and coordination of the Safety and Health Procedures. The Director of LLRW Operations is responsible for on-site implementation and enforcement of all safety and health provisions. It is recognized that industrial accidents pose a greater risk to employees than radiation risks, and a significant effort is made to ensure a safe workplace. Employees are instructed to bring all health and safety concerns to their supervisor or the Director of LLRW Operations. Unresolved concerns may be brought to the attention of Utah's Occupational Safety and Health Administration for immediate reconciliation.

The Safety and Health Procedures rely on identification of risks, development of procedures to control those risks and to comply with Utah's Occupational Safety and Health Administration regulations, pre-employment safety training, continuing on-the-job safety training and on-going safety inspections of all operations. All site personnel are given the authority to enforce safety regulations, including authorization to stop work when unsafe conditions exist.

5.7.1 ALARA Program

"(2) The licensee or registrant shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA)." **– R313-15-101(2).**

"The licensee shall perform an annual ALARA audit of the radiation safety program which shall be led by the DHP or designate, qualified by way of specialized radiation protection training equivalent to that required for the DHP as defined in License Condition 9.10, in accordance with Section 2.3.3 of NRC Regulatory Guide 8.31, as amended. A report of this audit shall be submitted to corporate headquarters and the Executive Secretary, by March 31st for the previous year. 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:

[Applicable NRC Amendments: 24, 31, and 41][UDRC Amendment 6][UDRC Amendment 7]

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 monthly reviews.
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 Executive Secretary and previously submitted to the NRC.
h) Reviews of operating and monitoring procedures completed during the period.

The audit shall also address any noticeable 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." **– LICENSE CONDITION 12.3.**

It is the policy of Energy*Solutions*, to maintain personnel/occupational radiation exposures ALARA. Because of the nature of the 11e.(2) wastes, experience has shown that radiation exposures are normally low and Energy*Solutions* is committed to continuing to minimize exposures to the workers and the environment.

The average annual dose for 294 workers involved in the Vitro Remedial Action Project during 1986 was 50 mrem, with maximum exposures of 250 mrem. This maximum value is only 5% of the radiation dose standard of 10 CFR 20.101. Energy*Solutions*' annual employee dose summary since 1992 is presented in Table 5-7. Procedures and methods to keep internal exposures ALARA include:

a. Dust suppression on all operational roads by application of water or other dust suppressant materials or methods (e.g., Magnesium Chloride) as necessary.
b. Speed limit of 25 mph on roads treated by dust suppressants.
c. Stopping operations in high wind conditions (all operations cease at winds of greater than or equal to 35 mph; radiation safety personnel have authority to stop operations at lower wind speeds if dusting or other safety considerations warrant).
d. Weekly area radiation surveys with investigation of increasing levels to determine the cause.
e. Requiring workers to wear respirators in areas of potential high dust concentrations, for example, the rollover and selected heavy equipment operations.
f. Pre-planning tasks that have the potential for higher than normal exposures to limit exposures through efficient use of time and handling procedures.
g. Reviews of new proposed Waste Profile Records to assure that Energy*Solutions*' procedures, facilities, and equipment are appropriate and sufficient to limit exposures to workers and the environment.

Table 5-7

Energy*Solutions* Employee Annual Dose Summary

Dose (mrem)	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
<10	20	92	93	84	209	325	412	363	431	538
10 – 50	40	5	15	62	16	61	104	138	154	85
51 – 100	11	1	1	4		1	4	19	37	21
101 – 150	2				2			5	6	8
151 – 200	1						1	2	5	5
201 – 250	1							1	6	
251 – 500				1				1	5	1
500 +									1	

Dose (mrem)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
<10	483	520	441	649	495	287	232	239	263	215
10 – 50	105	74	142	103	70	59	45	39	42	54
51 – 100	27	13	30	26	15	5	8	12	8	14
101 – 150	5	3	9	14	6	6	5	3	6	7
151 – 200	4	2	6	3	2	2	3	2	2	4
201 – 250	3	7	7	9	2	3	2		1	4
251 – 500	1				6	5	5	6	3	6
500 +					0					

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

a. Monthly reviews of work area, perimeter, and environmental air monitoring results noting trends and adjusting work procedures when practical to further reduce potential exposures; and
b. Monthly reviews of work area gamma-ray exposure rates and advising the Vice – President of Clive on operational changes that will reduce radiation exposure.

An audit of ALARA activities is conducted and documented by the Director of Health Physics at least annually.

5.7.2 Radiation Safety Permits

"Each licensee or registrant shall develop, document, and implement a radiation protection program sufficient to ensure compliance with the provisions of Rule R313-15. See Section R313-15-1102 for recordkeeping requirements relating to these programs." **– R313-15-101(1).**

Radiation Safety Permit are not included in the Clive Facility Radiation Protection Program.

5.7.3 Radiation Work Permits

"9.13 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.
The DHP, or designate, qualified by way of special radiation protection training equivalent to that required for the DHP as defined in License Condition 9.10, shall indicate by signature, the review and approval of each RWP, prior to the initiation of the work." **– LICENSE CONDITION 9.13.**

The Radiation Work Permit operating procedure (CL-RS-PR-140) provides guidance for the initiation, approval and use of Radiation Work Permits. Work that generally requires a Radiation Work Permits includes, but is not limited to:

- All work activities inside a Contamination Area, Airborne Radioactivity Area, Radiation Area or High Radiation Area.
- Specified work activities involving waste conveyances outside of the restricted area.
- Work involving radioactive sources and material outside of the restricted area.

Violations of Radiation Work Permit requirements or instructions are documented. The Director of Health Physics, or designee, and the supervisor of the individual committing the infraction determine disciplinary actions. To facilitate ingress and egress to and from Contamination Areas and to allow for routine work in Non-contaminated Restricted Areas, Personal Protective Equipment requirements and limitations on Radiation Work Permits apply only to work in the posted Contamination Areas of the Restricted Area unless otherwise specified on the Radiation Work Permit.

Radiological controls, including Personal Protective Equipment requirements, may be upgraded by the Health Physics Technician providing job coverage. However, the Director of Health Physics is notified when this occurs to assess the need for a revision of the Radiation Work Permit. Neither radiological controls nor Personal Protective Equipment requirements specified for radiological purposes may be downgraded without approval from the Director of Health Physics or designee. All incidences of downgrading of Radiation Work Permit requirements are noted in the Access Control Point Log.

The Director of Health Physics or designee, qualified by training, reviews and approves all Job Specific Radiation Work Permits covering work with 11e.(2) materials and any Radiation Work Permit that permits exposures exceeding ALARA goals. Pre-job and job coverage radiological surveys in support of Radiation Work Permits are documented on a Radiological Survey form, CL-RS-PR-112-F1. For general access and work that has an associated general Radiation Work Permit, the Radiation Work Permit may be used to access the Restricted Area and the applicable Standard Operating Procedures used for work on the 11e. (2) Embankment. Each Radiation Work Permit is reviewed/updated at least on an annual basis. The Radiation Work Permit review includes, at a minimum, a review of physical and radiological characteristics of the waste managed under that Radiation Work Permit from an internal dose perspective.

5.7.4 Respiratory Protection

"If the licensee or registrant uses respiratory protection equipment to limit the intake of radioactive material:
(1) Except as provided in Subsection R313-15-703(2), the licensee or registrant shall use only respiratory protection equipment that is tested and certified by the National Institute for Occupational Safety and Health.
(2) The licensee or registrant may use equipment that has not been tested or certified by the National Institute for Occupational Safety and Health or for which there is no schedule for testing or certification, provided the licensee or registrant has submitted to the Executive Secretary and the Executive Secretary has approved an application for authorized use of that equipment. The application must include a demonstration by testing, or a demonstration on the basis of reliable test information, that the material and performance characteristics of the equipment are capable of providing the proposed degree of protection under anticipated conditions of use.
(3) The licensee or registrant shall implement and maintain a respiratory protection program that includes:
(a) Air sampling sufficient to identify the potential hazard, permit proper equipment selection, and estimate doses; and
(b) Surveys and bioassays, as necessary, to evaluate actual intakes; and
(c) Testing of respirators for operability, user seal check for face sealing devices and functional check for others, immediately prior to each use; and
(d) Written procedures regarding
(i) Monitoring, including air sampling and bioassays;
(ii) Supervision and training of respirator users;
(iii) Fit testing;
(iv) Respirator selection;
(v) Breathing air quality;
(vi) Inventory and control;
(vii) Storage, issuance, maintenance, repair, testing, and quality assurance of respiratory protection equipment;
(viii) Recordkeeping; and
(ix) Limitations on periods of respirator use and relief from respirator use; and
(e) Determination by a physician prior to initial fitting of respirators, before the first field use of non-face sealing respirators, and either every 12 months thereafter or periodically at a frequency determined by a physician, that the individual user is medically fit to use the respiratory protection equipment; and
(f) Fit testing, with fit factor greater than or equal to ten times the APF for negative pressure devices, and a fit factor greater than or equal to 500 for positive pressure, continuous flow, and pressure-demand devices, before the first field use of tight fitting, face-sealing respirators and periodically thereafter at a frequency

not to exceed one year. Fit testing must be performed with the facepiece operating in the negative pressure mode.
(4) The licensee or registrant shall advise each respirator user that the user may leave the area at any time for relief from respirator use in the event of equipment malfunction, physical or psychological distress, procedural or communication failure, significant deterioration of operating conditions, or any other conditions that might require such relief.
(5) The licensee or registrant shall also consider limitations appropriate to the type and mode of use. When selecting respiratory devices the licensee shall provide for vision correction, adequate communication, low temperature work environments, and the concurrent use of other safety or radiological protection equipment. The licensee or registrant shall use equipment in such a way as not to interfere with the proper operation of the respirator.
(6) Standby rescue persons are required whenever one-piece atmosphere-supplying suits, or any combination of supplied air respiratory protection device and personnel protective equipment are used from which an unaided individual would have difficulty extricating himself or herself. The standby persons must be equipped with respiratory protection devices or other apparatus appropriate for the potential hazards. The standby rescue persons shall observe or otherwise maintain continuous communication with the workers (visual, voice, signal line, telephone, radio, or other suitable means), and be immediately available to assist them in case of a failure of the air supply or for any other reason that requires relief from distress. A sufficient number of standby rescue persons must be immediately available to assist all users of this type of equipment and to provide effective emergency rescue if needed.
(7) Atmosphere-supplying respirators must be supplied with respirable air of grade D quality or better as defined by the Compressed Gas Association in publication G-7.1, "Commodity Specification for Air," 1997 ed. and included in 29 CFR 1910.134(i)(1)(ii)(A) through (E), (2010). Grade D quality air criteria include:
(a) Oxygen content (v/v) of 19.5 to 23.5%;
(b) Hydrocarbon (condensed) content of five milligrams per cubic meter of air or less;
(c) Carbon monoxide (CO) content of ten ppm or less;
(d) Carbon dioxide content of 1,000 ppm or less; and
(e) Lack of noticeable odor.
(8) The licensee shall ensure that no objects, materials or substances, such as facial hair, or any conditions that interfere with the face and facepiece seal or valve function, and that are under the control of the respirator wearer, are present between the skin of the wearer's face and the sealing surface of a tight-fitting respirator facepiece.
(9) In estimating the dose to individuals from intake of airborne radioactive materials, the concentration of radioactive material in the air that is inhaled when respirators are worn is initially assumed to be the ambient concentration in air without respiratory protection, divided by the assigned protection factor. If the dose is later found to be greater than the estimated dose, the corrected value must be used. If the dose is later found to be less than the estimated dose, the corrected value may be used." **– R313-15-703.**

"The Executive Secretary may impose restrictions in addition to the provisions of Section R313-15-702, Section R313-15-703, and Appendix A of 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference to:
(1) Ensure that the respiratory protection program of the licensee or registrant is adequate to limit doses to individuals from intakes of airborne radioactive materials consistent with maintaining total effective dose equivalent ALARA; and
(2) Limit the extent to which a licensee or registrant may use respiratory protection equipment instead of process or other engineering controls." **– R313-15-704**

"The licensee shall have qualified individual(s), designated by the DHP and Risk Manager, 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(s) 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." **– LICENSE CONDITION 9.15.**

A respiratory protection program has been implemented, based on ANSI guidance (ANSI, 2006). The program elements include employee training, quantitative fit testing, cleaning and maintenance, written standard operating procedure covering the program, medical surveillance, and recordkeeping. The Director of Health Physics and Safety and Health Manager are responsible for administering the respiratory protection program (and is catalogued in Appendices B and E).

5.7.5 Radiological Surveys

"(1) Each licensee or registrant shall make, or cause to be made, surveys that:
(a) Are necessary for the licensee or registrant to comply with Rule R313-15; and
(b) Are necessary under the circumstances to evaluate:
(i) The magnitude and the extent of radiation levels; and
(ii) Concentrations or quantities of radioactive material; and
(iii) The potential radiological hazards.
(2) The licensee or registrant shall ensure that instruments and equipment used for quantitative radiation measurements, for example, dose rate and effluent monitoring, are calibrated at intervals not to exceed 12 months for the radiation measured, except when a more frequent interval is specified in another applicable part of these rules or a license condition.
(3) All personnel dosimeters, except for direct and indirect reading pocket ionization chambers and those dosimeters used to measure the dose to any extremity, that require processing to determine the radiation dose and that are used by licensees and registrants to comply with Section R313-15-201, with other applicable provisions of these rules, or with conditions specified in a license or registration shall be processed and evaluated by a dosimetry processor:
(a) Holding current personnel dosimetry accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology; and
(b) Approved in this accreditation process for the type of radiation or radiations included in the NVLAP program that most closely approximates the type of radiation or radiations for which the individual wearing the dosimeter is monitored.
(4) The licensee or registrant shall ensure that adequate precautions are taken to prevent a deceptive exposure of an individual monitoring device." **– R313-15-501.**

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

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

5.7.6 Effluent Control Techniques

"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." – **LICENSE CONDITION 9.14.**

Engineering controls and dust suppression techniques performed in accordance with Energy*Solutions*' Air Order are used to minimize levels of airborne effluent particulates. This includes methods such as limited vehicle speeds, and use of water and other surface fixatives. Because of the importance of dust control in the minimization of occupational exposure to radioactive particulates, the following engineering controls are implemented inside the Restricted Area during periods of site operation:

1. A water truck is on-site all days of operation.
2. Facility roads are cleaned as needed. Waste collected is disposed within the Class A Embankment. If any other areas within the restricted area are being used in addition to those that have been swept, these areas are watered as needed to ensure dust is minimized.
3. Each day of operation a daily record is kept of water application. The records include the following items:
   a. Date of application.
   b. Number of treatments.
   c. Times of day treatments are made.

5.7.7 External Radiation Exposure Monitoring Program

"(1) If the licensee or registrant is required to monitor pursuant to both Subsections R313-15-502(1) and R313-15-502(2), the licensee or registrant shall demonstrate compliance with the dose limits by summing external and internal doses. If the licensee or registrant is required to monitor only pursuant to Subsection R313-15-502(1) or only pursuant to Subsection R313-15-502(2), then summation is not required to demonstrate compliance with the dose limits. The licensee or registrant may demonstrate compliance with the requirements for summation of external and internal doses pursuant to Subsections R313-15-202(2), R313-15-202(3) and R313-15-202(4). The dose equivalents for the lens of the eye, the skin, and the extremities are not included in the summation, but are subject to separate limits.

(2) Intake by Inhalation. If the only intake of radionuclides is by inhalation, the total effective dose equivalent limit is not exceeded if the sum of the deep dose equivalent divided by the total effective dose equivalent limit, and one of the following, does not exceed unity:

(a) The sum of the fractions of the inhalation ALI for each radionuclide, or

(b) The total number of derived air concentration-hours (DAC-hours) for all radionuclides divided by 2,000, or

(c) The sum of the calculated committed effective dose equivalents to all significantly irradiated organs or tissues (T) calculated from bioassay data using appropriate biological models and expressed as a fraction of the annual limit. For purposes of this requirement, an organ or tissue is deemed to be significantly irradiated if, for that organ or tissue, the product of the weighting factors, wT, and the committed dose

equivalent, HT,50, per unit intake is greater than ten percent of the maximum weighted value of HT,50, that is, wTHT,50, per unit intake for any organ or tissue.
(3) Intake by Oral Ingestion. If the occupationally exposed individual receives an intake of radionuclides by oral ingestion greater than ten percent of the applicable oral ALI, the licensee or registrant shall account for this intake and include it in demonstrating compliance with the limits.
(4) Intake through Wounds or Absorption through Skin. The licensee or registrant shall evaluate and, to the extent practical, account for intakes through wounds or skin absorption. The intake through intact skin has been included in the calculation of DAC for hydrogen-3 and does not need to be evaluated or accounted for pursuant to Subsection R313-15-202(4)." **– R313-15-202.**

"(1) Licensees or registrants shall, when determining the dose from airborne radioactive material, include the contribution to the deep dose equivalent, lens dose equivalent, and shallow dose equivalent from external exposure to the radioactive cloud. See footnotes 1 and 2 of Appendix B of 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference.
(2) Airborne radioactivity measurements and DAC values shall not be used as the primary means to assess the deep dose equivalent when the airborne radioactive material includes radionuclides other than noble gases or if the cloud of airborne radioactive material is not relatively uniform. The determination of the deep dose equivalent to an individual shall be based upon measurements using instruments or individual monitoring devices." **– R313-15-203.**

All personnel entering the Restricted Area are required to wear radiation dosimeters at all times. Permanent employees are issued a thermoluminescent dosimeter badge or equivalent, as approved by the Director of Health Physics. These badges are exchanged semi-annually or read as soon as practical upon termination of employment. Badges are selected that measure the skin dose equivalent (shallow dose) as well as the deep dose equivalent for compliance with 10 CFR 20.1203 and 10 CFR 20.1502 and are worn in the proper place as instructed by the Director of Health Physics. All badges, along with control badges, are maintained in designated areas at the Clive site when the employee is not at work.

Processing is done by a dosimetry processor holding accreditation from the National Voluntary Laboratory Accreditation Program of the National Institute of Standards and Technology appropriate for the radiation fields at the Energy*Solutions* site. It is not anticipated that the measurement of the shallow dose equivalent will be significant since the very weak beta radiations will be absorbed by the protective clothing of the employees as well as the relative large thickness of the air between the personnel and the waste.

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

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

NRC Regulatory Guide 8.30 discusses the concern for measuring the shallow dose from yellowcake where the contact dose rate is approximately 150 mrad/hour and the dose at 30 cm is approximately 1 mrad/hour. While Energy*Solutions* understands this concern, it believes that the beta dose will be significant in the 11e.(2) wastes received at the site. Disposal of 11e.(2) material will normally be depleted in uranium isotopes and the disposal of separated uranium will be limited by the concentration limits in the waste acceptance criteria which is small compared to the approximately 600,000 pCi/g in yellowcake or other uranium compounds. During waste handling operations at Energy*Solutions*, direct contact with the waste is normally not made and the combination of low activities, large distances, and protective clothing will limit the shallow dose equivalent to acceptable levels for wastes containing uranium compounds.

Because of the low radionuclide activities in the waste, there is little potential for a significant penetrating or non-penetrating external radiation dose from airborne radioactive material. The deep dose equivalent component of this small dose will be included in the employee's personal dosimeter reading. Energy*Solutions* allows visiting members of the public to access the Controlled and Restricted Areas of the site for tours, visits, and inspections. All visitors requiring access to the Restricted Area are provided dosimetry and an informational briefing appropriate for the expected hazards, and are accompanied by a responsible Energy*Solutions* radiation worker. Procedurally, visitors are not allowed in posted radiation areas or areas where respiratory protection is required. Individuals who are visiting the site on a limited basis will be issued a pocket dosimeter or other self-reading dosimetry to monitor their external gamma radiation dose. The dosimeter is read upon exiting the Controlled Area and recorded on the Access Log. In the case of individuals visiting as a group, one dosimeter may be used providing they stay together. Energy*Solutions* measures gamma-ray exposures in accordance with the Environmental Monitoring Plan, controlled by Condition 26 of Energy*Solutions*, (2012b).

5.7.7.1 Dosimetry

"(3) All personnel dosimeters, except for direct and indirect reading pocket ionization chambers and those dosimeters used to measure the dose to any extremity, that require processing to determine the radiation dose and that are used by licensees and registrants to comply with Section R313-15-201, with other applicable provisions of these rules, or with conditions specified in a license or registration shall be processed and evaluated by a dosimetry processor:
(a) Holding current personnel dosimetry accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology; and
(b) Approved in this accreditation process for the type of radiation or radiations included in the NVLAP program that most closely approximates the type of radiation or radiations for which the individual wearing the dosimeter is monitored." **– R313-15-501(3).**

"Each licensee or registrant shall monitor exposures from sources of radiation at levels sufficient to demonstrate compliance with the occupational dose limits of Rule R313-15. As a minimum:
(1) Each licensee or registrant shall monitor occupational exposure to radiation from licensed, unlicensed, and registered radiation sources under the control of the licensee and shall supply and require the use of individual monitoring devices by:
(a) Adults likely to receive, in one year from sources external to the body, a dose in excess of ten percent of the limits in Subsection R313-15-201(1); and
(b) Minors likely to receive, in one year, from radiation sources external to the body, a deep dose equivalent in excess of one mSv (0.1 rem), a lens dose equivalent in excess of 1.5 mSv (0.15 rem), or a shallow dose equivalent to the skin or to the extremities in excess of five mSv (0.5 rem); and

(c) Declared pregnant women likely to receive during the entire pregnancy, from radiation sources external to the body, a deep dose equivalent in excess of one mSv (0.1 rem); and
(d) Individuals entering a high or very high radiation area; and
(e) Individuals working with medical fluoroscopic equipment.
(i) An individual monitoring device used for the dose to an embryo/fetus of a declared pregnant woman, pursuant to Subsection R313-15-208(1), shall be located under the protective apron at the waist.
(A) If an individual monitoring device worn by a declared pregnant woman has a monthly reported dose equivalent value in excess of 0.5 mSv (50 mrem), the value to be used for determining the dose to the embryo/fetus, pursuant to Subsection R313-15-208(3)(a) for radiation from medical fluoroscopy, may be the value reported by the individual monitoring device worn at the waist underneath the protective apron which has been corrected for the potential overestimation of dose recorded by the monitoring device because of the overlying tissue of the pregnant individual. This correction shall be performed by a radiation safety officer of an institutional radiation safety committee, a qualified expert approved by the Board, or a representative of the Executive Secretary.
(ii) An individual monitoring device used for lens dose equivalent shall be located at the neck, or an unshielded location closer to the eye, outside the protective apron.
(iii) When only one individual monitoring device is used to determine the effective dose equivalent for external radiation pursuant to Subsection R313-15-201(3)(b), it shall be located at the neck outside the protective apron. When a second individual monitoring device is used, for the same purpose, it shall be located under the protective apron at the waist. Note: The second individual monitoring device is required for a declared pregnant woman.
(iv) A registrant is not required to supply and require the use of individual monitoring devices provided the registrant has conducted a survey, pursuant to Section R313-15-501, that demonstrates that the working environment the individual encounters will not likely result in a dose in excess of ten percent of the limits in Subsection R313-15-201(1), and that the individual is neither a minor nor a declared pregnant woman.
(2) Each licensee or registrant shall monitor, to determine compliance with Section R313-15-204, the occupational intake of radioactive material by and assess the committed effective dose equivalent to:
(a) Adults likely to receive, in one year, an intake in excess of ten percent of the applicable ALI(s) in Table I, Columns 1 and 2, of Appendix B of 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference; and
(b) Minors likely to receive, in one year, a committed effective dose equivalent in excess of one mSv (0.1 rem); and
(c) Declared pregnant women likely to receive, during the entire pregnancy, a committed effective dose equivalent in excess of one mSv (0.1 rem).
Note: All of the occupational doses in Section R313-15-201 continue to be applicable to the declared pregnant worker as long as the embryo/fetus dose limit is not exceeded." **– R313-15-502.**

"Each licensee or registrant shall ensure that individuals who are required to monitor occupational doses in accordance with Subsection R313-15-502(1) wear individual monitoring devices as follows:
(1) An individual monitoring device used for monitoring the dose to the whole body shall be worn at the unshielded location of the whole body likely to receive the highest exposure. When a protective apron is worn, the location of the individual monitoring device is typically at the neck (collar).
(2) An individual monitoring device used for monitoring the dose to an embryo/fetus of a declared pregnant woman, pursuant to Subsection R313-15-208(1), shall be located at the waist under any protective apron being worn by the woman.

(3) An individual monitoring device used for monitoring the lens dose equivalent, to demonstrate compliance with Subsection R313-15-201(1)(b)(i), shall be located at the neck (collar), outside any protective apron being worn by the monitored individual, or at an unshielded location closer to the eye.
(4) An individual monitoring device used for monitoring the dose to the extremities, to demonstrate compliance with Subsection R313-15-201(1)(b)(ii), shall be worn on the extremity likely to receive the highest exposure. Each individual monitoring device shall be oriented to measure the highest dose to the extremity being monitored." **– R313-15-503.**

The regulatory requirements for determining the occupational internal dose are in 10 CFR 20.1204. Energy*Solutions* will use the dose calculations methods described in Regulatory Guide 8.34, but will use data based on the updated Dose Conversion Factors of ICRP 68 in lieu of the ICRP 30 Dose Conversion Factors to perform these dose calculations. The chemical form of significant dose contributors will be determined as needed from the available waste stream manifests, air sample data, or other available sources of information. The applicable lung clearance classes will then be determined from the tables in ICRP 68. If the chemical form of significant dose contributors cannot be determined, the most restrictive class is used in the dose assessment.

The preliminary indication provided by workplace air sampling will guide the subsequent assessments of possible internal doses from inhaled radioactive materials. Regulatory Guide 8.34 provides several acceptable methods for determining internal doses from inhaled radionuclides. If it becomes necessary to calculate an employee's internal dose from inhaled radioactive material, Regulatory Guide 8.34 will guide the dose calculations, with updated data based on the Dose Conversion Factors of ICRP Publication 68 replacing ICRP 30 data in the calculations as applicable. If the initial estimates indicate a potential dose equivalent in excess of 100 mrem (CDE or CEDE), additional evaluations will be performed to further assess the dose and guide follow-up actions.

The ingestion of radionuclides at the Energy*Solutions* site is suppressed primarily by prohibiting eating and drinking inside Restricted Areas (with the exception that drinking from closeable beverage containers is allowed). In addition, the use of respiratory protection in the most highly contaminated areas minimizes the potential for facial contamination and subsequent ingestion of radioactive material. If it becomes necessary to calculate an employee's internal dose from ingested radioactive material, Regulatory Guide 8.34 will guide the dose calculations, with updated data based on the Dose Conversion Factors of ICRP Publication 68 replacing ICRP 30 data in the calculations as applicable. If the initial estimates indicate a potential dose equivalent in excess of 100 mrem (CDE or DEDE) additional evaluations will be performed to further assess the dose and guide follow-up actions.

Employees at the Energy*Solutions* Clive site are normally protected from intake through wounds and skin absorption by wearing protective clothing. Should an accident result in an open wound, the Director of Health Physics informs the attending physician of the fact for his guidance in effecting removal or reduction of the amount of radioactive material remaining in the wound. The Director of Health Physics will then perform an investigation and estimate the intake using data from wound monitoring or other available information.

The CDE to any organ will be estimated using methods similar to those used in NCRP Report 111, "Developing Radiation Emergency Plans for Academic, Medical or Industrial Facilities." August, 1991. Table 4.2 of NCRP Report 1111 provides values of maximum committed dose equivalent to any organ for adults per unit intake. These were derived by taking the ICRP Publication 30 values for ingestion and dividing by the gut transfer factor f1. Energy*Solutions* will use a similar approach by estimating the

radionuclide mixture and intake for each radionuclide, and calculating the CDE to each organ using appropriate f1 values and CDE per unit intake for each radionuclide of significance via the ingestion pathway, using the dose conversion factors of ICRP 68. Calculated CDEs will be compared to CFR 20.1201. Additional efforts at reducing dose will be based on total CDE and the potential for reducing the CDE through available means.

5.7.8 Airborne Radiation Monitoring Program

"(1) If the licensee or registrant is required to monitor pursuant to both Subsections R313-15-502(1) and R313-15-502(2), the licensee or registrant shall demonstrate compliance with the dose limits by summing external and internal doses. If the licensee or registrant is required to monitor only pursuant to Subsection R313-15-502(1) or only pursuant to Subsection R313-15-502(2), then summation is not required to demonstrate compliance with the dose limits. The licensee or registrant may demonstrate compliance with the requirements for summation of external and internal doses pursuant to Subsections R313-15-202(2), R313-15-202(3) and R313-15-202(4). The dose equivalents for the lens of the eye, the skin, and the extremities are not included in the summation, but are subject to separate limits.
(2) Intake by Inhalation. If the only intake of radionuclides is by inhalation, the total effective dose equivalent limit is not exceeded if the sum of the deep dose equivalent divided by the total effective dose equivalent limit, and one of the following, does not exceed unity:
(a) The sum of the fractions of the inhalation ALI for each radionuclide, or
(b) The total number of derived air concentration-hours (DAC-hours) for all radionuclides divided by 2,000, or
(c) The sum of the calculated committed effective dose equivalents to all significantly irradiated organs or tissues (T) calculated from bioassay data using appropriate biological models and expressed as a fraction of the annual limit. For purposes of this requirement, an organ or tissue is deemed to be significantly irradiated if, for that organ or tissue, the product of the weighting factors, wT, and the committed dose equivalent, HT,50, per unit intake is greater than ten percent of the maximum weighted value of HT,50, that is, wTHT,50, per unit intake for any organ or tissue.
(3) Intake by Oral Ingestion. If the occupationally exposed individual receives an intake of radionuclides by oral ingestion greater than ten percent of the applicable oral ALI, the licensee or registrant shall account for this intake and include it in demonstrating compliance with the limits.
(4) Intake through Wounds or Absorption through Skin. The licensee or registrant shall evaluate and, to the extent practical, account for intakes through wounds or skin absorption. The intake through intact skin has been included in the calculation of DAC for hydrogen-3 and does not need to be evaluated or accounted for pursuant to Subsection R313-15-202(4)." **– R313-15-202.**

"(1) For purposes of assessing dose used to determine compliance with occupational dose equivalent limits, the licensee or registrant shall, when required pursuant to Section R313-15-502, take suitable and timely measurements of:
(a) Concentrations of radioactive materials in air in work areas; or
(b) Quantities of radionuclides in the body; or
(c) Quantities of radionuclides excreted from the body; or
(d) Combinations of these measurements.
(2) Unless respiratory protective equipment is used, as provided in Section R313-15-703, or the assessment of intake is based on bioassays, the licensee or registrant shall assume that an individual inhales radioactive material at the airborne concentration in which the individual is present.
(3) When specific information on the physical and biochemical properties of the radionuclides taken into the body or the behavior of the material in an individual is known, the licensee or registrant may:

(a) Use that information to calculate the committed effective dose equivalent, and, if used, the licensee or registrant shall document that information in the individual's record; and
(b) Upon prior approval of the Executive Secretary, adjust the DAC or ALI values to reflect the actual physical and chemical characteristics of airborne radioactive material, for example, aerosol size distribution or density; and
(c) Separately assess the contribution of fractional intakes of Class D, W, or Y compounds of a given radionuclide to the committed effective dose equivalent. See Appendix B of 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference.
(4) If the licensee or registrant chooses to assess intakes of Class Y material using the measurements given in Subsections R313-15-204(1)(b) or R313-15-204(1)(c), the licensee or registrant may delay the recording and reporting of the assessments for periods up to seven months, unless otherwise required by Section R313-15-1202 or Section R313-15-1203. This delay permits the licensee or registrant to make additional measurements basic to the assessments.
(5) If the identity and concentration of each radionuclide in a mixture are known, the fraction of the DAC applicable to the mixture for use in calculating DAC-hours shall be either:
(a) The sum of the ratios of the concentration to the appropriate DAC value, that is, D, W, or Y, from Appendix B of 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference, for each radionuclide in the mixture; or
(b) The ratio of the total concentration for all radionuclides in the mixture to the most restrictive DAC value for any radionuclide in the mixture.
(6) If the identity of each radionuclide in a mixture is known, but the concentration of one or more of the radionuclides in the mixture is not known, the DAC for the mixture shall be the most restrictive DAC of any radionuclide in the mixture.
(7) When a mixture of radionuclides in air exists, a licensee or registrant may disregard certain radionuclides in the mixture if:
(a) The licensee or registrant uses the total activity of the mixture in demonstrating compliance with the dose limits in Section R313-15-201 and in complying with the monitoring requirements in Subsection R313-15-502(2), and
(b) The concentration of any radionuclide disregarded is less than ten percent of its DAC, and
(c) The sum of these percentages for all of the radionuclides disregarded in the mixture does not exceed 30 percent.
(8) When determining the committed effective dose equivalent, the following information may be considered:
(a) In order to calculate the committed effective dose equivalent, the licensee or registrant may assume that the inhalation of one ALI, or an exposure of 2,000 DAC-hours, results in a committed effective dose equivalent of 0.05 Sv (5 rem) for radionuclides that have their ALIs or DACs based on the committed effective dose equivalent.
(b) For an ALI and the associated DAC determined by the nonstochastic organ dose limit of 0.50 Sv (50 rem), the intake of radionuclides that would result in a committed effective dose equivalent of 0.05 Sv (5 rem), that is, the stochastic ALI, is listed in parentheses in Table I of Appendix B of 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference. The licensee or registrant may, as a simplifying assumption, use the stochastic ALI to determine committed effective dose equivalent. However, if the licensee or registrant uses the stochastic ALI, the licensee or registrant shall also demonstrate that the limit in Subsection R313-15-201(1)(a)(ii) is met." **– R313-15-204.**

"The licensee is granted an exemption to UAC 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)..” – **LICENSE CONDITION 11.4.**

Work areas are monitored for airborne radioactive particulates following the intent of NRC (NRC, 1992a). The continuous airborne particulate samplers operated on site as part of the environmental monitoring program provide an overall average of the concentrations of airborne radioactivity. In addition to the fixed-location environmental stations, work-place samples are collected to better assess potential exposure to employees. Environmental Air Sampling is performed in accordance with the Environmental Monitoring Plan, controlled by condition 26 of Energy*Solutions*, (2012b).

Some air particulate samples are collected by means of F & J Specialty Products, Co. Model FJ-28B Low Volume Air Sampler, or equivalent, typically operating at 60 liters per minute (lpm) with a 2-inch diameter filter. This sampler was selected on the basis of its demonstrated reliability, continuous flow control, and ability to collect sufficient sample during the sample period to meet the sensitivity requirements set forth in the Environmental Monitoring Plan, controlled by condition 26 of Energy*Solutions*, (2012b).

Work area samples are also collected with FJ-HV-1 high volume air samplers, or equivalent. The FJ-HV-1 sampler collects samples at 120 lpm and is used as a moveable sampler to collect airborne particulates at locations where a.c. power is available, or by means of a portable generator. For locations where a.c. power is not available, battery-powered portable lapel samplers capable of collecting at least 2.0 lpm are used. Both samplers were selected to collect sufficient sample on a 2-inch filter to permit detection levels comparable to Table 1 of Appendix B to 10 CFR 20 , making estimation of potential exposures sufficiently sensitive for occupational exposures.

The a.c.-powered samplers are used at locations such as the rollover/rotary dump, along haul ways, or near excavation and disposal activities to collect workday samples. Samples are collected as needed to provide adequate assessment of the radiological conditions at each worksite, in keeping with the intent of NRC, 1992a. During the times when disposal work is not being performed, no measurements are made. Sample collection data include a short statement of weather conditions during collection so that results may be compared to prevailing conditions, waste stream data, and other applicable information.

At the end of the sampling period, air particulate samples are stored in envelopes and marked with the pertinent information. After a delay of seven days, air filters are counted for gross alpha and beta levels. Gross alpha activity levels are compared to the Derived Air Concentration for Th-232, and gross beta activity levels are compared to the DAC for Pb-210.

Gross alpha concentrations of $3x10^{-12}$ microcuries per milliliter or gross beta concentrations of 1 $x10^{-10}$ microcuries per milliliter on individual air filters are considered “action levels.” The alpha action level is based on six times the most restrictive Derived Air Concentration value from Appendix B to 10 CFR 20 (Class W) and assumes the presence of alpha-emitting thorium decay products in secular equilibrium with Th-232. NRC guidance states that all Thorium ores and mill tailings are of the less restricted Class Y, so the action level is conservative in this regard (NRC, 1982). Experience has demonstrated that even this conservative action level is rarely exceeded, so it will serve as an adequately sensitive indicator of the need for follow-up action. If these action levels are exceeded, the Director of Health Physics will initiate follow-up actions that may include any or all of the following, as needed:

1. Evaluate site conditions to determine whether additional dust suppression methods are needed, whether posting for airborne radioactivity (20 CFR 10.1902) is required, and whether respiratory protection requirements are adequate.
2. The samples are analyzed by gamma spectrometry and, if necessary, by radiochemical separation and laboratory analysis to determine the activities of the radionuclides present.
3. If it is confirmed that any employee(s) exceeded the concentration limits of 10 CFR 20, Appendix B, Table 1, considering any respiratory protection devices, special urine/or fecal samples may be collected from the most significantly exposed employee to determine the extent of radionuclide uptake due to inhalation of dust. The situations are investigated to determine the cause of such concentrations and the means of reducing such exposures in the future.

Air sampling results for airborne particulates and radon are used to indicate the need for further evaluation and to calculate internal doses to employees if necessary. Those employees in assignments most likely to receive exposure to higher concentrations of airborne particulates are required to routinely wear respirators.

The handling of large quantities of Ra-226 and Th-232 bearing byproduct materials is expected to release Rn-222 (radon) and Rn-220 (thoron). The concentrations will vary depending upon the type of waste handled. The occupational limit for radon daughter exposure is four Working Level Months while the limit for thoron daughter exposure is 12 Working Level Months. The occupational exposure limit for radon without daughters present is 4,000 pCi/l while for radon with all daughters present (100 % equilibrium) is 30 pCi/l. The exposure limit for thoron without daughters is 7,000 pCi/l and 9 pCi/l with daughters in equilibrium.

Work areas, including buildings where radioactive waste is being processed or stored, will be monitored for radon and thoron using pairs of E-Perm ion chambers. One chamber responds to radon and thoron, the other responds primarily to radon. The readings along with the difference in the readings are used to calculate the radon and thoron concentrations. The minimum detectable concentration varies with the mixture of radon and thoron. If only radon is present, the Minimum Detectable Concentration is approximately 500 pCi/liter-hours, or 0.75 pCi/l-month, where a month is considered continuous exposure for four (4) weeks. If only thoron is present, the Minimum Detectable Concentration is approximately 3.6 pCi/l-month. Detectors will be placed in the work areas and read weekly. While the measured average concentrations will be for 24 hours/day rather than the average for the work day, the results should be conservative in that the meteorology of the site is expected to enhance the levels at night.

Due to the long exposure times for the E-Perms, other measurements of the work area environment will be made to assess worker exposure to radon and thoron and their daughter products. The E-Perm results of the radon and thoron measurements will be supplemented by grab samples for radon and thoron concentration and grab samples for radon and thoron WL determinations. If exposures are likely to exceed 10 percent of the allowable limits over a 40 hour exposure period, the grab sample results will be used to estimate the radon daughter equilibrium and the E-Perm radon concentration results will be used to calculate a monthly average WL for radon and thoron. The radon and thoron Working Levels results will then be used in determining the internal dose equivalents for the workers.

The occupational limit for radon daughter exposure is four Working Level Months per year, which is equivalent to a DAC of 30 pCi/l of Rn-222 in equilibrium with its daughters. Instant Working Level Monitors or grab sample techniques will be used to monitor the work area on a weekly basis during periods of calm winds. For work areas routinely falling below 10 percent of the WL limits for radon and thoron

daughters (0.03 Working Levels and 0.1 Working Levels for radon and thoron, respectively), the exposure will not be considered in the dosimetry program, provided there are no minors or declared pregnant women in the area (see 10 CFR 20.1205 (g)).

If grab samples are taken, the method used to measure either radon and/or thoron daughter-Working Level concentrations will have sample collection volumes and counting times sufficient to provide a lower limit of detection (sensitivity) of better than 0.03 Working Level (See NRC Regulatory Guide 8.30, "Health Physics Surveys in Uranium Mills"). Instant Working Level meters or continuous Working Level monitors will be used only if the equivalent sensitivity can be achieved. The method used will be approved by the Director of Health Physics or designee.

5.7.9 Exposure Calculations

"(1) The licensee or registrant shall control the occupational dose to individual adults, except for planned special exposures pursuant to Section R313-15-206, to the following dose limits:

a) An annual limit, which is the more limiting of:

(i) The total effective dose equivalent being equal to 0.05 Sv (5 rem); or

(ii) The sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 0.50 Sv (50 rem).

b) The annual limits to the lens of the eye, to the skin of the whole body, and to the skin of the extremities which are:

(i) A lens dose equivalent of 0.15 Sv (15 rem), and

(ii) A shallow dose equivalent of 0.50 Sv (50 rem) to the skin of the whole body or to the skin of any extremity.

(2) Doses received in excess of the annual limits, including doses received during accidents, emergencies, and planned special exposures, shall be subtracted from the limits for planned special exposures that the individual may receive during the current year and during the individual's lifetime. See Subsections R313-15-206(5)(a) and R313-15-206(5)(b).

(3) When the external exposure is determined by measurement with an external personal monitoring device, the deep dose equivalent must be used in place of the effective dose equivalent, unless the effective dose equivalent is determined by a dosimetry method approved by the Executive Secretary, U.S. Nuclear Regulatory Commission, or an Agreement State. The assigned deep dose equivalent must be for the part of the body receiving the highest exposure. The assigned shallow dose equivalent must be the dose averaged over the contiguous ten square centimeters of skin receiving the highest exposure.

a) The deep dose equivalent, lens dose equivalent and shallow dose equivalent may be assessed from surveys or other radiation measurements for the purpose of demonstrating compliance with the occupational dose limits, if the individual monitoring device was not in the region of highest potential exposure, or the results of individual monitoring are unavailable; or

b) When a protective apron is worn while working with medical fluoroscopic equipment and monitoring is conducted as specified in Subsection R313-15-502(1)(d), the effective dose equivalent for external radiation shall be determined as follows:

(i) When only one individual monitoring device is used and it is located at the neck outside the protective apron, and the reported dose exceeds 25 percent of the limit specified in Subsection R313-15-201(1), the reported deep dose equivalent value multiplied by 0.3 shall be the effective dose equivalent for external radiation; or

(ii) When individual monitoring devices are worn, both under the protective apron at the waist and outside the protective apron at the neck, the effective dose equivalent for external radiation shall be assigned the value of the sum of the deep dose equivalent reported for the individual

monitoring device located at the waist under the protective apron multiplied by 1.5 and the deep dose equivalent reported for the individual monitoring device located at the neck outside the protective apron multiplied by 0.04.
(4) Derived air concentration (DAC) and annual limit on intake (ALI) values are specified in Table I of Appendix B of 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference, and may be used to determine the individual's dose and to demonstrate compliance with the occupational dose limits. See Section R313-15-1107.
(5) Notwithstanding the annual dose limits, the licensee shall limit the soluble uranium intake by an individual to ten milligrams in a week in consideration of chemical toxicity. See footnote 3, of Appendix B of 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference.
(6) The licensee or registrant shall reduce the dose that an individual may be allowed to receive in the current year by the amount of occupational dose received while employed by any other person. See Subsection R313-15- 205(5)." **– R313-15-201.**

"The licensee is granted an exemption to UAC 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).." **– LICENSE CONDITION 11.4.**

Routine worker evaluations in Section 4 of Energy*Solutions*, (2005a) demonstrate that it is extremely unlikely that any employee could receive a lung burden of radioactivity that would require any action. If such an event did happen, the individual involved will receive a whole-body count to evaluate the potential dose. Subsequent actions, such as reassignment to a function not involving radiation exposure would be considered.

A worker might be injured in an accident that would result in the impaction of radioactive material into a wound. Energy*Solutions* will attempt to monitor injured employees before they are transported to medical care. In any case, the treating physician will be informed that the injury involves possible radioactive contamination. Because the radionuclides involved are relatively insoluble, normal cleansing of the wound should remove most, if not all, of the radioactivity. A radiation survey will be used to estimate any remaining radioactivity and potential doses calculated. The need for additional treatment would be based on the monitoring results.

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

5.7.9.1 External and Internal Dose

"(1) If the licensee or registrant is required to monitor pursuant to both Subsections R313-15-502(1) and R313-15-502(2), the licensee or registrant shall demonstrate compliance with the dose limits by summing external and internal doses. If the licensee or registrant is required to monitor only pursuant to Subsection R313-15-502(1) or only pursuant to Subsection R313-15-502(2), then summation is not required to demonstrate compliance with the dose limits. The licensee or registrant may demonstrate compliance with the requirements for summation of external and internal doses pursuant to Subsections R313-15-202(2), R313-15-202(3) and R313-15-202(4). The dose equivalents for the lens of the eye, the skin, and the extremities are not included in the summation, but are subject to separate limits.

(2) Intake by Inhalation. If the only intake of radionuclides is by inhalation, the total effective dose equivalent limit is not exceeded if the sum of the deep dose equivalent divided by the total effective dose equivalent limit, and one of the following, does not exceed unity:

a) The sum of the fractions of the inhalation ALI for each radionuclide, or

b) The total number of derived air concentration-hours (DAC-hours) for all radionuclides divided by 2,000, or

c) The sum of the calculated committed effective dose equivalents to all significantly irradiated organs or tissues (T) calculated from bioassay data using appropriate biological models and expressed as a fraction of the annual limit. For purposes of this requirement, an organ or tissue is deemed to be significantly irradiated if, for that organ or tissue, the product of the weighting factors, wT, and the committed dose equivalent, HT,50, per unit intake is greater than ten percent of the maximum weighted value of HT,50, that is, wTHT,50, per unit intake for any organ or tissue.

(3) Intake by Oral Ingestion. If the occupationally exposed individual receives an intake of radionuclides by oral ingestion greater than ten percent of the applicable oral ALI, the licensee or registrant shall account for this intake and include it in demonstrating compliance with the limits.

(4) Intake through Wounds or Absorption through Skin. The licensee or registrant shall evaluate and, to the extent practical, account for intakes through wounds or skin absorption. The intake through intact skin has been included in the calculation of DAC for hydrogen-3 and does not need to be evaluated or accounted for pursuant to Subsection R313-15-202(4)." **– R313-15-202.**

"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 will be no eating, drinking, smoking, defecating, or urinating in the restricted areas at any time." **– LICENSE CONDITION 10.1.**

Summation of external and internal doses is required in 10 CFR 20.1202 when both internal and external monitoring of an individual are required by 10 CFR 20.1502 (a) and (b). The cumulative operating experience at the Clive site indicates that the monitoring criteria of 10 CFR 20.1502 (a) and (b) are not likely to be exceeded.

Data for the UMTRA Project disposal at Clive show that the average annual dose equivalent from direct radiation was 50 mrem, with a maximum individual dose equivalent of 250 mrem. Energy*Solutions* has been operating radioactive material disposal facilities since 1988. Energy*Solutions*' employee dose history can be found in Table 5-7. Lapel sample and work area monitoring results indicate that the airborne particulate concentrations are near background levels.

Should Energy*Solutions* find that summation of occupational internal and external doses is necessary, one of the five methods for calculating the Committed Effective Dose Equivalent (CEDE), as described by NRC (NRC, 1992b), or an equivalent method, will be used. ICRP dose conversion factors (ICRP, 1979) provide

the scientific basis for the current Annual Limit on Intake (ALI) and DAC values of 10 CFR 20 Appendix B and Federal Guidance Report 11 (EPA, 1988). Since ICRP 30 is superseded by ICRP Publication 68, Energy*Solutions* will incorporate the updated dose conversion factors from ICRP Publication 68 into its internal CEDE and Committed Dose Equivalent (CDE) calculations, following the intent of NRC, 1992b, by substituting ICRP 68 values for ICRP-30 based values as applicable. ALI, DAC, and ECL values based on the ICRP 68 conversion factors will be calculated, as needed for internal dose estimation, following the methodology described in the notes to 10 CFR 20 Appendix B.

5.7.9.2 Prior Occupational Dose

"(1) For each individual likely to receive, in a year, an occupational dose requiring monitoring pursuant to Section R313-15-502, the licensee or registrant shall Determine the occupational radiation dose received during the current year; and

(2) Prior to permitting an individual to participate in a planned special exposure, the licensee or registrant shall determine:

a) The internal and external doses from all previous planned special exposures; and

b) All doses in excess of the limits, including doses received during accidents and emergencies, received during the lifetime of the individual.

(3) In complying with the requirements of Subsections R313-15-205(1) or (2), a licensee or registrant may:

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

b) Attempt to obtain the records of cumulative occupational radiation dose. A licensee or registrant may accept, as the record of cumulative radiation dose, an up-to-date form DRC-05 or equivalent, signed by the individual and countersigned by an appropriate official of the most recent employer for work involving radiation exposure, or the individual's current employer, if the individual is not employed by the licensee or registrant; and

c) Obtain reports of the individual's dose equivalents from the most recent employer for work involving radiation exposure, or the individual's current employer, if the individual is not employed by the licensee or registrant, by telephone, telegram, facsimile, other electronic media or letter. The licensee or registrant shall request a written verification of the dose data if the authenticity of the transmitted report cannot be established.

(4) The licensee or registrant shall record the exposure history, as required by Subsection R313-15- 205(1) or (2), on form DRC-05, or other clear and legible record, of all the information required on form DRC-05. The form or record shall show each period in which the individual received occupational exposure to radiation or radioactive material and shall be signed by the individual who received the exposure. For each period for which the licensee or registrant obtains reports, the licensee or registrant shall use the dose shown in the report in preparing form DRC-05 or equivalent. For any period in which the licensee or registrant does not obtain a report, the licensee or registrant shall place a notation on form DRC-05 or equivalent indicating the periods of time for which data are not available.

(5) For the purpose of complying with this requirement, licensees or registrants are not required to reevaluate the separate external dose equivalents and internal committed dose equivalents or intakes of radionuclides assessed pursuant to the rules in Rule R313-15 in effect before January 1, 1994. Further, occupational exposure histories obtained and recorded on form DRC-05 or equivalent before January 1, 1994, would not have included effective dose equivalent, but may be used in the absence of specific information on the intake of radionuclides by the individual.

(6) If the licensee or registrant is unable to obtain a complete record of an individual's current and previously accumulated occupational dose, the licensee or registrant shall assume:

a) In establishing administrative controls under Subsection R313-15-201(6) for the current year, that the allowable dose limit for the individual is reduced by 12.5 mSv (1.25 rem) for each quarter for which records were unavailable and the individual was engaged in activities that could have resulted in occupational radiation exposure; and

b) That the individual is not available for planned special exposures.

(7) The licensee or registrant shall retain the records on form DRC-05 or equivalent until the Executive Secretary terminates each pertinent license or registration requiring this record. The licensee or registrant shall retain records used in preparing form DRC-05 or equivalent for three years after the record is made. This includes records required under the standards for protection against radiation in effect prior to January 1, 1994." – **R313-15-205.**

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

1. Obtaining a written, signed statement from the employee or his most immediate employer, that discloses the nature and the amount of any occupational dose that the individual may have received during the current year; and
2. Obtaining or attempting to obtain from the employee's most recent employer, a written, signed statement in the form of an NRC Form 4 or an equivalent form, showing the life-time occupational exposure history. In case this cannot be done, the guidance in 10 CFR 20.2104 will be followed.

5.7.9.3 Planned Special Exposures

"A licensee or registrant may authorize an adult worker to receive doses in addition to and accounted for separately from the doses received under the limits specified in Section R313-15-201 provided that each of the following conditions is satisfied:

(1) The licensee or registrant authorizes a planned special exposure only in an exceptional situation when alternatives that might avoid the dose estimated to result from the planned special exposure are unavailable or impractical.

(2) The licensee or registrant, and employer if the employer is not the licensee or registrant, specifically authorizes the planned special exposure, in writing, before the exposure occurs.

(3) Before a planned special exposure, the licensee or registrant ensures that each individual involved is:

a) Informed of the purpose of the planned operation; and

b) Informed of the estimated doses and associated potential risks and specific radiation levels or other conditions that might be involved in performing the task; and

c) Instructed in the measures to be taken to keep the dose ALARA considering other risks that may be present.

(4) Prior to permitting an individual to participate in a planned special exposure, the licensee or registrant ascertains prior doses as required by Subsection R313-15-205(2) during the lifetime of the individual for each individual involved.

(5) Subject to Subsection R313-15-201(2), the licensee or registrant shall not authorize a planned special exposure that would cause an individual to receive a dose from all planned special exposures and all doses in excess of the limits to exceed:

a) The numerical values of any of the dose limits in Subsection R313-15-201(1) in any year; and

b) Five times the annual dose limits in Subsection R313-15-201(1) during the individual's lifetime.

(6) The licensee or registrant maintains records of the conduct of a planned special exposure in accordance with Section R313-15-1106 and submits a written report in accordance with Section R313-15-1204.
(7) The licensee or registrant records the best estimate of the dose resulting from the planned special exposure in the individual's record and informs the individual, in writing, of the dose within 30 days from the date of the planned special exposure. The dose from planned special exposures shall not be considered in controlling future occupational dose of the individual pursuant to Subsection R313-15-201(1) but shall be included in evaluations required by Subsections R313-15-206(4) and R313-15-206(5)." – **R313-15-206.**

Energy*Solutions* does not anticipate authorizing planned special exposures since the radiation levels and radioactive constituent concentrations in 11e.(2) byproduct material are low. In the event that circumstances warrant a planned special exposure, Energy*Solutions* does so in full compliance with the guidance in 10 CFR 20.1206.

5.7.9.4 Occupational Dose for Minors

"The annual occupational dose limits for minors are ten percent of the annual occupational dose limits specified for adult workers in Section R313-15-201." – **R313-15-207.**

The annual occupational dose limits for minors are 10 percent of the annual dose limits specified for adults. In accordance with Section 2.1.6 of the Radiation Protection Program, minors shall not be granted access to the Restricted Area.

5.7.9.5 Dose to an Embryo/Fetus

"The annual occupational dose limits for minors are ten percent of the annual occupational dose limits specified for adult workers in Section R313-15-201." – **R313-15-208.**

The dose equivalent to the embryo/fetus is limited to 0.5 rem during the entire pregnancy in accordance with 10 CFR 20.1208. Energy*Solutions*' policy is to inform female workers of the regulations regarding protection of the embryo/fetus and to ask them to inform Energy*Solutions* in writing, upon discovery or suspicion of a pregnancy. The Director of Health Physics reviews the work assignments and offers the woman the opportunity to take available positions in non-radiation areas for the duration of the pregnancy. If no positions are available, the Director of Health Physics counsels the individual to assure an understanding by the individual of the additional risks of continued employment. If the woman continues to work in the radiation area, the Director of Health Physics monitors the work assignments and activities to assure that the Total Effective Dose Equivalent (TEDE) to the embryo/fetus is ALARA and limited to 0.5 rem.

5.7.9.6 Dose Limits to Individual Members of the Public

"(1) Each licensee or registrant shall conduct operations so that:

a) The total effective dose equivalent to individual members of the public from the licensed or registered operation does not exceed one mSv (0.1 rem) in a year, exclusive of the dose contributions from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released, under Rule R313-32 (incorporating 10 CFR 35.75 by reference), from voluntary participation in medical research programs, and from the licensee's or registrant's disposal of radioactive material into sanitary sewerage in accordance with Section R313-15-1003; and

b) The dose in any unrestricted area from external sources, exclusive of the dose contributions from patients administered radioactive material and released in accordance with Rule R313-32 (incorporating 10 CFR 35.75 by reference), does not exceed 0.02 mSv (0.002 rem) in any one hour; and

c) Notwithstanding Subsection R313-15-301(1)(a), a licensee may permit visitors to an individual who cannot be released, under R313-32 (incorporating 10 CFR 35.75 by reference), to receive a radiation dose greater than one mSv (0.1 rem) if:
(i) The radiation dose received does not exceed five mSv (0.5 rem); and
(ii) The authorized user, as defined in R313-32, has determined before the visit that it is appropriate.; and
d) The total effective dose equivalent to individual members of the public from infrequent exposure to radiation from radiation machines does not exceed 5 mSv (0.5 rem) in a year.
(2) If the licensee or registrant permits members of the public to have access to controlled areas, the limits for members of the public continue to apply to those individuals.
(3) A licensee, registrant, or an applicant for a license or registration may apply for prior Executive Secretary authorization to operate up to an annual dose limit for an individual member of the public of five mSv (0.5 rem). This application shall include the following information:
a) Demonstration of the need for and the expected duration of operations in excess of the limit in Subsection R313-15-301(1); and
b) The licensee's or registrant's program to assess and control dose within the five mSv (0.5 rem) annual limit; and
c) The procedures to be followed to maintain the dose ALARA.
(4) In addition to the requirements of R313-15, a licensee subject to the provisions of the United States Environmental Protection Agency's generally applicable environmental radiation standards in 40 CFR 190 shall comply with those standards.
(5) The Executive Secretary may impose additional restrictions on radiation levels in unrestricted areas and on the total quantity of radionuclides that a licensee or registrant may release in effluents in order to restrict the collective dose." – **R313-15-301.**

Operations are conducted such that the resulting dose equivalent to any individual members of the public is less than the limits of 10 CFR 20.1301, 10 CFR 61, and the ALARA constraint of 10 CFR 20.1101. Compliance with 10 CFR 20.1301 is demonstrated using the data acquired under the "Environmental Monitoring Plan" as described under condition 26 of Energy*Solutions*, (2012b). Airborne particulate monitoring is performed to confirm those predictions.

5.7.9.7 Compliance to Dose Limits to Individual Members of the Public

"(1) The licensee or registrant shall make or cause to be made surveys of radiation levels in unrestricted and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public in Section R313-15-301.
(2) A licensee or registrant shall show compliance with the annual dose limit in Section R313-15-301 by:
a) Demonstrating by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed or registered operation does not exceed the annual dose limit; or
b) Demonstrating that:
(i) The annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed the values specified in Table II of Appendix B of 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference; and
(ii) If an individual were continuously present in an unrestricted area, the dose from external sources would not exceed 0.02 mSv (0.002 rem) in an hour and 0.50 mSv (0.05 rem) in a year.

(3) Upon approval from the Executive Secretary, the licensee or registrant may adjust the effluent concentration values in Appendix B, Table II of 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference, for members of the public, to take into account the actual physical and chemical characteristics of the effluents, such as, aerosol size distribution, solubility, density, radioactive decay equilibrium, and chemical form." **– R313-15-302.**

The analysis presented in Appendices A and A-1 of Energy*Solutions*, (2005b) addresses the specific impacts of releases under normal operating conditions. Release mechanisms were evaluated, exposures to workers and the public assessed, and the results compared to applicable standards and regulations. It was concluded that with the proposed waste characteristics and operating procedures, exposures to the workers and the public will be within acceptable limits and the design limits the radon flux to less than 20 pCi/m^2/s as provided in 10 CFR Part 40, Appendix A.

While the exposures to site custodial personnel during the active institutional control period were not specifically evaluated, all wastes will have been covered, gamma exposure rates will be near background, and radon emission rates will be less than the design criterion of 20 pCi/m^2/s. There is no reason to believe that exposures during this period are more than a small fraction of those to the workers during operations.

Section 7.5 discusses the impacts of releases due to accidents or unusual operating conditions. In general, because of the relatively low radionuclide concentrations of the Clive wastes, it is difficult to postulate an on-site accident that could cause significant exposures to on- or off-site personnel.

5.7.10 Bioassay Program

"(1) If the licensee or registrant is required to monitor pursuant to both Subsections R313-15-502(1) and R313-15-502(2), the licensee or registrant shall demonstrate compliance with the dose limits by summing external and internal doses. If the licensee or registrant is required to monitor only pursuant to Subsection R313-15-502(1) or only pursuant to Subsection R313-15-502(2), then summation is not required to demonstrate compliance with the dose limits. The licensee or registrant may demonstrate compliance with the requirements for summation of external and internal doses pursuant to Subsections R313-15-202(2), R313-15-202(3) and R313-15-202(4). The dose equivalents for the lens of the eye, the skin, and the extremities are not included in the summation, but are subject to separate limits.

(2) Intake by Inhalation. If the only intake of radionuclides is by inhalation, the total effective dose equivalent limit is not exceeded if the sum of the deep dose equivalent divided by the total effective dose equivalent limit, and one of the following, does not exceed unity:

a) The sum of the fractions of the inhalation ALI for each radionuclide, or

b) The total number of derived air concentration-hours (DAC-hours) for all radionuclides divided by 2,000, or

c) The sum of the calculated committed effective dose equivalents to all significantly irradiated organs or tissues (T) calculated from bioassay data using appropriate biological models and expressed as a fraction of the annual limit. For purposes of this requirement, an organ or tissue is deemed to be significantly irradiated if, for that organ or tissue, the product of the weighting factors, wT, and the committed dose equivalent, HT,50, per unit intake is greater than ten percent of the maximum weighted value of HT,50, that is, wTHT,50, per unit intake for any organ or tissue.

(3) Intake by Oral Ingestion. If the occupationally exposed individual receives an intake of radionuclides by oral ingestion greater than ten percent of the applicable oral ALI, the licensee or registrant shall account for this intake and include it in demonstrating compliance with the limits.

(4) Intake through Wounds or Absorption through Skin. The licensee or registrant shall evaluate and, to the extent practical, account for intakes through wounds or skin absorption. The intake through intact skin has been included in the calculation of DAC for hydrogen-3 and does not need to be evaluated or accounted for pursuant to Subsection R313-15-202(4).” **– R313-15-202.**

“(1) For purposes of assessing dose used to determine compliance with occupational dose equivalent limits, the licensee or registrant shall, when required pursuant to Section R313-15-502, take suitable and timely measurements of:

a) Concentrations of radioactive materials in air in work areas; or
b) Quantities of radionuclides in the body; or
c) Quantities of radionuclides excreted from the body; or
d) Combinations of these measurements.

(2) Unless respiratory protective equipment is used, as provided in Section R313-15-703, or the assessment of intake is based on bioassays, the licensee or registrant shall assume that an individual inhales radioactive material at the airborne concentration in which the individual is present.

(3) When specific information on the physical and biochemical properties of the radionuclides taken into the body or the behavior of the material in an individual is known, the licensee or registrant may:

a) Use that information to calculate the committed effective dose equivalent, and, if used, the licensee or registrant shall document that information in the individual's record; and
b) Upon prior approval of the Executive Secretary, adjust the DAC or ALI values to reflect the actual physical and chemical characteristics of airborne radioactive material, for example, aerosol size distribution or density; and
c) Separately assess the contribution of fractional intakes of Class D, W, or Y compounds of a given radionuclide to the committed effective dose equivalent. See Appendix B of 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference.

(4) If the licensee or registrant chooses to assess intakes of Class Y material using the measurements given in Subsections R313-15-204(1)(b) or R313-15-204(1)(c), the licensee or registrant may delay the recording and reporting of the assessments for periods up to seven months, unless otherwise required by Section R313-15-1202 or Section R313-15-1203. This delay permits the licensee or registrant to make additional measurements basic to the assessments.

(5) If the identity and concentration of each radionuclide in a mixture are known, the fraction of the DAC applicable to the mixture for use in calculating DAC-hours shall be either:

a) The sum of the ratios of the concentration to the appropriate DAC value, that is, D, W, or Y, from Appendix B of 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference, for each radionuclide in the mixture; or
b) The ratio of the total concentration for all radionuclides in the mixture to the most restrictive DAC value for any radionuclide in the mixture.

(6) If the identity of each radionuclide in a mixture is known, but the concentration of one or more of the radionuclides in the mixture is not known, the DAC for the mixture shall be the most restrictive DAC of any radionuclide in the mixture.

(7) When a mixture of radionuclides in air exists, a licensee or registrant may disregard certain radionuclides in the mixture if:

a) The licensee or registrant uses the total activity of the mixture in demonstrating compliance with the dose limits in Section R313-15-201 and in complying with the monitoring requirements in Subsection R313-15-502(2), and
b) The concentration of any radionuclide disregarded is less than ten percent of its DAC, and

c) The sum of these percentages for all of the radionuclides disregarded in the mixture does not exceed 30 percent.

(8) When determining the committed effective dose equivalent, the following information may be considered:

a) In order to calculate the committed effective dose equivalent, the licensee or registrant may assume that the inhalation of one ALI, or an exposure of 2,000 DAC-hours, results in a committed effective dose equivalent of 0.05 Sv (5 rem) for radionuclides that have their ALIs or DACs based on the committed effective dose equivalent.

b) For an ALI and the associated DAC determined by the nonstochastic organ dose limit of 0.50 Sv (50 rem), the intake of radionuclides that would result in a committed effective dose equivalent of 0.05 Sv (5 rem), that is, the stochastic ALI, is listed in parentheses in Table I of Appendix B of 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference. The licensee or registrant may, as a simplifying assumption, use the stochastic ALI to determine committed effective dose equivalent. However, if the licensee or registrant uses the stochastic ALI, the licensee or registrant shall also demonstrate that the limit in Subsection R313-15-201(1)(a)(ii) is met." **– R313-15-204.**

All monitored individuals are required to participate in a bioassay program to assist in evaluating internal deposition of radionuclides. A baseline sample is taken either through urinalysis or use of a whole body counter at the beginning of the monitoring period. A termination sample is taken whenever possible either through urinalysis or use of a whole body counter. All in-vivo baseline and termination samples are analyzed by gamma spectroscopy for naturally occurring radioactive material, including uranium and Ra-226. Urine samples are analyzed for total uranium and Ra-226. Energy*Solutions* evaluates laboratory bioassay analysis results in accordance with NRC Regulatory Guide 8.9 (NRC, 1993b).

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

Evaluation Level: If internal bioassay measurements indicate that an intake is greater than an intake of 0.02 ALI, additional available data, such as airborne measurements or additional bioassay measurements, should be used to obtain the best estimate of actual intake.

Investigation Level: If a potential intake exceeds an investigation level of 0.1 ALI, multiple bioassay measurements and an evaluation of available workplace monitoring data will be conducted.

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

Specific bioassay sampling is also used on a periodic basis for individual personnel working in areas with an elevated potential of intake. The potential of an intake is evaluated by review of air sampling results, work practices, and pre-operational modeling. At least two specific samples per month are analyzed for isotopic thorium from personnel working in waste handling areas even if there was no indication of elevated air concentrations.

Excretion models are used along with waste characterization data, bioassay data, and operational data to estimate the radionuclide intake and the resultant dose to the organs. Methods recommended by NCRP are used (NCRP, 1987). The guidance of 10 CFR 20.1201 is followed in cases where significant organ doses or Total Effective Dose Equivalents are found.

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

No single method exists that adequately detects intakes of potential 11e.(2) radionuclides at levels near the ALI. Bioassay methods work well for the normally soluble uranium isotopes but fail to detect the insoluble thorium isotopes. Similarly, whole-body counting or lung counting methods may detect levels of Th-232 and Ra-226 (radon daughters) at or near the ALI, depending upon the distribution in the body but fail to detect Th-230, Ra-228 or other alpha or beta emitting radionuclides. For acute intakes, analysis of the feces is normally more sensitive than other methods, while for chronic intakes it is not a viable method.

The radiation safety staff under the direction of the Director of Health Physics are responsible for selecting appropriate methods, properly assessing dose intakes and reporting the intakes.

5.7.11 Contamination Control Program

"(1) Each licensee or registrant shall conduct operations so that:

a) The total effective dose equivalent to individual members of the public from the licensed or registered operation does not exceed one mSv (0.1 rem) in a year, exclusive of the dose contributions from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released, under Rule R313-32 (incorporating 10 CFR 35.75 by reference), from voluntary participation in medical research programs, and from the licensee's or registrant's disposal of radioactive material into sanitary sewerage in accordance with Section R313-15-1003; and

b) The dose in any unrestricted area from external sources, exclusive of the dose contributions from patients administered radioactive material and released in accordance with Rule R313-32 (incorporating 10 CFR 35.75 by reference), does not exceed 0.02 mSv (0.002 rem) in any one hour; and

c) Notwithstanding Subsection R313-15-301(1)(a), a licensee may permit visitors to an individual who cannot be released, under R313-32 (incorporating 10 CFR 35.75 by reference), to receive a radiation dose greater than one mSv (0.1 rem) if:

(i) The radiation dose received does not exceed five mSv (0.5 rem); and

(ii) The authorized user, as defined in R313-32, has determined before the visit that it is appropriate.; and

d) The total effective dose equivalent to individual members of the public from infrequent exposure to radiation from radiation machines does not exceed 5 mSv (0.5 rem) in a year.

(2) If the licensee or registrant permits members of the public to have access to controlled areas, the limits for members of the public continue to apply to those individuals.

(3) A licensee, registrant, or an applicant for a license or registration may apply for prior Executive Secretary authorization to operate up to an annual dose limit for an individual member of the public of five mSv (0.5 rem). This application shall include the following information:

a) Demonstration of the need for and the expected duration of operations in excess of the limit in Subsection R313-15-301(1); and

b) The licensee's or registrant's program to assess and control dose within the five mSv (0.5 rem) annual limit; and

c) The procedures to be followed to maintain the dose ALARA.

(4) In addition to the requirements of R313-15, a licensee subject to the provisions of the United States Environmental Protection Agency's generally applicable environmental radiation standards in 40 CFR 190 shall comply with those standards.

(5) The Executive Secretary may impose additional restrictions on radiation levels in unrestricted areas and on the total quantity of radionuclides that a licensee or registrant may release in effluents in order to restrict the collective dose." **– R313-15-301.**

"Applicants for licenses, other than renewals, shall describe in the application how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of waste." **– R313-15-406.**

Routine external gamma surveys using a gamma scintillation survey meter will be conducted and documented in areas involving disposal material in accordance with the type, frequency, and location(s) listed in Table 5-8. Additional area gamma surveys will be performed during daily operations as considered necessary by health physics personnel.

Routine wipe surveys for surface contamination will be conducted as listed in Table 5-8. The wipes will be analyzed for gross alpha contamination using a Ludlum Model 1000 Scalar or equal with a Model 43-10 alpha scintillation probe or equal. They will also be analyzed for gross beta contamination using a Ludlum Model 2200 scalar or equivalent and a Model 120 gas flow proportional counter or equivalent.

5.7.12 Airborne Effluent and Environmental Program

"(1) Each licensee or registrant shall conduct operations so that:

a) The total effective dose equivalent to individual members of the public from the licensed or registered operation does not exceed one mSv (0.1 rem) in a year, exclusive of the dose contributions from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released, under Rule R313-32 (incorporating 10 CFR 35.75 by reference), from voluntary participation in medical research programs, and from the licensee's or registrant's disposal of radioactive material into sanitary sewerage in accordance with Section R313-15-1003; and

b) The dose in any unrestricted area from external sources, exclusive of the dose contributions from patients administered radioactive material and released in accordance with Rule R313-32 (incorporating 10 CFR 35.75 by reference), does not exceed 0.02 mSv (0.002 rem) in any one hour; and

Table 5-8

Routine External Gamma Surveys

Type	Location	Frequency
A. Gamma Radiation Levels	1. Perimeter of Controlled Area(s)	Weekly
	2. Office Area	Weekly
	3. Lunch/Change Area	Weekly
	4. Transport Vehicles	Upon Arrival at Site and before departure
B. Contamination Wipes	1. Eating Area	Weekly
	2. Change Area	Weekly
	3. Office Area	Weekly
	4. Railcar Rollover and control shack	Weekly
	5. Equipment/Vehicles	Once before release
C. Employee/Personnel	1. Skin & Personal Clothing	Prior to exiting the controlled area
D. Gamma Exposure	1. Operations Building	Quarterly
E. Radon Concentration	1. Operations Building	Quarterly

c) Notwithstanding Subsection R313-15-301(1)(a), a licensee may permit visitors to an individual who cannot be released, under R313-32 (incorporating 10 CFR 35.75 by reference), to receive a radiation dose greater than one mSv (0.1 rem) if:

(i) The radiation dose received does not exceed five mSv (0.5 rem); and

(ii) The authorized user, as defined in R313-32, has determined before the visit that it is appropriate.; and

d) The total effective dose equivalent to individual members of the public from infrequent exposure to radiation from radiation machines does not exceed 5 mSv (0.5 rem) in a year.

(2) If the licensee or registrant permits members of the public to have access to controlled areas, the limits for members of the public continue to apply to those individuals.

(3) A licensee, registrant, or an applicant for a license or registration may apply for prior Executive Secretary authorization to operate up to an annual dose limit for an individual member of the public of five mSv (0.5 rem). This application shall include the following information:

a) Demonstration of the need for and the expected duration of operations in excess of the limit in Subsection R313-15-301(1); and

b) The licensee's or registrant's program to assess and control dose within the five mSv (0.5 rem) annual limit; and

c) The procedures to be followed to maintain the dose ALARA.

(4) In addition to the requirements of R313-15, a licensee subject to the provisions of the United States Environmental Protection Agency's generally applicable environmental radiation standards in 40 CFR 190 shall comply with those standards.

(5) The Executive Secretary may impose additional restrictions on radiation levels in unrestricted areas and on the total quantity of radionuclides that a licensee or registrant may release in effluents in order to restrict the collective dose." – **R313-15-301.**

Energy*Solutions* has obtained an Air Approval Order from the State of Utah, Division of Air Quality. Prior to the issuance of this order the Division of Air Quality performed a review of air quality concerns. The Utah Division of Air Quality performs routine audits of Energy*Solutions'* facility to determine compliance with their Order. In order to ensure that radiological contamination does not leave the facility, Energy*Solutions* employs a rigorous, point-of-compliance air monitoring program at the facility fence line. Further, Energy*Solutions* is required by License Condition 53.D of its Low-Level Radioactive Waste Radioactive Material License to cease all bulk waste handling operations when the 5-minute average wind speed reaches 35 mph. It should also be noted that the air order requires Energy*Solutions* to maintain minimum waste moisture conditions as well as optimum air opacity standards. When these conditions are not met, dust suppression is applied as needed regardless of the time of year.

Energy*Solutions* performs environmental monitoring in accordance with the Environmental Monitoring Plan in and around its 11e.(2) Embankment (condition 26 of Energy*Solutions*, 2012b). The analytical data from air, soil, vegetation, and storm water is evaluated to ensure compliance with the State of Utah radiation safety rules, Radioactive Material License and 11e.(2) License Conditions. Data are compiled into a report and submitted to the Division on a quarterly basis. The Environmental Monitoring Program is designed to detect and quantify the net radiological effects in Unrestricted Areas that occur as a result of the licensed activities.

Energy*Solutions* has operated a meteorological station on the Clive site since July, 1992. Seasonal wind charts, derived from the information collected by the meteorological station, were used to select locations

for environmental stations. This wind rose data was primarily used to select the airborne radioactivity monitoring locations most likely to intercept effluents from the waste management areas during operations. The soil sampling locations and gamma monitoring locations are spaced relatively uniformly around the facility, and at those locations that are most likely to be occupied during or affected by operations. The specific details of the Environmental Monitoring Plan are contained in condition 26 of Energy*Solutions*, (2012b).

The basis for Energy*Solutions'* programs for monitoring radioactive particulates in the air is described in condition 26 of Energy*Solutions*, (2012b). Energy*Solutions* has initiated an outdoor-air radon monitoring plan in accordance with condition 26 of Energy*Solutions*, (2012b). Airborne particulate sampling will be performed in accordance with condition 26 of Energy*Solutions*, (2012b).

5.7.13 Ground-Water and Surface-Water Monitoring Programs

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (b) An assessment of any impact on waterways and groundwater resulting from the activities conducted pursuant to the license or amendment;" **– R313-24-3(1)(b).**

"The licensee shall assume full responsibility for cleaning up the groundwater of all hazardous constituents detected at the POC in concentrations that exceed the limits specified in Tables 1-A the Groundwater Quality Permit. 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 Executive Secretary's satisfaction, based on field and laboratory data, that the 11e.(2) facility is not the source of particular constituents. The Executive Secretary shall have the final decision concerning any claim by the licensee that the 11e.(2) facility is not the source of a particular constituent that is detected at the POC.
The licensee shall undertake corrective action to clean up groundwater contamination if and when required, 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." **– LICENSE CONDITION 10.3.**

"The Licensee shall fulfill and maintain compliance with all conditions and all compliance schedules stipulated in the Ground Water Discharge Permit, number UGW 450005, issued by the Executive Secretary of the Utah Water Quality Board, as amended." **– LICENSE CONDITION 11.1.**

Energy*Solutions* has initiated and performs a groundwater monitoring program based on the requirements found in Ground Water Quality Discharge Permit No. UGW450005 issued and approved by the Utah Division of Water Quality. Energy*Solutions* has completed the performance of pre-operational monitoring for this license application.

A hydrogeological study (Envirocare, 2004) describes the results obtained from a system of monitoring wells which had been established to monitor potential contamination from the Energy*Solutions* disposal embankments. This system of monitoring wells is also used to establish and monitor background water quality in accordance with Part I.F.5 of the Ground Water Quality Discharge Permit. The hydrogeologic study has been completed to better define and characterize the aquifer underlying the disposal site.

The detection monitoring strategy includes sampling all Point of Compliance (POC) wells on an annual basis for the required set of constituents. Other indicator parameters may be selected and added to the constituents monitored, based on characterization of the actual waste that is disposed.

The POC wells consist of a monitoring network of 15 wells identified in Part I.F.1.a.2 of the Ground Water Quality Discharge Permit. Currently, these wells are: GW-19A, GW-20, GW-24, GW-25, GW-26, GW-27, GW-28, GW-29, GW-36, GW-57, GW-58, GW-60, GW-63, GW-126, and GW-127. Wells GW-37 and GW-38R are within the footprint of the embankment and are not used as POC wells. Should an out-of-compliance situation arise, sampling frequency and analyses will occur in accordance with Parts I.G.2 and I.G.3 of the Ground Water Quality Discharge Permit.

Sample collection for the detection monitoring program, preservation, handling, frequency and analyses is conducted in strict accordance with the Ground Water Quality Discharge Permit. Table 6 in Part I.E.2 of the Ground Water Quality Discharge Permit lists the maximum VOC concentrations allowed in 11e.(2) waste. Energy*Solutions* screens for these parameters in order to ensure that the waste received meets 11e.(2) disposal requirements.

5.7.14 Quality Assurance

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

"The licensee shall implement the quality assurance plan as provided in the license application." – **LICENSE CONDITION 10.5.**

Energy*Solutions'* organizational structure, functional responsibilities, levels of authority and lines of communication for activities affecting quality are established and documented. The Quality Assurance Manager is responsible for assuring that a quality assurance program is established and verifying activities affecting quality have been correctly performed. The Quality Assurance Manager has sufficient authority, access to work areas and organizational freedom to:

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

The Quality Assurance Manager has direct access to the responsible management at a level where appropriate actions can be effected. The Quality Assurance Manager reports to the Director of Q/A Processing/Disposal where the required authority and organizational freedom is provided, including sufficient independence from cost and schedule considerations. Quality is achieved and maintained by those individuals who have been assigned responsibility for performing the work. Quality achievement is verified by other individuals not directly responsible for directing the work.

Where more than one organization is involved in the execution of verifying activities that affect quality, the responsibility and authority of each organization are clearly established and documented. Energy*Solutions* has a Quality Assurance Program that is planned, implemented and maintained. The Quality Assurance Program is implemented through the following documents:

- The Statement of Corporate Quality Assurance Policy.
- Quality Assurance Program Document.
- Quality Assurance Procedures.
- Implementing Procedures - Controlled documents that prescribe processes (a sequence of actions) to be performed to achieve a desired outcome. Implementing procedures may apply to the entire company, an organization, a program or a project.

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

The program provides for the accomplishment of activities affecting quality under controlled conditions. Such conditions include the use of appropriate equipment, suitable environmental conditions, and those prerequisites for a certain activity have been satisfied. The program takes into account the need for special controls, processes, test equipment, tools and skills to attain the required quality and verification of quality. The program provides for indoctrination and training of personnel performing quality related activities to assure that proficiency is achieved and maintained.

The Director of Q/A Processing/Disposal reports to the Vice-President of EHSQS Global Commercial Group and is responsible and accountable for the effective implementation of the Quality Assurance Program. The Quality Assurance Manager has the authority, responsibility, and accountability for establishing and maintaining the Quality Assurance Program.

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

- Providing resources to accomplish quality objectives in each work task.
- Continuously improving processes, products, and services.
- Ensuring that schedule and budget considerations are not used to compromise the attainment of the requisite level of quality
- Identifying, monitoring, evaluating, and reporting results of selected performance indicators.
- Providing employees with adequate education and training.
- Participating in recommending specific changes to policy, programmatic, or procedural documents.
- Identifying, preparing and approving procedures necessary to implement requirements applicable to the scope of work.
- Working with support organizations to resolve concerns and issues.
- Conducting management assessments.

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

5.7.14.1 Design Control

Energy*Solutions* has established measures to define, control and verify design. Applicable design inputs are appropriately specified on a timely basis and correctly translated into design documents. Design interfaces are identified and controlled. Persons other than those who designed the item verify design adequacy. Design changes, including field changes, are governed by control measures commensurate with those applied to the original design. Design documents are adequate to support facility design, construction, and operation. Appropriate quality standards are identified and documented and their selection reviewed and approved. Changes from specified quality standards, including the reasons for the changes, are identified, approved, documented and controlled, (see operating procedure CL-EN-PR-001).

5.7.14.2 Procurement Document Control

The Energy*Solutions* procurement system provides controls to ensure that items and services comply with established requirements and perform as specified. Applicable design bases and other requirements necessary to assure adequate quality are included or referenced in documents for the procurement of items or services. Procedures direct incorporation of design and operational requirements into corresponding purchase requirements so that:

- prospective suppliers are evaluated before orders are placed,
- items received and services provided are verified as complying with purchase requirements.

Procedures provide instructions for identifying, controlling, distributing and approving documents, including those provided by the supplier. They also specify criteria for purchasing commercial grade items and for preventing the purchase of suspect or counterfeit material. Procurement documents require that all suppliers have an established management system that implements appropriate controls for the service of items being procured. The extent of the program depends on the type and use of the item or service being procured. Procurement documents identify the documentation required to be submitted for information, review, or approval. Procurement documents require the identification of appropriate spare and replacement parts or assemblies, as well as the appropriate delineation of the technical and quality assurance related data required for ordering these parts or assemblies. Procurement document changes are subject to the same degree of control utilized in the preparation of the original documents.

5.7.14.3 Instructions, Procedures, and Drawings

Activities affecting quality are prescribed by documented instructions, procedures, or drawings of a type appropriate to the circumstances and are accomplished in accordance with these instructions, procedures, or drawings. Instructions, procedures, or drawings include appropriate quantitative or qualitative acceptance criteria for determining that prescribed activities have been satisfactorily accomplished.

5.7.14.4 Document Control

Energy*Solutions* controls the preparation, approval, issue, and changes of documents that specify quality requirements or prescribe activities affecting quality. Document Control is the act of assuring that documents are reviewed for adequacy, approved for release by authorized personnel, and distributed to and used at the location where the prescribed activities are performed. The Energy*Solutions* document control system provides for:

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

Changes (revisions) to documents are reviewed and approved by the same individuals or organizations that performed the original review and approval.

5.7.14.5 Control of Purchased Items and Services

Energy*Solutions* controls the procurement of items and services affecting quality to assure conformance with specified requirements. Such control provides for the following as appropriate: source evaluation and selection, evaluation of objective evidence of the quality furnished by the Supplier, source inspection, audit, and examination of items and services upon delivery or completion. Procurement activities are planned and documented to assure a systematic approach to the procurement process. Procurement planning results in the documented identification of procurement methods and organizational responsibilities.

The selection of Suppliers is based on evaluation of their capability to provide items or services in accordance with the requirements of the procurement documents. The methods selected for evaluating a Supplier are based on the importance, complexity, and value of the items or services being procured.
Suppliers are monitored to ensure compliance with performance and schedule. Monitoring may include assessments, surveillance of work activities; inspection of items, facilities and processes; review of plans and progress reports; processing change information; and review and disposition of nonconformance reports.

The procurement process includes verification of acceptability of items or services. Verification includes (as appropriate) inspecting materials, equipment or activities at the supplier facility; reviewing objective evidence; testing items before or after shipment; inspecting products of services at receipt; or testing items after installation. Nonconforming items or services are documented and controlled to preclude inadvertent use. Deviations from procurement requirements are documented and reviewed and approved in accordance with implementing procedures.

Commercial grade items are procured in accordance with the Quality Assurance Program Document. A method for preventing the purchase of counterfeit or suspect materials has been established. Commercial grade items are identified in the purchase requisition by the manufacturer's published product description. Receipt inspections are performed for damage; and that any specified documentation was received and is acceptable. Commercial grade items are items not subject to design or specification requirements that are unique to nuclear facilities; used in applications other than nuclear facilities; and/or ordered from the manufacturer/supplier on the basis of specifications set forth in the manufacturer's published product description (for example, catalog).

5.7.14.6 Identification and Control Items

Energy*Solutions* establishes controls to assure that only correct and accepted items are used, treated, installed or disposed. Identification is maintained on the items or in the documents traceable to the item, or in a manner, which assures that identification is established and maintained. Items of production (batch, lot, generator, component, bates number) are identified from initial receipt and fabrication (treatment) of items up to and including installation or use.

Physical identification is used to the maximum extent possible. Where physical identification on the item is either impractical or insufficient, physical segregation, procedural control, or other appropriate means are employed. When specified by permits, licenses, or specifications that include specific identification or traceability requirements, the program is designed to provide such identification and traceability control.

5.7.14.7 Control of Processes

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

5.7.14.8 Inspection

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

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

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

Planning for inspection activities are accomplished and documented. The documentation identifies characteristics, methods and acceptance criteria, and provide for recording objective evidence of inspection results. When a sample is used to verify acceptability of a group of items, the sampling is based on recognized standard practices.

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

Completed items are inspected for completeness, markings, calibration, adjustments, protection from damage or other characteristics as required to verify quality and conformance of an item to specified requirements. Final inspections include a record review of the results and resolution of nonconformance identified by prior inspections.

In service inspection or surveillance of structures, systems, or components are planned and executed by or for the organization responsible for operation. Inspection and test records as a minimum identify the following:

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

Quality records are reviewed and signed for adequacy and completeness.

5.7.14.9 Test Control

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

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

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

5.7.14.10 Control of Measuring and Test Equipment

Tools, gauges, instruments and other measuring and test equipment used for activities affecting quality are controlled and at specific periods calibrated and adjusted to maintain accuracy within necessary limits. The selection of measuring and test equipment is controlled to assure that such items are of proper type, range, accuracy and tolerance to accomplish the function for determining conformance to specified requirements.

Measuring and test equipment is calibrated, adjusted, and maintained at prescribed intervals or, prior to use, against certified equipment having known relationships to nationally recognized standards. If no nationally known standard exists, the basis for the calibration is documented. Measuring and test equipment is calibrated at intervals depending on the required accuracy, intended use, stability characteristics and other conditions affecting the performance of the instrument.

When measuring and test equipment is found to be out of calibration, an evaluation is performed and documented of the validity of previous inspection or test results and the acceptability of the items previously inspected or tested. Out-of-calibration devices are tagged and segregated and not used until they have been

recalibrated. If any measuring or test equipment is consistently found to be out of calibration, it is repaired or replaced. A calibration is performed when the accuracy of the equipment is suspect.

Calibration and control measures are not required for rulers, tape measures, levels and other such devices; normal commercial equipment provides adequate accuracy. These items must be treated with care to prevent damage or excessive wear and be replaced before accuracy becomes questionable. Measuring and test equipment are properly stored and handled to maintain accuracy. Calibration records are maintained and equipment and are suitably marked to indicate calibration status.

5.7.14.11 Handling, Storage, and Shipping

Energy*Solutions* controls handling, storage, packaging, shipping and preservation of items to prevent damage or loss and to minimize deterioration. Handling, storage and shipping of items are conducted in accordance with established work and inspection instructions, drawings, specifications, shipment instructions, or other pertinent documents or procedures specified for use in conducting the activity. Specific procedures are used when required for critical, sensitive, perishable or high-value articles.

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

5.7.14.12 Inspection, Test, and Operating Status

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

5.7.14.13 Control of Nonconforming Items

Energy*Solutions* controls items that do not conform with specified requirements to prevent inadvertent use or installation. Controls provide for identification, documentation, evaluation and segregation when practical and disposition of nonconforming items, and for notification of affected organizations. Identification of nonconforming items are by marking, tagging, or other methods, which do not adversely affect the end use of the item. The identification is legible and easily recognizable. If identification of each container is not practical, the container, package, or segregated storage area, as appropriate, is identified.

Nonconforming characteristics are reviewed and recommended dispositions of nonconforming items are proposed and approved in accordance with documented procedures. Authorized personnel control further processing, delivery, installation or use of a nonconforming item pending an evaluation and an approved disposition. The responsibility and authority for the evaluation and disposition of nonconforming items is defined. Personnel performing evaluations to determine a disposition are competent and they have an adequate understanding of the requirements and have access to pertinent background information.

The disposition, such as use-as-is, reject, repair or rework of nonconforming items is identified and documented. Technical justification for the acceptability of a nonconforming item, dispositioned repair or use-as-is is documented. Nonconformance to design requirements dispositioned use-as-is or repair is

subject to design control measures commensurate with those applied to the original design. The as-built records, if such records are required, reflect the accepted deviation. Repaired or reworked items are reexamined in accordance with the applicable procedures and with the original acceptance criteria unless the nonconforming item disposition has established alternate acceptance criteria.

5.7.14.14 Corrective Action

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

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

Conditions adverse to quality are defined as follows:

- Deficiencies in design, manufacturing, construction, testing, or process requiring substantial rework, repair or replacement.
- Loss of essential data.
- Repeated failure to implement a portion of an approved procedure.
- Deviations from licensing or permit requirements.

5.7.14.15 Quality Assurance Records

Records that furnish documentary evidence of quality are specified, prepared and maintained. Records are legible, identifiable and retrievable. Records are protected against damage, deterioration, or loss. Requirements for record transmittal, distribution, retention, maintenance and disposition are established and documented. A record system is established and this system shall be defined, implemented and enforced in accordance with written procedures or instructions. The term record used throughout this program element is to be interpreted as Quality Assurance Records.

The applicable design specification, procurement documents, test procedures, operational procedures or quality procedures specify the records to be generated, supplied or maintained by or for Energy*Solutions*. Documents that are designated to become records are legible, accurate, and completed appropriate to the work accomplished. Authorized personnel consider documents valid records only if initialed or signed and dated. These records may be originals or reproduced copies.

These records are indexed. The indexing system includes, as a minimum, record retention times and the location of the record within the record system. Energy*Solutions* classifies records as Lifetime or Nonpermanent in accordance with the license or permits and the criteria as follows:

- Those which would be of significant value in demonstrating capability for safe operation.
- Those which would be of significant value in maintaining, reworking, repairing, replacing or modifying an item.

- Those which would be of significant value in determining the cause of an accident or malfunction of an item.
- Those which provide required baseline data for in-service inspections.

Energy*Solutions* maintains lifetime records for the life of the facility. Nonpermanent records are those required to show evidence that an activity was performed in accordance with applicable requirements but need not be retained for the life of the item because they do not meet the criteria for lifetime records. Records are contained in accordance with the above classifications. The retention period for nonpermanent records is established in writing.

When required, records are corrected in accordance with procedures, which provide for appropriate review or approval. The correction includes the date and the identification of the individual making the correction. Each organization responsible for the receipt of records designates an individual responsible for receiving the records. This individual or organization is responsible for implementing a receipt control system.

The records are stored in a predetermined location(s) that meet the requirements of applicable standards, codes and regulatory agencies. A written storage procedure has been prepared and responsibility assigned for enforcing the requirements of the procedure. This procedure includes:

- A description of the storage facility.
- The filing system to be used.
- A method for verifying that the records received are in agreement with the transmittal document and that the records are legible.
- Rules governing access and control of the files.
- A method for maintaining control of and accountability for records removed from the storage facility.
- A method for filing supplemental information and disposing of superseded records.

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

5.7.14.16 Audits

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

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

"Upon the receipt of a license termination plan or decommissioning plan from the licensee, or a proposal by the licensee for release of a site pursuant to Sections R313-15-403 or R313-15-404, or whenever the Executive Secretary deems such notice to be in the public interest, the Executive Secretary shall:
(1) Notify and solicit comments from:
a) Local and State governments in the vicinity of the site and any Indian Nation or other indigenous people that have treaty or statutory rights that could be affected by the decommissioning; and
b) Federal, state and local governments for cases where the licensee proposes to release a site pursuant to Section R313-15-404.
(2) Publish a notice in a forum, such as local newspapers, letters to State or local organizations, or other appropriate forum, that is readily accessible to individuals in the vicinity of the site, and solicit comments from affected parties." **– R313-15-405.**

"(1) A specific license expires at the end of the day on the expiration date stated in the license unless the licensee has filed an application for renewal under Section R313-22-37 no less than 30 days before the expiration date stated in the existing license. If an application for renewal has been filed at least 30 days prior to the expiration date stated in the existing license, the existing license expires at the end of the day on which the Executive Secretary makes a final determination to deny the renewal application or, if the determination states an expiration date, the expiration date stated in the determination.
(2) A specific license revoked by the Executive Secretary expires at the end of the day on the date of the Executive Secretary's final determination to revoke the license, or on the expiration date stated in the determination, or as otherwise provided by an Order issued by the Executive Secretary.
(3) A specific license continues in effect, beyond the expiration date if necessary, with respect to possession of radioactive material until the Executive Secretary notifies the licensee in writing that the license is terminated. During this time, the licensee shall:
a) limit actions involving radioactive material to those related to decommissioning; and
b) continue to control entry to restricted areas until they are suitable for release so that there is not an undue hazard to public health and safety or the environment.
(4) Within 60 days of the occurrence of any of the following, a licensee shall provide notification to the Executive Secretary in writing of such occurrence, and either begin decommissioning its site, or any separate building or outdoor area that contains residual radioactivity so that the building or outdoor area is suitable for release so that there is not an undue hazard to public health and safety or the environment, or submit within 12 months of notification a decommissioning plan, if required by Subsection R313-22-36(7), and begin decommissioning upon approval of that plan if:
a) the license has expired pursuant to Subsections R313-22-36(1) or (2); or
b) the licensee has decided to permanently cease principal activities at the entire site or in any separate building or outdoor area that contains residual radioactivity such that the building or outdoor area is unsuitable for release because of an undue hazard to public health and safety or the environment; or
c) no principal activities under the license have been conducted for a period of 24 months; or
d) no principal activities have been conducted for a period of 24 months in any separate building or outdoor area that contains residual radioactivity such that the building or outdoor area is unsuitable for release because of an undue hazard to public health and safety or the environment.

(5) Coincident with the notification required by Subsection R313-22-36(4), the licensee shall maintain in effect all decommissioning financial assurances established by the licensee pursuant to Section R313-22-35 in conjunction with a license issuance or renewal or as required by Section R313-22-36. The amount of the financial assurance must be increased, or may be decreased, as appropriate, to cover the detailed cost estimate for decommissioning established pursuant to Subsection R313-22-36(7)(d)(v).

a) A licensee who has not provided financial assurance to cover the detailed cost estimate submitted with the decommissioning plan shall do so on or before August 15, 1997.

b) Following approval of the decommissioning plan, a licensee may reduce the amount of the financial assurance as decommissioning proceeds and radiological contamination is reduced at the site with the approval of the Executive Secretary.

(6) The Executive Secretary may grant a request to extend the time periods established in Subsection R313-22-36(4) if the Executive Secretary determines that this relief is not detrimental to the public health and safety and is otherwise in the public interest. The request must be submitted no later than 30 days before notification pursuant to Subsection R313-22-36(4). The schedule for decommissioning set forth in Subsection R313-22-36(4) may not commence until the Executive Secretary has made a determination on the request.

(7)a) A decommissioning plan shall be submitted if required by license condition or if the procedures and activities necessary to carry out decommissioning of the site or separate building or outdoor area have not been previously approved by the Executive Secretary and these procedures could increase potential health and safety impacts to workers or to the public, such as in any of the following cases:

(i) procedures would involve techniques not applied routinely during cleanup or maintenance operations;

(ii) workers would be entering areas not normally occupied where surface contamination and radiation levels are significantly higher than routinely encountered during operation;

(iii) procedures could result in significantly greater airborne concentrations of radioactive materials than are present during operation; or

(iv) procedures could result in significantly greater releases of radioactive material to the environment than those associated with operation.

b) The Executive Secretary may approve an alternate schedule for submittal of a decommissioning plan required pursuant to Subsection R313-22-36(4) if the Executive Secretary determines that the alternative schedule is necessary to the effective conduct of decommissioning operations and presents no undue risk from radiation to the public health and safety and is otherwise in the public interest.

c) Procedures such as those listed in Subsection R313-22-36(7)(a) with potential health and safety impacts may not be carried out prior to approval of the decommissioning plan.

d) The proposed decommissioning plan for the site or separate building or outdoor area must include:

(i) a description of the conditions of the site or separate building or outdoor area sufficient to evaluate the acceptability of the plan;

(ii) a description of planned decommissioning activities;

(iii) a description of methods used to ensure protection of workers and the environment against radiation hazards during decommissioning;

(iv) a description of the planned final radiation survey; and

(v) an updated detailed cost estimate for decommissioning, comparison of that estimate with present funds set aside for decommissioning, and a plan for assuring the availability of adequate funds for completion of decommissioning.

(vi) For decommissioning plans calling for completion of decommissioning later than 24 months after plan approval, the plan shall include a justification for the delay based on the criteria in Subsection R313-22-36(8).

e) The proposed decommissioning plan will be approved by the Executive Secretary if the information therein demonstrates that the decommissioning will be completed as soon as practical and that the health and safety of workers and the public will be adequately protected.

(8)a) Except as provided in Subsection R313-22-36(9), licensees shall complete decommissioning of the site or separate building or outdoor area as soon as practical but no later than 24 months following the initiation of decommissioning.

b) Except as provided in Subsection R313-22-36(9), when decommissioning involves the entire site, the licensee shall request license termination as soon as practical but no later than 24 months following the initiation of decommissioning.

(9) The Executive Secretary may approve a request for an alternative schedule for completion of decommissioning of the site or separate building or outdoor area, and license termination if appropriate, if the Executive Secretary determines that the alternative is warranted by consideration of the following:

a) whether it is technically feasible to complete decommissioning within the allotted 24-month period;

b) whether sufficient waste disposal capacity is available to allow completion of decommissioning within the allotted 24-month period;

c) whether a significant volume reduction in wastes requiring disposal will be achieved by allowing short-lived radionuclides to decay;

d) whether a significant reduction in radiation exposure to workers can be achieved by allowing short-lived radionuclides to decay; and

e) other site-specific factors which the Executive Secretary may consider appropriate on a case-by-case basis, such as the regulatory requirements of other government agencies, lawsuits, ground-water treatment activities, monitored natural ground-water restoration, actions that could result in more environmental harm than deferred cleanup, and other factors beyond the control of the licensee.

(10) As the final step in decommissioning, the licensee shall:

a) certify the disposition of all licensed material, including accumulated wastes, by submitting a completed Form DRC-14 or equivalent information; and

b) conduct a radiation survey of the premises where the licensed activities were carried out and submit a report of the results of this survey, unless the licensee demonstrates in some other manner that the premises are suitable for release in accordance with the criteria for decommissioning in Sections R313-15-401 through R313-15-406. The licensee shall, as appropriate:

(i) report levels of gamma radiation in units of millisieverts (microroentgen) per hour at one meter from surfaces, and report levels of radioactivity, including alpha and beta, in units of megabecquerels (disintegrations per minute or microcuries) per 100 square centimeters--removable and fixed-- for surfaces, megabecquerels (microcuries) per milliliter for water, and becquerels (picocuries) per gram for solids such as soils or concrete; and

(ii) specify the survey instrument(s) used and certify that each instrument is properly calibrated and tested.

(11) Specific licenses, including expired licenses, will be terminated by written notice to the licensee when the Executive Secretary determines that:

a) radioactive material has been properly disposed;

b) reasonable effort has been made to eliminate residual radioactive contamination, if present; and

c) documentation is provided to the Executive Secretary that:

(i) a radiation survey has been performed which demonstrates that the premises are suitable for release in accordance with the criteria for decommissioning in Sections R313-15-401 through R313-15-406; or

(ii) other information submitted by the licensee is sufficient to demonstrate that the premises are suitable for release in accordance with the criteria for decommissioning in Sections R313-15-401 through R313-15-406." **– R313-22-36.**

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (d) Consideration of the long-term impacts including decommissioning, decontamination, and reclamation impacts, associated with activities to be conducted pursuant to the license or amendment." **– R313-24-3(1)(d).**

"The licensee shall, at least three months prior to license termination, provide 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 UAC R313-24-4 (10 CFR Part 40, Appendix A, Criterion 11 incorporated by reference). Specifically, the licensee shall document that: (1) the concentrations of all of the listed hazardous constituents at the POC are within their designated concentration limits (standards); (2) if a corrective action program was carried out that the hazardous constituents contaminating the ground-water were returned to their designated limits; and (3) the facility has been properly decontaminated and decommissioned in accordance with the decontamination and decommissioning plan proposed by the applicant in the license application approved by the Executive Secretary. The license termination will not occur until the licensee has demonstrated that these actions have been completed." **– LICENSE CONDITION 12.7.**

11e.(2) Embankment closure and stabilization includes decontamination and decommissioning. However, removal of facilities that have also been used for Class A LLRW Management, including roads, rail spurs, railcar rollover, storage pads, wash pads, and administrative buildings is considered as part of Radioactive Material License #UT 2300249. Any material contaminated solely with 11e.(2) isotopes that did not meet the standards for unrestricted release would be 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 H). General decommissioning of Section 32 of Energy*Solutions*' facility, as is outlined in Appendix C, will be performed to meet site closure requirements of both the LLRW and 11e.(2) Radioactive Material Licenses; i.e., License #UT 2300249 and License #UT 2300478.

6.1 PLANS AND SCHEDULES FOR GROUND-WATER QUALITY RESTORATION

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (d) Consideration of the long-term impacts including decommissioning, decontamination, and reclamation impacts, associated with activities to be conducted pursuant to the license or amendment." **– R313-24-3(1)(d).**

"The licensee shall assume full responsibility for cleaning up the groundwater of all hazardous constituents detected at the POC in concentrations that exceed the limits specified in Tables 1-A the Groundwater Quality Permit. 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 Executive Secretary's satisfaction, based on field and laboratory data, that the 11e.(2) facility is not the source of particular constituents. The Executive Secretary shall have the final decision concerning any claim by the licensee that the 11e.(2) facility is not the source of a particular constituent that is detected at the POC.
The licensee shall undertake corrective action to clean up groundwater contamination if and when required, 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." **– LICENSE CONDITION 10.3.**

"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." **– LICENSE CONDITION 10.4.**

"The Licensee shall fulfill and maintain compliance with all conditions and all compliance schedules stipulated in the Ground Water Discharge Permit, number UGW 450005, issued by the Executive Secretary of the Utah Water Quality Board, as amended." **– LICENSE CONDITION 11.1.**

It is concluded there is limited potential for degradation of water quality in the vicinity of the11e.(2) Embankment. The groundwater at the site is already characterized by a briny quality, with levels of many constituents (major ions, metals, total dissolved solids, uranium) establishing the water as Class IV in accordance with UAC R317-6-3.7. The water might be suitable only for limited industrial uses without extensive treatment. There are no identified uses of groundwater within 3 miles of the site.

The 11e.(2) Embankment design minimizes the potential for transport of contaminants away from the tailings. The cover reduces the potential for infiltration, which is already likely to be minimal in the area due to the low incident precipitation and high potential evapotranspiration. 11e.(2) Embankment and cover design is discussed at greater detail in Sections 2 and 3.

Seepage is not expected to reach the groundwater as a result of moisture redistribution within the waste. The impact of this seepage on the groundwater is expected to be minimal for several reasons:

1. Waste must have equal to or less than 1% free standing liquids upon arrival. Most shipments have no free standing liquids.
2. Waste must have no free liquids at disposal.
3. Evaporation at the site exceeds precipitation. Accordingly, even waste with some moisture content upon receipt is likely to dry out during placement.
4. The existing poor quality of the groundwater makes it difficult to significantly degrade it.
5. The hydraulic head gradient in the groundwater is minimal, limiting the velocity of groundwater movement away from the site to a maximum of about a foot per year.
6. Modeling analyses indicate that it would take approximately 400 to 600 years for leachate to move through the unsaturated zone.

Site closure and stabilization would include decontamination and decommissioning of the entire site. This would include the restoration of groundwater quality. Plans and schedules for groundwater quality restoration are discussed further in the 11e.(2) Environmental Assessment (Appendix H).

6.2 PLANS AND SCHEDULES FOR RECLAIMING DISTURBED LANDS

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (d) Consideration of the long-term impacts including decommissioning, decontamination, and reclamation impacts, associated with activities to be conducted pursuant to the license or amendment." **– R313-24-3(1)(d).**

Penetration of radionuclides into underlying soils is minimized by Best Available Technology Performance Monitoring in accordance with Condition I.F.2 and Appendices J and K of the Ground Water Quality Discharge Permit. This includes the reclamation of 11e.(2) Embankment disturbed lands. Plans and schedules for disturbed lands reclamation are discussed further in the 11e.(2) Environmental Assessment (Appendix H).

6.3 PROCEDURES FOR REMOVING AND DISPOSING OF STRUCTURES AND EQUIPMENT

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (d) Consideration of the long-term impacts including decommissioning, decontamination, and reclamation impacts, associated with activities to be conducted pursuant to the license or amendment." **– R313-24-3(1)(d).**

Procedures for removing and disposing of structures and equipment contaminated with 11e.(2) byproduct wastes are addressed in Appendix C. Currently, it is assumed that additional support facilities will not be required beyond that specified in this License Renewal Application. It is also assumed that these support facilities will be decontaminated and decommissioned upon site closure. The decontamination and decommissioning activities addressed include:

a. Decontaminating off-site soils and rail road spur, if necessary, by removing all surface materials contaminated with 11e.(2) materials such that the contamination in the residual soil or rail road ballast is ALARA and below the respective cleanup limits. Soil will be disposed of at the Energy*Solutions*' 11e.(2) Embankment using disposal methods approved for 11e.(2) material.
b. Decontaminating on-site soils within the Energy*Solutions*' property but excluding the disposal embankments, by removing all surface soils contaminated with 11e.(2) materials such that the contamination in the residual soils is ALARA and below the respective cleanup limits. Soils will be disposed of at the Energy*Solutions*' disposal site using disposal methods approved for 11e.(2) material.
c. Decontaminating on-site structures such as the rollover facility, geotechnical laboratory, and rail spur to meet the unconditional release criteria or, remove and place structures in the Class A Embankment.

d. Decontaminating the on-site support structures and contents including the change and laboratory facilities within the administration building to meet the unrestricted release criteria, or remove and dispose of contents and structures in the Class A Embankment.
e. Implementing a continued corrective action plan to remove groundwater contamination at the site based on guidelines in 10 CFR 40, Appendix A, Criterion 5.

6.4 COVER DESIGN, PLACEMENT AND PERFORMANCE

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

The cover design is shown in the embankment cross section found in Figure 9420-05, Appendix L of Energy*Solutions*, (2005b). 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. See Figure 9420-05, Appendix L of Energy*Solutions*, (2005b).
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 Figure 9420-4, Appendix L of Energy*Solutions*, (2005b).

6.4.1 Radon Barrier

The compacted, clay layer acts as a radon barrier for the 11e.(2) Embankment. The compaction of the clay produces a soil barrier that prevents radon gas from leaving the embankment and also protects the waste material from receiving significant amounts of moisture. The rock cover reduces the potential for drying of the compacted clay by trapping dew and condensation.

The excavation for the disposal site is finished to the lines, grades, and typical section shown on the plans or as directed. The material may be stockpiled or re-deposited upon the completed grade of the contaminated material. The radon barrier material is placed on top of the final compacted lift of the tailings to a minimum depth of 3.5 feet on the side slopes and 4 feet on the top slope, to form a radon barrier.

Detailed specifications and quality control/quality assurance requirements for radon barrier construction are provided in the LLRW and 11e.(2) Construction Quality Assurance/Quality Control Manual (CQA/QC Manual). The CQA/QC Manual is approved as revision 25d at the time of this application. The radon barrier material is placed in layers not exceeding 12 inches (uncompacted depth) and compacted before the next layer is placed. Each lift is compacted to not less than 95 percent of maximum dry density as determined by the Standard Proctor Method (ASTM D698). The upper one foot of radon barrier will exhibit a saturated hydraulic conductivity less than or equal to $5x10^{-8}$ cm/sec. The remainder of the radon barrier will exhibit a saturated hydraulic conductivity less than or equal to $1x10^{-6}$ cm/sec.

At the time of compaction, the moisture of the material is between optimum and 5 percent above the optimum moisture content as determined by the Standard Proctor Method (ASTM D698). Radon barrier construction is maintained in such condition that it will be well drained at all times. Specifications are provided in the CQA/QC Manual to address drying prevention, snow removal, cold weather placement, spring start-up, and contamination control.

6.4.2 Rock Erosion Barrier

A one-foot to one and one-half foot thick layer of rock is placed on top of the radon barrier to act as an erosion barrier. The top of the embankment is covered with rock as specified in Figure 9420-04, Appendix L of Energy*Solutions*, (2005b). Underlying both top and side slope layers is a filter zone having gradations as specified in Figure 9420-04, Appendix L of Energy*Solutions*, (2005b). The filter zone also protects the radon barrier from deep penetration by the larger diameter rock used for outer cover. The specifications, construction methods, and tests to be performed on the rock erosion barrier can be found in the CQA/QC Manual.

6.4.3 Long Term Performance of Embankment Cover

The proposed design assures that the cover contains all the disposed waste. Additionally, the Embankment design provides long-term stability and is maintenance-free after site closure. It is important that these design features are in place for long-term containment of the waste. Energy*Solutions*' final embankment cover has been designed in accordance with NRC, 1983 and NRC, 1999b. These documents require that containment and protection be provided for up to 1,000 years. Important areas of long-term containment are discussed in this section.

6.4.3.1 Protection from Water Erosion

To protect the embankment from the effects of water erosion, the embankment will be covered with a graded rock erosion barrier. The slopes of the embankment will be limited to 20 percent. The top of the embankment will be convex with gentle (2.1 to 2.4 percent) slopes to promote drainage.

The rock layer is designed to resist erosion and gully formation during the Probable Maximum Precipitation and the resulting Probable Maximum Flood. The DOE has determined that this is the most conservative approach when considering the effects of water and wind erosion factors. The Probable Maximum Precipitation is the most severe possible event that could occur as a result of combination of the most severe meteorological conditions occurring over a watershed at the same time. Although no recurrence interval can be assigned to this event (since no records are available in excess of 100 years), it is felt by most hydrologists that the recurrence interval is on the order of 100,000 years.

Rainfall rates for the Probable Maximum Precipitation were computed using Hydrometeorological Report 49 (NOAA, 1984), found in Appendix J of Energy*Solutions*, (2005b). For the Clive area, the one-hour local Probable Maximum Precipitation is 6.1 inches. The six-hour local storm Probable Maximum Precipitation was determined to be 10.08 inches. The design of the rock erosion barrier is found in (Appendix F of Energy*Solutions*, 2005b). The erosion barrier has been designed in accordance with NRC, 1999b.

To ensure that the embankments will withstand water erosion during the design life, the surfaces of the radon barrier will be graded and the corners rounded, and the entire embankment radon barrier will be covered with a rock erosion barrier.

6.4.3.2 Protection From Wind Erosion

Since the Clive facility is in an area of long open reaches, wind velocities at the site must be considered. MSI, 2012 contains a full meteorological report done using data from July 1992 to December 2011. Information about wind patterns and velocities are discussed at great length in this report. The rock layer used to protect against water erosion also provides protection against wind erosion. Since the Probable Maximum Precipitation is the worst event that could occur as a result of severe meteorological conditions, the erosion barrier designed to withstand the Probable Maximum Precipitation also withstands any winds at the Clive site.

6.4.3.3 Geotechnical Stability

The 11e.(2) Embankment is being constructed with a side slope of five horizontal to one vertical. This design was studied in detail to assure that the slopes would not fail due to the expected maximum seismic event. While the study does discuss the possibility of synthetic liners in the cover it should be noted that synthetic liners are not used in the 11e.(2) Embankment. The study, found in Appendix K of Energy*Solutions*, (2005b), showed that the side slopes were able to withstand the design seismic event.

The DOE Technical Approach Document (DOE, 1989), provides data and calculations used in evaluating the slope stability and liquefaction potential for the Vitro embankment. These calculations are found in Appendix K of Energy*Solutions*, (2005b). It was concluded that "*due to the short- and long-term unsaturated embankment conditions, the dense nature of the granular site soils and a depth to groundwater in excess of 25 feet below existing grade, liquefaction in the embankment or foundation soils will not occur at the site due to MCE acceleration.*"

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

In support of Energy*Solutions*' efforts to amend its Class A Low Level Radioactive Material License, AMEC prepared an updated assessment of the seismic hazard for the Clive site consistent with the requirements of the Utah Code of Regulations R313-25-8(5). The revisited seismic hazard assessment is based on an assessment of the peak ground acceleration associated with the Maximum Credible Earthquake for known active or potentially active faults in the site region, and the peak ground acceleration obtained from a probabilistic seismic hazard analysis to assess the seismic hazard for earthquakes that may occur on unknown faults in the area surrounding the project site (i.e., background seismicity). The approach utilized by AMEC to select a Maximum Credible Earthquake peak ground acceleration from the larger of the values associated with the deterministic Maximum Credible Earthquake for faults or the probabilistic seismic hazard analysis result for background earthquakes at a 5,000 year return period is consistent with the recommendations of the Utah Seismic Safety Commission (USSC, 2003) and as required by the Utah Division of Water Rights (Dam Safety Section) for assessment of dams.

Based on their reevaluation, AMEC determined that the maximum 84th-percentile peak ground acceleration from fault-specific earthquake sources is computed to be 0.24 g for a maximum magnitude earthquake occurring on the Stansbury fault (M 7.3) or the Skull Valley fault (M 7.1). The probabilistic analysis of the background seismicity shows the mean peak ground acceleration for a return period of 5,000 years is 0.24 g for non-fault-specific earthquakes up to M 7. Therefore, the largest peak ground acceleration computed for the Energy*Solutions* Clive site is 0.24 g based on deterministic procedures and using NGA models for fault-specific sources and on probabilistic procedures for the background earthquake with a recurrence interval of 5,000 years.

Liquefaction and cyclic softening evaluations, as well as previous embankment stability calculations, were based on a peak ground acceleration of 0.28 g, which is higher than the updated maximum 84th percentile peak ground acceleration calculated with deterministic procedures in the 2012 study. It is also higher than the median peak ground acceleration value for background earthquakes with 5,000-year recurrence intervals calculated with probabilistic seismic hazard analysis procedures. Therefore, AMEC projects that the results of seismic stability calculations at the Energy*Solutions* site remain appropriate and applicable because the updated peak ground acceleration for the site does not exceed the peak ground acceleration previously used. Therefore, the analysis initially conducted continues to be conservative in demonstrating Embankment stability.

6.4.3.4 Water Infiltration

Energy*Solutions* has evaluated the performance of the cover to minimize infiltration of precipitation into and through the waste zone. Field investigations, laboratory testing and detailed analyses have been performed to assess cover performance. Appendix E of Energy*Solutions*, (2005b) provides Groundwater Flow Modeling results including both unsaturated and saturated flow modeling. The Clive site is very favorable due to the semi-arid climate with 8.62 inches of annual precipitation and 52.73 inches of annual evaporation (MSC, 2012).

The modeling demonstrates that the amount of precipitation that infiltrates into the Embankment and percolates to the shallow groundwater will be on the order of 0.40 centimeters annually. That translates to travel times on the order of 500 years. These results support studies performed by the DOE on the same issue that stated the infiltration amount into the cover system will be very small.

6.4.3.5 Settlement of Embankment

Settlement analyses were performed for the 11e.(2) Embankment and cover materials to ensure that total and differential settlements would be in an acceptable range for the cover system. The Embankment consists of the excavation of approximately eight feet of soil, placement of a two-foot compacted clay liner, approximately 35 to 52 feet of tailings and then a six foot thick cover system. The foundation soils include both sand and clay that will settle under the weight of the tailings and cover. The sand layers are relatively free draining and will settle rapidly and the tailing are also assumed to consist of primarily sand size particles that will settle rapidly when the loads are applied.

Settlement of the tailings due to self-weight was estimated based on the assumption that the compacted tailings will compress 1.5 percent or approximately 0.7 feet. Since the settlement of the tailings due to self-weight is assumed to occur prior to placement of the cover, it is not included in the differential settlement evaluations. Table 6-1 summarizes the soil parameters used in the settlement analyses (see Section 6.3.5 of Energy*Solutions*, 2005b).

Table 6-2 provides a summary of the settlement analyses for the foundation soils (see Section 6.3.5 of Energy*Solutions*, 2005b). Total settlement of the foundation soils is calculated to range from 0.63 to 2.72 feet with the majority of the settlement occurring immediately in the sand layers. Most of the clay consolidation is estimated to occur within one year. Differential settlement was evaluated by computing the consolidation settlement at the top and edge of the embankment side-slopes. Differential settlement was calculated to be insignificant and should not affect the cover integrity.

In summary the settlement analysis indicates:

1. The proposed embankment and cover system will perform adequately based on total and differential settlement estimates.
2. Maximum settlement of the compacted tailings due to self weight is estimated to be 0.7 feet with the majority occurring prior to placement of the cover.
3. Maximum settlement of the foundation soils is estimated to be 2.72 feet with approximately 80 percent of the total settlement occurring prior to placement of the cover.
4. Horizontal strains resulting from differential settlement after cover placement will not compromise the integrity of the cover.

6.4.3.6 Protection from Roots and Burrowing Animals

One of the advantages of the Rock Erosion Barrier is the protection it provides the radon barrier from both burrowing animals and from roots. DOE, 1989 provides five environmental conditions related to a higher potential for biointrusion:

1. Nearby deep rooted plants;
2. Prairie dog colonies or other burrowing animals nearby;
3. Humid to sub-humid climate;
4. Long to moderate growing season; and,
5. Deep or rich top soil.

Each of these issues is discussed in the following paragraphs. The information in sections 6.4.3.7 through 6.4.3.11 comes directly from DOE, 1984.

6.4.3.7 Vegetation

The vegetation of the Clive site is a homogeneous, semi-desert low shrubland, primarily composed of shadscale (Atriplex confertifloia). The shrubland is part of the Northern Desert Shrub Biome of the Cold Desert Formation and has been described as a Saltbush (Shadscale)-Greasewood Shrub complex. Plant communities identified on the site are Shadscale-Gray Molly (Kochia americana var. vestita), a transitional community type as Shadscale-Gray Molly-Black Greasewood (Sarcobatus vermiculatus), and Black Greasewood-Gardner Saltbush (Atriplex nuttallii). Vegetation patterns of the Clive site are correlated with soil salinity and corresponding shifts in presence or abundance of species. All three communities are low in species diversity. Seep-weed or inkweed (Suaeda torreyana) and scattered perfoliate pepperweed (Lepidium perfoliatum) are the only prominent understory species of the Shadscale-Gray Molly community. This

Table 6-1. Parameters Selected for Settlement Analysis

Unit Numbers	USCS	Layer Thickness (average)	Dry Density g_d, (pcf)	Moisture Content, W, (%)	Initial Void Ratio, e	Preconsolidation Pressure, P_p, (ksf)	Compression index, C_c	Recompression Index, C_{cr}	Coefficient of Consolidation, C_v, (ft^2/day)
4	CL	4*	95	34	0.90	1100	0.098	0.00011	0.14
3	SM	15	112	16	0.48	3200	0.036	0.00012	1.94
2	CL	14	80	45	1.10	7000	0.143	0.00021	0.11
1	SM	320	112	30			0.036	0.00012	

*Assume upper clay unit 12 feet thick and excavate 8 feet.

Table 6-2. Summary of Settlement Analysis

Section	Soil Profile	Horizontal Distance Between Sections (feet)	Compressible Layer Thickness (feet)	Fill and Cover Thickness (feet)	I_{90} (years)	Immediate Settlement (feet)	Consolidation Settlement (feet)	Total Settlement (feet)	Differential Settlement Due to Consolidation (S_i-S_{i-1})
1			350	53	0.8	0.72	0.02	0.74	
	B-B'	225							0.0024
2			350	53	0.8	1.9	0.57	2.47	
3			350	53	1.0	0.58	0.11	0.69	
	D-D'	225							0.0029
4			350	53	1.0	1.69	0.77	2.46	
5			350	53	1.4	0.59	0.04	0.63	
	E-E'	225							0.0019
6			350	53	1.4	1.71	0.47	2.18	

community occurs over most of the Clive site, although black greasewood becomes prominent enough on the eastern quarter to form a Shadscale-Black Greasewood-Gray Molly community. Except for the black greasewood and occasional stands of halogeton (Halogeton glomeratus) the composition is similar to the more prominent Shadscale-Gray Molly community. The Black Greasewood-Gardener Saltbush community type is floristically the most diverse, but only occurs in the extreme northeast corner and eastern edge of the Clive site. In addition to Gardener saltbush, the flora is composed of all species found in the other communities except halogeton.

The Clive site occurs in the Desert Alkali range site that is rated by the Bureau of Land Management as being poor for grazing or forage production. However, the vegetation forms an important ground cover and deterrent to soil erosion, and provides habitat for wildlife species. Annual production of the three community types ranged from 152 to 517 pounds per acre, air dry. Annual production for the range site is given as 50 to 200 and 500 to 1500 pounds per acre during unfavorable and favorable years respectively. Livestock carrying capacity with such production would range from 3 to 80 acres per animal-unit month.

6.4.3.8 Terrestrial Wildlife

Two habitat types, shadscale flats and greasewood, occur on the Clive site. Animal species typical of the site include black-tailed jackrabbit (Lepus californicus), deer mouse, (Peromyscus maniculatus), horned lark (Eremopholia alpestric), and desert horned lizard, (Phrynosoma platyrhinos); species diversity is low. All of these animal species could use the site for breeding or nesting.

6.4.3.9 Climate

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

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

6.4.3.10 Growing Season

Because of the lack of agricultural activities in the Clive area information on the growing season is somewhat limited. The mean length of freeze-free period of Salt Lake City is 202 days. Data for Salt Lake City can be considered to be characteristic of the region. Any adjustment for the Clive site should reduce the length of freeze-free days to about 180.

6.4.3.11 Soils

The U.S. Soil Conservation Service has described and mapped the soil of the Clive site as Iosepa silt loam. Since this soil unit is the only soil delineated on the site no soil map is included. The soil at the Clive site is classified as having a horizon of clay and alkali (sodium) accumulation. The soil lacks moisture for plant growth for long periods and is low in organic matter. Soils of this type are periodically saturated with water in some sub-horizon within one meter of the surface.

Soil samples were collected from a trench located in the NW corner of the Clive site. Soil samples were also obtained from soil cores in each of the four corners, in the center of the site and surrounding adjacent area. Laboratory analysis of physical and chemical properties are listed in Table 6-3.

The highly saline, slowly permeable soils in this extremely arid location are unsuitable for re-establishing a lasting, self-sustaining vegetation to protect the soil covering the disposed materials. Even if the low precipitation could be overcome by irrigation, the nature of the soils would impose insurmountable problems that would prevent satisfactory plant cover within 10 to 20 years.

The high clay content at depths of 4 to 15 inches (Table 6-3) and sodium content combine to give the Clive site soils natural properties for compaction to form an impervious soil layer. The highly toxic sodium concentration will act as a barrier to all but the most shallow-rooted plant species, and the density of the clay will deter burrowing animals. In addition to plant growth inhibitory properties listed, boron was present in levels that are hazardous for plant growth. The soil of the site has properties that make it unsuitable for most plant growth.

Based on the five environmental conditions listed as areas of concern, the Clive site is excellent for inhibiting biointrusion. The number of deep-rooted plants is limited, there are no burrowing animals in the area, the climate is dry, the growing season is relatively short, and the soils in the area are basically unsuitable for most plant growth.

6.4.3.12 Frost Protection

The low-permeability clay radon barrier that is part of the cover system was evaluated to assess the potential for degradation due to frost penetration. Two frost penetration analyses have been completed to assess frost penetration for varying cover designs (Montgomery Watson, 1998; Montgomery Watson, 2000). Temperature data for the Montgomery Watson analyses was generated based on the lowest recorded high and low temperature on each day through the freezing season (October through April) over the 47 years of data available from Dugway, Utah. The modeled data set is lower than 500-year return rate data provided by the Western Regional Climate Center (2000). The modeled average temperatures are lower than the projected 500-year return average minimum temperatures throughout the freezing season. Therefore, the frost penetration modeling performed by Montgomery Watson provides conservative estimates of the abnormal condition frost depths. The reports project that the maximum frost penetration depth does not reach the surface of the clay radon barrier, demonstrating that degradation of this layer will not occur as a result of freeze/thaw processes. Therefore, the projected performance meets the design criteria for frost penetration under normal and abnormal conditions.

Table 6-3. Physical-Chemical Properties of Soils at South Clive Site and Vicinity

Sample Number	Depth inches	pH	ECa mmbos/cm	Saturation Percent	Particle Size Percentage			Soil Texture	OM %b	Milliequivelents per Liter			
					Sand	Silt	Clay			Na	Ca	Mg	SARc
1[d]	0-4	7.8	24	37.2	29.2	45.6	25.2	Loam	1.70	227	27.8	9.5	53
2[e]	0-4	8.1	23	40.1	31.2	44.8	24.0	Loam	2.09	234	10.7	6.1	81
1	4-7	8.1	19	45.4	29	43.2	27.8	Clay/Loam	1.96	180	8.2	3.4	75
2	4-7	8.4	22	52.8	24	40.0	26.0	Clay/Loam	1.63	237	6.0	4.7	102
1	7-15	8.2	24	51.6	21	47.2	31.8	Clay/Loam	1.61	222	7.8	5.9	85
2	7-15	8.5	26	62.3	26	43.0	31.0	Clay/Loam	1.51	278	6.1	6.8	109
1	15-24	8.2	30	68.7	23.2	58.0	18.8	Clay/Loam	1.40	289	13.0	13.0	80
2	15-24	8.6	23	97.5	17	80.0	3.0	Silt	1.23	241	4.6	6.3	103
1	24-31	8.1	53	66.8	18.6	76.0	5.4	Silt/Loam	1.25	469	31.0	34.0	82
2	24-31	8.3	33	93.7	17	81.0	2.0	Silt	0.91	335	21.8	17.6	76
1	31-51	8.1	63	77.3	8.2	84.6	7.2	Silt	1.32	559	25.4	38.0	99
2	31-51	8.3	40	78.6	9	85.0	6.0	Silt	1.06	421	40.5	23.5	74

EC[a] = Electrical Conductivity
OM%[b] Organic Matter
SAR[c] Sodium Adsorption Ratio
Sample 1[d]: Soil obtained from diagnostic horizons from excavated trench
Sample 2[e]: Soil obtained from 5 cores with soil samples composited from depths corresponding to Sample No. 1.
The 5 cores were taken from each corner and center of section 32, South Clive site.

6.4.4 Radon Attenuation

The cover system provides many necessary protective functions for the embankment. The cover was designed originally by the DOE for the Vitro tailings project. Energy*Solutions* uses a similar design. Section 4 to this License Renewal Application provides design and construction features for the 11e.(2) cover system. Energy*Solutions* analyzed the problem of radon flux through the clay cover to assure that the cover design provides all of the necessary items of protection. Using a model based on the predictive correlation between soil moisture and porosity, it was calculated that a three and one-half-foot compacted clay cover on the side slopes and four feet of compacted clay cover on top would reduce the radon emanation from an embankment containing an average of 4,000 pCi/g Ra-226 to less than 20 pCi/m^2-sec, (Section 6.4 of EnergySolutions, 2005b). The model also serves to provide guidance to the necessary depth of burial within the embankment for wastes containing higher concentrations of Ra-226 to maintain the desired emanation rate at the surface of the radon barrier.

Energy*Solutions* performs radon flux measurements as soon as achievable after placement of the final cover using the ERG Method as approved by NRC, 1995b. The measurements are taken when ground temperatures are well above 32° F. The area for each disposal embankment is divided into 100 quadrants. Charcoal canisters are placed along with field blanks into the quadrants. The canisters are retrieved within 28 hours. The canisters are analyzed by gamma-spectrometry. The results of radon flux measurements are included in the Annual Environmental Report provided in accordance with the license.

6.4.5 Direct Gamma Levels

Momeni reports an exposure rate in microR/h from a depth of tailings of more than 1 or 2 feet of 3.1 times the average concentration of Ra-226 in pCi/g (Momeni, 1979). Based on this relationship, the average exposure rate over a pile containing 500 pCi/g would be 1,250 microR/h. The exposure rate would be reduced to background levels when calculated at the surface of the cover as the compacted clay has a tenth thickness of approximately nine inches for Ra-226. The 2 foot rock erosion barrier would reduce that exposure rate even further. 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. For waste containing mixtures of each, the Sum of Fractions Rule will apply. This will assure that the handling of higher activity wastes does not increase gamma exposure rates at the surface of the completed embankment. The effective exposure rate from gamma activity penetrating the radon barrier would be insignificant relative to that from natural background.

To be conservative potential shielding effectiveness was evaluated for Tl-208 using MicroShield software. MicroShield identified the tenth thickness in soil for Tl-208 photons to be 17 inches. The cell design requires at least a 42 inch soil cover and an additional 30 inches of rock cover for a total cover thickness of 72 inches, or 4 tenth thickness values. The maximum Ra-226 concentration in the top three feet of the 11e.(2) cell is 300 pCi/g Ra-226. So the exposure rate on the top of the waste would be: (300 pCi/g Ra-226) * (3.1 μR/hr) / (1 pCi/g Ra/226) = 930 μR/hr. The resulting dose on top of the radon barrier would be (930 μR/hr) * (1E-4) = 0.093 μR/hr.

6.4.6 Radiological Limits of Cover Materials

The clay cover material to be used for the radon barrier is excavated from the embankment area before placing waste. Clay from outlying areas around Section 32 is also excavated and used for the radon barrier. Soils in these areas have been shown to contain less than 2 pCi/g Ra-226. Rock selected for the erosion

barrier will not exceed that concentration. Therefore, the cover will not contribute to the radon exhalation at a rate greater than normal background in the area.

6.4.7 Post Closure Containment of Non-radiological Hazards

6.4.7.1 Containment of Hazardous Constituents

During the operational phase, Energy*Solutions* manages the waste according to the Ground Water Quality Discharge Permit. At the end of the operational phase, all waste material will be contained in the embankment within a cover as described in this section. Additionally, the embankment is lined with a bottom liner as described in the CQA/QC Manual and depicted in Appendix I. All of these measures serve to prevent release of both radiological and non-radiological hazardous constituents. The expected non-radiological hazards are described in Section 5.2.

6.4.7.2 Containment of Leachate

The Energy*Solutions* design does not include a synthetic liner or leachate collection system. It is assumed in the modeling that the water that passes through the radon cover continues through the waste and eventually passes through the clay liner and into the clay below the embankment. As a result of this slow rate of flow, any radiological or non-radiologic hazards contained in the water passing through the embankment does not pose a threat to health or environment.

6.4.7.3 Containment of Contaminated Rainwater

During the construction of the 11e.(2) Embankment rainwater comes in contact with the waste material. Rainwater may also come in contact with the waste when it is in bulk temporary storage. It is possible that this rainwater becomes contaminated with non-radiologic hazards.

This contaminated rainwater will be contained within the run-off berms as described in Appendices G-1, J, and L of Energy*Solutions*, (2005b). Run-off berms will be constructed around all embankments. The run-off berms are constructed to store a six-hour Probable Maximum Precipitation storm of 10.08 inches of precipitation. Water that comes in contact with the waste is placed in lined evaporation ponds or is placed back on the embankments for engineering purposes (dust and moisture control).

The rainwater passing through the embankment poses no threat to human health or the environment. This statement is justified by the low solubilities of the waste material disposed, the flow rate of precipitation through the embankment, and the lack of receptors for groundwater. See Envirocare, (2004) for rates of flow through the embankment.

6.4.7.4 Containment of Waste Decomposition Products

Waste decomposition may result in two classes of products. First is the production of radioactive and stable isotopes resulting from the radioactive decay of the emplaced radionuclides. The radioactive daughters of the emplaced radionuclides are the same isotopes as included in the waste itself. The relative concentrations may change with time, but the potential for release from the embankment are not increased over that for those emplaced with the waste. The stable decay product of the waste radionuclides is lead. While lead is a heavy metal of health concern, the mass of lead potential contained in the waste is relative to the concentration of Ra-226. Assuming a concentration of 500 pCi/g for Ra-226, the potential lead mass is about $5x10^{-10}$ g/g soil, or about 5 $x10^{-8}$ percent, which is not a health risk; particularly while contained in the covered, closed embankment.

Chemical and biological decomposition of organic materials emplaced as part of the waste could ultimately lead to the production of methane gas. The largest potential source of any organic material is scrap wood that might be included in a cleanup. While this is possible, the potential - based on disposal of NORM site cleanup waste disposed of at the Clive site - is for very small amounts relative to the amount of soil type solids. Any methane gas produced would diffuse through the pile and eventually into the atmosphere over long periods of time. Such releases would be far smaller and much slower than for a similarly sized sanitary landfill.

6.4.8 Decontamination and Decommissioning

Decontamination and decommissioning of the facility will be in accordance with the Decontamination and Decommissioning Plan (Appendix C), as amended at the time of closure.

6.5 PROCEDURES FOR CONDUCTING POST-RECLAMATION AND DECOMMISSIONING RADIOLOGICAL SURVEYS

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (d) Consideration of the long-term impacts including decommissioning, decontamination, and reclamation impacts, associated with activities to be conducted pursuant to the license or amendment." **– R313-24-3(1)(d).**

"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." **– LICENSE CONDITION 10.4.**

Upon closure of the facility, Energy*Solutions* will perform annual inspections of the facility to confirm the integrity of the embankments and to determine the need, if any, for maintenance, monitoring, or contingency repair. All findings of these inspections will be reported to the Division within 60 days of the inspection. For the site inspection phase of surveillance, a team of inspectors is assembled to conduct a ground-based inspection of the disposal site, facilities, and surrounding areas. Three types of inspections are considered:

1. Phase I inspections. Inspections conducted annually by a small team of qualified inspectors to identify conditions that could lead to tailing cover, diversion ditch, or other design feature damage.
2. Phase II inspections. Follow-up visit, if appropriate, to further investigate conditions observed during the Phase I visit.
3. Contingency Inspection. Unscheduled, and conducted based on information received from other agencies (e.g., NOAA) that indicate the potential that site integrity has been, or may be threatened by natural events, (e.g., earthquake or flood) or other means.

Phase I inspections are conducted annually. Phase I inspections are undertaken by a small number of trained personnel using common and simple instruments.

A Phase II inspection is conducted by technical specialists experienced in investigating the type of problem encountered by a Phase I inspection at the site. Procedures for a Phase II inspection are specified at the time this inspection becomes necessary. It is conceivable that a Phase II inspection could be carried out in two or more steps. The first step would be an on-site visit to gather first-hand knowledge for the development of a plan-of-action to conduct the tests necessary to understand the phenomenon in progress. Follow-up visits

would then be undertaken to gather the data needed to draw conclusions and recommend mitigative or remedial actions.

Contingency inspections are unscheduled, situation-unique inspections ordered when outside information indicates that site integrity has been or may be threatened. The type of contingency inspections to be conducted will be dependent upon the situation of concern. As part of a contingency inspection, procedures are established by the responsible agency to ensure that the agency is notified of extreme seismic or meteorological events. The contingency plans are also identify names, addresses, and phone numbers of local or state officials or agencies to be notified.

The determination of an extreme seismic event is dependent on the particular site design and construction. Knowledge of seismic event occurrence is obtained by the responsible agency subscribing to the U.S. Geological Survey's Earthquake Early Warning Service. This service provides data on the magnitude of the event and the location of the epicenter. Energy*Solutions* periodically checks the Earthquake Early Warning Service at the following web domain: https://sslearthquake.usgs.gov/ens/.

To obtain notification of extreme meteorologic events, the responsible agency has established a dialogue with the National Weather Service, NOAA, or other agency to investigate data gathering and reporting systems that would best serve to alert the responsible agency. The responsible agency completes an interagency agreement for a continuing reporting service.

In accordance with the recommendations contained in DOE, (1985a), visual inspections will be performed annually by Energy*Solutions* on the completed Disposal Embankment(s).

After cessation of 11e.(2) operations at the Clive site, the waste burial embankments will be fenced and posted. After cessation of all operation at the Clive Site, work areas will be decontaminated and equipment and structures will be removed. Energy*Solutions* will then proceed to carry out the post-operational monitoring program. Justification will be provided for any changes in the organization of the environmental monitoring or training programs that relate to the authority and responsibility of those persons responsible for the programs.

Continuous airborne particulate air sampling will be performed for one quarter after all other operations at the site have ceased. Air filters will be analyzed for gross alpha, total uranium, Ra-226, Th-230, Th-232, Pb-210 and Po-210. Since all embankments will have been covered with clean fill and all contaminated areas decontaminated, no further air particulate sampling should be necessary at the site, barring unexpected damage of the embankment surfaces identified during an inspection.

If any air sample result exceeds the pre-operational average concentration by more than three standard deviations, air sampling will continue for an additional quarter while additional gamma surveys are made to determine if there is a possible source of surface contamination that would account for such a finding. If a source is found it will be removed and placed into the temporarily re-opened disposal embankment. Air particulate sampling would then continue for a quarter after final closure, as before. If no source is found and if the second quarter samples are consistent with pre-operational samples, air sampling will be discontinued.

Radon canisters will be placed on the surface of the closed disposal embankment to confirm that emissions are below 20 pCi/m2/s. If that value is exceeded, additional radon barrier will be placed to achieve that level and the area will be re-tested.

Passive environmental radon monitors and environmental TLDs or electret ionization chambers will be placed at onsite and offsite stations. Monitoring will continue for one year after operations have ceased. As radon emissions sampling is part of final cover construction, post closure remediation will not be needed. Therefore, no further radon, gamma monitoring, or radon progeny measurements should be necessary at the site.

Extensive area surveys by NaI scintillation and pressurized ion chamber survey meters should eliminate any possibility of measuring an external gamma dose above background following closure. If any of the station gamma monitors measures a quarterly dose more than five mrem above pre-operational levels the area will be surveyed to locate the source. Any source of radiation will be cleaned up and placed into the temporarily re-opened disposal embankment.

If any site boundary samples contain concentrations of radionuclides greater than the mean plus two standard deviations determined for the background samples an investigation will be made to determine the possible cause and sampling will continue in that area and at the background sites until the levels return to background.

Post-closure groundwater sampling and analysis will be performed for the wells specified in Part I.F.1.a.2 of the Ground Water Quality Discharge Permit. The wells will be sampled on an annual basis for 100 years following closure. This water-sampling program will also conform to recommendations contained in "Guidance for UMTRA Project Surveillance and Maintenance" (UMTRA-DOE/AL-350124.000).

In accordance with the recommendations contained in "Guidance for UMTRA Project Surveillance and Maintenance" (UMTRA-DOE/AL-350124.000), geotechnical monitoring inspections will be performed annually by Energy*Solutions* on the completed disposal embankment(s). Settlement markers will be placed on the embankment. Surveys will be made annually and will be made to second order standards. Other monitoring and remediation activities as suggested in the UMTRA manual will be performed.

Information in the form of an inspection checklist with appended field notes, ground and aerial photographs, water quality analyses, field measurements, field notations on base maps, and the resulting reports will be compiled in a site file. The site file will be retained by Energy*Solutions* for review by the Division.

Carefully compiled, complete, accurate reports of site surveillance, inspection and maintenance activities will be maintained in a manner to ensure their long-term survival. Reports and records will:

1. Provide the information necessary to forecast future site surveillance and maintenance.
2. Provide information that will be available to the public that will demonstrate that site integrity has been maintained.
3. Demonstrate that license provisions continue to be met.

Archival procedures for records will be those set forth in the Code of Federal Regulations; Title 41, Public Contractors and Property Management; Chapter 102-193, Creation, Maintenance, and Use of Records. This information can also be made available to the public.

Energy*Solutions* will provide an annual report to the Division that summarizes, describes, and evaluates all surveillance, inspection, and maintenance actions and certifies that site license requirements continue to be met. A copy of all inspections, monitoring, maintenance, and contingency repair reports for the reporting period will be appended to the report. Discussed in the following sections are reporting and recordkeeping requirements for each component of this plan.

A site file will be maintained. A site file will contain all of the information necessary to prepare for, and conduct, site surveillance and maintenance. At a minimum, a site file will include:

1. Environmental impact statement or environmental assessment.
2. Remedial action plan/site conceptual design.
3. Disposal site characterization report.
4. Site certification report.
5. Final site condition records.
6. Site inspection records and reports.
7. Groundwater monitoring records and reports.
8. Aerial photography and interpretive reports.
9. Maintenance and contingency repair records and reports.
10. License.
11. As-built drawings.
12. Site atlas.

Final site conditions records will consist of the following documents:

1. As-built drawings.
2. Construction and baseline photographs.
3. Baseline data maps.
4. Site aerial photographs.
5. Site atlas.
6. Locations of monuments, site markers, and signs.
7. Location of monitoring wells.
8. Location of settlement plates and other surveillance features.

Site inspection records will consist of:

1. Phase I inspection reports.
2. Phase II inspection reports.
3. Contingency inspection reports.
4. Letters and documents pertaining to the appointment, qualifications, and training of inspectors.
5. Letters and documents commenting on and analyzing inspection reports.
6. Letters and documents directing maintenance and contingency repair actions as a result of site inspections.
7. Other site inspection related documents as deemed appropriate by the responsible agency.

All site inspection records will be kept current in the site file for a minimum of five years except for inspection reports. The inspection reports will be kept for a minimum of 10 years in the site file. At the end of the specified retention period, the inspection records will be microfiched (or equivalent) and stored in the archives of the responsible agency. There are three types of site inspection reports:

1. Phase I inspection reports.
2. Phase II inspection reports, which will concentrate on potential problems raised by Phase I inspections, with appropriate conclusions and recommendations.
3. Contingency inspection report. This report will document the conditions at the site, determine whether an imminent hazard exists, and provide recommendations for repair and notification to affected parties.

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

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (d) Consideration of the long-term impacts including decommissioning, decontamination, and reclamation impacts, associated with activities to be conducted pursuant to the license or amendment." **– R313-24-3(1)(d).**

Custodial maintenance such as repair of a damaged perimeter fence is expected to be 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 will be constructed in a manner that will minimize 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 (see Design Drawings 9420-4, 9420-5 and 9420-6 in Appendix I):

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. Section 6 shows that the embankment will be resistant to water erosion, wind erosion, and slope failure for the 1,000 year design life of the facility. There should 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" (UMTRA-DOE/AL-350124.0000). 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 DRC prior to surveillance activities.

This section explains the procedures to be 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 6-4. Conditions that may trigger contingency repair action are listed in Table 6-5.

When compared with contingency repair, maintenance is expected to be generally less costly, smaller in scale, and more frequent in occurrence. In contrast, contingency repairs are unlikely to be needed; 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 to be 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 6-6. A remote possibility exists for failure of a site to adequately contain the waste material. For the Clive site, the only feasible scenario would 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 6-4

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 6-5

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 6-6

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.

6.6.1 Surety

"(1)a) Applicants for a specific license authorizing the possession and use of unsealed radioactive material of half-life greater than 120 days and in quantities exceeding 105 times the applicable quantities set forth in Appendix B of 10 CFR 30.1 through 30.72, 2010, which is incorporated by reference, shall submit a decommissioning funding plan as described in Subsection R313-22-35(5). The decommissioning funding plan shall also be submitted when a combination of radionuclides is involved if R divided by 105 is greater than one, where R is defined here as the sum of the ratios of the quantity of each radionuclide to the applicable value in Appendix B of 10 CFR 30.1 through 30.72, 2010, which is incorporated by reference.

b) Holders of, or applicants for, a specific license authorizing the possession and use of sealed sources or plated foils of half-life greater than 120 days and in quantities exceeding 1012 times the applicable quantities set forth in Appendix B of 10 CFR 30.1 through 30.72, 2010, which is incorporated by reference, or when a combination of isotopes is involved if R, as defined in Subsection R313-22-35(1)(a), divided by 1012 is greater than one, shall submit a decommissioning funding plan as described in Subsection R313-22-35(5).

c) Applicants for a specific license authorizing the possession and use of more than 100 mCi of source material in a readily dispersible form shall submit a decommissioning funding plan as described in Subsection R313- 22-35(5).

(2) Applicants for a specific license authorizing possession and use of radioactive material of half- life greater than 120 days and in quantities specified in Subsection R313-22-35(4), or authorizing the possession and use of source material greater than 10 mCi but less than or equal to 100 mCi in a readily dispersible form shall either:

a) submit a decommissioning funding plan as described in Subsection R313-22-35(5); or

b) submit a certification that financial assurance for decommissioning has been provided in the amount prescribed by Subsection R313-22-35(4) using one of the methods described in Subsection R313-22-35(6). Applicants for a specific license authorizing the possession and use of source material in a readily dispersible form shall submit a certification that financial assurance for decommissioning has been provided in the amount of $225,000 by October 20, 2007. For an applicant subject to this subsection, this certification may state that the appropriate assurance will be obtained after the application has been approved and the license issued but before the receipt of licensed material. If the applicant defers execution of the financial instrument until after the license has been issued, a signed original of the financial instrument obtained to satisfy the requirements of Subsection R313-22-35(6) shall be submitted to the Executive Secretary before receipt of licensed material. If the applicant does not defer execution of the financial instrument, the applicant shall submit to the Executive Secretary, as part of the certification, a signed original of the financial instrument obtained to satisfy the requirements in Subsection R313-22-35(6).

(3)a) Holders of a specific license issued on or after October 20, 2006, which is of a type described in Subsections R313-22-35(1) or (2), shall provide financial assurance for decommissioning in accordance with the criteria set forth in Section R313-22-35.

b) Holders of a specific license issued before October 20, 2006, and of a type described in Subsection R313-22-35(1), shall submit by October 20, 2007, a decommissioning funding plan as described in Subsection R313- 22-35(5) or a certification of financial assurance for decommissioning in an amount at least equal to $1,125,000 in accordance with the criteria set forth in Section R313-22-35. If the licensee submits the certification of financial assurance rather than a decommissioning funding plan, the licensee shall include a decommissioning funding plan in any application for license renewal.

c) Holders of a specific license issued before October 20, 2006, and of a type described in Subsection R313-22-35(2), shall submit by October 20, 2007, a decommissioning funding plan as described in Subsection R313- 22-35(5) or a certification of financial assurance for decommissioning in accordance with the criteria set forth in Section R313-22-35.

d) A licensee who has submitted an application before October 20, 2006, for renewal of license in accordance with Section R313-22-37, shall provide financial assurance for decommissioning in accordance with Subsections R313-22-35(1) and (2).

e) Waste collectors and waste processors, as defined in Appendix G of 10 CFR 20.1001 to 20.2402, 2010, which is incorporated by reference, shall provide financial assurance in an amount based on a decommissioning funding plan as described in Subsection R313-22-35(5). The decommissioning funding plan shall include the cost of disposal of the maximum amount (curies) of radioactive material permitted by the license, and the cost of disposal of the maximum quantity, by volume, of radioactive material which could be present at the licensee's facility at any time, in addition to the cost to remediate the licensee's site to meet the license termination criteria of Rule R313-15.

f) Holders of a specific license issued prior to October 20, 2006, which is of a type described in Subsections R313-22-35(1), (2), or (3)(g), shall submit a decommissioning funding plan to the Executive Secretary on or before October 20, 2007. Holders of a specific license issued on or after October 20, 2006, which is of a type described in Subsections R313-22-35(1), (2), or (3)(g), shall submit a decommissioning funding plan to the Executive Secretary as a part of the license application.

g) Applicants for a specific license authorizing the possession and use of radioactive materials in sufficient quantities that require financial assurance and recordkeeping for decommissioning under Section R313-22-35 shall assure that all documents submitted to the Executive Secretary for the purpose of demonstrating compliance with financial assurance and recordkeeping requirements meet the applicable criteria contained in the Nuclear Regulatory Commission's document NUREG-1757, Volume 3, "Consolidated NMSS Decommissioning Guidance: Financial Assurance, Recordkeeping, and Timeliness" (9/2003).

h) Documents provided to the Executive Secretary under Subsection R313-22-35(3)(g) shall provide that legal remedies be sought in a court of appropriate jurisdiction within Utah.

(4) Table of required amounts of financial assurance for decommissioning by quantity of material. Licensees required to submit an amount of financial assurance listed in this table must do so during a license application or as part of an amendment to an existing license. Licensees having possession limits exceeding the upper bounds of this table must base financial assurance on a decommissioning funding plan.

(5) A decommissioning funding plan shall contain a cost estimate for decommissioning and a description of the method of assuring funds for decommissioning from Subsection R313-22-35(6), including means for adjusting cost estimates and associated funding levels periodically over the life of the facility. Cost estimates shall be adjusted at intervals not to exceed 3 years. The decommissioning funding plan shall also contain a certification by the licensee that financial assurance for decommissioning has been provided in the amount of the cost estimate for decommissioning and a signed original of the financial instrument obtained to satisfy the requirements of Subsection R313-22-35(6).

(6) Financial assurance for decommissioning shall be provided by one or more of the following methods:

a) Prepayment. Prepayment is the deposit prior to the start of operation into an account segregated from licensee assets and outside the licensee's administrative control of cash or liquid assets so that the amount of funds would be sufficient to pay decommissioning costs. Prepayment may be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities;

b) A surety method, insurance, or other guarantee method. These methods shall guarantee that decommissioning costs will be paid. A surety method may be in the form of a surety bond, letter of credit, or line of credit. A parent company guarantee of funds for decommissioning costs based on a financial test may be used if the guarantee and test are as contained in Subsection R313-22-35(8). A parent company guarantee may not be used in combination with other financial methods to satisfy the requirements of Section R313-22-35. A guarantee of funds by the applicant or licensee for decommissioning costs based on a financial test may be used if the guarantee and test are as contained in Subsection R313-22-35(9). A guarantee by the applicant or licensee may not be used in combination with any other financial methods to satisfy the requirements of Section R313-22-35 or in any situation where the applicant or licensee has a parent company holding majority control of the voting stock of the company. A surety method or insurance used to provide financial assurance for decommissioning shall contain the following conditions:

(i) the surety method or insurance shall be open-ended or, if written for a specified term, such as five years, shall be renewed automatically unless 90 days or more prior to the renewal date the issuer notifies the Executive Secretary, the beneficiary, and the licensee of its intention not to renew. The surety method or insurance shall also provide that the full face amount be paid to the beneficiary automatically prior to the expiration without proof of forfeiture if the licensee fails to provide a replacement acceptable to the Executive Secretary within 30 days after receipt of notification of cancellation,

(ii) the surety method or insurance shall be payable to a trust established for decommissioning costs. The trustee and trust shall be acceptable to the Executive Secretary. An acceptable trustee includes an appropriate state or federal government agency or an entity which has the authority to act as a trustee and whose trust operations are regulated and examined by a Federal or State agency, and

(iii) the surety method or insurance shall remain in effect until the Executive Secretary has terminated the license;

c) An external sinking fund in which deposits are made at least annually, coupled with a surety method or insurance, the value of which may decrease by the amount being accumulated in the sinking fund. An external sinking fund is a fund established and maintained by setting aside funds periodically in an account segregated from licensee assets and outside the licensee's administrative control in which the total amount of funds would be sufficient to pay decommissioning costs at the time termination of operation is expected. An external sinking fund may be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities. The surety or insurance provisions shall be as stated in Subsection R313-22-35(6)(b);

d) In the case of Federal, State or local government licensees, a statement of intent containing a cost estimate for decommissioning or an amount based on the Table in Subsection R313-22-35(4) and indicating that funds for decommissioning will be obtained when necessary; or

e) When a governmental entity is assuming custody and ownership of a site, an arrangement that is deemed acceptable by such governmental entity.

(7) Persons licensed under Rule R313-22 shall keep records of information important to the decommissioning of a facility in an identified location until the site is released for unrestricted use. Before licensed activities are transferred or assigned in accordance with Subsection R313-19-34(2), licensees shall transfer all records described in Subsections R313-22-35(7)(a) through (d) to the new licensee. In this case, the new licensee will be responsible for maintaining these records until the license is terminated. If records important to the decommissioning of a facility are kept for other purposes, reference to these records and their locations may be used. Information the Executive Secretary considers important to decommissioning consists of the following:

a) records of spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site. These records may be limited to instances when contamination remains after any cleanup procedures or when there is reasonable likelihood that contaminants may have spread to inaccessible areas as in the case of possible seepage into porous materials such as concrete. These records shall include any known information on identification of involved nuclides, quantities, forms, and concentrations;

b) as-built drawings and modification of structures and equipment in restricted areas where radioactive materials are used or stored, and of locations of possible inaccessible contamination such as buried pipes which may be subject to contamination. If required drawings are referenced, each relevant document need not be indexed individually. If drawings are not available, the licensee shall substitute appropriate records of available information concerning these areas and locations;

c) except for areas containing only sealed sources, provided the sources have not leaked or no contamination remains after a leak, or radioactive materials having only half-lives of less than 65 days, a list contained in a single document and updated every two years, including all of the following:

(i) all areas designated and formerly designated as restricted areas as defined under Section R313-12-3;

(ii) all areas outside of restricted areas that require documentation under Subsection R313-22-35(7)(a);

(iii) all areas outside of restricted areas where current and previous wastes have been buried as documented under Section R313-15-1109; and

(iv) all areas outside of restricted areas which contain material such that, if the license expired, the licensee would be required to either decontaminate the area to meet the criteria for decommissioning in Sections R313- 15-401 through R313-15-406, or apply for approval for disposal under Section R313-15-1002; and

d) records of the cost estimate performed for the decommissioning funding plan or of the amount certified for decommissioning, and records of the funding method used for assuring funds if either a funding plan or certification is used.

(8) Criteria relating to use of financial tests and parent company guarantees for providing reasonable assurance of funds for decommissioning.

a) To pass the financial test referred to in Subsection R313-22-35(6)(b), the parent company shall meet one of the following criteria:

(i) The parent company shall have all of the following:

(A) Two of the following three ratios: a ratio of total liabilities to net worth less than 2.0; a ratio of the sum of net income plus depreciation, depletion, and amortization to total liabilities greater than 0.1; and a ratio of current assets to current liabilities greater than 1.5;

(B) Net working capital and tangible net worth each at least six times the current decommissioning cost estimates, or prescribed amount if a certification is used;

(C) Tangible net worth of at least $10 million; and

(D) Assets located in the United States amounting to at least 90 percent of total assets or at least six times the current decommissioning cost estimates, or prescribed amount if a certification is used; or

(ii) The parent company shall have all of the following:

(A) A current rating for its most recent bond issuance of AAA, AA, A, or BBB as issued by Standard and Poor's or Aaa, Aa, A or Baa as issued by Moody's;

(B) Tangible net worth at least six times the current decommissioning cost estimate, or prescribed amount if a certification is used;

(C) Tangible net worth of at least $10 million; and

(D) Assets located in the United States amounting to at least 90 percent of total assets or at least six times the current decommissioning cost estimates, or prescribed amount if certification is used.

b) The parent company's independent certified public accountant shall have compared the data used by the parent company in the financial test, which is derived from the independently audited, year end financial statements for the latest fiscal year, with the amounts in such financial statement. In connection with that procedure the licensee shall inform the Executive Secretary within 90 days of any matters coming to the auditor's attention which cause the auditor to believe that the data specified in the financial test should be adjusted and that the company no longer passes the test.

c) (i) After the initial financial test, the parent company shall repeat the passage of the test within 90 days after the close of each succeeding fiscal year.

(ii) If the parent company no longer meets the requirements of Subsection R313-22-35(8)(a) the licensee shall send notice to the Executive Secretary of intent to establish alternative financial assurance as specified in Section R313-22-35. The notice shall be sent by certified mail within 90 days after the end of the fiscal year for which the year end financial data show that the parent company no longer meets the financial test requirements. The licensee shall provide alternate financial assurance within 120 days after the end of such fiscal year.

d) The terms of a parent company guarantee which an applicant or licensee obtains shall provide that:

(i) The parent company guarantee will remain in force unless the guarantor sends notice of cancellation by certified mail to the licensee and the Executive Secretary. Cancellation may not occur, however, during the 120 days beginning on the date of receipt of the notice of cancellation by both the licensee and the Executive Secretary, as evidenced by the return receipts.

(ii) If the licensee fails to provide alternate financial assurance as specified in Section R313-22- 35 within 90 days after receipt by the licensee and Executive Secretary of a notice of cancellation of the parent company guarantee from the guarantor, the guarantor will provide such alternative financial assurance in the name of the licensee.

(iii) The parent company guarantee and financial test provisions shall remain in effect until the Executive Secretary has terminated the license.

(iv) If a trust is established for decommissioning costs, the trustee and trust shall be acceptable to the Executive Secretary. An acceptable trustee includes an appropriate State or Federal Government agency or an entity which has the authority to act as a trustee and whose trust operations are regulated and examined by a Federal or State agency.

(9) Criteria relating to use of financial tests and self guarantees for providing reasonable assurance of funds for decommissioning.

a) To pass the financial test referred to in Subsection R313-22-35(6)(b), a company shall meet all of the following criteria:

(i) Tangible net worth at least ten times the total current decommissioning cost estimate, or the current amount required if certification is used, for all decommissioning activities for which the company is responsible as self-guaranteeing licensee and as parent-guarantor;

(ii) Assets located in the United States amounting to at least 90 percent of total assets or at least ten times the total current decommissioning cost estimate, or the current amount required if certification is used, for all decommissioning activities for which the company is responsible as self-guaranteeing licensee and as parent-guarantor; and

(iii) A current rating for its most recent bond issuance of AAA, AA, or A as issued by Standard and Poor's, or Aaa, Aa, or A as issued by Moody's.

b) To pass the financial test, a company shall meet all of the following additional requirements:

(i) The company shall have at least one class of equity securities registered under the Securities Exchange Act of 1934;

(ii) The company's independent certified public accountant shall have compared the data used by the company in the financial test which is derived from the independently audited, yearend financial statements for the latest fiscal year, with the amounts in such financial statement. In connection with that procedure, the licensee shall inform the Executive Secretary within 90 days of any matters coming to the attention of the auditor that cause the auditor to believe that the data specified in the financial test should be adjusted and that the company no longer passes the test; and

(iii) After the initial financial test, the company shall repeat passage of the test within 90 days after the close of each succeeding fiscal year.

c) If the licensee no longer meets the requirements of Subsection R313-22-35(9)(a), the licensee shall send immediate notice to the Executive Secretary of its intent to establish alternate financial assurance as specified in Section R313-22-35 within 120 days of such notice.

d) The terms of a self-guarantee which an applicant or licensee furnishes shall provide that:

(i) The guarantee will remain in force unless the licensee sends notice of cancellation by certified mail to the Executive Secretary. Cancellation may not occur, however, during the 120 days beginning on the date of receipt of the notice of cancellation by the Executive Secretary, as evidenced by the return receipt.

(ii) The licensee shall provide alternative financial assurance as specified in Section R313-22-35 within 90 days following receipt by the Executive Secretary of a notice of a cancellation of the guarantee.

(iii) The guarantee and financial test provisions shall remain in effect until the Executive Secretary has terminated the license or until another financial assurance method acceptable to the Executive Secretary has been put in effect by the licensee.

(iv) The licensee shall promptly forward to the Executive Secretary and the licensee's independent auditor all reports covering the latest fiscal year filed by the licensee with the Securities and Exchange Commission pursuant to the requirements of section 13 of the Securities and Exchange Act of 1934.

(v) If, at any time, the licensee's most recent bond issuance ceases to be rated in a category of "A" or above by either Standard and Poor's or Moody's, the licensee shall provide notice in writing of such fact to the Executive Secretary within 20 days after publication of the change by the rating service. If the licensee's most recent bond issuance ceases to be rated in any category of A or above by both Standard and Poor's and Moody's, the licensee no longer meets the requirements of Subsection R313-22-35(9)(a).

(vi) The applicant or licensee shall provide to the Executive Secretary a written guarantee, a written commitment by a corporate officer, which states that the licensee will fund and carry out the required decommissioning activities or, upon issuance of an order by the Board, the licensee shall set up and fund a trust in the amount of the current cost estimates for decommissioning." **– R313-22-35.**

"Each person licensed by the Executive Secretary pursuant to Rules R313-21 or R313-22 shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to Rules R313-21 or R313-22 shall

carry with it the right to receive, possess, and use source or byproduct material. Preparation for shipment and transport of source or byproduct material shall be in accordance with the provisions of Section R313-19-100." **– R313-24-4, 10 CFR 40.41(c).**

"The Licensee shall at all times maintain a Surety that satisfies the requirements of UAC R313-24-4 (10 CFR 40, Appendix A, Criterion 9 and 10 incorporated by reference) in an amount adequate to cover the estimated costs, if accomplished by a third party contractor, for completion of the Executive Secretary-approved reclamation/decommissioning plan of the Licensees' grounds, equipment and facilities including; above-ground decommissioning and decontamination, soil and water sample analyses, and groundwater restoration associated with the site, as warranted.

The licensee's currently approved surety instrument, irrevocable letter of credit from Zions First National Bank, and a related standby trust agreement, in favor of the Executive Secretary, shall be continuously maintained for the purpose of complying with UAC R313-24-4 (10 CFR 40, Appendix A, Criterion 9 incorporated by reference), in an amount approved by the Executive Secretary, until a replacement is preauthorized by the Executive Secretary.

The Licensee shall annually review the amount and basis of the surety and submit a written report of its findings by May 31 each year for Executive Secretary approval. At a minimum, this annual report shall meet the following requirements:

a. Summary of Changes - the annual report shall include a written summary of any change in the cost estimate previously approved by the Executive Secretary, including, but not limited to:

i. A description of any modification, addition, or deletion of any direct cost or post-closure monitoring and maintenance (PCMM) cost line item, including supporting justification, calculations and basis;

ii. Any change to the unique reference number (cost line item) assigned or approved by the Executive Secretary for any cost line item.

b. In-direct Costs shall be based on the sum of all direct costs in accordance with the following values:

Surety ID No.	*Description*	*Percentage*
300	*Working Conditions*	*5.5%*
301	*Mobilization / Demobilization*	*4.0%*
302	*Contingency*	*11.0%*
303	*Engineering and Redesign*	*2.25%*
304	*Overhead and Profit*	*19.0%*
305	*Management Fee and Legal Expenses*	*4.0%*
306	*DEQ Oversight*	*4.0%*

c. RS Means Guide estimates of direct construction costs provided in the annual report shall be derived from or based on the most recent edition of the RS Means Guide for Construction.

d. Report Certification – the annual report shall be prepared under the direct supervision of and be certified by a professional with at least 5 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.

e. Electronic Format – the Licensee shall provide the report in both paper and electronic formats, as directed by the Executive Secretary.

f. Within 60-days of Executive Secretary approval of said annual report, the Licensee shall submit written evidence that the surety has been adequately funded." **– LICENSE CONDITION 9.12.**

"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." **– LICENSE CONDITION 9.16.**

A financial surety has been arranged in an amount that allows for the closure of the disposal facility to the standards discussed within this document and in accordance with the license. The financial surety is for the amount that would be needed to place all 11e.(2) material properly into the Embankment and to complete all phases of the Embankment to the required standards, and to fund post-closure monitoring.

The 11e.(2) Surety is intended to protect the State of Utah from having to provide funding for the closure of Energy*Solutions*' 11e.(2) Embankment. The Surety provides adequate monies for site decommissioning and reclamation in the event that Energy*Solutions* is unable to provide funds at the time of closure. The amount is such that the area covered within the surety could be closed by an independent contractor to the standards approved by the Director of the Utah Division of Radiation Control. The Surety conservatively estimates the amount of funding that would be required to:

- Place all appropriate waste material in the disposal embankment
- Close the embankment as outlined in 11e.(2) Radioactive Material License No. UT2300478.
- Complete required long term surveillance

The Surety is reviewed annually to account for inflation or any changes in activities or design. This annual review will ensure that the amount is adequate to fund the closure of the 11e.(2) Embankment in the event that Energy*Solutions* is unable to do so. Any monies not used in the closure of the site or required for long term surveillance will be returned to Energy*Solutions*.

Energy*Solutions* has implemented a financial mechanism that meets the guidance listed in NUREG-1757 (NRC, 2003) and Regulatory Guide 1.202 (NRC, 2005), thereby meeting the requirements listed in Criterion 9 of 10 CFR Part 40, Appendix A. The value of the financial surety is reviewed annually in accordance with the license to assure that the total surety is sufficient to account for inflation or other price adjustments. The Surety amount is arrived at through the determination of quantities of materials, time, etc., required to decommission the Surety area; and by determining the costs to perform each Surety item as required by the approved documents.

Quantities are based on documents and figures provided to DRC annually by Energy*Solutions*. Where it is not possible to determine exact quantities from approved references, conservative assumptions are used. For example, the quantity of on-site waste to be disposed of was assumed to be the maximum amount of on-site waste allowed by the license. Cost estimates, detailed quantity calculations, and assumptions were most recently provided DRC in 2011 (McCandless, 2011).

Costs are largely based on the RS Means Heavy Construction Cost Data for the associated year. For elements that are not included in Means, such as sampling and analysis, costs were developed from Energy*Solutions*' historic cost for that item and are adjusted annually for inflation. The annual surety revision also anticipates costs associated with long-term site surveillance and monitoring. These costs include annual site inspections, groundwater sampling, soil sampling and other environmental activities specific to the 11e.(2) Embankment. Site surveillance and monitoring costs for the adjacent Class A and Mixed Waste facilities are addressed in their respective sureties. The program is more intensive in the first years after closure compared to the last years of post-closure monitoring. The annual surety revision also identifies the amounts that will need to be available for surveillance and monitoring for 100 years following closure.

SECTION 7. ENVIRONMENTAL EFFECTS

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (a) An assessment of the radiological and non-radiological impacts to the public health from the activities to be conducted pursuant to the license or amendment;" **– R313-24-3(1)(a).**

The calculations and results in this section are primarily based on the reports prepared by Momeni and Associates (M&A), Analysis of Radiological Pathways of Exposure: Disposal of 11e.(2) Materials at Clive, Utah and Analysis of Pathways of Exposure (Appendices A and A-1 of Energy*Solutions*, 2005b). The waste characteristics, environmental and operating parameters, and local demographic features needed to project the radioactive exposures to the workers and the environment are defined in that analysis and are consistent with those presented in this section.

7.1 SITE PREPARATION AND CONSTRUCTION

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (a) An assessment of the radiological and non-radiological impacts to the public health from the activities to be conducted pursuant to the license or amendment;" **– R313-24-3(1)(a).**

The environmental effects from the preparation and construction of Energy*Solutions*' 11e.(2) Embankment are reflected in the Environmental Monitoring data reported annually to the Division and projected in the M&A Assessments of Appendices A and A-1 from Energy*Solutions*, (2005b). Review of the most recent quarterly Environmental Monitoring Report (Energy*Solutions*, 2011) demonstrates that no air samples exceeded the conservative upper estimates of the M&A Assessment or the alpha action level, 1.4×10^{-13} μCi/ml, in the first quarter, 2011. Similarly, no samples collected during the quarter exceeded upper-bound values of the M&A Assessment or the beta action level of 2.1×10^{-12} μCi/ml. The highest Committed Effective Dose Equivalent exposure during the quarter, with occupancy considered, was 0.03 mrem.

The highest average radon equivalent concentration measured during the quarter was 0.5 pCi/L above background. The quarterly radon Committed Effective Dose Equivalent for this concentration, with an assumed 25% occupancy, is 0.3 mrem. The highest Deep Dose Equivalent measured during the quarter was 8.8 mrem, with occupancy considered (however, it is expected that the magnitude of this dose at the monitor location is attributable to the storage of depleted uranium in the Storage Building constructed and put into operation during first quarter, 2011. All of the fourth quarter environmental exposures were below regulatory limits and those used as upper bounds in the M&A Assessment.

The routine soil sample analytical results include the analytical results from; the Quarterly Soil Samples, and the Quarterly Restricted Area Exit Gate Samples. All of the soil samples collected were below the Soil Action level.

7.2 EFFECTS OF OPERATIONS

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (a) An assessment of the radiological and non-radiological impacts to the public health from the activities to be conducted pursuant to the license or amendment;" **– R313-24-3(1)(a).**

The environmental effects of the operations of Energy*Solutions*' 11e.(2) Embankment are reflected in the Environmental Monitoring data reported annually to the Division and projected in the M&A assessments of Appendices A and A-1 of Energy*Solutions*, (2005b). Data reported annually include Point of Compliance dose estimates that demonstrate that the applicable regulatory requirements are achieved with a substantial margin of safety.

The annual report includes Committed Effective Dose Equivalent calculations that refer to the applicable ICRP 68 dose coefficients and the quarterly filter composite sample analytical results. The reported doses consider the occupancy factors for each location as identified in Clive's ALARA program.

The results of the monitoring and dose calculations demonstrate compliance with R313-15-301. The tabulated Total Effective Dose Equivalent conservatively estimates a presumed maximally exposed individual dose as a potential upper bound for each listed area. The Total Effective Dose Equivalent measured west of the 11e.(2) and Class A embankment is below the 100 mrem R313-15-301 limit for the most recent quarter. In fact, the Total Effective Dose Equivalent, excluding Rn-222, to "the individual member of the public" likely to receive the highest dose did not exceed 10 mrem in the most recent 4 quarters.

The highest Committed Effective Dose Equivalent measured during 2011, excluding radon, is 0.27 mrem. The reported value used an occupancy factor of 4 to be consistent with the process used to evaluate the limits listed in R313-15-301. An occupancy factor of 1/50 is used to evaluate the ALARA constraint limit in UAC, R313-15-101(4). When the occupancy of 1/50 is applied the resulting dose is 0.005 mrem which is less than the UAC, R313-15-101(4) limit and below the conservative estimates of the M&A Assessment.

7.3 RADIOLOGICAL EFFECTS – EXPOSURE PATHWAYS

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (a) An assessment of the radiological and non-radiological impacts to the public health from the activities to be conducted pursuant to the license or amendment;" **– R313-24-3(1)(a).**

The 11e.(2) material encompasses a broad spectrum of byproduct wastes including uranium mill tailings, thorium tailings, and other process residues. The concentrations in the original ores and the extraction processes normally limit the concentrations to less than 12,000 pCi/g for any radionuclide, with the average concentration at any large site ranging from a few hundred pCi/g to approximately 1,000 pCi/g. In order to

arrive at a reasonable estimate of the characteristics of 11e.(2) waste, Energy*Solutions* has considered available data from operating and non-operating uranium mill sites and three sites where uranium and thorium processing has occurred.

The EPA compiled data on uranium mills for which statistical descriptions of 11e.(2) wastes can be derived (EPA, 1989). Table 7-1 provides volume and Ra-226 estimates for the 18 UMTRA inactive mill tailings sites where the volume-weighted mean Ra-226 concentration is 421 pCi/g. The type of waste being received at the Energy*Solutions* site is consistent with the site mean concentration and standard deviation for the UMTRA sites, which is 421 ± 508 pCi/g, with a range of 45 to 2,315 pCi/g. The highest concentration was reported for the Canonsburg site, which was a radium processing site rather than a mill site. If the Canonsburg site is excluded, the tailings range from 45 to 745 pCi/g.

Characterization data for the UMTRA sites generally show that in acid extraction processes, Th-230 follows the liquid effluent to a greater degree than Ra-226. Therefore, concentrations of Th-230 of up to 10,000 pCi/g are not uncommon in tailings slimes, raffinate pits, and evaporation ponds. However the site-wide average concentration of Th-230, Ra-226, and decay products should be approximately equal. The U-238 concentration averages approximately eight (8) percent of the Ra-226 concentration in uranium mill tailings.

The EPA also compiled data for the 11 mills that were operating in 1989. Table 7-2 provides the average Ra-226 concentration for the mill tailings where the site Ra-226 concentrations averaged 319 pCi/g with a standard deviation of 230 pCi/g. The Ra-226 concentration range was 87 to 981 pCi/g. No information was provided on tailings volume.

The UMTRA Disposal Site at Clive, Utah was created from relocating the uranium mill tailings from the Vitro Chemical Company Site in Salt Lake City. There are various reported average Ra-226 concentration values for this material, ranging from 460 pCi/g to 900 pCi/g, with individual sample analyses ranging from 100 to 2,000 pCi/g (DOE, 1983). The DOE used an average of 670 pCi/g as the basis for their Environmental Impact Assessment.

Other potential sources of 11e.(2) material are similar to those at the Weldon Spring Site, owned by the federal government and managed by the DOE. Four raffinate pits existed at that site with a total volume of 167,194 m^3. The EPA summarized the waste characteristics for the pits, which are provided in Table 7-3 (EPA, 1993). The volume-weighted average concentration of most radionuclides is below 600 pCi/g, with the exception of Th-230, which is greater than 12,000 pCi/g.

In addition to the material presented in Table 7-3, the Weldon Spring Site reports (EPA, 1989) the storage of various wastes including 140.1 m^3 of 3.8 percent thorium residues in drums, 42,000 m^3 of contaminated plant and demolition rubble, and 422 m^3 of drummed three percent thorium residues. Assuming that the Th-232 is in equilibrium with the daughter products, approximately 562 m^3 of drummed higher activity waste exists at the site with Th-232 and daughter product activities in the range of 9,000 to 12,000 pCi/g.

Table 7-1

Characteristics of UMTRA Mill Tailings

Mill Site	Volume (cu m)	Ra-226 (pCi/g)	Vol x Ra (cu m – pCi/g)/Volume
Tuba City	52,661	550	8.52
Durango	129,323	670	25.48
Grand Junction	249,410	665	48.77
Gunnison	119,863	315	11.1
Maybell	365,781	200	21.51
Naturita	58,167	45	0.77
New/Old Rifle	304,949	745	66.81
Slick Rock	7,513	115	0.25
Lowman	5,694	160	0.27
Ambrosia Lake	549,525	570	92.11
Shiprock	311,346	420	38.45
Bowman/Belfield	21,250	50	0.31
Lakeview	83,480	110	2.7
Canonsburg	38,958	2315	26.52
Falls City	901,125	190	50.35
Green River	13,774	75	0.3
Mexican Hat	9,045	670	1.78
Salt Lake	178,730	480	25.23
total volume	**3,400,594**		
mean		**464**	
std deviation		**509**	
vol st'd ave concentration			**421.25**

Table 7-2

Tailings Characteristics of Operating Mills

Site	Ra-226 Concentration (pCi/g)
Canon City	400
Ambrosia Lake	87
Homestake	300
Panna Maria	198
White Mesa	981
Rio Algora-Lower	420
Shootaring	280
Sherwood	200
Lucky Pile 1-3	153
Shirley Basin	208
Sweetwater	280
Mean Concentration	319
Std Dev	230

Table 7-3

Characteristics of Raffinate Pits at Weldon Spring Site

Average Radionuclide Concentration (pCi/g)					Volume Weighted Concentration
Radionuclide	Pit 1	Pit 2	Pit 3	Pit 4	
U-238	710	470	520	620	556
U-234	810	560	570	610	598
Th-232	100	120	120	120	118
Th-230	24,000	24,000	14,000	1,600	12,448
Ra-228	850	200	100	60	157
Ra-226	430	440	460	11	343
Waste Volume (m^3)	13,224	13,224	98,490	42,256	167,194

Another large cleanup of 11e.(2) wastes included properties in Maywood, New Jersey, estimated to create 395,000 cubic yards of contaminated soil and building debris (DOE, 1992). However, individual sample results indicate that thorium concentrations range up to 6,000 pCi/g or more, which is similar to those at other thorium processing plants (e.g. West Chicago Rare Earths Facility). Radionuclides from the U-238 decay chain are present in lesser concentrations. While the maximum concentrations are high, a large portion of the wastes appear to be from the dispersal of process waste and, therefore, may be highly diluted.

The waste sites described above all have similar characteristics. Process waste concentrates such as the sludges, slimes, and raffinates usually are segregated and constitute significantly large volumes (1,000 m3 or more) of higher activity wastes with average Ra-226 concentrations up to 2,000 pCi/g and average Th-232 concentrations up to 6,000 pCi/g. Building debris, contaminated soils, and mill tailings will make up approximately 80 percent of the waste. The average activity of this material will be below 1,000 pCi/g for any site with most probable averages closer to 400 pCi/g.

Summarizing the data presented above, the following radiological waste characteristics are observed for the Energy*Solutions* 11e.(2) Embankment. Considering the relative proportions of lower and higher activity waste that could be sent to the Clive Facility, Energy*Solutions* estimates that the overall average concentration for any radionuclide will be approximately 500 pCi/g. However, individual sites may vary widely around that average, as described above. Because of this, individual shipments of wastes may contain higher average concentrations of Ra-226 and Th-232. In the context of waste deliveries to the disposal site a shipment is taken to mean a single waste-hauling truck or rail car from a single generator. Weighted average concentrations in a shipment must not exceed 4,000 pCi/g for natural uranium or any radionuclide in the Ra-226 series; 60,000 pCi/g of thorium-230; or 6,000 pCi/g for any radionuclide within the thorium series, although they may be present at those concentrations together.

Estimate that the volume of material to be handled and disposed of at the site would be 500,000 tons/year. Assuming an average Ra-226 and Th-232 concentration of 500 pCi/g, the estimated annual average total activity disposed of would be 227 Curies for each of the radionuclides. Since the daughter products may be assumed to be in secular equilibrium, there would be approximately 227 Curies of each of the other important radionuclides, such as Ra-228 and Ra-224. The amount of uranium would be expected to be less than 25 percent that of Ra-226. The average Th-230 concentration is expected to be similar to that of Ra-226 and will depend upon the disequilibrium of the radionuclides in that decay series. The actual amount of radioactivity disposed of in a given year will vary around the estimated 227 curies per radionuclide as actual concentrations and disposal amounts vary.

In addition to the radiological constituents, these wastes would be expected to include those constituents found in mill tailings in general, regardless of the source. The EPA has reported the upper ranges of elements in mill tailings from several sources that are presented in Table 7-4. In some cases these are not significantly different from "normal" soils, but due to the limited number of sources, concentrations of any of these constituents could be several times higher than reported. At these concentrations it is expected that arsenic, barium and lead would fail TCLP and that those wastes would be classified as exempt wastes.

Table 7-4

Concentrations of stable elements in Uranium Mill Tailings compared to the average Earth's crustal abundance.

Element	Concentration (PPM)	Average Crustal Concentration (PPM)
Aluminum	72,000	81,000
Aresenic	600 [1,2]	5
Barium	4,000 [1,2]	250
Bromine	6	2
Calcium	87,000	36,000
Chlorine	68,000 [1]	310
Chromium	7,300 [1,2]	200
Cobalt	140 [1]	23
Copper	1,200 [1]	70
Iron	320,000 [1]	50,000
Lead	3,100 [1,2]	16
Magnesium	17,000	21,000
Manganese	2,100 [1]	1,000
Mercury	34 [1,2]	0.5
Molybdenum	550 [1]	15
Nickel	1,100 [1]	80
Potassium	25,000	26,000
Rubidium	560	310
Selenium	230 [1,2]	0.1
Silver	10 [1,2]	0.1
Sodium	47,000	28,000
Strontium	4,100 [1]	300
Terbium	5	0.9
Thallium	10 [1]	0.6
Tin	6,200 [1]	40
Titanium	5,700	4,400
Tungsten	570 [1]	69
Vanadium	4,400 [1]	150
Zinc	2,200 [1]	132

1. Maximum observed concentrations substantially greater than average
2. Hazardous constituents from 10 CFR 40, App A, Criterion 5C.

For most of those elements listed as hazardous constituents, the very high concentrations were found at only one mill site; therefore, the average concentrations are expected to be much lower. Rough averages, based on the observed range of concentrations of the hazardous constituents, were less than half of the maximum observed concentrations. The NRC's Uranium Recovery Field Office in Denver, Colorado, conducted an extensive characterization of uranium mill tailing impoundments located in Wyoming, New Mexico and South Dakota over a five-year period to determine what hazardous constituents would likely be found in uranium mill tailings. Based on the findings of the investigation, the hazardous constituents listed in Table 7-5 were identified.

Energy*Solutions*' Hydrogeologic Report (Envirocare, 2004) concluded that it would take 400 to 600 years for leachate to travel through the unsaturated zone and then another 800 years to reach the nearest off-site well. No non-radiological constituent would reach the ground water in less than 700 years.

Release of radionuclides under normal conditions during operation of the site is limited to the following mechanisms:

1. Release of interstitially trapped radon and thoron gas when handling bulk wastes.
2. Exhalation of radon gas from embankment area(s) that have not been covered with the compacted clay radon barrier.
3. Exhalation of radon gas from embankment area(s) that have been covered with the compacted clay radon barrier.
4. Exhalation of thoron gas from the top layer of embankment areas that have not been covered with a layer of non-thorium-containing waste or clean clay.
5. Localized resuspension of dust from waste handling operations.
6. Windblown materials from the embankment and unloading area.

These release mechanisms, along with the exposure to direct radiation (gamma radiation), result in a radiation dose to the workers and off-site population.

Other release mechanisms have been determined to be insignificant at the Clive site. No surface water systems exist that could transport waste from the site. In addition, the lack of significant biota within the region reduces the potential for embankment or waste penetration and ultimate release to the environment. The local climate and the principal design features of the embankment create conditions for minimizing infiltration of radionuclides into the groundwater. Furthermore, the groundwater is not usable and therefore not a valid exposure pathway. Because of the negligible impact, these potential release mechanisms will not be discussed further in this section.

After closure, the principal design features of the embankment cover system will eliminate windblown particles from the embankment, reduce the radon emission to 20 pCi/m^2 s, and reduce direct gamma ray exposure rates near the disposal cells to background levels (approximately 10-15 mR/hr).

For a generic disposal site, the most significant radioactivity transport mechanisms are air, groundwater, surface water, direct radiation and biotic pathways. The five periods of principal concern to NRC include operational, closure, observational and surveillance, active institutional control, and passive institutional control periods (NRC, 1991). The periods of highest concern are operational and post-closure.

Table 7-5

Hazardous Constituent List: Wyoming, New Mexico and South Dakota Uranium Mill Tailing Impoundments

Metals	Volatile Organics	Semi-Volatile Organics	Radionuclides
Arsenic	Acetone	Diethylphthalate	Radium-226
Barium	2-Butanone	2-Methylnaphthalene	Radium-228
Beryllium	Chloroform		Thorium-230
Cadmium	Carbon disulfide		Thorium-232
Chromium	1,2-Dichloroethane		Uranium
Cyanide	Methylene chloride		
Fluorine	Naptha		
Lead			
Mercury			
Molybdenum			
Nickel			
Selenium			
Silver			

During the closure period one would not ordinarily expect continuing shipments of waste, so exposures from air, surface water, direct radiation, and biotic pathways should be less than exposures received during the operational period. No new wastes are being received, old wastes are being covered, and the surface is being decontaminated.

During the observational and surveillance, active institutional control, and passive institutional control periods, the site has already been decontaminated, wastes are covered, and there should again be no changes in exposures.

The evaluations of Appendices A, A-1, and E of Energy*Solutions*, (2005b) address exposure pathways for operational periods and were compared to regulatory standards. Results were used to determine potential exposures to on- and off-site personnel. Projected doses to on-site radiation workers are 1 rem/year or less and the annual regional population TEDE to off-site residents and nearby industrial workers is approximately 0.5 rem.

M&A (Appendices A and A-1 of Energy*Solutions*, 2005b) provided estimates of projected radionuclide release rates and radiological impacts during site operations, assuming waste that exhibits the radiological characteristics estimated for the overall 11e.(2) profile (500,000 tons per year of waste containing 500 pCi/g of each of the radionuclides in the uranium and thorium series). While these estimates demonstrate compliance with 10 CFR 20.1301 and 10 CFR 20.1302 under the assumed conditions, they do not completely serve the purpose of evaluating the variable characteristics of waste quantities and radionuclide concentrations that are expected to occur annually, or over shorter periods of time. M&A performed a sensitivity analysis of Energy*Solutions*' waste management procedures and waste characteristics (Appendices A and A-1 from Energy*Solutions*, 2005b). This analysis permits each waste handling procedure, from receipt to final closure, to be evaluated for its environmental impact while handling any quantity of wastes at any specified radioactivity concentration. The application of Energy*Solutions*, (2005b) to waste management will allow Energy*Solutions* to manage wastes within an envelope of quantities and radioactivity characteristics during the year while meeting the overall environmental results of Energy*Solutions*, (2005b).

Table 3.20, revised, of Energy*Solutions*, (2005b) provides a projection of Total Effective Dose Equivalent (TEDE) to eight receptors. This projection assumed that the waste was made up of both the thorium series and the uranium series with all radionuclide concentrations equal to 500 pCi/g, a conservative and improbable situation chosen to represent the expected long-term average concentrations of waste that might be received. A maximum off-site TEDE of 116.1 mrem/y at the south boundary was projected, if the radon and thoron impacts are included. The maximum TEDE for the nearest members of the public occurs for workers at Clean Harbors (Clive facility) at 5.2 mrem/yr.

Also reported in Table 3.20, revised, are TEDE for occupants in the controlled area (outside of the restricted area, but within Energy*Solutions'* controlled area). The TEDE for occupants of the Administration Building was calculated to be 76.3 mrem/y. The regional collective population TEDE was calculated (see Energy*Solutions*, (2005b), Table 3.21) to be approximately 0.016 person rem/year after 16 years of operation. This small value reflects the very limited population in the area and is considered insignificant.

The dose calculations above, from Appendices A and A-1 of Energy*Solutions*, (2005b) were based on a single assumed average concentration in waste with an annual total of 500,000 tons of waste disposed, or an annual disposal of 227 Ci of each of the radionuclides in the uranium and thorium series. Occupational and environmental doses are shown to be almost completely dependent upon the total amount of radioactivity managed. While the use of Energy*Solutions*, (2005b) provides considerable flexibility in waste management, the reliance upon the modeling of Appendices A, A-1, and E of Energy*Solutions*, (2005b) will assure that occupational and environmental impacts are as described in those appendices. With this option, Energy*Solutions* can safely dispose of any combination of radioactivity concentrations up to the shipment limits of 4,000 pCi/g for natural uranium and any radionuclide in the Ra-226 series; 60,000 pCi/g of thorium-230; and 6,000 pCi/g for any radionuclide in the thorium series. Application of this approach would automatically restrict the amount of waste that could be received at higher concentrations.

Included in the modeled receptor locations of Appendices A, A-1, and E of Energy*Solutions*, (2005b) are the environmental monitoring stations, making it possible to make a direct comparison between model results and measured airborne concentrations. The model and calculation spreadsheet will be used for operational planning purposes only. Energy*Solutions* will use environmental monitoring results to modify operations, if necessary, and to demonstrate compliance with dose and effluent concentration limits.

Projections of annual occupational TEDE were made by M&A for workers performing various operations at the site. It was assumed that the incoming wastes consisted of the uranium and thorium series with each radionuclide present at an average concentration of 500 pCi/g. Using other very conservative assumptions, a maximum TEDE of approximately 1 rem/year for any worker was calculated, meeting the criteria of 10 CFR 20.1201. Projections for each of the six types of waste handing operations are given in Table 3.22 of Energy*Solutions*, (2005b).

The potential for beta doses to the skin and lens of the eye was estimated from the equation (Schleien, 1989):

$$bD = 0.23\ Eb\ c$$

where: bD = Dose rate from an infinite cloud (rad/s)
Eb = Average beta energy per disintegration (MeV/dis)
c = Concentration of the beta emitting isotope in the cloud (Ci/m^3)

With 500 pCi/g of each of the nuclides of the thorium and uranium series in waste there are 5,000 pCi/g of beta emitters with an average beta energy of approximately 0.205 MeV. With an airborne particulate concentration of 1 mg/m^3, the beta dose rate to the skin or lens of the eye is calculated to be approximately 7.4 mrem/y. Therefore, external beta doses are not considered to be significant.

The model of Appendices A, A-1, and E of Energy*Solutions*, (2005b), based on an assumption of handling the maximum quantity of waste permitted under this application (500,000 tons per year) with an average concentration of each nuclide at 500 pCi/g, is believed to be conservative. It is not possible to model each potential situation, such as a shorter waste disposal period while handling wastes at higher concentrations. Occupational doses are primarily a function of the total radioactivity disposed of during the year. For those cases where waste containing radioactivity concentrations significantly greater than 500 pCi/g for each radionuclide are handled for extended periods, Energy*Solutions* will closely monitor internal and external exposures to maintain TEDE as low as reasonably achievable and, in all cases, below the standards of 10 CFR 20.1201.

7.4 NON-RADIOLOGICAL EFFECTS

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (a) An assessment of the radiological and non-radiological impacts to the public health from the activities to be conducted pursuant to the license or amendment;" **– R313-24-3(1)(a).**

Industrial Health Incorporated performed an analysis of projected fatalities associated with the excavation, transportation, and disposal of 11e.(2) byproduct material. This analysis is included as Appendix I-1 of Energy*Solutions*, (2005b). The analysis is based upon U.S. Department of Labor statistical data from 1989 and U.S. Department of Transportation (DOT) statistical data from 1990. IHI determined that for Standard Industrial Classification Code 16, which includes construction activities, there were 0.000293 fatalities per worker year.

This means that for an estimated 20 construction workers at any of the alternatives there would be 0.00586 expected fatalities per year. For rail transportation, based on 152,900m^3(200,000 yd^3) and a 3700-km (2300-mi) haul, it was determined that there would be an estimated 0.26 fatalities per year. Non-radiological effects are discussed further in the 11e.(2) Environmental Assessment (Appendix H).

7.5 EFFECTS OF ACCIDENTS

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (a) An assessment of the radiological and non-radiological impacts to the public health from the activities to be conducted pursuant to the license or amendment;" **– R313-24-3(1)(a).**

NRC categorizes incidents involving releases of radioactivity as trivial incidents, small releases, and large releases (NRC, 1980). Trivial releases for a model mill all involve plumbing releases up to and including a breach of a tailings disposal line carrying 70 tons per hour of tailings. Small releases include failure of the yellowcake air-cleaning system, fire or explosion in the solvent extraction circuit, and gas explosion in the yellowcake drying operation. Large releases could occur from tornadoes or breaches in the tailings dam caused by flooding, earthquakes, or structural failure. Obviously the types of releases that could occur at the Clive site are more limited than those that could occur at a mill site and would largely be classed as trivial in that the potential for either significant on-site or significant off-site doses would be expected to be small.

Since we have no movement of mill tailings through piping or other plumbing we would have no releases of radioactivity from piping breaks. Flammable or explosive fuels are not stored in close proximity to the wastes and the principal flammable material is in the fuel tanks of the individual work vehicles. A vehicle fire, even on a loaded haul truck, would not be expected to release any significant quantity of the load as airborne dust. The possible release scenarios, all of low probability but ranged in order of increasing improbability, are:

1. on-site truck turnover or collision;
2. train derailment;
3. flooding; and,
4. tornado.

The above scenarios all result in the exposure of wastes to the natural elements and forces of nature. The Department of Energy evaluated the impacts of accidental releases of material associated with the disposal of mill tailings at Clive (DOE, 1984). They concluded that the worst accident would result in the spillage of the equivalent of a train car of bulk waste material in transit to the site. A second case was evaluated where a similar size spill occurred but the spillage occurred into the Great Salt Lake. Impacts of these events were found to be negligible compared to the impacts from normal operations. The average bulk 11e.(2) waste brought to the Energy*Solutions* site will be similar in physical and chemical form to the Vitro mill tailings and, therefore, no additional assessments of accidental releases off site will be made. The following accidental on-site releases have been evaluated 1) On-site truck turnover or collision, 2) Train derailment, 3) Flooding, 4) Tornado, and 5) Severe Winds.

7.5.1 On-site truck turnover or collision:

From NUREG-0706 the probability of a truck accident is in the range of 1.0 to 1.6×10^{-6}/km (NRC, 1980). There are two kinds of truck movements to be considered at the Clive site. These are arriving waste shipments and haul trucks moving material from the rollover or storage to the disposal cell. Assuming that there are 3 incoming trucks per day and 50 loaded trucks per day from the rollover or storage to the trench and assuming that the on-site distance traveled by any loaded truck is one kilometer, the probability of an accident in any one year is:

1.3 x 10-6/km x 53 loads/day x 260 days/year x 1 km/load
= 1.8 x 10-2 or about 1.8%.

Most of the material from the truck would be deposited on the ground in the immediate vicinity of the truck. Based on NUREG-0706, for a wind speed of 10 mph, about 0.1% of the material would become airborne immediately (for dry material) (NRC, 1980). Obviously if the material is moist, the release fraction would be less. For a 20-ton (40,000 pound) truck, about 40 pounds or less might become airborne. This compares with about 24 pounds of dust that becomes airborne daily per hectare of a mill tailings pile surface. If the spill is not cleaned up or dust controlled rapidly, the release fraction over a 24-hour period might increase to as much as 0.9 percent or 360 pounds. This is highly unlikely because of the presence on-site of crews and equipment that are there for the express purpose of managing bulk wastes. Because of moisture differences and differences in waste composition from the model mill assumptions, we would expect to have lower release fractions in an actual accident situation.

For a theoretical truck accident involving a yellowcake shipment, a 24-hour release period, all particles in the reparable range, and a population density of 7.5 persons per square mile, the NRC estimated 50-year

dose commitments to the lungs of the general public in the range of 0.7 to 9 person-rem. The yellowcake specific activity is about 6.77×10^5 pCi/g while the average uranium or thorium concentrations expected at Energy*Solutions* would be 500 pCi/g, or a factor of 1,300 lower. Individual shipments to Energy*Solutions* might have Ra-226 concentrations as high as 4,000 pCi/g, or similar to those found in uranium mill tailings. Concentrations of 232Th in a small fraction of shipments could be as high as 6,000 pCi/g. The dose per unit intake via inhalation is higher for Th-232 wastes than for yellowcake by up to a factor of 1,000, depending upon the chemical form and radionuclide mix. Therefore, the postulated off-site public doses could be approximately an order of magnitude higher than for a yellowcake spill under the same circumstances. However, the population distribution around the Clive site is insignificant compared to that in the calculation and, therefore, the off-site population dose would be inconsequential.

For on-site workers, there would be a very short exposure time since there would be no reason to stand downwind for 24 hours (or even one hour). Assuming an accident involving the spill of a load of waste with a concentration of 15,000 pCi/g; a period of three hours for cleanup with no use of respiratory protection; an airborne concentration of 1 mg/m^3; and a respiratory rate of 1.2 m^3/hr a total of 54 pCi of each nuclide would be inhaled. Comparing these to the Allowable Limit of Intake (ALIs) from Appendix B of 10 CFR 20.1.001 - 4201, the sum of fractions is 0.022. The external gamma dose, using the relationship of 3.1 mrem/h/pCi/g for Ra-226 from condition 26 of Energy*Solutions*, (2012b) and doubling for the contribution from Ra-228, would be less than 140 mrem. Such a dose added to the projected maximum TEDE of 1,032 mrem/yr would still be well within the permissible annual exposures for radiation workers. In actual fact, no workers would be present under such conditions without respiratory protection and would not be standing on the spilled waste for more than a few minutes.

Radiation doses to non-radiation workers would be limited by promptly evacuating such persons from the vicinity of such an accident. Non-radiation workers who might respond as part of an emergency team would be monitored and would spend a limited amount of time in proximity to the waste. It is believed that no person who is not a radiation worker would remain in the vicinity for more than 30 minutes. Therefore, comparing inhalation exposures and external doses to those for radiation workers, it is obvious that no non-radiation worker would receive in excess of 100 mrem.

7.5.2 Train derailment

The probability of a train derailment occurring on the Clive site is not readily calculable. However, because of the short length of track involved and the low train speeds compared to truck speeds, the impact of derailment should be much less than the impact of a truck accident.

The dose to the workers and to the population should be much less than that for an off-site derailment and spillage event since trained workers and equipment would be available to immediately use dust control measures to control releases and clean-up the spill. The DOE, as discussed above, concluded that the dose to cleanup workers and nearby residents from such an off-site spill was insignificant. As a worst case, the same assumptions could be applied as for the truck accident scenario above, with the same low total dose to emergency response teams.

7.5.3 Flooding

Flood control features for both the Vitro and Clive sites have been designed and constructed to prevent erosion or off-site transport of wastes from the sites by overland flooding. Details of the flood control features are provided in Section 3.4.4 of Energy*Solutions*, (2005a). No off-site transport of radioactive waste by flooding is anticipated.

7.5.4 Tornado

From NUREG-0706, the probability of tornado occurrence in Utah is probably in the range of 1 to $5x10^{-4}$ (NRC, 1980). NUREG-0706 also estimates the consequences of a tornado striking a model uranium mill. In this case about 12.6 tons of yellowcake is entrained in the vortex, the vortex dissipates at the site boundary, all of the yellowcake is reparable in size, and the cloud is dispersed as a volume source by the prevailing winds. Settling velocity is negligible. The model predicts a maximum exposure at 2.5 miles from the mill, where the 50-year dose commitment is estimated to be 0.83 micro-rem. At the fence line (1600 feet) the dose is estimated to be 0.22 micro-rem. Our wastes would have average activities considerably less than this but as discussed above, the TEDE per unit intake is higher, resulting in comparable doses at receptor locations. Since there are no nearby population groups, this very small potential dose is even more insignificant.

7.5.5 Severe Winds

In the preceding discussion of airborne exposures resulting from tornadoes it was concluded that the maximum 50-year dose commitment at 2.5 miles would be less than 1 micro-rem. That conclusion is derived from a NUREG-0706 analysis of tornado-dispersed yellowcake from a uranium mill and is considered a conservative analysis compared to the transport of Th-232 waste from the Clive Site under similar conditions (NRC, 1980).

While severe winds on the order of 35 m/s have been recorded in the vicinity, the occurrence is infrequent and the duration is short. Assuming an order of magnitude increase in airborne concentrations during severe wind conditions that occur approximately one percent of the time, the time-weighted average off-site exposure would increase by only 10 percent. This would result in a maximum additional annual collective TEDE of less than 1 mrem to nearby population groups.

7.5.6 Transfer Mechanism - Groundwater

The possibility of contamination releases to known water resources is highly unlikely. Without extensive treatment, use of groundwater in the Clive area is confined to very limited industrial uses. There is minimal potential for degradation of water quality in the vicinity of the Clive site, inasmuch as the water at the site has been characterized as a brine, with levels of many constituents often exceeding EPA primary or secondary drinking water standards by a large amount.

The Revised Hydrogeologic Report (Envirocare, 2004) concluded that it would take 400 to 600 years for leachate to travel through the unsaturated zone and then another 800 years to reach the nearest off-site well. No non-radiological constituent would reach the groundwater in less than 700 years. Using this estimate, it would take well over 1,000 years for any groundwater from the 11e.(2) Embankment to reach the boundary of the Energy*Solutions* facility.

7.5.7 Transfer Mechanism - Air

Because of the location of the Clive facility, the meteorological characteristics of the area, and the lack of population within 20 miles of the facility, the impact of air as a transfer mechanism for radioactivity is limited. The modeling study conducted by Momeni, 1980 concluded that the annual population TEDE (exclusive of doses to workers at the nearby hazardous waste operations) after 16 years of operation would be 0.016 person-rem/year. Calculated TEDE to the nearby hazardous waste workers would add approximately 0.5 person-rem/year.

7.5.8 Transfer Mechanism - Surface Water

The probability of contamination through surface water is highly unlikely inasmuch as there are no surface waters at the site.

7.5.9 Other Transfer Mechanisms

Because of the location of the Clive facility, the sparse biota in the area, and the lack of population within 20 miles of the facility, the impacts of other transfer mechanisms such as gamma radiation through air and transfer of radioactivity through biotic pathways are very small.

7.6 ECONOMIC AND SOCIAL EFFECTS OF CONSTRUCTION AND OPERATION

"A license application shall be approved if the Executive Secretary determines that:(f) in the case of an application for a license to receive and possess radioactive material for commercial waste disposal by land burial, or for the conduct of other activities which the Executive Secretary determines will significantly affect the quality of the environment, the Executive Secretary, before commencement of construction of the plant or facility in which the activity will be conducted, has concluded, after weighing the environmental, economic, technical and other benefits against environmental costs and considering available alternatives, that the action called for is the issuance of the proposed license, with any appropriate conditions to protect environmental values. The Executive Secretary shall respond to the application within 60 days. Commencement of construction prior to a response and conclusion shall be grounds for denial of a license to receive and possess radioactive material in the plant or facility. As used in this paragraph the term "commencement of construction" means clearing of land, excavation, or other substantial action that would adversely affect the environment of a site. The term does not mean site exploration, necessary borings to determine foundation conditions, or other preconstruction monitoring or testing to establish background information related to the suitability of the site or the protection of environmental values." **– R313-22-33(1)(f).**

"*Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (a) An assessment of the radiological and non-radiological impacts to the public health from the activities to be conducted pursuant to the license or amendment;*" **– R313-24-3(1)(a).**

Current 11e.(2) waste shipments originate at the Maywood, NJ and the Kerr McGee West Chicago, IL projects. Future shipments could originate from other, currently unidentified, locations. Most rail and truck shipments that now arrive at the Clive Facility have minimal travel time through populated areas. During both the Vitro project and the operation of the Clive Facility, there have been no socioeconomic effects from the shipment of waste through populated areas. All waste that is shipped to Clive must be properly packaged in accordance with the DOT standards for the respective waste. This has proven to minimize the concern of citizens along the transportation routes. Economic and social effects of construction and operation are discussed further in the 11e.(2) Environmental Assessment (Appendix H).

7.7 PUBLIC AND OCCUPATIONAL HEALTH

In general, site-specific assessments of potential radiological impacts for the Energy*Solutions* 11e.(2) byproduct material disposal facility are not sufficiently advanced to estimate occupational and public doses with confidence. In lieu of such assessments, potential radiological health impacts have been estimated by a comparison of the proposed operations with the operations of the disposal facility for uranium mill tailings from the South Salt Lake Uranium Mill Tailings Remedial Action Project (UMTRAP). This disposal facility is located immediately adjacent to the disposal facility for 11e.(2) byproduct material. Although some differences exist between the two disposal facilities for disposal operations and estimated source terms, the facilities are sufficiently similar to estimate potential radiological impacts of the proposed 11e.(2) byproduct material disposal facility. In addition, because disposal operations at the UMTRAP facility are complete, the environmental and occupational data collected during waste disposal operations at the facility provide reliable information to confirm the validity of the estimates of the projected radiological impacts. Major sources and levels of background radiation exposure; current sources and levels of radioactive material exposure; major sources and levels of chemical exposure; historical exposure; historical exposures to radioactive materials; occupational injury rates and occupational fatality rates; summary of health effects studies are discussed further in the 11e.(2) Environmental Assessment (Appendix H).

SECTION 8. EMERGENCY RESPONSE PLAN

"a) Applications to possess radioactive materials in unsealed form, on foils or plated sources, or sealed in glass in excess of the quantities in Section R313-22-90, "Quantities of Radioactive Materials Requiring Consideration of the Need for an Emergency Plan for Responding to a Release", shall contain either:

(i) An evaluation showing that the maximum dose to a individual off-site due to a release of radioactive materials would not exceed one rem effective dose equivalent or five rems to the thyroid; or

(ii) An emergency plan for responding to a release of radioactive material.

b) One or more of the following factors may be used to support an evaluation submitted under Subsection R313-22-32(8)(a)(i):

(i) The radioactive material is physically separated so that only a portion could be involved in an accident;

(ii) All or part of the radioactive material is not subject to release during an accident because of the way it is stored or packaged;

(iii) The release fraction in the respirable size range would be lower than the release fraction shown in Section R313-22-90 due to the chemical or physical form of the material;

(iv) The solubility of the radioactive material would reduce the dose received;

(v) Facility design or engineered safety features in the facility would cause the release fraction to be lower than shown in Section R313-22-90;

(vi) Operating restrictions or procedures would prevent a release fraction as large as that shown in Section R313-22-90; or

(vii) Other factors appropriate for the specific facility.

c) An emergency plan for responding to a release of radioactive material submitted under Subsection R313-22-32(8)(a)(ii) shall include the following information:

(i) Facility description. A brief description of the licensee's facility and area near the site.

(ii) Types of accidents. An identification of each type of radioactive materials accident for which protective actions may be needed.

(iii) Classification of accidents. A classification system for classifying accidents as alerts or site area emergencies.

(iv) Detection of accidents. Identification of the means of detecting each type of accident in a timely manner.

(v) Mitigation of consequences. A brief description of the means and equipment for mitigating the consequences of each type of accident, including those provided to protect workers on-site, and a description of the program for maintaining equipment.

(vi) Assessment of releases. A brief description of the methods and equipment to assess releases of radioactive materials.

(vii) Responsibilities. A brief description of the responsibilities of licensee personnel should an accident occur, including identification of personnel responsible for promptly notifying off-site response organizations and the Executive Secretary; also responsibilities for developing, maintaining, and updating the plan.

(viii) Notification and coordination. A commitment to and a brief description of the means to promptly notify off-site response organizations and request off-site assistance, including medical assistance for the treatment of contaminated injured on-site workers when appropriate. A control point shall be established. The notification and coordination shall be

planned so that unavailability of some personnel, parts of the facility, and some equipment will not prevent the notification and coordination. The licensee shall also commit to notify the Executive Secretary immediately after notification of the appropriate off-site response organizations and not later than one hour after the licensee declares an emergency. NOTE: These reporting requirements do not supersede or release licensees of complying with the requirements under the Emergency Planning and Community Right-to-Know Act of 1986, Title III, Public Law 99-499 or other state or federal reporting requirements, including 40 CFR 302, 2010.

(ix) Information to be communicated. A brief description of the types of information on facility status, radioactive releases, and recommended protective actions, if necessary, to be given to off-site response organizations and to the Executive Secretary.

(x) Training. A brief description of the frequency, performance objectives and plans for the training that the licensee will provide workers on how to respond to an emergency including special instructions and orientation tours the licensee would offer to fire, police, medical and other emergency personnel. The training shall familiarize personnel with site-specific emergency procedures. Also, the training shall thoroughly prepare site personnel for their responsibilities in the event of accident scenarios postulated as most probable for the specific site including the use of team training for the scenarios.

(xi) Safe shutdown. A brief description of the means of restoring the facility to a safe condition after an accident.

(xii) Exercises. Provisions for conducting quarterly communications checks with off-site response organizations and biennial on-site exercises to test response to simulated emergencies. Quarterly communications checks with off-site response organizations shall include the check and update of all necessary telephone numbers. The licensee shall invite off-site response organizations to participate in the biennial exercises. Participation of off-site response organizations in biennial exercises although recommended is not required. Exercises shall use accident scenarios postulated as most probable for the specific site and the scenarios shall not be known to most exercise participants. The licensee shall critique each exercise using individuals not having direct implementation responsibility for the plan. Critiques of exercises shall evaluate the appropriateness of the plan, emergency procedures, facilities, equipment, training of personnel, and overall effectiveness of the response. Deficiencies found by the critiques shall be corrected.

(xiii) Hazardous chemicals. A certification that the applicant has met its responsibilities under the Emergency Planning and Community Right-to-Know Act of 1986, Title III, Public Law 99-499, if applicable to the applicant's activities at the proposed place of use of the radioactive material.

d) The licensee shall allow the off-site response organizations expected to respond in case of an accident 60 days to comment on the licensee's emergency plan before submitting it to the Executive Secretary. The licensee shall provide any comments received within the 60 days to the Executive Secretary with the emergency plan." **– R313-22-32(8).**

Energy*Solutions'* Emergency Response Plan is catalogued in Appendix E. This plan establishes requirements to protect personnel and the environment in the event of an explosion, a fire, or an unplanned release to the environment. In addition to Energy*Solutions* Clive staff, the Emergency Response Plan also applies to contractors and visitors that enter the Energy*Solutions* premises at Clive.

8.1 NOTIFICATIONS

"(1) Licensees shall notify the Executive Secretary as soon as possible but not later than four hours after the discovery of an event that prevents immediate protective actions necessary to avoid exposures to radiation or radioactive materials that could exceed regulatory limits or releases of licensed material that could exceed regulatory limits. Events may include fires, explosions, toxic gas releases, etc.

(2) The following events involving licensed material require notification of the Executive Secretary by the licensee within 24 hours:

a) an unplanned contamination event that:

(i) requires access to the contamination area, by workers or the public, to be restricted for more than 24 hours by imposing additional radiological controls or by prohibiting entry into the area;

(ii) involves a quantity of material greater than five times the lowest annual limit on intake specified in Appendix B of 10 CFR 20.1001 through 20.2402 (2010), which is incorporated by reference, for the material; and

(iii) has access to the area restricted for a reason other than to allow radionuclides with a half- life of less than 24 hours to decay prior to decontamination; or

b) an event in which equipment is disabled or fails to function as designed when:

(i) the equipment is required by rule or license condition to prevent releases exceeding regulatory limits, to prevent exposures to radiation and radioactive materials exceeding regulatory limits, or to mitigate the consequences of an accident;

(ii) the equipment is required by rule or license condition to be available and operable; and

(iii) no redundant equipment is available and operable to perform the required safety function; or

c) an event that requires unplanned medical treatment at a medical facility of an individual with spreadable radioactive contamination on the individual's clothing or body; or

d) an unplanned fire or explosion damaging licensed material or a device, container, or equipment containing licensed material when:

(i) the quantity of material involved is greater than five times the lowest annual limit on intake specified in Appendix B of 10 CFR 20.1001 through 20.2402 (2010), which is incorporated by reference, for the material; and

(ii) the damage affects the integrity of the licensed material or its container.

(3) Preparation and submission of reports. Reports made by licensees in response to the requirements of Section R313-19-50 must be made as follows:

a) For radioactive materials, other than special nuclear material, licensees shall make reports required by Subsections R313-19-50(1) and (2) by telephone to the Executive Secretary. To the extent that the information is available at the time of notification, the information provided in these reports must include:

(i) the caller's name and call back telephone number;

(ii) a description of the event, including date and time;

(iii) the exact location of the event;

(iv) the radionuclides, quantities, and chemical and physical form of the licensed material involved; and

(v) available personnel radiation exposure data.

b) For special nuclear materials, licensees shall make reports required by Subsections R313-19-50(1) and (2) by telephone to the Executive Secretary. To the extent that the information is available at the time of notification, the information provided in these reports must include:

(i) the caller's name, position title, and call-back telephone number;

(ii) the date, time, and exact location of the event; and
(iii) a description of the event, including:
(A) radiological or chemical hazards involved, including isotopes, quantities, and chemical and physical form of any material released; and
(B) actual or potential health and safety consequences to the workers, the public, and the environment, including relevant chemical and radiation data for actual personnel exposures to radiation or radioactive materials or hazardous chemicals produced from radioactive materials (e.g., level of radiation exposure, concentration of chemicals, and duration of exposure).

c) Written report for materials other than special nuclear materials. A licensee who makes a report required by Subsections R313-19-50(1) or (2) shall submit a written follow-up report within 30 days of the initial report. Written reports prepared pursuant to other rules may be submitted to fulfill this requirement if the reports contain all of the necessary information and the appropriate distribution is made. These written reports shall be sent to the Executive Secretary. The report shall include the following:
(i) A description of the event, including the probable cause and the manufacturer and model number, if applicable, of equipment that failed or malfunctioned;
(ii) the exact location of the event;
(iii) the radionuclides, quantities, and chemical and physical form of the licensed material involved;
(iv) date and time of the event;
(v) corrective actions taken or planned and results of evaluations or assessments; and
(vi) the extent of exposure of individuals to radiation or radioactive materials without identification of individuals by name.

d) Written report for special nuclear material. A licensee who makes a report required by Subsections R313-19-50(1) or (2) shall submit a written follow-up report within 30 days of the initial report. Written reports prepared pursuant to other rules may be submitted to fulfill this requirement if the reports contain all of the necessary information and the appropriate distribution is made. These written reports shall be sent to the Executive Secretary. The report shall include the following:
(i) the complete applicable information required by Subsection R313-19-50(3)(b);
(ii) the probable cause of the event, including all factors that contributed to the event and the manufacturer and model number (if applicable) of any equipment that failed or malfunctioned; and
(iii) corrective actions taken or planned to prevent occurrence of similar or identical events in the future and the results of any evaluations or assessments." **– R313-19-50.**

"(1) Telephone Reports. Each licensee or registrant shall report to the Executive Secretary by telephone as follows:

a) Immediately after its occurrence becomes known to the licensee or registrant, stolen, lost, or missing licensed or registered radioactive material in an aggregate quantity equal to or greater than 1,000 times the quantity specified in Appendix C of 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference, under such circumstances that it appears to the licensee or registrant that an exposure could result to individuals in unrestricted areas;

b) Within 30 days after its occurrence becomes known to the licensee or registrant, lost, stolen, or missing licensed or registered radioactive material in an aggregate quantity greater than ten times the quantity specified in Appendix C of 10 CFR 20.1001 to 20.2402, (2010), which is incorporated by reference, that is still missing.

c) Immediately after its occurrence becomes known to the registrant, a stolen, lost, or missing radiation machine.

(2) Written Reports. Each licensee or registrant required to make a report pursuant to Subsection R313-15-1201(1) shall, within 30 days after making the telephone report, make a written report to the Executive Secretary setting forth the following information:

a) A description of the licensed or registered source of radiation involved, including, for radioactive material, the kind, quantity, and chemical and physical form; and, for radiation machines, the manufacturer, model and serial number, type and maximum energy of radiation emitted;

b) A description of the circumstances under which the loss or theft occurred; and

c) A statement of disposition, or probable disposition, of the licensed or registered source of radiation involved; and

d) Exposures of individuals to radiation, circumstances under which the exposures occurred, and the possible total effective dose equivalent to persons in unrestricted areas; and

e) Actions that have been taken, or will be taken, to recover the source of radiation; and

f) Procedures or measures that have been, or will be, adopted to ensure against a recurrence of the loss or theft of licensed or registered sources of radiation.

(3) Subsequent to filing the written report, the licensee or registrant shall also report additional substantive information on the loss or theft within 30 days after the licensee or registrant learns of such information.

(4) The licensee or registrant shall prepare any report filed with the Executive Secretary pursuant to Section R313-15-1201 so that names of individuals who may have received exposure to radiation are stated in a separate and detachable portion of the report." **– R313-15-1201.**

"(1) Immediate Notification. Notwithstanding other requirements for notification, each licensee or registrant shall immediately report each event involving a source of radiation possessed by the licensee or registrant that may have caused or threatens to cause any of the following conditions:

a) An individual to receive:

(i) A total effective dose equivalent of 0.25 Sv (25 rem) or more; or

(ii) A lens dose equivalent of 0.75 Sv (75 rem) or more; or

(iii) A shallow dose equivalent to the skin or extremities or a total organ dose equivalent of 2.5 Gy (250 rad) or more; or

b) The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake five times the occupational ALI. This provision does not apply to locations where personnel are not normally stationed during routine operations, such as hot- cells or process enclosures.

(2) Twenty-Four Hour Notification. Each licensee or registrant shall, within 24 hours of discovery of the event, report to the Executive Secretary each event involving loss of control of a licensed or registered source of radiation possessed by the licensee or registrant that may have caused, or threatens to cause, any of the following conditions:

a) An individual to receive, in a period of 24 hours:

(i) A total effective dose equivalent exceeding 0.05 Sv (five rem); or

(ii) A lens dose equivalent exceeding 0.15 Sv (15 rem); or

(iii) A shallow dose equivalent to the skin or extremities or a total organ dose equivalent exceeding 0.5 Sv (50 rem); or

b) The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake in excess of one occupational ALI. This provision does not apply to locations where personnel are not normally stationed during routine operations, such as hot- cells or process enclosures.

(3) The licensee or registrant shall prepare each report filed with the Executive Secretary pursuant to Section R313-15-1202 so that names of individuals who have received exposure to sources of radiation are stated in a separate and detachable portion of the report.
(4) Licensees or registrants shall make the reports required by Subsections R313-15-1202(1) and R313- 15-1202(2) to the Executive Secretary by telephone, telegram, mailgram, or facsimile.
*(5) The provisions of Section R313-15-1202 do not apply to doses that result from planned special exposures, provided such doses are within the limits for planned special exposures and are reported pursuant to Section R313-15-1204."***– R313-15-1202.**

"The licensee shall immediately notify the Executive Secretary, by telephone within 24 hours and by letter within 7 days of any waste shipment where a violation of applicable regulations or license conditions has been found." **– LICENSE CONDITION 12.5**

"The licensee shall immediately report to the Executive Secretary: 1) any failure of the 11e.(2) byproduct material disposal cell that results in a release of waste into unrestricted areas; or 2) 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." **– LICENSE CONDITION 12.8**

Notification of the implementation of the Emergency Response Plan (catalogued in Appendix E) are transmitted on the Emergency Channel or EMT Channel of the Site Radio System and following the protocol established for emergency announcements on the mobile phone system. Send Word Now Distribution Lists are established as follows:

- Emergency Coordinators and Site Directors: Notifications are made via Assigned Mobile Phone and/or e-mail to this distribution list.
- Facility EMTs First Responders and Ambulance Drivers: Notifications are made to Assigned Mobile Phones.
- Spill Response Team Members: Notifications are made to Assigned Mobile Phones.
- All facility personnel: Notifications are made to Assigned Mobile Phones (also include e-mail for Site Directors).

A radio group has been established for all facility EMTs. A radio compatible with transmission between facility EMTs is also maintained in the security office and on the facility ambulance. Prior to the beginning of each week the Facility Director or designee is determined who will fulfill the following positions for Outside Operations, LLRW Operations, and Mixed Waste:

- Emergency Coordinator
- EMT Leads
- Spill Response Team Leads

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

8.2 LEAKING SHIPMENTS

"The licensee shall, upon arrival of the waste and before acceptance on site, visually inspect the waste or use the Environmental Protection Agency's Paint Filter Liquids Test (SW-846, Method 9095) to determine if the waste contains free liquids. The licensee shall not accept any waste containing free liquid for disposal. The licensee however, shall be subject to the following minimum frequency of Paint Filter Liquids Test analyses and sample collection requirements: (1) for each waste stream, the minimum number of samples to be analyzed shall be one sample for each shipment (rail or highway) for the first 1,000 yd 3 (or any part thereof), and (2) thereafter the minimum number of samples to be analyzed shall be one sample for each set of ten (10) shipments. The licensee shall manage leaking waste shipments and/or waste containing greater than one percent (1%) free liquid as listed below, or for other reasons, reject the shipment for disposal:

a) Upon discovery of free-liquids or a leaking shipment, the licensee shall immediately notify the Executive Secretary (within 24 hours) and shall provide a written notification to the Executive Secretary within fourteen (14) calendar days of the immediate notification containing the following:
   (1) Generator number
   (2) RSR number or Bates Number for the shipment(s)
   (3) Date accepted or rejected for disposal
   (4) Corrective Actions

b) The licensee shall take leaking rail shipments to the railcar decontamination wash-down pad and leaking truck shipments to the decontamination wash-down pads or railcar rollover facility.

c) The licensee shall take shipments containing more than one percent (1%) free liquids to one of the following areas:
   (1) Restricted-area sections of the railroad
   (2) Restricted-area asphalt or concrete surfaces
   (3) Wash-down pads
   (4) Approved temporary storage areas
   (5) Rollover containment area
   (6) Unloading area

d) The licensee shall remediate using one or more of the following methods:
   (1) Solidification through the use of agents generally accepted by the industry, such as clay, sand, and other adsorptive materials and documenting formula development.
   (2) Evaporation
   (3) Physical removal of liquid

e) Upon completion of remediation, the shipment may be accepted for disposal and moved to either the 11e.(2) disposal cell or to an approved 11e.(2) waste management area." **– LICENSE CONDITION 10.6.**

Leaking shipments of 11e.(2) material are managed and reported in accordance with the requirements found in condition 10.6 of the 11e.(2) Radioactive Material License UT2300478. If the initial identifier observes liquids draining from a waste container or conveyance, the initial identifier contacts Security and implements the emergency response plan.

If the Spill Response Team Leader or Emergency Coordinator is unable to determine the source of the liquid, they must direct action to be taken to control the leaking liquid and move the container into the

restricted area (if outside) so that further evaluation can be done to determine the source. The period of time for evaluation will not exceed twenty four hours.

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

At a minimum, measure the pH of the potentially contaminated liquid and record result(s) on 24 Hour/5 Day Spill Notification Report, CL-SH-PR-500-F1. Liquid grab sample(s) for radiological analysis may be taken if at least 500 ml of volume is collected. Use sample equipment provided by the lab for liquid grab samples (Note: Analytical results will be considered suspect for liquid samples that have come in contact with other contaminated sources). Grab samples for radiological and or chemical analysis in the lab require the following proper characterization of the spill area:

- One background sample taken from an area approximately 10 feet from the spill area,
- At least one pre-clean up sample and,
- At least one post-clean up sample.

Surface swipe for radiological or chemical analysis may be performed to identify contamination. All samples submitted to the lab require a Chain of Custody in accordance with CL-LB-PR-011, Chain of Custody. All reviewed analytical data and Chain of Custodies are attached to the 24 Hour/5 Day Spill Notification Report, CL-SH-PR-500-F1.

SECTION 9. ALTERNATIVES TO PROPOSED ACTION

"A license application shall be approved if the Executive Secretary determines that:(f) in the case of an application for a license to receive and possess radioactive material for commercial waste disposal by land burial, or for the conduct of other activities which the Executive Secretary determines will significantly affect the quality of the environment, the Executive Secretary, before commencement of construction of the plant or facility in which the activity will be conducted, has concluded, after weighing the environmental, economic, technical and other benefits against environmental costs and considering available alternatives, that the action called for is the issuance of the proposed license, with any appropriate conditions to protect environmental values. The Executive Secretary shall respond to the application within 60 days. Commencement of construction prior to a response and conclusion shall be grounds for denial of a license to receive and possess radioactive material in the plant or facility. As used in this paragraph the term "commencement of construction" means clearing of land, excavation, or other substantial action that would adversely affect the environment of a site. The term does not mean site exploration, necessary borings to determine foundation conditions, or other preconstruction monitoring or testing to establish background information related to the suitability of the site or the protection of environmental values." **– R313-22-33(1)(f).**

"Each new license application, renewal, or major amendment shall contain an environmental report describing the proposed action, a statement of its purposes, and the environment affected. The environmental report shall present a discussion of the following: (c) Consideration of alternatives, including alternative sites and engineering methods, to the activities to be conducted pursuant to the license or amendment;" **– R313-24-3(1)(c).**

The Clive, Utah, site adjoins the 100-acre location where the DOE disposed of 2,800,000 cubic yards of uranium mill tailings from the Vitro Chemical Company. Also, Energy*Solutions* has four licensed disposal facilities adjacent to the 11e.(2) Embankment, an LARW embankment (which is capped and no longer receiving waste), the Class A and Class A North embankments, and a Mixed Waste landfill cell.

Energy*Solutions*, as part of the original license application, evaluated whether the proposed site for the disposal of 11e.(2) material met the requirements of 10 CFR Part 40, including Appendix A, by reviewing the initial site selection for the Vitro tailings project and evaluating suitability of three additional sites. Energy*Solutions* developed and reviewed six alternatives as part of the original license application. They are as follows:

Alternative 1	Disposal at the Clive site in an above ground embankment;
Alternative 2	Disposal at the Clive site in a deep below-ground embankment;
Alternative 3	Disposal at the Clive site in a shallow below-ground embankment;
Alternative 4	Disposal at the Skunk Ridge site, located northeast of the Clive site, in Tooele County, Utah;
Alternative 5	Disposal at the Blanding site, located in San Juan County, Utah; and,
Alternative 6	Disposal at a hypothetical existing mill tailings site located in the northeastern United States.

Energy*Solutions* evaluated each alternative on the basis of the requirements of Criterion 1. Eleven criteria were developed, covering Criterion 1 and other factors. The six criteria that comprise the three principal requirements of Criterion 1 were given a weight factor of 10, two criteria were given factors of eight, while

the remaining three criteria were given factors of 3. The criteria were then rated from 1 to 10 for each alternative. The results of the evaluation are presented in Table 9-1.

After evaluating the six options, Energy*Solutions* concluded that Alternative 1 – above-grade disposal at the proposed site at Clive, Utah, met the requirements of the regulations, and was the most acceptable site for the disposal of 11e.(2) material. In addition to site selection evaluations, Energy*Solutions* has collected and observed environmental data gathered from Section 32 since operations began. This data has been analyzed against data obtained and assumptions made in the original 11e.(2) Environmental Impact Statement (DOE, 1984). Strong correlations between the data postulated and the data observed can be found upon initial comparison of the 11e.(2) Environmental Impact Statement defined characteristics and Energy*Solutions* observed characteristics. Geological and seismological conditions remain unchanged in the area surrounding Section 32.

Review of the meteorological data suggests that temperature, precipitation and evaporation data are within the boundary conditions expected. Wind speed data do not correlate very well as there was only one year worth of wind speed and directional data available during the initial Environmental Impact Statement review. Having collected wind speed and directional data for nearly two decades now, Energy*Solutions* has been able to establish and identify trends that were not immediately evident during the initial Environmental Impact Statement review. Groundwater data presented in the original 11e.(2) Environmental Impact Statement has been substantiated and documented by the data acquired by Energy*Solutions*.

A greater understanding of site slopes and run-off potential helped Energy*Solutions* determine a more refined idea of the potential maximum flooding that could occur on Section 32. Energy*Solutions* synthetic flood modeling concluded that a Probable Maximum Precipitation event of 10.08 inches over a six-hour period of time could produce a Probable Maximum Flood of 48,512 ft^3/sec. However, Energy*Solutions* constructs its runoff control ditches to accommodate a 60,000 ft^3/sec flooding event. Ecological conditions on Section 32 remain the same today as they did in 1993.

Socioeconomic conditions within Tooele County have changed greatly since publication of the data in the 11e.(2) Environmental Impact Statement. The major change has come in overall population within Tooele County. Population within 80 km (50 miles) of the site has increased from 25,442 people (based on the 1990 census) to an estimated 55,763people (based on the 2010 census). The closest resident lives roughly 7 miles to the Northeast from the site and acts as caretaker for the rest stop at mile marker 55 off of I-80. However, with this exception and despite the increase in population, overall centers of population have not changed in the county and the site remains isolated.

Energy*Solutions* continues to monitor background radiation with its Environmental Monitoring Program. This information is submitted to the Division on a quarterly basis and remains largely unchanged from conditions that existed at the publication of the 11e.(2) Environmental Impact Statement. There are no data available that suggest the cultural resources on Section 32 have changed from initial Environmental Impact Statement conditions, nor are there any other environmental conditions that require discussion or update for this license renewal application. Alternatives to the proposed action are discussed further in the 11e.(2) Environmental Assessment (Appendix H).

Table 9-1

Alternative Evaluation

Criteria	Item	Criteria	Weight	Alternative Sites					
1.a				**1**	**2**	**3**	**4**	**5**	**6**
1.b	1	Remoteness	10	9.3	9.3	9.3	7.7	4	4
1.b	2	Soils	10	9.7	9.3	9.3	7	5.3	5
1.b	3	Groundwater	10	8.3	4.3	5.7	7	5.7	3.7
1.b	4	Surface Water	10	9.3	9.3	8.7	8	7	4.3
1.c	5	Meteorology	10	9	9	9	8.7	6.7	4.3
General	6	Minimization of Dispersion	10	9.3	9.3	9.3	8.3	7.7	5
General	7	No Active Maintenance	8	9.3	9.3	9.3	8.3	8	6.3
General	8	Feasibility	8	9.7	4.7	6.7	3.7	6.3	4
General	9	Land Cost	5	9.7	9	7.3	6.7	6.7	4.7
General	10	Transportation	5	6.3	6.3	6.3	6.3	3.3	7.3
General	11	Construction Cost	5	8.7	6.3	4	6.7	4.7	4.7
			Weighted Totals	824.5	725	729	661.5	551.9	428.9

SECTION 10. COST BENEFIT ANALYSIS

"A license application shall be approved if the Executive Secretary determines that:(c) the applicant's facilities are permanently located in Utah, otherwise the applicant shall seek reciprocal recognition as required by Section R313-19-30;" **– R313-22-33(1)(c).**

There are large quantities of uranium and thorium mill tailings [11e.(2) byproduct material] that exist throughout the United States. These mill tailings are located at sites that are neither licensed by NRC or Agreement States nor are one of the 24 abandoned mill tailings sites being remediated by DOE under Title I of UMTRA. The State of Utah has granted the applicant licenses to dispose of both Naturally-Occurring Radioactive Material (NORM) and Low-Level Waste (LLW) at the Clive site. The benefits to the general public of having a safe, remotely-located disposal site for 11e.(2) byproduct material appear to be significant. However, because these costs and benefits are not localized, it is appropriate to review the specific site-related benefits and costs for the Energy*Solutions* Facility.

The disposal project is beneficial because it fills a public need in that it provides a location for the safe disposal of 1le.(2) byproduct material and consolidates numerous sources of waste at one location, where other types of wastes [i.e., low-level radioactive, NORM, and Resource Conservation and Recovery Act (RCRA) wastes] are currently being consolidated. In addition, the waste would be consolidated in an area specifically zoned for handling of hazardous waste remote from populated areas.

The cost of the project is limited to a slight increase, during operations, in radiation exposure to the nearby public and along transportation corridors, over and above that which currently exists due to the LLRW, NORM, and RCRA operations. However, the monitoring and mitigating measures will keep such potential exposure well below permissible guidelines for the protection of the health and safety of the public. After project completion and license termination, the site will be turned over for long-term care to DOE, to another Federal Agency designated by the President, or to the State of Utah at its option. The cost-benefit analysis of the alternatives is discussed further in the 11e.(2) Environmental Assessment (Appendix H).

SECTION 11. ENVIRONMENTAL APPROVALS AND CONSULTATIONS

"A license application shall be approved if the Executive Secretary determines that:(f) in the case of an application for a license to receive and possess radioactive material for commercial waste disposal by land burial, or for the conduct of other activities which the Executive Secretary determines will significantly affect the quality of the environment, the Executive Secretary, before commencement of construction of the plant or facility in which the activity will be conducted, has concluded, after weighing the environmental, economic, technical and other benefits against environmental costs and considering available alternatives, that the action called for is the issuance of the proposed license, with any appropriate conditions to protect environmental values. The Executive Secretary shall respond to the application within 60 days. Commencement of construction prior to a response and conclusion shall be grounds for denial of a license to receive and possess radioactive material in the plant or facility. As used in this paragraph the term "commencement of construction" means clearing of land, excavation, or other substantial action that would adversely affect the environment of a site. The term does not mean site exploration, necessary borings to determine foundation conditions, or other preconstruction monitoring or testing to establish background information related to the suitability of the site or the protection of environmental values." **– R313-22-33(1)(f).**

A quarterly Environmental Monitoring Report is submitted to the Division within 90 days after the end of each calendar quarter, unless otherwise approved by the Division Director. Each quarterly report includes a brief introduction and narrative that summarizes and explains the data, the results obtained, and conclusions. The narrative also explains any unusual or anomalous results and any exceedance of a limit that occurred during the reporting period. Each quarterly report also includes the following data from the current report quarter:

- Contract laboratory data that pertains to any sample analysis that was performed under this program. The data package includes the results of QC checks the contractor laboratory performs in the course of analyzing the samples (splits and duplicates, for example). The outside laboratory data may be submitted either electronically or by hard copy.
- The analytical results from gamma spectroscopy performed on quarterly soil samples and associated analytical results from soil samples used to verify soil radioactivity in areas where the environmental soil samples exceed the action level.
- Historical Ra-226 and U-238 in soil data used for trending to determine if a positive change in soil concentrations is occurring;
- The results of any quality control tests performed to meet a requirement of the Environmental Monitoring Plan, including but not limited to duplicates, split samples, and known exposures;
- A summary and tabulation of any data acquired as a result of sampling performed during the report quarter, to the extent that such data applies to a requirement of the Environmental Monitoring Plan;
- A table listing the activities and estimated relative dose weighting of each disposed radionuclide considered for additional radiochemical analysis according to the selection criteria of the Environmental Monitoring Plan;
- Vacuum Thermal Desorption (VTD) operating history and the results for any VTD monitoring performed during the reporting period.
- Results of weekly alpha-beta counting of air filters at each monitored location.
- Quarterly average alpha and beta air particulate concentrations at each monitored location.

- The cumulative TEDE, DDE, and CEDE at each POC for the current report quarter and the prior three quarters
- The calculated annual dose from the monitoring results to demonstrate compliance with UAC R313-15-301, R313-15-101(4), and R313-25-19. The information includes DDE, CDE, CEDE, and TEDE calculations.
- Soil Sample Results
- A brief narrative summarizing the dosimetry data and explaining the CEDE estimates.

SECTION 12. APPLICABLE REGULATIONS

"A license application shall be approved if the Executive Secretary determines that:(f) in the case of an application for a license to receive and possess radioactive material for commercial waste disposal by land burial, or for the conduct of other activities which the Executive Secretary determines will significantly affect the quality of the environment, the Executive Secretary, before commencement of construction of the plant or facility in which the activity will be conducted, has concluded, after weighing the environmental, economic, technical and other benefits against environmental costs and considering available alternatives, that the action called for is the issuance of the proposed license, with any appropriate conditions to protect environmental values. The Executive Secretary shall respond to the application within 60 days. Commencement of construction prior to a response and conclusion shall be grounds for denial of a license to receive and possess radioactive material in the plant or facility. As used in this paragraph the term "commencement of construction" means clearing of land, excavation, or other substantial action that would adversely affect the environment of a site. The term does not mean site exploration, necessary borings to determine foundation conditions, or other preconstruction monitoring or testing to establish background information related to the suitability of the site or the protection of environmental values." **– R313-22-33(1)(f).**

To the extent practicable, the information presented in this application conforms to all of the recommendations referenced in 10 CFR 40, Appendix A. Energy*Solutions* believes that all applicable regulatory concerns have been adequately addressed in this application. Documents used in the preparation of this application have been provided as references at the end of this section.

12.1 CONFORMANCE TO REGULATIONS AND REGULATORY GUIDES

As requested in the Federal Register Notice of January 25, 1991, this application has been based on the following 10 CFR requirements:

1. 10 CFR, part 40, including Appendix A: Domestic Licensing of Source Material;
2. 10 CFR, part 51: Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions;
3. 10 CFR, part 61, subpart G: Records, Reports, Tests, and Inspections;
4. 10 CFR 20.311: Transfer for Disposal and Manifests;
5. 10 CFR, part 19: Notices, Instructions, and Investigations;
6. 10 CFR, part 20: Standards for Protection Against Radiation;
7. 10 CFR, part 21: Reporting Defects and Noncompliance

12.1.1 Compliance with 10 CFR, Part 19

Energy*Solutions* complies with the requirements of § 19.5 by addressing all communications and reports concerning the regulations of Part 19 to the Director of the Utah Division of Radiation Control. Energy*Solutions* will comply with the requirements of § 19.11 by posting Form NRC-3, "Notice to Employees", and any Notices of Violation, proposed civil penalty, or other order pursuant to Subpart B of 10 CFR 2, and any response from Energy*Solutions* in a sufficient number of locations to permit employees to observe them. The above documents, other than NRC-3, will be posted within two (2) working days of receipt. Energy*Solutions* will post responses by Energy*Solutions* within two working days of dispatch. Energy*Solutions* will also post at those same locations a notice describing and giving the locations where copies of the regulations of Parts 19 and 20, the license, license conditions, incorporated documents, and

amendments thereof can be found. Energy*Solutions* complies with the requirements of § 19.20. Energy*Solutions* complies with the requirements of § 19.32 by adhering to its policy on nondiscrimination:

> "*EnergySolutions provides equal employment opportunities to all job applicants and employees, making employment-related decisions based upon qualifications and abilities without regard to race, color, religion, sex, national origin, age, disability, veteran status, citizenship or any other status or condition protected by applicable state or federal laws. EnergySolutions recruits, hires, assigns, transfers, promotes, trains, compensates, provides benefits, and administers programs without consideration of these differences. EnergySolutions is committed to providing a work environment, free from discrimination based upon any of these protected differences.*"

12.1.2 Compliance with 10 CFR, Part 21

Energy*Solutions* will comply with § 21.6 by posting on the employees' bulletin board a copy of Section 206 of the Energy Reorganization Act of 1974. Energy*Solutions* will also post a notice stating where the regulations of Part 21 and the procedures adopted pursuant to Part 21 can be found.

As a facility for the disposal of 11e.(2) wastes, Energy*Solutions* is not a purchaser of basic components and is not subject to the type of failures to comply which would result in a substantial safety hazard as described in § 21.21. The evaluation of such defects, deviations, or failures to comply is not a credible activity for such an operation.

As a facility for the disposal of 11e.(2) wastes, Energy*Solutions* is not a purchaser of facilities or basic components and is not subject to the requirements of § 21.31. In compliance with § 21.41, Energy*Solutions* will permit Division representatives to inspect its records, premises, activities, and basic components, as necessary, to effectuate the purposes of 10 CFR, Part 21. As a disposal facility for 11e.(2) wastes, Energy*Solutions* is not a purchaser of basic components. However, Energy*Solutions* will permit the Division Director to inspect records pertaining to such possible basic components at all reasonable times.

In compliance with § 21.61, Energy*Solutions* acknowledges that any director or responsible officer subject to the regulations in Part 21 who knowingly and consciously fails to provide the notice required by § 21.21 is subject to a civil penalty equal to the amount provided by Section 234 of the Atomic Energy Act of 1954, as amended.

12.1.3 Compliance with 10 CFR 61.80, 10 CFR 61.81, and 10 CFR 61.82

Energy*Solutions* will comply with the requirements of 10 CFR 61.80 (a), (b), (c), and (d) by establishing and maintaining files of all records and reports required by 10 CFR 61 for the land disposal of 11e.(2) byproduct material.

Energy*Solutions* will comply with the requirements of 10 CFR 61.80 (i) by submitting annual reports to the Director of the Utah Division of Radiation Control. The report, which will be submitted by April 30 of each year, for the preceding year will include:

1. The specification of the quantity of each of the principal radionuclides released to uncontrolled areas in liquid and airborne effluents during the preceding year;
2. The results of the environmental monitoring program;
3. A summary of disposal survey and maintenance activities;
4. A summary of the activities and quantities of radionuclides disposed of;
5. Any instances in which observed site characteristics were significantly different from those described in the license application; and

6. Other information the Division's Director may require.

Energy*Solutions* will comply with the requirements of 10 CFR 61.81 by performing, or permitting the Division's Director to perform, any tests the Division's Director deems appropriate or necessary for the administration of the applicable regulations, including tests of:

1. Radioactive wastes and facilities used for the receipt, storage, treatment, handling, and disposal of radioactive wastes;
2. Radiation detection and monitoring instruments; and
3. Other equipment and devices used in connection with the receipt, possession, handling, treatment, storage, or disposal of radioactive waste.

Energy*Solutions* will comply with the requirements of 10 CFR 61.82 by:

1. Affording to the Division's Director at all reasonable times opportunity to inspect radioactive waste not yet disposed of, and the premises, equipment, operations, and facilities in which radioactive wastes are received, possessed, handled, treated, stored, or disposed of; and
2. Making available to the Division's Director for inspection, upon reasonable notice, records kept pursuant to the applicable regulations. Authorized representatives of the Division's Director may take copies of records required to be kept by those regulations for the Division Director's use.

Energy*Solutions* will comply with the requirements of Utah Administrative Code R313-24 by:

1. Affording to the Division's Director at all reasonable times opportunity to inspect 11e.(2) waste not yet disposed of, and the premises, equipment, operations, and facilities in which radioactive wastes are received, possessed, handled, treated, stored, or disposed of;
2. Prescribing to the rules and requirements for the possession or disposal of source material as related to Energy*Solutions*' 11e.(2) disposal operations; and,
3. Prescribing to the conditions set forth in its Ground Water Quality Discharge Permit.

Energy*Solutions* will comply with the requirements of Utah Administrative Code R317-6 by prescribing to the conditions set forth in its Ground Water Quality Discharge Permit.

12.2 SUMMARY/STATUS OF FEDERAL, STATE, AND LOCAL PERMITS, LICENSES, APPROVALS, OTHER ENTITLEMENT AND REGIONAL AUTHORITIES

12.2.1 Utah Division of Radiation Control – Radioactive Material License

Utah regulation R313-19-2 states that "*No person shall receive, possess, use, transfer, own, or acquire radioactive material except as authorized in a specific or general license issued pursuant to R313-21 or R313-22, or as otherwise provided in this chapter*." Energy*Solutions* has received a radioactive material license (License Number UT2300249). The license permits receipt, management, and disposal of Class A LLRW materials. A Safety Analysis Report was prepared in support of that license.

12.2.2 Utah Division of Solid and Hazardous Waste – Hazardous Waste Plan Approval (State-issued Part B Permit)

Utah Hazardous Waste Management Rule R450-3-1.1 (a) (and similar requirement in 40 CFR 270.10[f] [1], " *. . . no person shall own, construct, modify, or operate any facility for the purpose of treating, storing, or disposing of hazardous waste without first submitting and receiving the approval of the Committee for a*

hazardous waste operation plan for that facility." The State-issued Part B Permit was renewed on April 4, 2003, providing continued approval for the management and disposal of Mixed Waste.

12.2.3 Utah Division of Solid and Hazardous Waste – Solid Waste Disposal Permit

Energy*Solutions* has received a permit to dispose of solid waste at the Clive facility.

12.2.4 Bureau of Land Management – Right-of-Way or Temporary Use Permit

Pursuant to Federal Land Policy and Management Act (43 U.S.C. 1701 et seq., 43 CFR 2800).

12.2.5 Utah State Department of Environmental Quality, Division of Air Quality Approval Order

Department of Environmental Quality, Division of Air Quality Approval Order # DAQE-AN0717012-05, as amended.

12.2.6 Office of State Engineer, Utah Division of Water Rights – Approval of Well Plugging

Pursuant to Water Laws of Utah, UCA 73, 5-9, and Regulations for Water Well Drillers, Utah Division of Water Rights, July 1, 1980, the State Engineer may require that any well be plugged to prevent pollution or contamination of groundwater. Prior to plugging wells, Energy*Solutions* will notify the Office of the State Engineer to determine the acceptability of plugging techniques.

12.2.8 Tooele County Corporation, Development Services – Conditional Use Permit

Pursuant to Tooele County Zoning Ordinances, a conditional use permit (CUP 2700-87) has been obtained.

12.2.8 State of Utah Division of Water Quality – Ground Water Discharge Permit

In compliance with the provisions of the Utah Water Pollution Control Act, Title 26, Chapter 11, Utah Code Annotated, 1953, as amended, the State Division of Water Quality issued Ground Water Discharge Permit No. UGW450005 to Energy*Solutions* in March of 1991.

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Appendix A

Operating Procedure Catalogue

SUBCATEGORY	REFERENCE	REV[1]	TITLE	DATE[1]
Administrative (14)	CL-AD-PO-001	0	Clive Equipment and Facility Operation Maintenance Policy	22-Jan-10
Administrative (14)	CL-AD-PR-010	0	Clive Facility Regulatory Notification Control	11-Jan-11
Administrative (14)	CL-AD-PR-020	1	Operating Work Permit	6-Dec-10
Administrative (14)	CL-AD-PR-021	0	Procedure Prep Guidelines	1-Nov-06
Administrative (14)	CL-AD-PR-030	3	LLRW Export Approval	20-Dec-11
Administrative (14)	CL-AD-PR-040	0	Classification of Discrepant Incoming Shipments	8-Jun-11
Administrative (14)	CL-AD-PR-060	1	EWIS WITS Administrative Procedure	12-Jan-10
Administrative (14)	CL-AD-PR-080	1	Stored Volume Surety Control	18-Jun-08
Administrative (14)	CL-AD-WI-001	6	Document Preparation	20-Jan-10
Administrative (14)	CL-AD-WI-002	8	Document Control	8-Nov-11
Administrative (14)	CL-AD-WI-003	1	Review Cycle Initiation	9-Jul-10
Administrative (14)	CL-AD-WI-004	3	Distribution Process	22-Dec-10
Administrative (14)	CL-AD-WI-005	0	Instructions for Correspondence	29-May-09
Administrative (14)	CL-AD-WI-007	0	Scanning Process	29-Oct-10
Business Development (1)	CL-BD-WI-001	0	Business Development QADEP for EWIS	5-Aug-09
Compliance (9)	CL-CL-WI-001	2	Regulatory Submittal Control	3-Jun-11
Compliance (9)	CL-CL-WI-002	2	Groundwater Compliance Tracking	8-Feb-12
Compliance (9)	CL-CL-WI-003	0	Annual Compliance Facility Assessment	24-Oct-11
Compliance (9)	CL-CL-WI-004	0	Surety Review Instruction	16-Apr-09
Compliance (9)	CL-CL-WI-013	1	Shipment Report	11-Apr-11
Compliance (9)	CL-CL-WI-015	1	Reports Due Compliance Tracking	3-Jun-11
Compliance (9)	CL-CL-WI-016	0	Biennial Review of Licenses and Permits	13-Jul-09
Compliance (9)	CL-CL-WI-017	0	WITS Container Movement	16-Nov-09
Compliance (9)	CL-LM-PR-001	0	Equipment and Facility Labeling Requirements	5-Dec-07
Containerized Waste (14)	CL-CW-PR-001	0	Containerized Waste Facility Incoming Shipment Acceptance	26-Nov-07
Containerized Waste (14)	CL-CW-PR-003	0	Containerized Waste Unloading and Handling	2-May-08
Containerized Waste (14)	CL-CW-PR-004	0	Storage and Shipment of Empty Type A Cask Containers	2-Jul-08
Containerized Waste (14)	CL-CW-PR-005	2	Transloading of Containers	2-Nov-10
Containerized Waste (14)	CL-CW-PR-100	0	Overpacking and Repairing Containers	2-May-08
Containerized Waste (14)	CL-CW-PR-101	2	CWF Waste Placement and Backfill Operations	16-Jan-12
Containerized Waste (14)	CL-CW-PR-102	1	Containerized Waste Void Remediation	19-Jul-10
Containerized Waste (14)	CL-CW-PR-200	2	Package Liquid Void Verification	19-Jul-10
Containerized Waste (14)	CL-CW-PR-201	0	Operations & Maintenance of the CWF Electronic Waste Information System	2-May-08

[1] Most current revision, as of 25 April 2012.

SUBCATEGORY	REFERENCE	REV[1]	TITLE	DATE[1]
Containerized Waste (14)	CL-CW-PR-202	0	Generator Certification	19-Oct-09
Containerized Waste (14)	CL-CW-PR-203	0	CWF Waste Acceptance Criteria	23-Feb-10
Containerized Waste (14)	CL-CW-PR-204	0	Tracking of Special Nuclear Material	30-May-08
Containerized Waste (14)	CL-CW-PR-301	2	Cask Operations at the CWF	16-Jan-12
Containerized Waste (14)	CL-CW-PR-400	2	CWF Waste Tracking	16-Jan-12
Containers (12)	CL-CH-PR-002	2	Incoming Waste Unloading and Handling at the Intermodal Unloading Facility	24-May-11
Containers (12)	CL-CH-PR-003	2	NORM LLRW 11E(2) Incoming Waste Unloading and Handling Rail Operation	16-Jun-11
Containers (12)	CL-CH-PR-004	0	Transferring Mixed Waste at East Truck Unloading Area	24-May-11
Containers (12)	CL-CH-PR-005	2	Incoming Waste Transferring and Handling at the East Truck Unloading Area	21-Feb-12
Containers (12)	CL-CH-PR-100	3	Container Management and Storage	4-Feb-11
Containers (12)	CL-CH-PR-101	3	Rail Movement Contamination Control	3-Feb-12
Containers (12)	CL-CH-PR-104	0	Decontamination Procedure	4-Jan-10
Containers (12)	CL-CH-PR-106	3	One Percent Free Liquid Volume Determination	26-May-11
Containers (12)	CL-CH-PR-109	2	Rotary Dump Facility Operation	4-Jan-12
Containers (12)	CL-CH-PR-110	0	Intermodal Container Wash Building Operation	31-Jan-08
Containers (12)	CL-CH-PR-200	3	Container Return Inspection	27-Feb-12
Containers (12)	CL-CH-PR-201	1	FiberGlass Lid Repair	27-Aug-08
Document Management (1)	CL-DM-WI-001	0	Document Control Indoctrination and Training	12-Feb-10
Engineering (5)	CL-EN-PR-001	4	Engineering Design Control	13-Oct-11
Engineering (5)	CL-EN-PR-002	0	Test Control	23-Oct-07
Engineering (5)	CL-EN-PR-003	0	Readiness Reviews	28-Apr-11
Engineering (5)	CL-EN-PR-023	0	Annual Evaporation Pond Pump Inspection	28-May-09
Engineering (5)	CL-EN-PR-091	1	Clay Mining and Excavation	4-Feb-11
Environmental (17)	CL-EV-PR-001	1	Weather Station Monitoring	5-Dec-07
Environmental (17)	CL-EV-PR-002	1	Radtrak Devices	24-Aug-10
Environmental (17)	CL-EV-PR-003	3	Area Radiation Monitoring	20-Sep-10
Environmental (17)	CL-EV-PR-004	3	Groundwater Monitoring	2-Feb-12
Environmental (17)	CL-EV-PR-005	0	Cover Test Cell Monitoring	2-Mar-09
Environmental (17)	CL-EV-PR-006	1	Environmental Tritium Monitoring	13-May-10
Environmental (17)	CL-EV-PR-007	0	PCB Soil Sampling	18-May-09
Environmental (17)	CL-EV-PR-008	0	PCB Air Sampler Single Point Flow Check	8-Mar-10
Environmental (17)	CL-EV-PR-009	0	PCB Air Sampler Calibration	8-Mar-10
Environmental (17)	CL-EV-PR-010	0	PCB Shredding Air Sample Collection	8-Mar-10
Environmental (17)	CL-EV-PR-022	1	Annual Bladder Pump Inspection and Total Depth Measurement	20-May-11
Environmental (17)	CL-EV-PR-024	1	Monthly Monitoring Well Apron Inspection	5-Jun-09

SUBCATEGORY	REFERENCE	REV[1]	TITLE	DATE[1]
Environmental (17)	CL-EV-PR-320	1	Airborne Particulate Monitoring Lo Vol	21-May-10
Environmental (17)	CL-EV-PR-330	3	Environmental Soil Monitoring	13-May-10
Environmental (17)	CL-EV-WI-001	1	Environmental Compliance Tracking	10-Jun-09
Environmental (17)	CL-EV-WI-002	0	SW Corner Pond and Well Nest Custodial Responsibilities	7-Jan-09
Environmental (17)	CL-EV-WI-003	0	Well Installation and Abandonment	17-Nov-11
Instrument (26)	CL-IN-PR-001	0	PCB Air Sampler-Single Point Flow Check	8-Jan-08
Instrument (26)	CL-IN-PR-002	0	PCB Air Sampler-Calibration	8-Jan-08
Instrument (26)	CL-IN-PR-003	1	PCB Shredding-Air Sample Collection	27-Feb-08
Instrument (26)	CL-IN-PR-310	0	E PERM Monitors	14-May-10
Instrument (26)	CL-IN-PR-401	1	MDA and CHI Square Test	12-May-11
Instrument (26)	CL-IN-PR-402	0	Calibration and Operation of the Canberra Tennelec Series 5XLB	21-Dec-11
Instrument (26)	CL-IN-PR-410	2	Calibration of the Ludlum Model 2360 w Model 43 93 Probe	11-May-10
Instrument (26)	CL-IN-PR-411	0	Calibration of the Ludlum Model 3030P	15-Nov-11
Instrument (26)	CL-IN-PR-412	2	Calibration of the Ludlum Model 3030	18-Feb-11
Instrument (26)	CL-IN-PR-413	1	Operation of the Ludlum Model 3030P	23-Mar-12
Instrument (26)	CL-IN-PR-414	0	Operation & Calibration of the Bladewerx SabreBPM	2-Dec-11
Instrument (26)	CL-IN-PR-418	1	Operation of the Ludlum Model 3030	8-Sep-10
Instrument (26)	CL-IN-PR-419	1	Operation of Ludlum Model 193 and 193-6 Gamma Survey Meters	24-Mar-11
Instrument (26)	CL-IN-PR-420	1	Protean Counter Model WPC-9550 Calibration and Operating Instruction	11-May-10
Instrument (26)	CL-IN-PR-422	2	Air Sample Pump Maintenance and Calibration	25-Jan-11
Instrument (26)	CL-IN-PR-425	2	Operation of the Ludlum Model 375-30 Rotary Monitor	26-Jul-11
Instrument (26)	CL-IN-PR-426	0	Operation of Victoreen 451B-RYR-SS Ion Chamber Survey Meters	7-Mar-11
Instrument (26)	CL-IN-PR-430	1	Lung Count Operation	7-Apr-10
Instrument (26)	CL-IN-PR-436	1	Use and Maintenance of Electronic Dosimeters	17-Nov-10
Instrument (26)	CL-IN-PR-437	1	Dose Rate Instrumentation	7-Mar-11
Instrument (26)	CL-IN-PR-439	1	Calibration of MGP DMC2000S Elec. Dosimeters	1-Feb-10
Instrument (26)	CL-IN-PR-441	2	Operation of the Ludlum Model 2360 with 43-93 Probe	15-Mar-12
Instrument (26)	CL-IN-PR-460	1	Canberra Argos 4AB Calibration	28-Dec-10
Instrument (26)	CL-IN-PR-461	1	Canberra 4AB Operation	8-Apr-11
Instrument (26)	CL-IN-PR-462	2	Operation of the Eberline Model PCM 2	17-Aug-11
Instrument (26)	CL-IN-PR-463	2	Calibration of the Eberline Model PCM 2	15-Feb-12
JHA (88)	CL-001	4	Shredder Maintenance	10-Dec-09
JHA (88)	CL-002	3	Shredder Operation 12.10.09	10-Dec-09
JHA (88)	CL-003	6	Rotary Dump Facility Operations	10-Dec-09
JHA (88)	CL-004	3	Waste Preparation for Shredder 12.10.09	10-Dec-09
JHA (88)	CL-005	1	hipping concrete out of cement truck drums	10-Dec-09

SUBCATEGORY	REFERENCE	REV[1]	TITLE	DATE[1]
JHA (88)	CL-006	1	Waste Drum Repackaging-Compacting	10-Dec-09
JHA (88)	CL-007	2	Flowable Filling Containers for Macro-Encapsulation	10-Dec-09
JHA (88)	CL-008	2	Incoming Shipment Sampling and Inspecting Boxes	10-Dec-09
JHA (88)	CL-009	4	Hyster Yardmaster Operation	10-Dec-09
JHA (88)	CL-010	3	Intermodal Decon	10-Dec-09
JHA (88)	CL-011	1	Operation of the Trackmobile 4500	10-Dec-09
JHA (88)	CL-012	3	Digestions, Separations and Analysis Using Acids in the Chem Lab	10-Dec-09
JHA (88)	CL-013	3	Excavation and Trenching	10-Dec-09
JHA (88)	CL-014	3	Maintenance Field Work on the Cells	10-Dec-09
JHA (88)	CL-015	0	g Lids on Box Type Containers	10-Dec-09
JHA (88)	CL-016	2	Inflating Tires on Equipment	10-Dec-09
JHA (88)	CL-017	3	Pre Inspection of the Trackmobile 4500	10-Dec-09
JHA (88)	CL-018	4	Track 4 Decon	10-Dec-09
JHA (88)	CL-019	1	Sorting and Repackaging Elemental Mercury	10-Dec-09
JHA (88)	CL-020	2	Incoming Shipment Sampling and Inspecting Drums	10-Dec-09
JHA (88)	CL-021	2	Loading and Unloading Track Hoe on to Railcars	10-Dec-09
JHA (88)	CL-022	2	Macro Vault Construction	10-Dec-09
JHA (88)	CL-023	2	Setting Hand Brakes on Rail Cars	10-Dec-09
JHA (88)	CL-024	3	Docking and Removing Containers at Intermodal Decon Bays	10-Dec-09
JHA (88)	CL-025	3	Loading and Unloading Railcars and Flatbed Trucks with the Hyster Yardmaster or Forklifts	10-Dec-09
JHA (88)	CL-026	1	Health Physics Functions and Unloding Trucks From an Elevated Dock	10-Dec-09
JHA (88)	CL-027	1	Amalgamation of Mercury Hg	10-Dec-09
JHA (88)	CL-028	1	Off-loading and Placement of Large Components 2.28.08	28-Feb-08
JHA (88)	CL-029	3	Vehicle Railroad Crossings 5.31.11	31-May-11
JHA (88)	CL-030	2	CWF Cask Shipments and Waste Placement 6.2.10	2-Jun-10
JHA (88)	CL-031	2	Unloading End Dumps	10-Dec-09
JHA (88)	CL-032	1	Extricating Vehicles and Equipment	10-Dec-09
JHA (88)	CL-033	2	Operation of Hand Held Grinder	10-Dec-09
JHA (88)	CL-034	2	Dumping Intermodals with Sterling Trucks	10-Dec-09
JHA (88)	CL-035	1	Vehicle Searches by Security	10-Dec-09
JHA (88)	CL-036	2	Debris Inspection	10-Dec-09
JHA (88)	CL-037	0	ial Duties Bathrooms	10-Dec-09
JHA (88)	CL-038	3	Hauling Waste Container to MW Embankment in Rock Trucks	10-Dec-09
JHA (88)	CL-039	1	Operation of Loader with Forks	10-Dec-09
JHA (88)	CL-040	2	Jump Starting Batteries	10-Dec-09
JHA (88)	CL-041	2	of dry material from rail cars (Rev 2).doc	10-Dec-09

SUBCATEGORY	REFERENCE	REV[1]	TITLE	DATE[1]
JHA (88)	CL-042	3	Rail Switching	10-Dec-09
JHA (88)	CL-043	1	Container Movement	10-Dec-09
JHA (88)	CL-044	1	Beryllium Waste Disposal in a Soil Lift.doc	10-Dec-09
JHA (88)	CL-045	0	Roll-off Hoist Operation 5.27.08	27-May-08
JHA (88)	CL-046	0	Use of Scissor Lift and Ladder for Entering or Exiting Railcars 10.22.08	22-Oct-08
JHA (88)	CL-047	2	HP Functions at (ICWF) Intermodal Container Wash Facility	10-Dec-09
JHA (88)	CL-048	1	peration of Servomat 75 MS Tire Changing Machine	10-Dec-09
JHA (88)	CL-049	0	Offloading from railcars with lifting equipment	10-Dec-09
JHA (88)	CL-050	2	Covering CLSM Pours with Tarps	10-Dec-09
JHA (88)	CL-051	0	LP Rotor Size Reduction with Track-hoe and Shear Attachment 1.13.09	13-Jan-09
JHA (88)	CL-052	1	Plasma Cutting	10-Dec-09
JHA (88)	CL-053	1	Carbon Arc Cutting	10-Dec-09
JHA (88)	CL-054	1	Hauling Waste Containers with Flatbed Trailer	10-Dec-09
JHA (88)	CL-055	0	Unloading End Dumps with Forklift	10-Dec-09
JHA (88)	CL-056	0	Shredding and Repackaging PCB Waste	10-Dec-09
JHA (88)	CL-057	0	Scanning Vehicles and Personnel at Gates	10-Dec-09
JHA (88)	CL-058	0	Gas Powered Weed Sprayer	10-Dec-09
JHA (88)	CL-059	1	Unloading-Hauling Waste from the Rotary Pit	10-Dec-09
JHA (88)	CL-060	0	Use of Low Speed Floor Finishing Machine	10-Dec-09
JHA (88)	CL-061	0	Mixed Waste Stabilization, Rev. 0	10-Dec-09
JHA (88)	CL-062	1	Operation of Hand Drill or Impact Gun	10-Dec-09
JHA (88)	CL-063	0	General Operation of Equipment	10-Dec-09
JHA (88)	CL-064	2	Large Intermodal Rollover (Bertha)	10-Dec-09
JHA (88)	CL-065	1	peration of 36K Pressure Washer	10-Dec-09
JHA (88)	CL-066	0	Liquid Waste Transfer Using Vacuum Truck or Trailor Rev. 0	10-Dec-09
JHA (88)	CL-068	0	Mixed Waste Shredder Operations, Rev. 0	10-Dec-09
JHA (88)	CL-069	0	Treatment Buidling Decon and Maintenance Activities, Rev. 0	10-Dec-09
JHA (88)	CL-070	1	Work in Monument Area 7.20.11	20-Jul-11
JHA (88)	CL-071	0	umping Containers inside Treatment Building	10-Dec-09
JHA (88)	CL-072	0	Operation of PTO Driven, Trailer Mounted Weed Sprayer	10-Dec-09
JHA (88)	CL-073	0	Operation and Maintenance of Shop Band Saw	10-Dec-09
JHA (88)	CL-074	0	Dumping of SeaLands with Sterling truck	10-Dec-09
JHA (88)	CL-075	0	Vehicle Lifts in Maintenance Shop	10-Dec-09
JHA (88)	CL-076	0	Welding Outside of the RA	10-Dec-09
JHA (88)	CL-077	0	De-Vegetating Soil Stations by Hand	10-Dec-09
JHA (88)	CL-078	0	Decon of End Dumps	10-Dec-09
JHA (88)	CL-079	1	Rotary Wash Facility	10-Dec-09

SUBCATEGORY	REFERENCE	REV[1]	TITLE	DATE[1]
JHA (88)	CL-080	0	Removal of Dunnage from Conveyance	10-Dec-09
JHA (88)	CL-081	0	Alternative Cover Machine	10-Dec-09
JHA (88)	CL-082	0	CLSM Debris Inspection	10-Dec-09
JHA (88)	CL-083	0	QC Use of Troxler	10-Dec-09
JHA (88)	CL-084	0	Using Lime Kilin Dust Silo to fill rock truck's	10-Dec-09
JHA (88)	CL-085	0	Unloading Diaphragms from Intermodals or Sealands with the use of a Crane	10-Dec-09
JHA (88)	CL-086	0	Chiming of Drums	10-Dec-09
JHA (88)	CL-087	0	Rotary Facility Inspection	10-Dec-09
JHA (88)	CL-088	0	Container Movement with Hyster Yardmaster	10-Dec-09
JHA (88)	CL-089	0	Sieve Shaker	10-Dec-09
Laboratory (30)	CL-LB-PR-001	1	Sample Control C of C Procedure	22-Mar-12
Laboratory (30)	CL-LB-PR-002	1	Sample Management	2-Nov-10
Laboratory (30)	CL-LB-PR-010	0	Pre-Shipment Waste Sample Acceptance & Tracking	30-Apr-10
Laboratory (30)	CL-LB-PR-011	3	Sampling Incoming Waste Shipments	28-Dec-10
Laboratory (30)	CL-LB-PR-012	0	Establishing Incoming Waste Sampling Requirements	28-Dec-10
Laboratory (30)	CL-LB-PR-015	0	Remote Sampling Procedure	19-Nov-10
Laboratory (30)	CL-LB-PR-020	0	Immediate Chemical Screening (Fingerprint) Analysis	10-Oct-07
Laboratory (30)	CL-LB-PR-030	2	Laboratory Instrument Calibration and Maintenance	15-Feb-12
Laboratory (30)	CL-LB-PR-040	1	Analytical Data Review	7-Sep-11
Laboratory (30)	CL-LB-PR-100	2	Gamma Spectroscopy	16-Jun-11
Laboratory (30)	CL-LB-PR-100	2	Gamma Spectroscopy	16-Jun-11
Laboratory (30)	CL-LB-PR-101	2	Radiological Review of Incoming Waste Shipments	27-Apr-11
Laboratory (30)	CL-LB-PR-102	0	Calibration of Gamma Spectroscopy Systems	3-Aug-11
Laboratory (30)	CL-LB-PR-130	0	PT 2900 TR Liquid Scintillator Analyzer Calibration & Operation	5-Dec-07
Laboratory (30)	CL-LB-PR-131	1	PT 2900tr Liqid Scintillation Analyzer Maintenance	31-Dec-09
Laboratory (30)	CL-LB-PR-132	0	Detection of Tritium by Scintillation Analysis	5-Dec-07
Laboratory (30)	CL-LB-WI-002	1	PCB Wipe Sampling	19-Jun-08
Laboratory (30)	CL-LB-WI-003	0	Sampling Equipment Decontamination	11-Feb-08
Laboratory (30)	CL-LB-WI-014	0	Preparation of Standards and Solutions for Trace Metals Analysis	16-Sep-11
Laboratory (30)	CL-LB-WI-016	0	Acid Digestion of Water for Total Recoverable or Dissolved Metals Analysis	16-Sep-11
Laboratory (30)	CL-LB-WI-017	0	Acid Digestion of Aqueous Samples and Extracts for Total Metals Analysis	16-Sep-11
Laboratory (30)	CL-LB-WI-018	0	Determination of Metals and Trace Elements in Waters and Wastes by ICP Emission Spectroscopy	16-Sep-11
Laboratory (30)	CL-LB-WI-022	0	Mercury in Liquid Waste Digestion and Analysis	16-Sep-11
Laboratory (30)	CL-LC-PR-001	1	Guidelines For Ensuring Data Integrity	31-Dec-09
Laboratory (30)	CL-LC-PR-100	0	Glassware Washing for Metal Prep and Analysis	31-Dec-09

SUBCATEGORY	REFERENCE	REV[1]	TITLE	DATE[1]
Laboratory (30)	CL-LC-PR-110	0	Toxicity Characteristic Leaching Procedure	19-Jan-10
Laboratory (30)	CL-LC-PR-120	0	Operation of the TEII II ICP Spectrometer	26-Aug-09
Laboratory (30)	CL-LC-PR-121	0	Maintenance of the TEII II ICP Spectrometer	26-Aug-09
Laboratory (30)	CL-LC-WI-001	0	Test Methods for Oxidizing Solids	7-Dec-09
Laboratory (30)	CL-LC-WI-017	0	Acid Digestion of Aqueous Samples and Extracts for Total Metals Analysis	16-Sep-11
LLRW Disposal (8)	CL-LD-PR-006	0	Disposal of Metals with HPTC	4-Jan-10
LLRW Disposal (8)	CL-LD-PR-007	0	ES Generated Waste at LLRW Disposal Facility	4-Jan-10
LLRW Disposal (8)	CL-LD-PR-100	1	Large Component Handling and Disposal	4-Oct-10
LLRW Disposal (8)	CL-LD-PR-101	0	Management of High Security Waste Types	4-Jan-10
LLRW Disposal (8)	CL-LD-PR-102	0	Ion Exchange Resin Blending and Disposal	4-Jan-10
LLRW Disposal (8)	CL-LD-PR-103	0	Control of Fugitive Dust	4-Jan-10
LLRW Disposal (8)	CL-LD-PR-209	0	Asbestos Disposal	4-Jan-10
LLRW Disposal (8)	CL-LD-PR-704	1	Stormwater Management	1-Jun-10
Maintenance (5)	CL-MN-PR-001	2	Used Oil Management	26-May-11
Maintenance (5)	CL-MN-WI-001	0	WI for Maintenance Filing & Record Keeping	29-Jun-09
Maintenance (5)	CL-MN-WI-002	0	Contaminated Equipment Maintenance and Decommissioning	25-Nov-09
Maintenance (5)	CL-MN-WI-003	0	Pressure Washing Stationary Equipment	21-Jul-11
Maintenance (5)	CL-MN-WI-004	0	Air Brake System External Inspection	21-Sep-11
Mixed Waste Disposal (37)	CL-MD-PR-001	5	Unloading and Handling Highway Shipments	1-Jun-11
Mixed Waste Disposal (37)	CL-MD-PR-002	2	EnergySolutions Generated Waste	27-Jul-11
Mixed Waste Disposal (37)	CL-MD-PR-003	3	Container Movement	28-Mar-11
Mixed Waste Disposal (37)	CL-MD-PR-004	2	Waste Disposal Direct and Treated	27-Feb-12
Mixed Waste Disposal (37)	CL-MD-PR-006	1	Removal of Placed Waste	18-May-09
Mixed Waste Disposal (37)	CL-MD-PR-007	3	Update Facility Tracking Record	16-Mar-12
Mixed Waste Disposal (37)	CL-MD-PR-008	1	Incoming Shipment Inspection and Sampling	27-Aug-10
Mixed Waste Disposal (37)	CL-MD-PR-009	2	Unloading and Handling Rail Shipments	1-Jun-11
Mixed Waste Disposal (37)	CL-MD-PR-010	1	Management of UNNPI Waste from US DOE and DOD	21-Oct-10
Mixed Waste Disposal (37)	CL-MD-PR-011	2	Empty PCB Container Management	2-Jun-10
Mixed Waste Disposal (37)	CL-MD-PR-012	1	Management of Waste for Disposal at LLRW	1-Jul-10
Mixed Waste Disposal (37)	CL-MD-PR-100	1	Decontamination of Transport Vehicles	7-Aug-09
Mixed Waste Disposal (37)	CL-MD-PR-101	2	Decontamination of Containers	28-Nov-11
Mixed Waste Disposal (37)	CL-MD-PR-102	1	Decontamination of Equipment	18-May-09
Mixed Waste Disposal (37)	CL-MD-PR-103	4	90 Day and Satellite Accumulation Container Management	17-Mar-11

SUBCATEGORY	REFERENCE	REV[1]	TITLE	DATE[1]
Mixed Waste Disposal (37)	CL-MD-PR-104	2	Leachate Collection	7-Nov-11
Mixed Waste Disposal (37)	CL-MD-PR-105	2	Waste Water Transfer	27-Jun-11
Mixed Waste Disposal (37)	CL-MD-PR-106	2	90 Day Evaporation and Settling Tank Clean Out	17-Oct-11
Mixed Waste Disposal (37)	CL-MD-PR-107	1	PCB Contaminated Empty Container Management	29-Sep-10
Mixed Waste Disposal (37)	CL-MD-PR-108	2	Polymer Application and Dust Suppression	25-Jul-11
Mixed Waste Disposal (37)	CL-MD-PR-109	0	Universal Waste Identification and Management	3-Apr-08
Mixed Waste Disposal (37)	CL-MD-PR-110	0	Decontamination of Gondolas in the MW Area	26-Aug-08
Mixed Waste Disposal (37)	CL-MD-PR-200	4	Daily Weekly and Monthly Inspections	24-Jun-11
Mixed Waste Disposal (37)	CL-MD-PR-201	1	Annual Inspections	7-Dec-10
Mixed Waste Disposal (37)	CL-MD-PR-202	1	Storage Summary Verification	27-Aug-10
Mixed Waste Disposal (37)	CL-MD-WI-001	1	MW to LLRW Equipment Transfer	30-Mar-11
Mixed Waste Disposal (37)	CL-MD-WI-002	1	MW Container Tracking	30-Mar-11
Mixed Waste Disposal (37)	CL-MD-WI-007	1	MW Operations QADEP	30-Mar-11
Mixed Waste Disposal (37)	CL-MD-WI-300	1	Stationary Truck Scale Operation	7-Feb-11
Mixed Waste Disposal (37)	CL-MD-WI-301	1	Vactor Truck Operations	14-Oct-10
Mixed Waste Disposal (37)	CL-MD-WI-302	2	Decontamination Pressure Pump Operations	19-Jan-12
Mixed Waste Disposal (37)	CL-MD-WI-303	1	Vacuum Trailer Operations	14-Oct-10
Mixed Waste Disposal (37)	CL-MD-WI-304	1	Portable Truck Scale Operation	7-Feb-11
Mixed Waste Disposal (37)	CL-MD-WI-305	2	Offloading of Liquid Waste Tankers	16-Dec-09
Mixed Waste Disposal (37)	CL-MD-WI-307	0	PCB Container Decontamination	23-Jan-08
Mixed Waste Disposal (37)	CL-MD-WI-308	0	Sampling Plan - 9407-03 Railcars	12-Mar-08
Mixed Waste Disposal (37)	CL-MD-WI-999	0	SPRU Drum Characterization	22-Nov-10
Mixed Waste Treatment (31)	CL-MT-PR-001	1	Pre Operational Briefing	28-Sep-10
Mixed Waste Treatment (31)	CL-MT-PR-002	3	Waste Stabilization	18-Aug-10
Mixed Waste Treatment (31)	CL-MT-PR-003	0	Decontamination Between Stabilization Waste Streams	6-Mar-08
Mixed Waste Treatment (31)	CL-MT-PR-004	1	Stablization Formula Development	10-May-10
Mixed Waste Treatment (31)	CL-MT-PR-005	0	Solidification Formula Development	8-Mar-11
Mixed Waste Treatment (31)	CL-MT-PR-101	2	Pre Processing Waste	28-Sep-10
Mixed Waste Treatment (31)	CL-MT-PR-103	0	Draining Battery Acid	18-Apr-08
Mixed Waste Treatment (31)	CL-MT-PR-104	0	Foam Filling Internal Voids	17-Apr-08
Mixed Waste Treatment (31)	CL-MT-PR-105	0	Macro Vault Operations	30-Oct-08

SUBCATEGORY	REFERENCE	REV[1]	TITLE	DATE[1]
Mixed Waste Treatment (31)	CL-MT-PR-107	1	Draining Large Capacitors	22-Jul-10
Mixed Waste Treatment (31)	CL-MT-PR-108	0	Draining and Flushing of PCB Items	22-Jul-10
Mixed Waste Treatment (31)	CL-MT-PR-200	3	Waste Constituent Verification	27-Jul-11
Mixed Waste Treatment (31)	CL-MT-PR-203	1	Fire System Inspection	7-Jan-11
Mixed Waste Treatment (31)	CL-MT-PR-300	1	Drum Compactor Operation	27-Aug-10
Mixed Waste Treatment (31)	CL-MT-PR-301	1	Mixer Number One Operation	27-Aug-10
Mixed Waste Treatment (31)	CL-MT-PR-302	1	Small Scale Operation	31-Mar-11
Mixed Waste Treatment (31)	CL-MT-PR-304	2	Primary Shredder Operation	29-Nov-11
Mixed Waste Treatment (31)	CL-MT-PR-305	1	Tertiary Shredder Operation	16-Feb-11
Mixed Waste Treatment (31)	CL-MT-PR-307	2	Baghouse Operation	31-Mar-11
Mixed Waste Treatment (31)	CL-MT-PR-400	1	Waste Solidification	14-Jan-10
Mixed Waste Treatment (31)	CL-MT-PR-401	1	Spray Wash Operation	14-Dec-10
Mixed Waste Treatment (31)	CL-MT-PR-500	1	Thermal Desorption Pre Operational Briefing	27-Aug-10
Mixed Waste Treatment (31)	CL-MT-PR-501	2	Thermal Desorption Operations	27-May-11
Mixed Waste Treatment (31)	CL-MT-PR-502	1	Thermal Desorption Waste Sampling	27-Aug-10
Mixed Waste Treatment (31)	CL-MT-WI-004	0	Treatment Reagent Management	2-Mar-09
Mixed Waste Treatment (31)	CL-MT-WI-006	0	Liquid Waste Repackaging	3-Mar-09
Mixed Waste Treatment (31)	CL-MT-WI-016	1	VTD Condensate Management	13-May-09
Mixed Waste Treatment (31)	CL-MT-WI-025	0	Antifreeze Recycling	2-Aug-09
Mixed Waste Treatment (31)	CL-MT-WI-306	1	Air Compressor Operation	15-Feb-11
Mixed Waste Treatment (31)	CL-MT-WI-313	1	VTD Waste Sort and Segregation Plan	13-May-09
Mixed Waste Treatment (31)	CL-MT-WI-320	0	Portable Mixer WI	22-Jul-09
Outside Support (1)	CL-OS-PR-300	2	Batch Plant Operations	6-Sep-11
Procurement (1)	CL-PU-PR-001	0	Completing Purchasing Requisitions in Oracle	3-Aug-10
Radiation Safety (23)	CL-RS-PR-051	0	Health Physics Training and Qualification	27-Aug-10
Radiation Safety (23)	CL-RS-PR-061	2	Director of Health Physics Inspections	20-Oct-10
Radiation Safety (23)	CL-RS-PR-112	3	Radiological Surveys	12-May-11
Radiation Safety (23)	CL-RS-PR-113	1	VTD Radiological Monitoring	28-Apr-10
Radiation Safety (23)	CL-RS-PR-114	2	Receipt and Evaluation of Radiologically Contaminated Material and Equipment for Use Reuse at EnergySolutions	23-Mar-12
Radiation Safety (23)	CL-RS-PR-120	9	Access Control Points	29-Nov-11
Radiation Safety (23)	CL-RS-PR-130	12	ALARA	16-Nov-11
Radiation Safety (23)	CL-RS-PR-130	2	Radiological Control	15-Nov-11
Radiation Safety (23)	CL-RS-PR-140	3	Radiation Work Permit	9-Mar-11

SUBCATEGORY	REFERENCE	REV[1]	TITLE	DATE[1]
Radiation Safety (23)	CL-RS-PR-150	2	Posting Requirements for Radiological Hazards	15-Nov-11
Radiation Safety (23)	CL-RS-PR-155	6	Radiation Protection Program	12-Mar-12
Radiation Safety (23)	CL-RS-PR-170	6	Restricted Area Material Release	29-Sep-11
Radiation Safety (23)	CL-RS-PR-180	1	Restricted Area Release Surveys	9-Jun-11
Radiation Safety (23)	CL-RS-PR-210	1	Personnel External Radiation Monitoring	9-Mar-10
Radiation Safety (23)	CL-RS-PR-220	1	Bioassay Monitoring	17-Mar-10
Radiation Safety (23)	CL-RS-PR-230	2	Work Area Air Sampling	29-Sep-11
Radiation Safety (23)	CL-RS-PR-240	2	Lapel Pump Air Sampling	23-Mar-12
Radiation Safety (23)	CL-RS-PR-250	1	Working Level Measurements Radon Thoron	20-Jan-10
Radiation Safety (23)	CL-RS-PR-280	1	Internal Dose Determination	3-Jun-11
Radiation Safety (23)	CL-RS-PR-290	1	Rn 222 Working Level Measurement Using Kusnetz Procedure	14-Jan-11
Radiation Safety (23)	CL-RS-PR-434	1	Source Leak Check Procedure	28-Apr-10
Radiation Safety (23)	CL-RS-PR-438	0	Radioactive Source Inventory	3-Jun-10
Radiation Safety (23)	CL-RS-PR-701	1	HIS 20 Health Physics Information System	9-Jun-11
Shipping and Receiving (8)	CL-SR-PR-041	8	Incoming Radioactive Waste Shipment Acceptance	30-Jun-11
Shipping and Receiving (8)	CL-SR-PR-051	1	Shipment of Radioactive Material	10-Feb-09
Shipping and Receiving (8)	CL-SR-PR-052	0	Package Preparation of Radioactive Material for Transportation	2-Jul-09
Shipping and Receiving (8)	CL-SR-PR-053	0	Shipping of Hazardous Material Lab Samples	28-Mar-08
Shipping and Receiving (8)	CL-SR-WI-001	0	Waste Acceptance Notification	28-Sep-09
Shipping and Receiving (8)	CL-SR-WI-002	1	Electronic Manifest 7 Day Return	6-Jul-10
Shipping and Receiving (8)	CL-SR-WI-009	0	EWIS QA Instruction	16-Sep-09
Shipping and Receiving (8)	CL-SR-WI-021	0	Empty Container Storage	18-May-09
Technical Services (1)	CL-TS-WI-001	0	QADEP for Technical Services	12-Jun-09
Training (7)	CL-TN-PR-010	2	General Training Procedure	2-Sep-11
Training (7)	CL-TN-PR-020	2	Initial Training Procedure	2-Sep-11
Training (7)	CL-TN-PR-030	6	Qualification Procedure	3-Nov-11
Training (7)	CL-TN-PR-040	2	Continuing Training Procedure	2-Sep-11
Training (7)	CL-TN-PR-050	2	Testing and Evaluation Procedure	2-Sep-11
Training (7)	CL-TN-PR-060	2	Training Documentation and Storage Procedure	2-Sep-11
Training (7)	CL-TN-PR-080	2	Trained Personnel Badging Procedure	2-Sep-11
Waste Management (1)	CL-WM-PR-001	4	Waste Profile Acceptance Process	11-Nov-11
Waste Processing (1)	CL-WP-PR-001	2	Shredder Operations	3-Nov-10

Appendix B

Site Security Procedure Catalogue

SUBCATEGORY	REFERENCE	REV[2]	TITLE	DATE[1]
Security (2)	CL-SE-PR-010	5	Security Operations Protocol	5-Jan-12
Security (2)	CL-SE-PR-020	6	Issuing Badges to Visitors	28-Jan-11

[2] Most current revision, as of 25 April 2012.

Appendix C

Decontamination and Decommissioning

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1.0 INTRODUCTION

The MARSSIM release described below centers on tracking the overall life cycle of the data as it is planned, executed, assessed and reviewed throughout the release process. As such, the release of Energy*Solutions*' Clive, Utah facility can be broken down into four distinct steps:

- The **PLANNING phase** of the data life cycle;
- The **IMPLEMENTATION phase** of the data life cycle;
- The **ASSESSMENT phase** of the data life cycle; and, if necessary,
- The **DECISION making** phase of the data life cycle.

Each phase will be described as the topic is introduced in the text below.

It should be noted that constant, regular communication with site regulators will be required to ensure that successful remediation and decommissioning of the facility meets and/or exceeds all stake holders' expectations. Further, the implementation of the MARSSIM release process should be considered in terms of accomplishing the overall Data Quality Objectives (DQO's) established through Energy*Solutions* and Regulatory cooperation.

The Null Hypothesis (H_o) associated with the decommissioning of the Clive facility shall be as follows:

> "The residual radioactivity in the survey unit(s) exceeds the release criterion."

1.1 Scope

The Scope of this document applies solely to the decommissioning of Section 32 of Energy*Solutions*' Clive, Utah facility. Decommissioning activities will be performed to meet site closure requirements of both the LLRW and 11e.(2) Radioactive Material Licenses; i.e., License #UT 2300249 and License #UT 2300478.

1.2 Assumptions

It is assumed that all contaminated facilities, equipment and miscellaneous support structures will be removed and disposed of as Class A radioactive waste to the extent outlined in Energy*Solutions*' Clive, Utah facility surety document.[1]

It is assumed that in accordance with Energy*Solutions*' Clive-related Surety fund, six inches of soil will have been removed from Section 32 and disposed of in an on-site radioactive waste embankment.

Any contamination found in the soil and/or groundwater during facility operations will have been remediated upon discovery and the records of said remediation maintained under Energy*Solutions*' institutional controls program.[2]

[1] Energy*Solutions*' Radioactive Material License UT2300249, Amendment 9, Condition 73.
[2] Radioactive Material License Application No UT2300249, Section 5.4.2, dated June 20, 2005.

It is also assumed that most of the activities described herein would not occur until the waste disposal capacity of the facility (outside of facility decommissioning) has been exhausted and all operational activities outside of remediation and final closure have ceased.

It is assumed that the Clive facility's current, health and safety program, site security program, site radiation safety program, personnel training program and quality assurance program will be implemented throughout the decommissioning process.

This decommissioning plan is germane only to Section 32. Based on the Clive facility's Environmental Monitoring and Data Reporting Program, it is assumed that Section 5 and Section 29 will be treated as non-impact areas, and therefore outside the scope of any release or decommissioning activities.

1.3 Reports Generated as a Result of the Decommissioning Plan

Three reports will be generated and submitted for regulatory review as a result of decommissioning activities at the Clive facility:

1. A **Historical Site Analysis (HSA)** as defined below;
2. A **Remedial Action Support Survey (RASS)** that will document remediation and site characterization activities that took place in order to decontaminate the Clive facility in preparation for the Final Status Survey; and,
3. The **Final Status Survey (FSS)** Report, which will document the general release of Section 32.

2.0 REMEDIAL ACTION SUPPORT ACTIVITIES (CHARACTERIZATION SURVEY)

Clive facility DQO's cannot be completely determined until a final characterization survey has been completed. In order to develop the DQO's for this project the characterization survey will provide data on:

- The identification and distribution of radiological hazards on Section 32;
- The concentration and distribution of these contaminants in surface and sub surface soils;
- The concentration and distribution of contaminants in groundwater and sediments; and,
- The concentration and distribution of contaminants in other media on Section 32 that are not otherwise disposed.[3]

Data obtained during the characterization survey will be used to plan for final remediation actions. Data will also be used to determine the design of the final status survey as well as refine the Derived Concentration Guideline Levels (DCGL's) used in the planning phase of the data life cycle (discussed further below).

[3] *Decommissioning Health Physics*, Chapter 3, Section 3.2, pg 36. E.W. Abelquist.

2.1 Historical Site Assessment (Outside Scope of MARSSIM)

The Historical Site Assessment is defined as an assessment that identifies all locations, inside and outside the facility, where radiological spills, disposal operations, or any type of radiological accident could have resulted in the contamination of property.[4]

The HSA for the Clive facility will include, but not be limited to:

1. A review of Environmental and Site Remediation records.
2. A review of historical aerial photographs of the Clive facility. This review will include but not be limited to:
    a. Bone Yard and equipment storage locations throughout Clive's history;
    b. Haul road and rail progressions;
    c. Decon facility locations;
    d. Evaporation and storage pond locations;
    e. Excavations or potential water accumulation zones within Section 32;
    f. Temporary equipment or Bone Yard storage locations;
    g. Waste offloading and management facilities.
3. Personnel interviews. Individuals who have extensive history with disposal operations at the Clive facility will be interviewed with respect to normal and abnormal operating conditions experienced during their tenure.
4. Regulator Interviews. Regulatory personnel who have worked with the Clive facility will be interviewed with respect to normal and abnormal operating conditions experienced during their tenure.
5. An inventory of radionuclides disposed of at the Clive facility. This inventory may be obtained via direct review of shipping records combined with reviews of past amendments to the Clive facility Radioactive Material License.

2.2 Direct Measurements

As mentioned in Section 1.3 above, it is assumed that at the point of final characterization, all buildings (with the exception of those structures supporting remediation) have been demolished and the resulting debris disposed of, rail removed, with nothing more than a skeleton crew remaining to complete final decommissioning. As such, surface scans of buildings, equipment or existing structures will not be required.

Past surface measurements of the soil at the Clive facility have illustrated the inefficiency of direct, ground surface scans in discovering contamination. For this reason, site characterization of the soil on Section 32 will be performed via gamma spec analysis or the best available technology available at the time of closure.

[4] NUREG-1700.

Based on the Clive facility HSA, a graded approach will be utilized when obtaining direct measurements from the facility. Areas suspected of contamination above the DCGL (defined below) will not require as much sampling or investigation as areas thought to be clean or conversely, potentially contaminated with little evidence available. Because of this graded approach, no specific, set number of samples will be delineated in this decommissioning plan.

3.0 PLANNING PHASE OF THE DATA LIFE CYCLE

3.1 DCGLw Determination (Outside Scope of MARSSIM)

The release criterion established for a facility represents the most restrictive component of a facility release. The Nuclear Regulatory Commission's release criterion is as follows:

> "A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and that the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA)."[5]

As the 25 mrem release limit is an NRC limit, Agreement States and other agencies might use more restrictive values. Condition 74 of Energy*Solutions*' Radioactive Material License states:

> "One (1) year prior to the anticipated closure of the site, the Licensee shall submit for review and approval by the Executive Secretary a site decontamination and decommissioning plan. As part of this plan, the Licensee shall demonstrate by measurements and/or modeling that concentrations of radioactive materials which may be released to the general environment, after site closure, will not result in an annual dose exceeding 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public."[6]

As release criterion cannot be measured directly, Energy*Solutions* will use dose modeling to translate the release criterion (e.g., 25 mrem) into a radionuclide concentration (e.g., pCi/g) that can be measured. Examples of current modeling platforms that can be employed to this purpose are RESRAD, RESRAD-Build and DandD. Energy*Solutions* will use whatever platform best supports the decommissioning process of the Clive facility.

[5] 20.1402 Radiological Criteria for Unrestricted Use.
[6] Energy*Solutions*' Radioactive Material License UT2300249, Amendment 9, Condition 74.

Modeling results will be used to develop a gray region in which the release criteria associated with a clean status are determined. The Derived Concentration Guideline Levels (DCGL's) that are nuclide specific, represents the upper boundary of the gray region. The DCGL is defined as the concentration of a specific nuclide that 'equates' to the release criterion. In other words, it is the maximum allowable average level of contamination in a specified area.[7] DCGL's are generally expressed in units of activity per unit-area (e.g., dpm/100 cm^2).

The Lower Bound of the Gray Region (LBGR) is generally set at 50% of the DCGL.

3.2 Gross DCGL ($DCGL_{Gross}$) Determination[8]

As multiple radionuclides will be analyzed for compliance with the established decommissioning DQO's, it will be necessary to determine a gross $DCGL_{Gross}$ for survey unit release. The $DCGL_{Gross}$ relies on establishing a ratio of the various radionuclides that are contributing to the expressed activity within the survey unit. The ratio of radionuclides will be established during the characterization survey of the facility.

Mathematically, the $DCGL_{Gross}$ is expressed as follows:

$$DCGL_{GROSS} = \frac{1}{\frac{f_1}{DCGL_1} + \frac{f_2}{DCGL_2} + \frac{f_3}{DCGL_3} + etc.}$$

Where:

f_1, f_2, f_3, etc, represent the *fraction* of the activity contributed by radionuclides 1, 2, 3, etc; and,

$DCGL_{1\text{-}3}$ represents the DCGL's for individual nuclides 1-3.

3.3 Adjust DCGLw for Surrogate Nuclides[9]

In some instances it may make sense or be necessary to utilize the presence of a 'surrogate' radionuclide to account for the presence of another, more difficult to analyze radionuclide. Should Energy*Solutions* choose to utilize this approach, standards illustrated in Section 4.3.2 of the MARSSIM guidance document will be followed and regulatory approval obtained.

3.4 Determine the $DCGL_{EMC}$[10]

The $DCGL_{EMC}$ is defined as the maximum average concentration allowed in a small area of contamination that can be measured without exceeding the release criteria for the site (otherwise known as a 'Hot Spot').

It is calculated as follows:

$$DCGL_{EMC} = DCGL_W AF$$

Where:

[7] *Decommissioning Health Physics*, Chapter 5, pg 64. E.W. Abelquist.
[8] MARSSIM 4.3.4.
[9] MARSSIM 4.3.2.
[10] NUREG-1505, Chapter 8.

AF is known as the Area Factor. Area Factors are nuclide specific and computed using computer codes such as RESRAD or RESRAD-Build. They are numbers that are greater than or equal to 1. In general, the smaller the area being measured, the larger the area factor.

3.5 Site Classification According to Contamination Potential[11]

Based on characterization survey results, Section 32 of the Clive facility will be separated into separate, distinct impact areas in preparation of final remediation and survey.

Establish Survey Units (MARSSIM 4.6)

Impact areas are areas that have the potential for containing contaminated material and can be subdivided into three different classifications:

1. Class 1 Areas: Areas that have (or had) the potential for radioactive contamination.
2. Class 2 Areas: Areas that have (or had) the potential for radioactive contamination but are not expected to exceed the DCGL.
3. Class 3 Areas: An impacted area that is not expected to contain any residual radioactivity based on site operating history and previous radiological surveys.[12]

3.6 Determine Scenario A or Scenario B Release[13]

The objective of a Scenario A release is to demonstrate that the average/median level of residual radioactivity in the established survey units is less than the DCGL. This is the most common scenario employed when releasing a facility.

The objective behind a Scenario B release is to demonstrate that measurements in the Survey units are indistinguishable from background. Scenario B is generally used when the DCGL is low, the radionuclide being measured is found in background and background is variable.

A Scenario A release will be employed for this project.

3.7 Determine Data Assessment Non Parametric Statistics[14]

The two primary statistical tests employed in Final Status Surveys are the Sign Test and the Wilkoxon Rank Sum (WRS) Test.

The Sign Test is used when:

- The analysis is nuclide specific and the nuclide *is not* in background;
- The analysis is nuclide specific and the nuclide *is* in background at a small fraction of the DCGL; and,
- Analysis is not nuclide specific and background is a small fraction of the DCGL.

The WRS Test is used when:

[11] MARSSIM 4.4, NUREG-1505: 2.2.3, 2.2.4.
[12] *Decommissioning Health Physics*, Chapter 3, pg 46. E.W. Abelquist.
[13] NUREG-1505.
[14] MARSSIM: Table 5.3, Table 5.5.

- The analysis is nuclide specific and the nuclide is in background at a significant fraction of the DCGL.

The determination of which test will be used will occur at the time of site characterization and in conjunction with Regulatory oversight. However, it is anticipated that the Sign Test will be utilized as it is not likely that the nuclides being measured will be seen in background samples.

4.0 IMPLEMENTATION PHASE OF THE DATA LIFE CYCLE

4.1 Frisk Area and Collect Soil Samples[15]

Initial soil samples can be obtained in order to further characterize and validate information obtained during the historic site assessment. However, it is anticipated that at this point in the release process, remediation of the site in accordance with information gleaned from the historical site assessment will render the site ready for a final status release survey. Prior to soil sampling, the release areas will be frisked by qualified Health Physics personnel to ensure that no area registers at twice background. Should any area register greater than twice background, further remediation of the site will be performed and the area re – surveyed. Upon achieving a compliant survey of the area, soil samples will be obtained. It should be noted that each final status release survey will be performed within the boundary conditions established by each survey unit.

5.0 ASSESSMENT PHASE OF THE DATA LIFE CYCLE

5.1 Data Verification[16]

Soil samples obtained during the final status survey will be analyzed via onsite gamma spectroscopy. A representative number of samples will be sent off site for inter comparison and quality assurance purposes.

6.0 DECISION MAKING PHASE OF THE DATA LIFE CYCLE AND FINAL STATUS SURVEY REPORT

Data obtained during the Assessment Phase will be analyzed against the release criteria. Should the data obtained fall within acceptable release criteria, the activities described herein will be catalogued in a Final Status Survey report. Should results fall outside of release criteria, further exploratory work will be performed within the boundary of the survey unit, re-classification of the survey unit will occur if necessary, further remediation performed and the area sampled again until such time as the survey unit passes.

[15] MARSSIM 6.4.1, 7.5.
[16] MARRSIM 9.3.1; NUREG-1576, Chapter 8.

Appendix D

Proposed 11e.(2) Material License

UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF RADIATION CONTROL
RADIOACTIVE MATERIAL LICENSE

Pursuant to Utah Code Annotated, Title 19, Chapter 3 and the Utah Radiation Control Rules, Utah Administrative Code R313, 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 # ~~7~~8
1. Name	Energy*Solutions*, LLC	)	**********
		)	4. Expiration Date
2. Address	423 W. 300 S., Suite 200	)	November 30, 2003 (under timely renewal)
	Salt Lake City, UT 84101	)	**********
		)	5. License Category 2-c

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	5.5 Million Cubic Yards

SECTION 9.0: ADMINISTRATIVE CONDITIONS

9.1 All notices to the Utah Division of Radiation Control required under this license shall be addressed to the ~~Executive Secretary~~Director of the Utah Division of Radiation Control~~Utah Radiation Control Board~~.

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, submitted to the NRC by cover letter dated 12/23/91; as amended by page changes submitted to the NRC on 07/02/92, 08/10/92, 04/05/93, 04/07/93, 04/10/93, 05/03/93, 05/06/93, 05/11/93, 05/21/93, 07/01/93, 07/25/93, 08/03/93, 08/11/93, 08/19/93, 08/25/93, 01/14/94 (deletes only Operating Procedure TRAIN-1; other documents submitted to the NRC on this date remain in force), 01/21/94, 03/01/94, 03/08/94, 04/19/94, 06/10/94, 06/29/94, 06/30/94, 07/27/94, 08/03/94, 09/01/94, 01/19/95, 03/24/95, 04/11/95 (deletes only Appendix JJ, Quality Assurance Manual; other documents submitted to the NRC on this date remain in force), 05/24/95, 06/14/95, 08/25/95, 09/18/95, 12/12/95, 02/07/96, 05/22/96, 07/19/96, 05/16/97, 01/09/98, 04/01/98, 04/07/98, 04/08/98, 04/17/98, 05/29/98, 06/24/98, 07/02/98, 07/07/98, 09/21/98, 03/31/99, 04/07/99, 04/30/99, 05/07/99, 07/08/99, 07/20/99, 08/16/99, 09/07/99,

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09/10/99, 09/16/99, 11/15/99, 11/17/99, 12/06/99, 02/16/00, 02/17/00, 03/01/00, 03/24/00, 04/27/00, 04/28/00, 05/08/00, 05/31/00, 06/09/00, 06/16/00, 06/23/00,06/30/00, 07/06/00, 07/10/00, 07/14/00 [NRC Amendment No. 24], 07/14/00 [NRC Amendment No. 29], 08/09/00, 08/28/00, 08/30/00, 09/18/00, 09/21/00 [NRC Amendment No. 35], 09/22/00, 09/26/00, 10/12/00, 12/20/00, 12/29/00, 01/31/01, 03/06/01, 04/11/01, 04/16/01, 04/24/01, 07/09/01 [NRC Amendment No. 36], 09/13/01 [NRC Amendment No. 37], 10/18/00, 10/05/01 [NRC Amendment No. 38], 05/30/02 [NRC Amendment No. 39]**,** 7/9/02 [NRC Amendment 42], 7/12/02, 9/4/02 [NRC Amendment No. 43], 10/17/02 and 02/27/03 [NRC Amendment 45],10/01/03 [NRC Amendment 48] and 09/19/05 (replacing Section 18 of the 11e.(2) License Application in its entirety, the descriptions, statements, representations of the approved Appendix I, *Organization*, from the license application for RML UT 2300249) [UDRC Amendment: 2], Environmental Monitoring and Surveillance Plan Appendix LL dated 6/19/07; Replacing Section 7 of the 11e.(2) License Application in its entirety with the approved Environmental Monitoring Plan dated November 24, 2008 for RML UT2300249 [URDC Amendments 4,5, and 6]~~[UDRC Amendment 5][UDRC Amendment 6]~~.

Notwithstanding the above, the following conditions shall override any conflicting statements contained in the licensee's application and supplements.
[Applicable NRC Amendments: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39**,** 42, 43, 45, and 48]
[Applicable UDRC Amendment 2]

9.4 Deleted by UDRC Amendment 5
[Applicable NRC Amendments: 7, 31, 38, 39, and 41][UDRC Amendment 5]

9.5 In order to assure 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 ~~Executive Secretary~~Division Director and the Utah State Historic Preservation Office (SHPO). The artifacts shall be inventoried and evaluated in accordance with UCA Section 404, and no disturbance shall occur until the licensee has received written authorization from the ~~Executive Secretary~~Division Director and SHPO to proceed.

9.6 Prior to the initial receipt and storage of any 11e.(2) byproduct material at the site, the licensee shall:

a) Establish and implement standard operating procedures (SOPs) for all operational activities involving the handling, storing or disposing 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) Deleted by NRC Amendment 1

UTAH DIVISION OF RADIATION CONTROL
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c) Deleted by NRC Amendment 1

d) Deleted by NRC Amendment 1

e) Modify the Quality Control/Quality Assurance Plan to provide quality controls for waste sampling and characterization. The plan must also be modified to provide controls for the quality of the protective equipment (e.g., anticontamination clothing and equipment that meets the ANSI Z-88.2 guidance (ANSI, 1989)) and respiratory protection equipment;

f) Design and implement an effective air sampling program in the workplace based on Revision 1 to NRC Regulatory Guide 8.25 (June 1992) entitled "Air Sampling in the Workplace," or an equivalent program.
[Applicable NRC Amendment: 1]

9.7 Deleted by UDRC Amendment 6.

9.8 The licensee shall have all written SOPs reviewed and approved by the Director of Health Physics (DHP), or designate, qualified by way of specialized radiation protection training equivalent to that required for the DHP as defined in License Condition 9.10, 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 DHP on an annual basis.
[Applicable NRC Amendments: 7, 31, and 41][UDRC Amendment 6]

9.9 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.
[Applicable NRC Amendment: 7]

9.10 The Licensee's staff shall meet the qualifications as described in the currently approved Appendix I, *Organization*, of the Radioactive Material License UT 2300249. In addition to the responsibilities and qualifications specified in the licensee's application, the DHP or their designate(s) 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 DHP shall also receive 40-hours of related health and safety refresher training every two years.
[Applicable UDRC Amendments: 2, 5, and 6]

For the purposes of this licensee 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.
[Applicable NRC Amendments: 11, 21, 29, 31, 41 46, and 48]

9.11 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.

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

9.12 The Licensee shall at all times maintain a Surety that satisfies the requirements of UAC R313-24-4 (10 CFR 40, Appendix A, Criterion 9 and 10 incorporated by reference) in an amount adequate to cover the estimated costs, if accomplished by a third party contractor, for completion of the ~~Executive Secretary~~Division Director-approved reclamation/decommissioning plan of the Licensees' grounds, equipment and facilities including; above-ground decommissioning and decontamination, soil and water sample analyses, and groundwater restoration associated with the site, as warranted.

The licensee's currently approved surety instrument, irrevocable letter of credit from Zions First National Bank, and a related standby trust agreement, in favor of the ~~Executive Secretary~~Division Director, shall be continuously maintained for the purpose of complying with UAC R313-24-4 (10 CFR 40, Appendix A, Criterion 9 incorporated by reference), in an amount approved by the ~~Executive Secretary~~Division Director, until a replacement is preauthorized by the ~~Executive Secretary~~Division Director.

The Licensee shall annually review the amount and basis of the surety and submit a written report of its findings by May 31 each year for ~~Executive Secretary~~Division Director's approval. At a minimum, this annual report shall meet the following requirements:

a. Summary of Changes - the annual report shall include a written summary of any change in the cost estimate previously approved by the ~~Executive Secretary~~Division Director, including, but not limited to:

i. A description of any modification, addition, or deletion of any direct cost or post-closure monitoring and maintenance (PCMM) cost line item, including supporting justification, calculations and basis;

ii. Any change to the unique reference number (cost line item) assigned or approved by the ~~Executive Secretary~~Division Director for any cost line item.

b. In-direct Costs shall be based on the sum of all applicable direct costs in accordance with the following values:

Surety ID No.	Description	Percentage
300	Working Conditions	5.5%
301	Mobilization / Demobilization	4.0%
302	Contingency	11.0%
303	Engineering and Redesign	2.25%
304	Overhead and Profit	19.0%

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305	Management Fee and Legal Expenses	4.0%
306	DEQ Oversight	4.0%

c. RS Means Guide estimates of direct construction costs provided in the annual report shall be derived from or based on the most recent printed edition of the RS Means Guide for Heavy Construction.

d. Report Certification – the annual report shall be prepared under the direct supervision of and be certified by a professional with at least 5 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.

e. Electronic Format – the Licensee shall provide the report in both paper and electronic formats, as directed by the ~~Executive Secretary~~Division Director.

f. Within 60-days of ~~Executive Secretary~~Division Director's approval of said annual report, the Licensee shall submit written evidence that the surety has been adequately funded.

[Applicable NRC Amendments: 1, 6, 8, 9, 10, 15, 17, 19, 23, 24, 28, 30, 36, 39, 44, 47, and 49]
[Applicable UDRC Amendments: 1, 2, 5, and 6]

9.13 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.

The DHP, or designate, qualified by way of special radiation protection training equivalent to that required for the DHP as defined in License Condition 9.10, shall indicate by signature, the review and approval of each RWP, prior to the initiation of the work.
[Applicable NRC Amendments: 7, 31, and 41][UDRC Amendment 6]

9.14 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.

9.15 The licensee shall have qualified individual(s), designated by the DHP and ~~Risk~~ Safety and Health Manager, 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(s) 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.
[Applicable NRC Amendments: 31 and 41][UDRC Amendments 6 and 8]

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9.16 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.

9.17 The licensee shall provide for an independent internal audit of facility operations to assure compliance with applicable regulations and license conditions. The independent internal audit will be conducted annually by a qualified health physicist knowledgeable on operations concerning radiation protection programs at milling/waste disposal facilities. The contractor report shall be submitted as part of the annual report.
[Applicable NRC Amendment: 7]

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 will be no eating, drinking, smoking, defecating, or urinating in the restricted areas at any time.

10.2 The licensee shall analyze and adequately characterize:

a) All incoming waste to identify any new hazardous constituents not listed in License Condition 11.1. The licensee shall develop and implement methodologies and procedures for systematic characterization and analysis of the incoming waste, so that any new hazardous constituents are identified. Furthermore, the licensee shall assume that the baseline background concentrations for any new constituents are below their detection levels, unless the licensee demonstrates to the ~~Executive Secretary~~Division 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.

b) The following key radon attenuation model parameter values 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 will be calculated and provided in the annual effluent and environmental monitoring report.
[Applicable NRC Amendments: 4 and 35][UDRC Amendment 6]

c) 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 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 2,500 c.y. of material placed for compaction; and at least once per lift

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for lifts smaller than 2,500 c.y. 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 will include the elevation (or lift number) of the sample location. The results will be presented as average values for each lift in the 4th quarter effluent and environmental monitoring report. [Applicable NRC Amendments: 4 and 30][UDRC Amendment 6]

10.3 The licensee shall assume full responsibility for cleaning up the groundwater of ~~all~~ hazardous constituents, originating from the 11e.(2) disposal facility, that have been detected at the POC in concentrations that exceed the limits specified in Tables 1-~~A~~ C and 1-D of the Ground W~~w~~ater Quality Discharge Permit. 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 ~~Executive Secretary~~Division Director's satisfaction~~, based on field and laboratory data,~~ that the 11e.(2) facility is not the source of particular constituents. ~~The Executive Secretary shall have the final decision concerning any claim by the licensee that the 11e.(2) facility is not the source of a particular constituent that is detected at the POC.~~

The licensee shall undertake corrective action to clean up groundwater contamination if and when required, no later than 18 months from the date when exceedence 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. [Applicable NRC Amendment: 7][UDRC Amendment 8]

10.4 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.

10.5 The licensee shall implement the quality assurance plan as provided in the license application.

10.6 The licensee shall, ~~upon arrival of the waste and before acceptance on site,~~ prior to managing the waste for disposal, visually inspect the waste ~~or use the Environmental Protection Agency's Paint Filter Liquids Test (SW-846, Method 9095)~~ to determine if the waste contains free liquids. 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.

~~10.6~~ Solid waste received and containing unexpected aqueous free liquid in excess of 1% by volume shall have the liquid removed and placed in the evaporation ponds or the liquid solidified prior to management.~~The licensee shall not accept any waste containing free~~

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~~liquid for disposal. The licensee, however, shall be subject to the following minimum frequency of Paint Filter Liquids Test analyses and sample collection requirements: (1) for each waste stream, the minimum number of samples to be analyzed shall be one sample for each shipment (rail or highway) for the first 1,000 yd 3 (or any part thereof), and (2) thereafter the minimum number of samples to be analyzed shall be one sample for each set of ten (10) shipments. The licensee shall manage leaking waste shipments and/or waste containing greater than one percent (1%) free liquid as listed below, or for other reasons, reject the shipment for disposal:~~

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~~a) Upon discovery of free liquids or a leaking shipment, the licensee shall immediately notify the Executive Secretary (within 24 hours) and shall provide a written notification to the Executive Secretary within fourteen (14) calendar days of the immediate notification containing the following:~~

~~(1) Generator number~~

~~(2) RSR number or Bates Number for the shipment(s)~~

~~(3) Date accepted or rejected for disposal~~

~~(4) Corrective Actions~~

~~b) The licensee shall take leaking rail shipments to the railcar decontamination wash-down pad and leaking truck shipments to the decontamination wash-down pads or railcar rollover facility.~~

~~c) The licensee shall take shipments containing more than one percent (1%) free liquids to one of the following areas:~~

~~(1) Restricted-area sections of the railroad~~

~~(2) Restricted-area asphalt or concrete surfaces~~

~~(3) Wash-down pads~~

~~(4) Approved temporary storage areas~~

~~(5) Rollover containment area~~

~~(6) Unloading area~~

~~d) The licensee shall remediate using one or more of the following methods:~~

~~(1) Solidification through the use of agents generally accepted by the industry, such as clay, sand, and other adsorptive materials and documenting formula development.~~

~~(2) Evaporation~~

~~(3) Physical removal of liquid~~

~~e) Upon completion of remediation, the shipment may be accepted for disposal and moved to either the 11e.(2) disposal cell or to an approved 11e.(2) waste management area.~~

a) ~~[Applicable NRC Amendments: 13 and 25]~~

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

c) Should shipment(s) arrive with greater than 1% unexpected free liquids (total of aqueous and non-aqueous), the Licensee shall notify the Division of Radiation Control within 24 hours that the shipment(s) failed the requirements for acceptance and manage in accordance with the Waste Characterization Plan.

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10.7 The licensee shall upon arrival of waste, perform external exposure rate measurements of the waste conveyances. Any shipment with exposure rates greater than 5 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 UAC R313-15-901, R313-15-902, and R313-15-903 [10 CFR 20.1902(a) incorporated by reference] until disposed.
[Applicable NRC Amendment: 1]

10.8 The licensee shall operate the facility in compliance with the following specifications:

a) The maximum bulk mass of waste disposed of annually will not exceed 4.536×10^5 tonnes (5×10^5 tons) or (3.82×10^5 m^3) or (4.00×10^5 yd^3).
[Applicable NRC Amendment: 19]

b) The open cell area will not exceed 69,955.41 m^2, 83,666.67 yd^2, 753,000 ft^2 or 17.29 acres.
[Applicable NRC Amendments: 14 and 19]
[Applicable UDRC Amendments: 1, 3, and 6]
~~[Applicable UDRC Amendment: 3]~~
~~[Applicable UDRC Amendment: 6]~~

c) Deleted by NRC Amendment 1

d) The total embankment capacity will not exceed 4.20×10^6 m^3 (5.50×10^6 yd^3)
[Applicable NRC Amendments: 5 and 19]

e) The maximum volume of waste that may be stored as in-cell bulk storage on site prior to disposal will not exceed 75,000yd^3 or ($5.735 \times 10^4 m^3$) at any one time.
[Applicable NRC Amendment: 19] [Applicable UDRC Amendment 5]

f) Waste with an average concentration above 4,000 pCi/g for natural uranium or for any radio nuclide in the radium-226 series; 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 will not be accepted.
[Applicable NRC Amendment: 14]

g) Deleted by NRC Amendment 1

h) Deleted by NRC Amendment 1

i) Deleted by NRC Amendment 45
[Applicable NRC Amendments: 4, 5, 19, and 45]

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The licensee shall maintain the detailed documents demonstrating compliance with the above specifications on-site and summarize the data in paragraphs a) and b) of this License Condition in the annual As-built report that is required in the Groundwater Quality Discharge Permit UGW450005." [Applicable UDRC Amendment 7]

10.9 The minimum compacted radon barrier thickness placed after December 1, 2001, will be 4.0 ft. on the top and 3.5 ft. on the side of the disposal cell.

a) The placed radon barrier material will be compacted to not less than 95 percent of maximum dry density in accordance with Standard Proctor Method ASTM-698, field-tested for compliance. At least one density test shall be performed for every 200 cubic yards (compacted) and at least one test shall be conducted on each lift. All lifts shall be field-tested for density and moisture content. At least one moisture content test shall be performed for every 200 cubic yards (compacted) and at least one test shall be conducted on each lift.

b) The waste in the upper ten feet of the 11e.(2) embankment shall be placed and compacted to not less than 90 percent of the maximum dry density in accordance with Standard Proctor Method ASTM D-698, field-tested for compliance. At least one density test shall be performed for every 1000 cubic yards (compacted) and at least one test shall be conducted on each lift. Field-tested density compliance may be demonstrated by data collected from the use of Computer-Aided Earthmoving System (CAES)- equipped compactors. All lifts in the upper ten feet of the 11e.(2) embankment shall be field-tested for moisture content. CLSM shall not be used in the upper ten feet of the 11e.(2) embankment.

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c) At the end of every calendar year starting with 2001, the licensee shall ensure that the cumulative average activity concentration of waste placed after Jan. 1, 2001, within the upper 3 feet of disposed waste does not exceed 300 pCi/g of Ra-226 or 900 pCi/g of Th-230, and within the next 7 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 will 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 3 feet and 1,500 pCi/g in the next 7 feet of waste, and

Y = 300 pCi/g in the upper 3 feet and 500 pCi/gm in the next 7 feet of waste

d) The cumulative average densities of the waste in the upper ten feet of the 11e.(2) embankment and of the compacted radon barrier placed since January 1, 2001, shall not be less than 1.5 g/cm^3 for either.

e) These cumulative average values of 10.9(d) will be provided in the 4th quarter effluent and environmental monitoring report, starting with the 2008 report, and in the construction completion report.
[Applicable NRC Amendment: 37][UDRC Amendment 6]

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SECTION 11: INSPECTION, MONITORING, AND RECORDING REQUIREMENTS

11.1 The Licensee shall fulfill and maintain compliance with all conditions and all compliance schedules stipulated in the Ground Water Discharge Permit, number UGW 450005, issued by the ~~Executive Secretary~~ Director of the Utah Division of Water Quality ~~Board~~, as amended.

11.2 Replaced by State of Utah Groundwater Quality Permit #450005.
[Applicable NRC Amendments: 21, 31, 41, and 42]

11.3 The licensee shall require that the DHP and the Site Engineer perform and document joint inspections of all work areas at least monthly. The licensee shall correct any deficiency noted during the inspection within 7 working days. The results of the inspections and any necessary corrective actions should be reported in the annual report.
[Applicable NRC Amendments: 31, 41, and 46][UDRC Amendment 6]

11.4 The licensee is granted an exemption to UAC 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).
[Applicable NRC Amendments: 32, 33, and 45]

SECTION 12: REPORTING REQUIREMENTS

12.1 Deleted by NRC Amendment 4.

12.2 Deleted by UDRC Amendment 6

12.3 The licensee shall perform an annual ALARA audit of the radiation safety program which shall be led by the DHP or designate, qualified by way of specialized radiation protection training equivalent to that required for the DHP as defined in License Condition 9.10, in accordance with Section 2.3.3 of NRC Regulatory Guide 8.31, as amended. A report of this audit shall be submitted to corporate headquarters and the ~~Executive Secretary~~Division Director, by March 31st for the previous year. 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:
[Applicable NRC Amendments: 24, 31, and 41][UDRC Amendments 6 and]~~[UDRC Amendment~~ 7]

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.

[Applicable NRC Amendment: 34]

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 monthly reviews.

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 ~~Executive Secretary~~Division Director and previously submitted to the NRC.

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

The audit shall also address any ~~noticeable~~ 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.

12.4 The licensee shall conduct an annual land-~~-~~use survey for a 5 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 annual report.

12.5 The licensee shall immediately notify the ~~Executive Secretary~~Division Director, by telephone within 24 hours and by letter within 7 days of any waste shipment where a violation of applicable regulations or license conditions has been found.
[Applicable NRC Amendment: 24]

12.6 The licensee shall, unless otherwise specified, submit an annual report documenting: 1) the annual reporting requirements as specified in the license conditions; 2) the results of calibration of equipment; 3) reports on audits and inspections completed during the year; 4) the results of all meetings and training courses required by this license; and 5) any other significant subsequent information, reviews, investigations, and corrective actions. This report, covering the calendar year, shall be submitted to the ~~Executive Secretary~~Division Director by March 1 following the first full year after receipt of this license, and by April 30 every year thereafter. Unless otherwise specified in the UAC rules, all such documentation shall be maintained at the site and corporate headquarters for a period of at least five (5) years.
[Applicable NRC Amendments: 4 and 22]
[Applicable UDRC Amendment 1]

12.7 The licensee shall, at least three months prior to license termination, provide 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 UAC R313-24-4 (10 CFR Part 40, Appendix A, Criterion 11 incorporated by reference). Specifically, the licensee shall document that: (1) the concentrations of all of the listed hazardous constituents at the POC are within their designated concentration limits (standards); (2) if a corrective action program was carried out that the hazardous constituents contaminating the ground-water were returned to their designated limits; and (3) the facility has been properly decontaminated and decommissioned in accordance with the decontamination and decommissioning plan proposed by the applicant in the license application approved by the ~~Executive Secretary~~Division Director. The license termination will not occur until the licensee has demonstrated that these actions have been completed.

12.8 The licensee shall immediately report to the ~~Executive Secretary~~Division Director: 1) any failure of the 11e.(2) byproduct material disposal cell that results in a release of waste into unrestricted areas; or 2) 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.
[Applicable NRC Amendment: 24]
[Table SDT-1 Deleted by NRC Amendment 38]
[Table S-1 replaced by State of Utah Groundwater Quality Permit #450005.]
[Applicable NRC Amendments: 2, 3, 5, 7, 18, 26, and 38]

SECTION 13: CLOSEOUT CONDITIONS

13.1 Except as specifically provided otherwise in this license, the Licensee shall conduct its program in accordance with the statements, representations, and procedures contained in the documents, including any enclosures, listed below. The Utah Radiation Control Rules, Utah Administrative Code R313 shall govern unless the statements, representations, and procedures in the Licensee's application and correspondence are more restrictive than the rules.

A. The following documents refer to revisions made in Amendment 1.

(1) Letter CD05-0102, dated March 4, 2005 refers to increase in the 11e.(2) open cell area.

(2) Letter CD05-0179, dated April 13, 2005 refers to increase of surety corresponding to increased open cell area.

B. The following documents and submittals are the basis for revisions made in Amendment 2.

(1) Letter CD05-0267, dated May 26, 2005, 11e.(2) 2005 annual surety review; and request to change License Condition 9.12.

(2) Deficiency letter regarding 11e.(2) annual surety submittal, from Stephen Palmer to Mark Ledoux, dated June 23, 2005.

(3) Letter CD05-0341, dated July 8, 2005, responding to deficiencies in 11e.(2) surety submittal.

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(4) Email Correspondence from Treesa Parker to Stephen Palmer dated June 29, 2005, regarding changes to Section 9.12.

(5) Letter CD05-0398, dated August 16, 2005, regarding changes to License Condition 9.12.

(6) Letter CD05-0453, dated September 19, 2005, regarding changes to License Condition 9.10.

(7) Letter CD05-0507, dated October, 2005, Envirocare's response to DRC request for additional information regarding proposed revisions to Appendix I of the RML UT 2300249 License Application

(8) Letter dated November 22, 2005, from John Hultquist to Mark Ledoux. Request for information regarding changes to License Condition 9.10.

(9) Email dated December 12, 2005, Treesa Parker to John Hultquist, transmitting redline/strikeout changes to License Condition 9.10, and redline/strikeout changes to Appendix I of the RML UT 2300249 License Application.

(10) Letter CD06-0012, dated January 12, 2006, requests change of address in License Condition 2.

(11) Letter CD06-0041, dated February 3, 2006, requests change in company name from Envirocare of Utah to Energy*Solutions*, LLC in License Condition 1.

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(12) Letter dated February 23, 2006, Dane Finerfrock to Tye Rogers, granting conditional approval of the 2005 11e.(2) annual surety submittal.

C. The following documents and submittals are the basis for revisions made in Amendment 3.

(1) Letter CD06-0207, dated May 22, 2006, 11e.(2); open cell area, request to change License Condition 10.8(b).

(2) Email dated July 14, 2006, from John Hultquist to Sean McCandless, open cell area request condition 10.8(b).

(3) Email dated 7/24/2006, from Sean McCandless to John Hultquist Amendment request open cell area 11e.(2) license condition 10.8(b) and associated attachments, Letter of Credit and insurance policy schedule B.

D. The following documents and submittals are the basis for revisions made in Amendment4

(1) Letters CD06-0445, dated December 1, 2006; CD07-0186, dated May 24, 2007; CD07-0204, dated June 19, 2007; CD07-0220, dated July 6, 2007, Wayne Johns to Dane Finerfrock, Revision to Appendix LL, Environmental Monitoring and Surveillance Plan.

(2) Letter dated May 30, 2007 from John Hultquist to Wayne Johns, Revision to Appendix LL, Environmental Monitoring and Surveillance Plan.

(3) Email dated May 29, 2007 from Kevin Carney to Wayne Johns; email dated May 29, 2007 from Wayne Johns to Kevin Carney; email dated May 31, 2007 from John Hultquist to Wayne Johns.

E. The following documents and submittals are the basis for revisions made in Amendment 5.

(1) Letter CD06-0004, dated January 9, 2006; Mark Ledoux to Dane Finerfrock; Request to amend License Conditions 9.4 and 11.1.c, and approve proposed revisions to the license application for the elimination of the Safety and Environmental Review Panel.

(2) Letter dated September 21, 2007, Craig Jones to Mark Ledoux, Re: Request to amend License Conditions 9.4 and 11.1.c, and approve proposed revisions to the license application for the elimination of the Safety and Environmental Review Panel.

(3) Letter dated May 25, 2007, Sean McCandless to Dane L. Finerfrock, Radioactive Material License No: UT2300478; Request to amend License Condition 9.12 and 10.8.e). Submittal of Annual Surety Review.

(4) Letter dated July 16, 2007, Sean McCandless to Dane L. Finerfrock, Radioactive Materials License No: UT2300478; Response to letter dated, June 19, 2007, regarding Annual Surety Review.

(5) Letter dated August 30, 2007, Sean McCandless to Dane L. Finerfrock, Radioactive Materials License No: UT2300478; Response to letter dated July 25, 2007, regarding Annual Surety Review.

(6) Letter dated September 10, 2007, Dane L. Finerfrock to Daniel Shrum, 2007 Annual Surety Submittal, May 25, 2007, July 16, 2007, and August 27, 2007 Update for 11e.(2) 2007 Engineering Module 30, Radioactive Materials License Number UT2300478: Conditional Approval.

(7) Letter dated September 28, 2007 (CD07-0318) Mark Ledoux to Dane L. Finerfrock, Radioactive Material License No: UT 2300478 Response letter dated September 21, 2007, regarding proposed license amendment to eliminate the SERP and comments of draft license.

(8) Letter dated March 27, 2007 from Zions Bank to the Executive Secretary of the Utah Radiation Control Board, Re: Standby Letter of Credit.

F. The following documents and submittals are the basis for revisions made in Amendment 6

(1) Letter dated August 8, 2008, Dane Finerfrock to Tye Rogers, 2007 Module 32 Engineering Inspection – 11e.(2) Waste Placement: Notice of Violation

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(2) Letter dated August 22, 2007 (CD07-0267) Wayne Johns to Dane Finerfrock, Response to Notice of Violation (NOV) identified by letter to Energy*Solutions* dated August 8, 2007.

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(3) Letter dated September 6, 2007 (CD07-0289) Tye Rogers to Dane Finerfrock, 2007 RML #UT2300478[2149] – Response to Notice of Violation dated August 7, 2007.

(4) Letter dated October 31, 2007 (CD07-349) from Tye Rogers to Dane Finerfrock, RML#UT2300478; Supplementary information regarding NOV dated August 7, 2007, and Request for License Amendment.

(5) Letter dated March 3, 2008 (CD08-0069) Dan Shrum to Dane Finerfrock, Request to Remove License Condition 11.1, revise Section 5 of the License Application, and approve modification of Tables 1C and 1D of the Groundwater Quality Discharge Permit UGW450005.

(6) Letter dated May 29, 2008, Dane Finerfrock to Tye Rogers, 2007 Module 32 Engineering Inspection – Notice of Violation dated August 7, 2007, RML #UT2300478[2149] License Amendment Request.

(7) Letter dated May 30, 2008 (CD08-0166) Sean McCandless to Dane Finerfrock, Radioactive Material License No: UT2300478; Request to amend License Condition 9.12 and 10.8 e.). Submittal of Annual Surety Review and request for increase in open cell area.

(8) Letter dated October 9, 2008, Dane Finefrock to Dan Shrum; Energy*Solutions* 2008 Annual Surety Submittal, May 30, 2008, and September 3, 2008 Update for 11e.(2), 2008 Engineering Module 30, RML UT2300478: Conditional Approval.

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(9) Letter dated November 24, 2008 (CD08-0376) Wayne Johns to Dane Finerfrock; Radioactive Material License No. UT2300249 and RML No. UT2300478, License Condition 13.1.D Environmental Monitoring Plan.

(10) Email dated 12/24/2008 from Sean McCandless to John Hultquist, Subject: 11e.(2) amendment –DRC letter 5/29/08.

(11) Email dated 12/29/2008 from Sean McCandless to John Hultquist, Subject: New Environmental Plan in 11e.(2) License.

(12) Emails dated 1/21/2009 and 1/22/2009 from Sean McCandless to John Hultquist, Subject: 11e.(2) License, condition 10.2.c.

(13) Email dated 01/26/2009 from Sean McCandless to John Hultquist, Subject: FW Draft RML UT2300478 (amendment 6).

(14) Letter dated January 26, 2009 (CD09-0020) from Dan Shrum to Dane Finerfrock, Revision to Appendix I *Organization*.

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(15) Letter dated January 28, 2009 John Hultquist to Dan Shrum, Request for Information, Revision to Appendix I *Organization* submitted Jan 26, 2009.

(16) Letter dated February 9, 2009 (CD09-0038) from Dan Shrum to Dane Finerfrock, Revision to Appendix I *Organization*. Response to Request for Information.

(17) Email dated 2/17/2009, from Sean McCandless to John Hultquist, Subject UT2300478 Energy*Solutions* Amend 6-draft.

G. The following documents and submittals are the basis for revisions made in Amendment 7

(1) Letter dated June 3, 2010, from Sean McCandless of Energy*Solutions* to Dane Finerfrock of the DRC. Radioactive Materials License UT 2300478 – Amendment Request to Consolidate 11e.(2) Embankment Groundwater Monitoring requirements with the Requirements listed in the Groundwater Quality Discharge Permit (UGW 450005)

(2) Letter (CD10-0231) dated August 12, 2010, Sean McCandless of Energy*Solutions* to Rusty Lundberg of the DRC. Radioactive Materials License No. UT 2300478 amendment request.

(3) Letter dated September 2, 2010, from Rusty Lundberg of the DRC to Sean McCandless of Energy*Solutions*. Radioactive Material License (RML) Number UT 2300478 amendment request dated August 12, 2010.

(4) Memorandum dated June 6, 2011, from Charles Bishop to John Hultquist/Loren Morton. Request to Consolidate 11e.(2) Embankment's Ground-Water Monitoring Requirements, 11e.(2) License UT2300478, Amendment #6, with the Ground Water Quality Discharge Permit, UGW 450005.

(5) Letter (SD11-0218) dated August 09, 2011, from Sean McCandless of Energy*Solutions* to Rusty Lundberg of the DRC. Radioactive Material License (RML) Number UT 2300478 amendment request dated August 12, 2010.

(6) Letter dated September 8, 2011, from Charles Bishop of the DRC to Sean McCandless of Energy*Solutions*. Energy*Solutions* request to amend Radioactive Material License UT 2300478, consolidating the 11e.(2) embankment's Ground Water Monitoring Requirements into the Ground Water Quality Discharge Permit, UGW450005: Division of Radiation Control Request for Information.

(7) Letter dated October 11, 2011, from Sean McCandless of Energy*Solutions* to Rusty Lundberg of the DRC. Response to Division of Radiation Control Request for Information – Radioactive Material License UT 2300478 - -Amendment Request to Consolidated 11e.(2) Embankment Ground Water Monitoring Requirements with the

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requirements listed in Ground Water Quality Discharge Permit UGW450005.

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UTAH ~~RADIATION~~ DIVISION OF RADIATION CONTROL ~~BOARD~~

Rusty Lundberg, ~~Executive Secretary~~Director Date
Utah Division of Radiation Control

UTAH DIVISION OF RADIATION CONTROL
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Appendix E

Safety and Health Procedure Catalogue

SUBCATEGORY	REFERENCE	REV[3]	TITLE	DATE[1]
Safety and Health (26)	CL-SH-PR-020	2	Safety Incidents	8-Dec-11
Safety and Health (26)	CL-SH-PR-050	3	Equipment Operations	5-Oct-11
Safety and Health (26)	CL-SH-PR-052	7	Safe Rail Operations	10-Feb-12
Safety and Health (26)	CL-SH-PR-053	1	Motor Carrier Safety Compliance	4-Jan-11
Safety and Health (26)	CL-SH-PR-070	3	Clive Respiratory Protection Program	21-Feb-12
Safety and Health (26)	CL-SH-PR-071	1	Respirator Maintenance and Issue	12-Jul-10
Safety and Health (26)	CL-SH-PR-072	0	Supplied Air Respirator Use	22-Sep-10
Safety and Health (26)	CL-SH-PR-120	1	Machine Guarding Flying Debris Protection	30-Dec-10
Safety and Health (26)	CL-SH-PR-130	1	Clive Heat Stress Program	23-Dec-10
Safety and Health (26)	CL-SH-PR-140	1	Material Handling	1-Feb-11
Safety and Health (26)	CL-SH-PR-141	2	Propane Storage Filling and Handling	26-Sep-11
Safety and Health (26)	CL-SH-PR-142	2	Extension Cord Safety	23-Aug-11
Safety and Health (26)	CL-SH-PR-150	1	Laboratory Chemical Hygiene Plan	3-Jun-09
Safety and Health (26)	CL-SH-PR-170	1	Hand and Power Tools	23-Dec-10
Safety and Health (26)	CL-SH-PR-201	3	Control of Hot Work	26-Mar-12
Safety and Health (26)	CL-SH-PR-301	0	Bloodborne Pathogens	7-Jul-11
Safety and Health (26)	CL-SH-PR-302	1	Beryllium Waste Handling	29-Mar-11
Safety and Health (26)	CL-SH-PR-303	1	Hazard Communication Labeling	3-Nov-08
Safety and Health (26)	CL-SH-PR-500	3	Emergency Response Plan	6-Aug-10
Safety and Health (26)	CL-SH-PR-501	3	Safe Site Shutdown Plan	9-Jun-11
Safety and Health (26)	CL-SH-PR-502	1	Medical Emergencies	30-Jun-08
Safety and Health (26)	CL-SH-PR-503	2	Clive Facility Fire Protection and Prevention Plan	5-Jan-12
Safety and Health (26)	CL-SH-WI-110	4	Confined Space Evaluation and Labeling	21-Jun-11
Safety and	CL-SH-WI-	0	Industrial Hygiene Surveys	13-Aug-09

[3] Most current revision, as of 25 April 2012.

SUBCATEGORY	REFERENCE	REV[3]	TITLE	DATE[1]
Health (26)	111			
Safety and Health (26)	CL-SH-WI-112	1	Confined Space Permit Issue	22-Jun-11
Safety and Health (26)	CL-SH-WI-113	0	Safety and Health Waste Stream Review	12-Sep-11

Appendix F

Quality Assurance Procedure Catalogue

SUBCATEGORY	REFERENCE	REV[4]	TITLE	DATE[1]
Quality Assurance/Quality Control (23)	CL-QA-PR-005	2	Quality Assurance Records	25-May-11
Quality Assurance/Quality Control (23)	CL-QA-PR-090	3	Receipt Inspection	11-Apr-11
Quality Assurance/Quality Control (23)	CL-QA-WI-018	2	Instructions for the Interim Storage and Destruction of Records	5-Aug-11
Quality Assurance/Quality Control (23)	CL-QA-WI-019	0	Quarterly Verification of Closed Condition Reports	1-Aug-11
Quality Assurance/Quality Control (23)	CL-QA-WI-021	2	Indoctrination and Training	2-Dec-10
Quality Assurance/Quality Control (23)	CL-QA-WI-120	2	Control of Measuring & Testing Equipment	16-Feb-12
Quality Assurance/Quality Control (23)	CL-QA-WI-163	2	Causal Analysis	18-May-11
Quality Assurance/Quality Control (23)	CL-QA-WI-171	2	Record Storage Environmental Control	6-Nov-09
Quality Assurance/Quality Control (23)	CL-QA-WI-172	0	Management of Clive Server Back Up Media	20-May-09
Quality Assurance/Quality Control (23)	CL-QC-PR-011	5	M and TE Calibration	6-Mar-12
Quality Assurance/Quality Control (23)	CL-QC-PR-015	3	Density Testing	20-Jun-11
Quality Assurance/Quality Control (23)	CL-QC-PR-016	1	Construction Surveying	28-Aug-09
Quality Assurance/Quality Control (23)	CL-QC-PR-018	1	In Cell Bulk Disposal	20-Jun-11
Quality Assurance/Quality Control (23)	CL-QC-PR-021	1	Standard Practice for Sampling Aggregates from Stockpiles	16-Mar-10
Quality Assurance/Quality Control (23)	CL-QC-PR-025	2	Standard Practice for Achieving Certified AMRL Results	1-Nov-11
Quality Assurance/Quality Control (23)	CL-QC-PR-032	3	Disposal of Waste with CLSM	6-Mar-12
Quality Assurance/Quality Control (23)	CL-QC-PR-034	2	Disposal of Waste Soils	6-Mar-12

[4] Most current revision, as of 25 April 2012.

SUBCATEGORY	REFERENCE	REV[4]	TITLE	DATE[1]
Quality Assurance/Quality Control (23)	CL-QC-PR-035	3	Debris Placement in Soil Waste Lifts	6-Mar-12
Quality Assurance/Quality Control (23)	CL-QC-PR-036	1	CWF Waste Placement and Backfilling Specifications	2-Sep-11
Quality Assurance/Quality Control (23)	CL-QC-PR-037	0	Placement of Intermediate & Backfill Cover Layers	13-May-08
Quality Assurance/Quality Control (23)	CL-QC-PR-038	4	Lift Approval Using an 826 Compactor	26-May-11
Quality Assurance/Quality Control (23)	CL-QC-PR-040	1	Railcar Moisture Determination	16-Mar-10
Quality Assurance/Quality Control (23)	CL-QC-PR-092	1	Open Cell Tracking	29-Sep-10

Appendix G

URS Round 2 Interrogatories

(October 2007)

1 INTERROGATORY ES-11E2-R313-24-4(1)-8/2

INTERROGATORY STATEMENT:

Please justify and discuss the horizontal groundwater velocity sensitivity to the assumption of using a porosity of 0.30 in Section 1.4.5.1. Please include the potential range of effects on the calculated horizontal velocity to uncertainties in this assumption. Please provide supporting information and justify why the value of 0.30 was selected for porosity, and include how the historical flux and groundwater mounding data are addressed in the uncertainties and assumptions.

Energy*Solutions* Response: The Division has accepted the approach and subsurface geotechnical properties over Energy*Solutions*' multiple licensing actions (since the 2000 Class B& C License Application). The saturated zone porosity has been reported and accepted as 0.30 since that time.

2 INTERROGATORY ES-11E2-R313-24-4(1)-9/2

INTERROGATORY STATEMENT:

Please justify and discuss the vertical groundwater velocity sensitivity to the assumptions of using a porosity of 0.30 and vertical hydraulic conductivity of 0.00283 ft/day in Section 1.4.5.2. Please include the potential range of effects on the calculated vertical velocity to uncertainties in this assumption, including variation in the parameters between saturated and unsaturated zones.

Energy*Solutions* Response: The Division has accepted the approach and subsurface geotechnical properties over Energy*Solutions*' multiple licensing actions (since the 2000 Class B& C License Application). The subsurface unsaturated zone porosity has been reported and accepted as 0.30 and vertical hydraulic conductivity of 0.00283 ft/day since that time.

3 INTERROGATORY ES-11E2-R313-24-4(4)-1/2

INTERROGATORY STATEMENT:

Provide Map 2B as referenced in Appendix G-1. Use consistent PMP value.

Energy*Solutions* Response: The HEC-calculated Probable Maximum Precipitations of 10.08 inches for the six-hour storm and 6.1 in. for a 1-hour storm have been consistently referenced in the revised 11e.(2) License Renewal Application. References to maps have been corrected. Additionally, the Division is referred to Energy*Solutions*' Annual As-Built Report for additional dimensional details of the 11e.(2) Embankment, (McCandless, 2011).

4 INTERROGATORY ES-11E2-R313-24-4(4)-3/2

INTERROGATORY STATEMENT:

Please clarify the use of equation (10) in Appendix G under Section 3.0. There appears to be two different equations used to calculate the 2-hour storm event for the storm distribution.

Energy*Solutions* Response: The referenced equation 10 of Appendix G from Energy*Solutions* (2005b) was erroneously labeled as applicable to a 2-hr event (instead of that for a 3-hr event). However, equation 9 was correctly used in the Analysis of Appendix G to estimate the 2-hr event and equation 10 for a 3-hr event in the analysis.

5 INTERROGATORY ES-11E2-R313-24-4(4)-6/2

INTERROGATORY STATEMENT:

In addition to pointing out the details on the design discharge calculation used in the PMF quantity calculation provided in Appendix J, please refer to Appendix G to address the calculations related to the perimeter ditch design calcs.

Energy*Solutions* Response: The perimeter ditch calculations were conducted according to approved NRC methodology (Nelson, 1986). References to the perimeter ditch design calculations have been correctly referred to Appendix G of Energy*Solutions*, (2005b).

6 INTERROGATORY ES-11E2-R313-24-4(4)-10/2

INTERROGATORY STATEMENT:

Provide slope stability analysis that uses input consistent to that provided in the engineering drawings and specifications. Please provide the lab results for friction angle and cohesion intercept for the various soils used in the stability analysis.

Energy*Solutions* Response: The slope stability analysis provided in Appendix K of EnergySolutions, (2005b) is consistent with that conducted by DOE for the Vitro Embankment (DOE, 1984). Even though more recent analyses predict lower lateral accelerations from the Maximum Credible Earthquake, the original analysis remains conservatively applicable.

7 INTERROGATORY ES-11E2-R317-6-1/2

INTERROGATORY STATEMENT:

Explain why the organic parameters cited in the Whetstone April 26, 2000 Tech Memo and used in the PATHRAE analysis have not been added to the list of analytes used in the sampling program.

Energy*Solutions* Response: The list of Whetstone-modeled analytes has been included in the License Renewal Application as Table 4-1.

8 INTERROGATORY ES-11E2-R317-6-3/2

INTERROGATORY STATEMENT:

Please specify how the value in Section 1.4.1.1 was determined.

Energy*Solutions* Response: The Division has accepted the approach and unsaturated soil characteristics presented in Section 2.9 (originally located in Section 1.4.1.1) over Energy*Solutions*' multiple licensing actions (since the 2000 Class B& C License Application).

9 INTERROGATORY ES-11E2-R317-6-6/2

INTERROGATORY STATEMENT:

Explain how infiltration modeling takes into account flooding issues (i.e. the potential PMF).

Energy*Solutions* Response: As is documented in Attachments G-1 and G-2 of Energy*Solutions*, (2005b), the PMF calculations are used to determine the necessary run-on berm heights necessary to protect the 11e.(2) Embankment from the corresponding erosional effects. Historically-representative fluctuations in precipitation are considered in the fate and transport analysis documented in Appendix E of Energy*Solutions*, (2005b).

10 INTERROGATORY ES-11E2-R317-6-7/2

INTERROGATORY STATEMENT:

Whetstone report cites that the EZD is a conservative estimate based on previous reports. Please reference EZD sensitivity analyses in Section 4.3.4 of the December 4, 1997 Adrian Brown document currently found in RML application.

Energy*Solutions* Response: The Division has accepted the approach and EZD value over Energy*Solutions*' multiple licensing actions (since the 2000 Class B& C License Application). As is correctly noted, the sensitivity of the fate and transport analysis to selected EZD value is also well described in these past license efforts and is equivalent to values used in Appendix E of Energy*Solutions*, (2005b).

11 INTERROGATORY ES-11E2-R317-6-11/2

INTERROGATORY STATEMENT:

The infiltration and transport report found in Appendix E discusses HELP model sensitivity to precipitation changes only. Please reference HELP model sensitivity analysis mention in Section 4.3 of the December 4, 1997 Adrian Brown document currently found in RML application.

Energy*Solutions* Response: The Division has accepted the approach and HELP sensitivity to variations in precipitation over Energy*Solutions*' multiple licensing actions (since the 2000 Class B& C License Application). As is correctly noted, the sensitivity of the fate and transport analysis to variations in precipitation is also well described in these past license efforts and are consistent with the analysis of Appendix E of Energy*Solutions*, (2005b).

12 INTERROGATORY ES-11E2-R317-6-12/2

INTERROGATORY STATEMENT:

How were the hydraulic properties (porosity, hydraulic conductivity, field capacity, and wilting point) used in the modeling obtained? If literature values were used, please provide the references and support for the values chosen.

Energy*Solutions* Response: The Division has accepted the hydraulic properties used in the fate and transport analysis over Energy*Solutions*' multiple licensing actions (since the 2000 Class B& C License Application). The values used in the analysis presented in Appendix E of Energy*Solutions*, (2005b) utilize these same values.

13 INTERROGATORY ES-11E2-R317-6-13/2

INTERROGATORY STATEMENT:

Include electronic copy of the HELP files that contain the generated daily values for the climate parameters.

Energy*Solutions* Response: The HELP analysis used in the fate and transport assessment is thoroughly documented in Appendix E of Energy*Solutions*, (2005b).

14 INTERROGATORY ES-11E2-R317-6-14/2

INTERROGATORY STATEMENT:

Please justify why the lower of the top slope infiltration rates predicted by HELP and UNSAT-H is used in the PATHRAE modeling.

Energy*Solutions* Response: The Division has accepted the fate and transport analysis methodology over Energy*Solutions*' multiple licensing actions (since the 2000 Class B& C License Application). Only a single top-slope infiltration rate is predicted by HELP and UNSAT-H and used in the PATHRAE modeling documented in Appendix E of Energy*Solutions*, (2005b).

15 INTERROGATORY ES-11E2-R317-6-15/2

INTERROGATORY STATEMENT:

On what basis were the van Genuchten functions for the various layers selected to use in the UNSAT-H simulations? Please give testing methods and results or literature sources with justification for the values chosen.

Energy*Solutions* Response: The Division has accepted the cover-layer parameters used in the UNSAT-H analysis of the fate and transport methodology over Energy*Solutions*' multiple licensing

actions (since the 2000 Class B& C License Application). The values included in Appendix E of Energy*Solutions*, (2005b) do not vary from historically accepted parameters.

16 INTERROGATORY ES-11E2-R317-6-25/2

INTERROGATORY STATEMENT:

Why were the elevations that would give the shortest transport distances between bottom of waste and groundwater elevation not used in the modeling?

Energy*Solutions* Response: The Division has accepted the fate and transport methodology over Energy*Solutions*' multiple licensing actions (since the 2000 Class B& C License Application). The vadose zone physical dimensions included in Appendix E of Energy*Solutions*, (2005b) do not vary from historically accepted parameters.

17 INTERROGATORY ES-11E2-R317-6-28/2

INTERROGATORY STATEMENT:

Please specify the standards and practices that were followed in the slug-out tests performed to determine the aquifer's hydraulic properties.

Energy*Solutions* Response: The slug test method is a common means of estimating the hydraulic properties of aquifers (primarily hydraulic conductivity). Methods for analyzing slug tests in confined and unconfined aquifers are documented in Bouwer and Rice (1976).

18 INTERROGATORY ES-11E2-R317-6-29/2

INTERROGATORY STATEMENT:

Please explain how the porosity of the upper aquifer was determined, and provide references.

Energy*Solutions* Response: The Division has accepted the approach and subsurface geotechnical properties over Energy*Solutions*' multiple licensing actions (since the 2000 Class B& C License Application). The upper aquifer porosity has been consistently reported and accepted since that time.

19 INTERROGATORY ES-11E2-R317-6-30/2

INTERROGATORY STATEMENT:

Please specify the frequency with which the organic constituents will be tested from groundwater samples and give the methods to be used in the analysis. If the organic constituents are not be analyzed, justify the reasons for their exclusion from any analysis and explain the measures that will be taken to ensure compliance for these constituents.

Energy*Solutions* Response: The sampling frequency of groundwater chemical and radiological constituents are governed by and documented in the Ground Water Quality Discharge Permit.

20 INTERROGATORY ES-11E2-R313-24-4(6)-1/2

INTERROGATORY STATEMENT:

Please use a consistent value for the 6-hr PMP or provide the basis for which the value is different than the value calculated in Appendix J. If the PMP value is to be used in calculating the volume of water from an area smaller than 50-square miles, provide a PMP calculation that uses a correct area factor.

Energy*Solutions* Response: The HEC-calculated Probable Maximum Precipitations of 10.08 inches for the six-hour storm and 6.1 in. for a 1-hour storm are the same as those calculated in Appendix J of EnergySolutions, (2005b).

21 INTERROGATORY ES-11E2-R313-24-4(6)-3/2

INTERROGATORY STATEMENT:

Please provide summary quantities, tables and information in Section 6.3.5, Settlement of Embankment, that is consistent with detailed back-up information provided in Section 6, Attachment 1, Settlement and Cover Cracking Report; Envirocare, 1993.

Energy*Solutions* Response: Parameters used in the settlement analysis are presented in Section 6.1 of EnergySolutions, (2005b) and consistent with the Division-accepted methodology over Energy*Solutions*' multiple licensing actions (since the 2000 Class B& C License Application). The settlement analysis parameters included in Energy*Solutions*, (2005b) do not vary from historically accepted parameters.

22 INTERROGATORY ES-11E2-R313-24-4(6)-9/2

INTERROGATORY STATEMENT:

Please provide the basis for equation 2 on page 1 of Appendix F, Rock Erosion Barrier which appears to depart from NUREG 1623.

Energy*Solutions* Response: The rock erosion barrier analysis included in Energy*Solutions*, (2005b) is consistent with the Division-accepted methodology over Energy*Solutions*' multiple licensing actions (since the 2000 Class B& C License Application). The rock erosion barrier analysis included in Energy*Solutions*, (2005b) does not vary from historically accepted methods.

23 INTERROGATORY ES-11E2-R313-24-4(8)-1/2

INTERROGATORY STATEMENT:

Please include written descriptions with reference to the specific operational procedures in the Application, as applicable, that address the control of gaseous, particulate or dust emissions during operations. The Application includes procedure RW-7.2 "Dust Suppressant Application," which addresses the application of both water and polymer within areas of the active cells and haul roads. Please discuss the methods used to control dust from each waste handling operation and each area where there is the potential for blowing dust. Potential airborne releases associated with the following operations should be addressed:

- *Handling, unloading, and storage of bulk waste- releases of radon and thorium gas*
- *Handling, unloading, and storage of bulk waste- releases of dust and particulates*
- *Dust generated from storage piles*
- *Application of daily cover*
- *Embankment/disposal operations such as windblown dusts and particulates from the embankment*
- *Embankment/disposal operations such as releases of radon gas from parts of cell covered with the radon barrier*
- *Embankment/disposal operations such as releases of radon and thorium gas from parts of cell NOT covered with the radon barrier or layer of non-thorium containing waste or clean clay*
- *Shredder operations involving 11e.(2) materials*

Please include the specific measures taken for each of the operations listed above to demonstrate that all airborne effluent releases are reduced to ALARA levels. Please address the specific methods taken to control emissions at each location where the operation takes place and which, if any, specific procedure applies (i.e., list the methods used to control dust emissions at each location where the waste is or may be handled and state if RW-7.2 or another procedure applies)."

Energy*Solutions* Response: Current standard operating procedures have been provided to the Division and are catalogued in Appendix A, B, E, and F of the 2012 11e.(2) License Renewal Application. Procedure descriptions/bases can be found within each procedure.

24 INTERROGATORY ES-11E2-R313-24-4(8)-2/2

INTERROGATORY STATEMENT:

The Application states that daily, weekly, and monthly inspections are performed, but it does not state the qualifications for the person(s) conducting the inspections. Please provide details on how inspectors will be qualified.

Energy*Solutions* Response: The 2012 11e.(2) License Renewal Application has been updated to indicate the staff position that must conduct the necessary inspections. Qualifications for the appropriate staff position are included in Condition 32.A of Energy*Solutions*, (2005b).

25 INTERROGATORY ES-11E2-R313-24-4(8)-4/2

INTERROGATORY STATEMENT:

Applicant states that EnergySolutions maintains minimum moisture conditions and applies dust suppression as needed regardless of the time of year. Please state how Applicant intends to measure moisture conditions and opacity requirements to meet minimum dust standards. Also, please provide which sections of the Air Order cover activities at the 11e.(2) facility.

Energy*Solutions* Response: Dust suppression and moisture conditional measurements are documented in the standard operating procedures catalogued in Appendices A, B, E, and F (which are already in the Division's possession).

26 INTERROGATORY ES-11E2-R313-24-4(15)-1/2

INTERROGATORY STATEMENT:

Please include detailed information on the tracking program and associated forms and procedures that are used to track the waste once it enters the facility. Please list and provide copies of all procedures used by the facility to accept, track, handle, and dispose of the waste.

Energy*Solutions* Response: Energy*Solutions*' Electronic Waste Information System (EWIS) is used to track 11e.(2) waste from receipt to disposal. Procedures governing EWIS use are included in the standard operating procedures catalogued in Appendices A, B, E, and F.

27 INTERROGATORY ES-11E2-R313-24-4(15)-2/1

INTERROGATORY STATEMENT:

Please clarify if procedure LAB-4.2 has replaced LAB-2.2. If this is correct, please identify all cross-references for updating during the next round of procedure revisions.

- *BPW-1.0, "11e.(2) Waste Management Plan"*
- *TS-1, "Waste Profile Record Acceptance Process"*
- *BPW-2.1, "11e (2) Incoming Waste Unloading and Handling at the Truck Unloading Area"*
- *BPW-2.2, "11e.(2) Incoming Waste Unloading and Handling at the Intermodal Unloading Facility"*
- *RW-4.0, "Container Management and Storage*
- *RW-4.1, "Container Return Inspection"*
- *LAB-4.3, "11e (2) Incoming Waste Sample and Analysis"*
- *S&H-7.0 , "Respiratory Protection Program"*
- *TRAIN-8.0, "Access Control Badging Procedure"*
- *Waste Characterization Plan*

Energy*Solutions* Response: Current standard operating procedures have been provided to the Division and are catalogued in Appendix A, B, E, and F of the 2012 11e.(2) License Renewal Application. Procedure descriptions/bases can be found within each procedure.

28 INTERROGATORY ES-11E2-R313-24-4(16)-5/2

INTERROGATORY STATEMENT:

No available authorization to dispose of asbestos type wastes in the 11e.(2) facility.

Energy*Solutions* Response: While no requirements exist regarding disposal of asbestos-type wastes in the 11e.(2) Embankment, Energy*Solutions* notes that analysis provided to the Division demonstrating compliance of the LARW and Class A Embankments with UDRC R315-301 through 320 also applies to the 11e.(2) Embankment (Envirocare, 2000).

ROUND 2 INTERROGATORY REFERENCES

Bouwer, H. and R.C. Rice, (1976). "A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells," Water Resources Research, vol. 12, no. 3, pp. 423-428, 1976.

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Appendix H

Environmental Assessment

STATE OF UTAH 11e.(2) BYPRODUCT MATERIAL ENVIRONMENTAL ASSESSMENT

May 3, 2012

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1 INTRODUCTION

This Environmental Assessment reflects information gathered by Energy*Solutions* (known then as Envirocare) and NRC in preparation of the 1993 Final Environmental Impact Statement for a license to dispose of byproduct material (uranium and thorium mill tailings and related wastes) at a site located in Tooele County, Utah, 65 miles west of Salt Lake City, Utah (NRC, 1993).

1.1 Purpose and Need for the Proposed Action

This Environmental Assessment has been prepared in response to a request by the Utah Division of Radiation Control (the Division), as part of a renewal application for a license to dispose of byproduct material (uranium and thorium mill tailings and related wastes) at a site located in Tooele County, Utah, 65 miles west of Salt Lake City, Utah. This document has been prepared in accordance with NRC's NUREG-1748 (NRC, 2003).

The principal objectives of this Environmental Assessment process are to build into decision-making an appropriate and careful consideration of environmental aspects of proposed actions and to make environmental information available before decisions are made and actions are taken. The process is intended to help Energy*Solutions* and the Division make decisions based on an understanding of environmental consequences and to take actions that will protect, restore, and enhance the environment.

The Environmental Assessment process focuses, among other things, on a continuing responsibility to use practicable means to improve and coordinate plans, functions, programs, and resources to the end that the Energy*Solutions* and the Division may:

- fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
- assure for all safe, healthful, productive, and aesthetically and culturally pleasing surroundings;
- attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;
- preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice;
- achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities; and
- enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Furthermore, with respect to major actions significantly affecting the quality of the human environment, NUREG-1748 calls for preparation of a detailed evaluation on:

- the environmental impact of the proposed action;
- any adverse environmental effects which cannot be avoided should the proposal be implemented;
- alternatives to the proposed action;
- the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and
- any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Pursuant to this Guidance, Energy*Solutions* has prepared a detailed statement on the foregoing considerations with respect to an application to renew a source material license to dispose of uranium and thorium byproduct material received from other entities.

The total environmental costs were evaluated and weighed against the environmental, economic, technical, and other benefits to be derived from the proposed license renewal. It is concluded (see Section 6.0) that the overall benefit-cost balance for renewal of the lle.(2) byproduct material disposal facility license is favorable and that the indicated action is that of proposed renewal of the licensed facility.

The need for the proposed action is to continue to provide a secure disposal site for large-volume, low-radioactivity lle.(2) byproduct wastes that would otherwise represent an environmental hazard through dispersal from their existing locations.

1.2 The Proposed Action

Energy*Solutions* has applied to the Division to renew a license to operate a facility to receive, store, and dispose of uranium and thorium byproduct material (as defined by Section lle.(2) of the Atomic Energy Act of 1954, as amended) at a site located in Tooele County, Utah. The Clive site lies approximately 1 mile south of Clive, a railroad siding for the Union Pacific railway system. Energy*Solutions* proposes to continue to dispose of high-volume, low-activity lle.(2) byproduct material transported in bulk to the site by rail and truck.

1.3 Applicable Regulatory Requirements, Permits, and Required Consultations

To the extent practicable, the information presented in this application conforms to the recommendations referenced in 10 CFR 40, Appendix A. Energy*Solutions* considers that all applicable regulatory concerns have been adequately addressed in this Assessment. Documents used in the preparation of this Assessment have been provided as references at the end of the Assessment.

1.3.1 Compliance with 10 CFR, Part 19

Energy*Solutions* complies with the requirements of § 19.5 by addressing all communications and reports concerning the regulations of Part 19 to the Director of the Utah Division of Radiation Control. Energy*Solutions* complies with the requirements of § 19.11 by posting Form NRC-3, "Notice to Employees", and any Notices of Violation, proposed civil penalty, or other order pursuant to Subpart B of 10 CFR 2, and any response from Energy*Solutions* in a sufficient number of locations to permit employees to observe them. Energy*Solutions* also posts at those same locations a notice describing and giving the locations where copies of the regulations of Parts 19 and 20, the license, license conditions, incorporated documents, and amendments thereof can be found. Energy*Solutions* complies with the requirements of § 19.20.

Energy*Solutions* complies with the requirements of § 19.32 by adhering to its policy on nondiscrimination:

> *"EnergySolutions provides equal employment opportunities to all job applicants and employees, making employment-related decisions based upon qualifications and abilities without regard to race, color, religion, sex, national origin, age, disability, veteran status, citizenship or any other status or condition protected by applicable state or federal laws. EnergySolutions recruits, hires, assigns, transfers, promotes, trains, compensates, provides benefits, and administers programs*

without consideration of these differences. EnergySolutions is committed to providing a work environment, free from discrimination based upon any of these protected differences."

1.3.2 Compliance with 10 CFR, Part 21

Energy*Solutions* complies with § 21.6 by posting on the employees' bulletin board a copy of Section 206 of the Energy Reorganization Act of 1974. Energy*Solutions* also has posted a notice stating where the regulations of Part 21 and the procedures adopted pursuant to Part 21 can be found.

As a facility for the disposal of 11e.(2) wastes, Energy*Solutions* is not a purchaser of basic components and is not subject to the type of failures to comply which would result in a substantial safety hazard as described in § 21.21. The evaluation of such defects, deviations, or failures to comply is not a credible activity for such an operation.

As a facility for the disposal of 11e.(2) wastes, Energy*Solutions* is not a purchaser of facilities or basic components and is not subject to the requirements of § 21.31. In compliance with § 21.41, Energy*Solutions* permits Division representatives to inspect its records, premises, activities, and basic components, as necessary, to effectuate the purposes of 10 CFR, Part 21. As a disposal facility for 11e.(2) wastes, Energy*Solutions* is not a purchaser of basic components. However, Energy*Solutions* permits the Division Director to inspect records pertaining to such possible basic components at all reasonable times.

In compliance with § 21.61, Energy*Solutions* acknowledges that any director or responsible officer subject to the regulations in Part 21 who knowingly and consciously fails to provide the notice required by § 21.21 is subject to a civil penalty equal to the amount provided by Section 234 of the Atomic Energy Act of 1954, as amended.

1.3.3 Compliance with 10 CFR 61.80, 10 CFR 61.81, and 10 CFR 61.82

Energy*Solutions* complies with the requirements of 10 CFR 61.80 (a), (b), (c), and (d) by establishing and maintaining files of all records and reports required by 10 CFR 61 for the land disposal of 11e.(2) byproduct material.

Energy*Solutions* complies with the requirements of 10 CFR 61.80 (i) by submitting annual reports to the Director of the Utah Division of Radiation Control. The report, which is submitted by April 30 of each year, for the preceding year includes:

1. The specification of the quantity of each of the principal radionuclides released to uncontrolled areas in liquid and airborne effluents during the preceding year;
2. The results of the environmental monitoring program;
3. A summary of disposal survey and maintenance activities;
4. A summary of the activities and quantities of radionuclides disposed of;
5. Any instances in which observed site characteristics were significantly different from those described in the license application; and
6. Other information the Executive Secretary may require.

Energy*Solutions* complies with the requirements of 10 CFR 61.81 by performing, or permitting the Division Director to perform, any tests the Division Director deems appropriate or necessary for the administration of the applicable regulations, including tests of:

1. Radioactive wastes and facilities used for the receipt, storage, treatment, handling, and disposal of radioactive wastes;
2. Radiation detection and monitoring instruments; and
3. Other equipment and devices used in connection with the receipt, possession, handling, treatment, storage, or disposal of radioactive waste.

Energy*Solutions* complies with the requirements of 10 CFR 61.82 by:

1. Affording to the Division Director at all reasonable times opportunity to inspect radioactive waste not yet disposed of, and the premises, equipment, operations, and facilities in which radioactive wastes are received, possessed, handled, treated, stored, or disposed of; and
2. Making available to the Division Director for inspection, upon reasonable notice, records kept pursuant to the applicable regulations. Authorized representatives of the Division Director may take copies of records required to be kept by those regulations for the Division Director's use.

Energy*Solutions* complies with the requirements of Utah Administrative Code R313-24 by:

1. Affording to the Division Director at all reasonable times opportunity to inspect 11e.(2) waste not yet disposed of, and the premises, equipment, operations, and facilities in which radioactive wastes are received, possessed, handled, treated, stored, or disposed of;
2. Prescribing to the rules and requirements for the possession or disposal of source material as related to Energy*Solutions*' 11e.(2) disposal operations; and,
3. Prescribing to the conditions set forth in its Ground Water Quality Discharge Permit (GWQDP).

Energy*Solutions* complies with the requirements of Utah Administrative Code R317-6 by prescribing to the conditions set forth in its GWQDP. Regulatory Guides used in the preparation of this Assessment have been provided as references at the end of the Assessment.

1.3.4 Utah Division of Radiation Control – Radioactive Material License

Utah regulation R313-19-2 states that "No person shall receive, possess, use, transfer, own, or acquire radioactive material except as authorized in a specific or general license issued pursuant to R313-21 or R313-22, or as otherwise provided in this chapter." Energy*Solutions* has received a radioactive material license (License Number UT2300249). The license permits receipt, management, and disposal of Class A LLRW materials. A Safety Analysis Report was prepared by the Division in support of that license.

1.3.5 Utah Division of Solid and Hazardous Waste – Hazardous Waste Plan Approval (State-issued Part B Permit)

Utah Hazardous Waste Management Rule R450-3-1.1 (a) (and similar requirement in 40 CFR 270.10[f][1], " . . . no person shall own, construct, modify, or operate any facility for the purpose of treating, storing, or disposing of hazardous waste without first submitting and receiving the approval of the Committee for a hazardous waste operation plan for that facility." The State-issued Part B Permit was renewed on April 4, 2007, providing continued approval for the management and disposal of Mixed Waste.

1.3.6 Utah Division of Solid and Hazardous Waste – Solid Waste Disposal Permit
Energy*Solutions* has received a permit to dispose of solid waste at the Clive facility.

1.3.7 Bureau of Land Management – Right-of-Way or Temporary Use Permit
EnergySolutions has received a Right-of-way for BLM lands adjacent to Section 32, pursuant to Federal Land Policy and Management Act (43 U.S.C. 1701 et seq., 43 CFR 2800).

1.3.8 Utah State Department of Environmental Quality, Division of Air Quality Approval Order
EnergySolutions has received Air Quality Approval Order # DAQE-AN0717012-05, as amended, from the Department of Environmental Quality, Division of Air Quality.

1.3.9 Office of State Engineer, Utah Division of Water Rights – Approval of Well Plugging
Pursuant to Water Laws of Utah, UCA 73, 5-9, and Regulations for Water Well Drillers, Utah Division of Water Rights, the State Engineer may require that any well be plugged to prevent pollution or contamination of groundwater. Prior to plugging wells, Energy*Solutions* notifies the Office of the State Engineer to determine the acceptability of plugging techniques.

1.3.10 Tooele County Corporation, Development Services – Conditional Use Permit
Pursuant to Tooele County Zoning Ordinances, a conditional use permit (CUP 2700-87) has been obtained.

1.3.11 State of Utah Division of Water Quality – Groundwater Discharge Permit
In compliance with the provisions of the Utah Water Pollution Control Act, Title 26, Chapter 11, Utah Code Annotated, 1953, as amended, the State Division of Water Quality renewed Ground Water Quality Discharge Permit No. UGW450005 in June, 2008.

2 ALTERNATIVES

Energy*Solutions* considered several alternatives in its decision to pursue renewal of its 11e.(2) License for continuing the disposal of 11e.(2) byproduct and associated wastes at its Clive facility. Energy*Solutions* analyzed three disposal site locations in the State of Utah: continued use of the Clive site, in Tooele County, Utah; pursuit of an 11e.(2) License at the Skunk Ridge site, located northeast of the Clive site, in Tooele County, Utah; and pursuit of an 11e.(2) License at the Blanding site, located in San Juan County, Utah. In addition, Energy*Solutions* considered disposal at a hypothetical existing mill tailings site located in the northeastern United States.

The active search by the Federal government for alternative disposal sites for the Vitro uranium mill tailings began in 1975. Altogether, 29 potential sites or areas were initially considered for disposal of the Vitro uranium mill tailings in a study completed in 1976. The 29 sites were either nominated by state agencies, Federal agencies, private individuals, or chosen by government contractor on the basis of their knowledge of suitable areas within 240 km (150 mi) of Salt Lake City.

As discussed in the DOE Vitro FEIS, Utah's governor, in early 1980 directed the State Division of Environmental Health to recommend a final disposal site for the Vitro tailings (NRC, 1993). A committee of eight members, representing all pertinent Bureaus in the Division of Environmental Health

and the Utah Geological and Mineral Office, was established to make the requisite studies and recommendations. The 29 sites were studied, and all but the three top-ranking candidates were eliminated. Eight new candidates were added, making a total of eleven sites. The Utah committee recommended a natural depression 8 miles north of Clive (North Clive) in Tooele County, as a primary site for final disposal of the tailings at the Vitro site. As secondary sites, the committee recommended a site 1 mile south of Clive (Clive) and a site 3 mile west of Delle (West Delle) in Tooele County, Utah.

In April 1981, a DOE contractor made an independent analysis of the three sites recommended by the State of Utah. At the conclusion of this evaluation, the DOE determined that the Clive site was superior to the other areas proposed by the State (NRC, 1993). The following actions and alterations further enhance the Clive site for continued disposal of 11e.(2) byproduct material:

- Infrastructure. As part of the activities to dispose of the Vitro material, DOE constructed features such as a railroad spur to the site and a railroad car rollover facility and brought utilities to the site. Energy*Solutions* has maintained and improved upon these infrastructure features. The State of Utah has improved the access to the site from Interstate 80.
- Existing radioactive waste disposal. Within the land section containing the Clive 11e.(2) byproduct material site are uranium mill tailings from the Vitro site, low-level and naturally-occurring, and accelerator-produced material wastes that Energy*Solutions* is disposing under license from the State of Utah. Thus, continued use of this site for disposal of 11e.(2) byproduct material would not result in introduction of radioactive material to an otherwise pristine site.
- Operating radioactive waste disposal facilities. By virtue of the operation of Energy*Solutions'* other radioactive disposal facilities, the Clive site already contains most of the structures (such as offices and laboratories) and facilities (such as fences, roads and utilities) needed to continue to operate an lle.(2) byproduct material disposal facility. Such structures and facilities would have to be constructed at a pristine site.

Based on the above considerations, Energy*Solutions* concludes that 11e.(2) License Renewal for the Clive site is the preferred alternative for continued disposal of lle.(2) byproduct material within the State of Utah. Alternatives outside the State of Utah are not considered in this document. Energy*Solutions* will not pursue construction or operation of an lle.(2) byproduct material disposal facility at other sites. Therefore, such alternates are equivalent to the "no action" alternative and need not be further considered.

2.1 Detailed Description of the Alternatives

Four alternatives were selected and evaluated by Energy*Solutions* with respect to their potential environmental impacts from the construction, operation, and closure of an lle.(2) byproduct material disposal facility. The four alternatives fall into three classes: two different design scenarios that involve granting a renewed license for disposal at the Clive site; a site alternative, which considers in general terms a different arid western site; and a no-action alternative.

A site in the arid west is preferable to other areas of the United States because (1) the major pathway for radioactive contamination is through water sources, which are less prevalent in the arid west; (2) the lower population density of remote regions in the arid west poses a lower risk to residents than are present in more densely populated areas; and (3) the lower density of certain wildlife species in the arid west presents a lower risk of disturbance to native wildlife.

Energy*Solutions* has provided an estimate of the lle.(2) byproduct material characteristics it receives and manages. The waste is expected to continue to contain three predominant radionuclides: Th-230, Th-232, and Ra-226.

The generation point of the lle.(2) waste is currently varied. However, most rail and truck shipments that now arrive at the existing Clive facility have minimal travel time through populated areas. All waste that is shipped to Clive must be properly packaged in accordance with the U.S. Department of Transportation (DOT) standards for the respective waste. This minimizes the safety risk to citizens along the transportation routes.

2.1.1 No-Action Alternative

This alternative represents a decision not the renew the Clive site's lle.(2) byproduct material disposal license. In terms of the potential environmental impacts at the Clive facility, this alternative is not significantly different than the Proposed Action, because Energy*Solutions* currently operates a facility that accepts wastes similar to lle.(2) byproduct material in composition and radioactivity. A No-Action decision by Energy*Solutions* on the 11e.(2) License will not affect its other existing licenses and permits. The differences would be in the classification of material accepted at the site, and possibly in the annual volumes and in how the waste streams were generated. A No-Action decision would mean that candidate material would be disposed of at its current locations, at licensed Title II uranium mill sites, or at other lle.(2) byproduct material disposal facilities.

The No-Action Alternative would occur if the requested 11e.(2) License renewal is not granted. This alternative would be a continuation of other current operations of the Clive site. Because Energy*Solutions'* existing permits allow for the disposal of radioactive materials that are very similar to lle.(2) byproduct materials and the proposed renewal for continued 11e.(2) disposal methods are very similar to the other existing disposal methods, the potential environmental impacts at the Clive facility under the No-Action Alternative would be similar to those under Proposed Action.

2.1.2 Proposed Action

For the Proposed Action, lle.(2) byproduct waste would continue to be transported by either train or truck to the Clive site. The design for the 11e.(2) Disposal Embankment for this alternative is based on a modified version of the embankment DOE used to dispose of 2.8×10^6 cubic yards of uranium mill tailings material from the Vitro Chemical Company site in Salt Lake City, Utah, at the Clive site. The DOE Vitro cell encompasses approximately 100 acres of a section of land originally owned by the State of Utah. The remainder of this section, 540 acres, is now private land owned by Energy*Solutions*.

Upon renewal of its lle.(2) Licensee, disposal would continue in the following manner at the site:

1. Existing terrain has been excavated to a depth of about 10 feet.
2. A 2 foot thick clay liner will be placed under all areas to receive waste, consisting of compacted processed clay. This liner provides a seepage liner/retardant for the bottom and sides of the excavation. The bottom of the clay liner is approximately 10 feet above the local groundwater level.
3. The 11e.(2) byproduct waste is being placed in the lined excavation in layers and compacted in place to a maximum elevation of approximately 4316 feet AMSL.
4. After reaching the maximum height of compacted waste, a 3.5 to 4 foot thick layer of low-permeability clay will be placed on top of the waste to form a radon barrier.

5. A barrier, consisting of a 1 foot thick filter zone of small-diameter rock and a 1.0 to 1.5 foot thick erosion protection layer of larger specification-sized rock, is placed over the embankment.

The following sequence is followed during disposal operations:

1. acceptance of waste at the facility,
2. disposal of waste in the embankment,
3. covering of waste with clay material, and
4. final cover with a rock erosion barrier.

It is anticipated that the operational activities would last for approximately 20 more years.

After the 11e.(2) and other Embankments are filled and covered, the area will be restored by removal of the railroad spurs and by filling in excavated areas to restore the natural grade. The restored surrounding areas will be revegetated except for the rock-covered mounds, and a permanent fence will be installed around the embankments.

2.1.3 Reasonable Alternatives

In addition to the No-Action and Preferred Alternatives, Energy*Solutions* evaluated two other reasonable alternatives: disposal at the Clive Site in a below-grade embankment and disposal at the Skunk Ridge Site.

Alternative 1—Disposal at the Clive Site in a Below-Ground Embankment

This alternative would place the Embankment entirely below grade, with the bottom of the clay liner for the excavation at an elevation of about 4,255 ft, or about 17 feet below the land surface. The below-grade design would entail a deeper excavation than the Proposed Action, and the surface of the site would be returned to the original ground level. Erosion control would be much simpler with an original ground level final configuration. This alternative would locate the bottom of the embankment within 5 feet of the highest measured level of the water table. This Alternative would hold less waste and have a lower disposal rate per unit of land area than the Proposed Action. No detailed design has been made for this alternative.

Once the site preparations have been completed in support of this Alternative, the same sequence would be followed as with the Proposed Action. It is anticipated that the operational activities would last for approximately 20 years. The below-grade design provides the following benefits: (1) no rock required for cover, (2) no drainage ditches would be required, and (3) overall waste isolation might be improved. While the below-grade design (Alternative 1) is viable, it is not preferred over the Proposed Action for two reasons: (1) the design places the wastes closer to the water table and any leached material could reach the groundwater sooner than for the Proposed Action, and (2) the Alternative 1 design requires a greater amount of acreage to dispose of the same volume of waste, increasing unit costs and land requirements.

Alternative 2 - Disposal at the Skunk Ridge Site, Located Northeast of the Clive Site, in Tooele County, Utah

This second reasonable Alternative involves consideration of an alternate site, located in Tooele County, Utah, known as Skunk Ridge (Section 4, Township 1 North, Range 9 West, SLM, on public land

administered by BLM). The availability of the land was not investigated by Energy*Solutions*. This location is about 18 miles northeast of the Clive site and the characteristics of the sites are similar.

The Skunk Ridge site is situated in a small flat valley halfway between a low ridge (Skunk Ridge) 2.4 km to the west and the Lakeside Mountains, which rise about 215 m above the valley floor, 2.4 km to the east. However, the site is not within the West Desert Hazardous Industry area. Additionally, there are no existing facilities at the site.

For this second alternative, the site would need to be prepared, the material would be transported from locations throughout the United States, and closure and long-term surveillance would be similar to those described for the Proposed Action. The potential environmental impact from construction and operation at the Skunk Ridge site would differ to some extent from the Proposed Action, since the soils, groundwater, and topography may require a different containment cell design.

Once the site preparations have been completed in support of this second Alternative, the following sequence would be followed during disposal operations:

1. acceptance of waste at the facility,
2. disposal of waste in the cell,
3. covering of waste with clay material radon barrier, and
4. final cover with a rock erosion barrier.

It is anticipated that the operational activities would last for approximately 20 years.

The groundwater at the Skunk Ridge site is slightly saline, although potable, and estimated to be at a depth of 225 to 420 feet, based on an existing pumping well within 1 mile of the site. At Skunk Ridge, any leakage through the cell liner would cause leaching of 11e.(2) byproduct waste material from the site toward and possibly into an aquifer that is producing a usable water supply.

2.2 Alternatives Considered but Eliminated

The following alternatives were also considered by Energy*Solutions*, but rejected:

1. a below-grade design that placed waste within 2 feet of the water table at Clive;
2. an additional site near Blanding, Utah; and
3. a hypothetical northeastern United States site containing 11e.(2) byproduct material to represent in-place remediation.

An additional below-grade design (similar to the first reasonable alternative) that would place waste within 2 feet of the water table was rejected, even though it would add 3 feet to the depth of waste within the embankment and reduce slightly the amount of land required, because the benefits did not seem to outweigh the additional risk to the groundwater.

Additionally, a site that had been given some previous investigation near Blanding, San Juan County, Utah, was considered by Energy*Solutions*, but rejected because it was within 3 miles of the City of Blanding, drainage could contaminate streams to the Colorado River system, and transportation of waste would presently require a 65 mile haul by truck to the site from rail facilities.

A hypothetical northeastern U.S. site was also considered by Energy*Solutions* as a site alternative in a contracting setting that would also represent the numerous present sites of 11e.(2) byproduct material where in-place remediation might be an alternative. Some of these might need only a radon barrier emplaced while others might not be suitable for remediation and the waste would have to be moved to a site away from its present location. This alternative was rejected by Energy*Solutions* because of lack of definitive information on which an evaluation could be made and the fact that Energy*Solutions* owns the Clive Site and will not pursue other site alternatives.

2.3 Cumulative Effects

Within the western United States, a site alternative and a design alternative at the Clive Site were evaluated. The alternatives are located in an arid region, with no surface water and with relatively stable geologic conditions. The groundwater at the Skunk Ridge site is slightly saline and estimated to be at a depth of 225 to 420 feet, based on an existing pumping well within 1 mile of the site. At Skunk Ridge, any leakage through the cell liner would cause leaching of 11e.(2) byproduct material from the site toward and possibly into an aquifer that is producing a usable water supply.

License renewal for disposal of 11e.(2) byproduct material at the current disposal facility at the Clive Site reduces the risk of contamination of usable water. At Clive, the unconfined near-surface aquifer has total dissolved solids of up to 75,000 ppm, is highly saline, and background levels for several parameters already exceed Utah Division of Water Quality standards. The aquifer has a very low horizontal gradient, and is recharged primarily from lower aquifers. The water from this aquifer is not a usable water supply, in terms of water quality or the volume of water that could be delivered through a well. Groundwater flow models indicate that any leachate from the facility would take over 600 years to reach the unconfined aquifer (based upon the Proposed Action). The first Reasonable Alternative is less desirable than the Proposed Action since it places the wastes closer to the water table, which could shorten the time for any leached material to reach the groundwater.

Two alternate designs for the operation of the facility were evaluated: The Proposed Action, which is continued use of the primarily above grade facility current in use at Clive, and the first Reasonable Alternative, which is constructed below grade. In evaluating designs for 11e.(2) byproduct material facilities, 10 CFR Part 40, Appendix A, requires that Energy*Solutions* consider below-grade designs for the disposal of 11e.(2) byproduct material. The regulations provide that in some instances, below-grade disposal may not be the most environmentally sound approach, such as may be the case if a groundwater formation is relatively close to the surface. In choosing continued use of their above-grade disposal facility, Energy*Solutions* demonstrates that the design provides reasonably equivalent isolation of the tailings from erosional forces. As such, the erosion barrier for the Proposed Action has been designed to meet the design criteria for above-grade embankments and provides reasonably equivalent isolation from erosional forces as proved by the first Reasonable Alternative.

It is possible that a site with characteristics similar to the Clive site, with similarly poor quality groundwater but at a much greater depth, may exist that is superior to the Proposed Action, because below-grade disposal would then be feasible. While the below-grade design of the first Reasonable Alternative is viable, it is not preferred over the Proposed Action at the Clive site for two reasons: 1) the design places the wastes closer to the water table and any leached material could reach the groundwater sooner than for the Proposed Action, and 2) the first Reasonable Action design requires a greater amount of acreage to dispose of the same volume of waste, increasing unit costs and land requirements. Any site other than Clive would require construction of the infrastructure which presently exists at Clive.

Other sites within the United States may be found that are acceptable for the disposal of 11e.(2) byproduct material. These sites may include some of those currently licensed by compacts pursuant to the Low-Level Radioactive Waste Policy Act or at existing mill tailings sites that are suitable for in-place remediation.

Therefore, on the basis of lower potential for radioactive releases to the environment, primarily through pathways associated with surface water and groundwater, and the generally lower occurrence and density of human population, the arid western United States is preferable to other locations in the United States for the siting of an 11e.(2) byproduct material facility. Based upon the foregoing, no other alternative is clearly superior to the Proposed Alternative.

As summarized in Table 2.1, the technical evaluation of alternatives has resulted in a narrowing of the focus for the Environment Assessment of viable alternatives. The first Reasonable Alternative (Clive, below-grade option), the second Reasonable Alternative (Skunk Ridge option), and the No-Action Alternative are therefore dropped from further, detailed assessment. An evaluation of the potential impacts from the Proposed Action is presented in Sections 3 through 8.

3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

Energy*Solutions'* Clive, UT disposal site is located within a 640-acre section in Tooele County, which was originally studied and selected for the disposal of uranium mill tailings from the Vitro Chemical Company. Approximately 100 acres of this section were used for the Vitro project. The remaining 540 acres of the section were sold to Energy*Solutions* by the State of Utah. Western portions of the site are presently being used by Energy*Solutions* for the disposal of Class A Low-Level Radioactive Waste. The southeast portion of the site has been permitted for the disposal of mixed radioactive and hazardous waste. The southwestern portion of the site is the area of current 11e.(2) disposal and the Proposed Action described in this Environmental Assessment. In this area, the current 11e.(2) byproduct Disposal Embankment will continued to be constructed following issuance of the license renewal.

The Low-Activity Radioactive Waste (LARW) embankment licensed by the State of Utah is currently covered with final materials and no longer in operation. The lle.(2) byproduct waste Embankment covers approximately 110 acres. Approximately 100 acres of the section were used for the permanent disposal of uranium mill tailings from the remedial action taken at the former Vitro Chemical Company site in Salt Lake County. The disposal of these tailings was part of a cooperative project undertaken by the U.S. Department of Energy (DOE) and the Utah Department of Health. Title to the property used for the placement of the Vitro mill tailings has been deeded to DOE by the State of Utah. The DOE property has been fenced and isolated from available land to be used in the Clive disposal project.

The Clive facility is located within the Tooele County Hazardous Waste Zone, approximately 30 km from any residents. The site is approximately 130 km west of Salt Lake City and 5 km south of Interstate 80. The actual property, which is owned by Energy*Solutions* and which is to be included in the location for licensed activities, is Section 32, Township 1 South, Range 11 West, Tooele County, Utah, except for the area occupied by the Vitro waste disposal embankment.

Table 2.1

Relative Ranking of the Best Three Sites

	Tooele County Sites		
Discipline	**Clive**	**North Clive**	**West Delle**
Vegetation	2	1	3
Wildlife	1	2	3
Soils and reclamation	2	3	1
Hydrology and water quality	1	2	3
Meteorology and air quality	1	2	3
Human resources	1	3	2
Geotechnical engineerings	1	3	2
Composite score (lower is better)	**9**	**16**	**17**

There are no chemical, sanitary, or other waste discharges associated with either the current operations at the Clive site or the continued operations.

3.1 Land Use

Most of the land within a 16-km radius of the site is public domain administered by the Bureau of Land Management (BLM). The climate is arid, with an average rainfall of approximately 8.62 inches per year. The federal government owns and controls the greatest percentage of land in Tooele County, 82% of the county land area of 4.43×10^6 acres. The greatest portion (1,952,852 acres) of the federal land is public domain administered by BLM. The U.S. Department of Defense controls the next greatest portion of 1,558,862 acres, with national forests occupying 152,223 acres. Approximately 6% of the county land area is administered by the State of Utah, which leaves approximately 12% in private ownership. The Clive site occupies 540 acres of private land owned by Energy*Solutions*.

On January 12, 1988, the Tooele County Commission established the West Desert Hazardous Industry Area. The area around the Clive site has been designated as a hazardous industries zone by Tooele County. This designation limits the future uses of land in the vicinity of the Clive site by prohibiting residential housing.

Tooele County amended the uniform zoning ordinance by adding the "Hazardous Industrial District" zoning classification (MG-H). This is the classification to which hazardous industry sites within the West Desert Hazardous Industry Area would be rezoned to provide for appropriate locations where hazardous industrial processes necessary to the economy may be conducted and to prohibit such activities in all other zoning classifications of Tooele County.

Previous to the Vitro project, there were no industrial, residential, or municipal activities near the site. The only use for the land was for grazing, hunting, and occasional recreational vehicle use. Since that time, several hazardous waste facilities have located in the Clive area.

BLM has several sheep and cattle grazing allotments in the Clive area. The Clive site occupies 540 acres of private land. The land surrounding the site is currently utilized for grazing purposes and dispersed recreation. Cattle utilize the area more during winter periods when snow is present and when puddles of water exist during wet periods.

Tables 3.1 through 3.5 show the nearest cattle, game animals, residences, and vegetable gardens as well as the relative location of the site boundary. Table 3.6 is a summary of the nearby dwellings, towns, and other receptors as required by NRC Regulatory Guide 3.8, Appendix B, pages B-4 and B-5. As can be seen from the tables, there are no residents or vegetable gardens within 8 km of the site. There is some cattle grazing in the area. This grazing is allowed approximately 3 months out of the year.

3.2 Transportation

The only route to the site is a 2 mile paved road from the Clive exit off Interstate 80. Regional access to the site is also provided by Interstate 15 and Interstate 84. The Utah Department of Transportation upgraded the Clive Interchange, including a complete, paved interchange in both directions.

The remoteness of the site from the urbanized areas of Tooele County and the zoning for hazardous waste makes the surrounding area an improbable location for any other significant industrial use that might be impacted by renewal of the disposal project.

Table 3.1

Nearest Grazing Animals (3 months out of year)

Compass Direction	Distance in Kilometers 0-1	1-2	2-3	3-4	4-5	>5
N	X	-	-	-	-	-
NNE	X	-	-	-	-	-
NE	X	-	-	-	-	-
ENE	X	-	-	-	-	-
ENE	X	-	-	-	-	-
ESE	X	-	-	-	-	-
SE	X	-	-	-	-	-
SSE	X	-	-	-	-	-
S	X	-	-	-	-	-
SSW	X	-	-	-	-	-
SW	X	-	-	-	-	-
WSW	X	-	-	-	-	-
WSW	X	-	-	-	-	-
WNW	X	-	-	-	-	-
NW	X	-	-	-	-	-
NNW	X	-	-	-	-	-

X = Animals located.

- = No inventory taken.

Table 3.2

Nearest Game Animals (3 months out of year)

Compass Direction	Distance in Kilometers 0-1	1-2	2-3	3-4	4-5	>5
N	X	-	-	-	-	-
NNE	X	-	-	-	-	-
NE	X	-	-	-	-	-
ENE	X	-	-	-	-	-
ENE	X	-	-	-	-	-
ESE	X	-	-	-	-	-
SE	X	-	-	-	-	-
SSE	X	-	-	-	-	-
S	X	-	-	-	-	-
SSW	X	-	-	-	-	-
SW	X	-	-	-	-	-
WSW	X	-	-	-	-	-
WSW	X	-	-	-	-	-
WNW	X	-	-	-	-	-
NW	X	-	-	-	-	-
NNW	X	-	-	-	-	-

X = Animals located.

- = No inventory taken.

Table 3.3

Nearest Residence

Compass Direction	Distance in Kilometers 0-1	1-2	2-3	3-4	4-5	>5
N	-	-	-	-	-	X
NNE	-	-	-	-	-	X
NE	-	-	-	-	-	X
ENE	-	-	-	-	-	X
ENE	-	-	-	-	-	X
ESE	-	-	-	-	-	X
SE	-	-	-	-	-	X
SSE	-	-	-	-	-	X
S	-	-	-	-	-	X
SSW	-	-	-	-	-	X
SW	-	-	-	-	-	X
WSW	-	-	-	-	-	X
WSW	-	-	-	-	-	X
WNW	-	-	-	-	-	X
NW	-	-	-	-	-	X
NNW	-	-	-	-	-	X

X = Residences located.

- = No residences located.

Table 3.4

Nearest Site Boundary

Compass Direction	Distance in Kilometers 0-1	1-2	2-3	3-4	4-5	>5
N	X	-	-	-	-	-
NNE	X	-	-	-	-	-
NE	X	-	-	-	-	-
ENE	X	-	-	-	-	-
ENE	X	-	-	-	-	-
ESE	X	-	-	-	-	-
SE	X	-	-	-	-	-
SSE	X	-	-	-	-	-
S	X	-	-	-	-	-
SSW	X	-	-	-	-	-
SW	X	-	-	-	-	-
WSW	X	-	-	-	-	-
WSW	X	-	-	-	-	-
WNW	X	-	-	-	-	-
NW	X	-	-	-	-	-
NNW	X	-	-	-	-	-

X = Boundary located.

- = Beyond site boundary.

Table 3.5

Nearest Vegetable Garden

Compass Direction	Distance in Kilometers 0-1	1-2	2-3	3-4	4-5	>5
N	-	-	-	-	-	X
NNE	-	-	-	-	-	X
NE	-	-	-	-	-	X
ENE	-	-	-	-	-	X
ENE	-	-	-	-	-	X
ESE	-	-	-	-	-	X
SE	-	-	-	-	-	X
SSE	-	-	-	-	-	X
S	-	-	-	-	-	X
SSW	-	-	-	-	-	X
SW	-	-	-	-	-	X
WSW	-	-	-	-	-	X
WSW	-	-	-	-	-	X
WNW	-	-	-	-	-	X
NW	-	-	-	-	-	X
NNW	-	-	-	-	-	X

X = Vegetable garden located.

- = No vegetable garden located.

Table 3.6

Location of Sources

Source	Distance East (km)	Distance North (km)
Nearest resident	>15	>15
Nearest resident in prevailing wind direction	>15	>15
Ranch	>15	>15
Farm	>15	>15
Orchard	>15	>15
Grazing location 1	1	1
Grazing location 2	1	1
Garden	>15	>15
Ranger bunk house	>15	>15
Mine camp	>15	>15
Other nearby residents (industrial or recreational facilities)	>15	>15
Restricted area boundaries	1	1

3.3 Geology and Soils

The Clive site is located in the extreme eastern margin of the Great Salt Lake Desert which is part of the Basin and Range Province of North America. The Basin and Range topography is typified by block-faulted mountain ranges that generally trend north to south. These predominant structural features and alluvium-filled basins are discontinuous and were created by extensional normal faulting. The unconsolidated to semi-consolidated valley fill is generally about 240 to 300 m thick throughout the central portions of the valleys in the Great Salt Lake Desert.

The block-faulted mountains mainly consist of Paleozoic limestones, dolomites, shales, quartzites, and sandstones. Tertiary basaltic lava flows and pyroclastics are also found in isolated areas of the Great Salt Lake Desert. The valley sediments are composed of alluvial fans, playa deposits, and unconsolidated and semi-consolidated valley fill. The alluvial fans grade laterally into fine-grained alluvium and thin toward the center of the valleys, where they are present as a veneer overlying and adjacent to fine-grained Lake Bonneville lakebed deposits. Table 3.7 shows the stratigraphic units typical of the region containing the Clive site.

The site rests on Quaternary lakebed deposits of Lake Bonneville. Site subsurface logs indicate that lacustrine deposits extend to at least 500 feet underneath the site. The underlying Tertiary and Quaternary age valley fill is composed of semi-consolidated clays, and sands and gravels where it comes in contact with bedrock.

The Clive site is located in a relatively flat topographic area and is bounded by the Great Salt Lake Desert to the west at approximate elevations of 4250 to 4300 feet AMSL. The desert area extends for approximately 50 miles to the Nevada-Utah border on the west. The eastern border of the desert is formed by the Cedar Mountains, which rise to a maximum elevation of 6,600 feet AMSL at Cedar Peak. The proximity of this mountain range results in a surficial drainage pattern for the site, which is generally in a westerly direction.

In the vicinity of the site, low-lying hills rise 50 to 100 feet from the desert floor. To the east and southeast, the site is bounded by the north-south trending Lone Mountain, a peak on the west flank of the Cedar Mountains, which rises to a height of 5362 feet AMSL. To the north of the site are the Grayback Hills, composed of limestone and quartzite mapped as Permian-Pennsylvanian Oquirrh Formation, which is as much as 10,000 feet thick in western Utah. Igneous extrusives form a resistant cap on the Grayback Hills, and are mapped as Pliocene-age basalt/rhyolite, (Montgomery Watson, 2007). The site has topographic relief of approximately 3 m, sloping in a southwest direction at a gradient of approximately 0.0019.

No active Holocene faults are known to have occurred in the vicinity of the site. The nearest Holocene faulting is located 18 miles north in the northwest Puddle Valley, east of the Grassy Mountains. Most of the faulting occurred between 1 million and 25 million years ago. Recent seismic activity is believed to be the result of rebound from the de-watering of ancient Lake Bonneville over 15,000 years ago.

Table 3.7

Generalized Stratigraphic Column, Clive, Utah

Era	Period/Epoch	Formation	Thickness (ft)
Cenozoic	Quarternary/Pleistocene	Lake Bonneville Group	500 to 800
	Permian	Pequop	2,800
	Devonian	Pilot Shale	330
		Guilmete	2,840
		Simonson Dolomite	600
	Silurian	Laketown Dolomite	1,310
Paleozoic	Ordovician	Fish Haven Dolomite	350
		Eureka Quartzite	490
		Crystal Peak Dolomite	150
		Swan Peak Quartzite	540
		Kanosh Shale	400
		Garden City Limestone	3,590
	Cambrian	Notch Peak	1,000
		Worm Creek Quartzite	60
		Undiff. Middle and Upper Cambrian	1,000

Natural resources in Tooele County include limestone, metallic minerals, potassium salts, tungsten, salt, clays, and sand and gravel. Gravel quarries have been located in the alluvial fans that flank the Ceder Mountains. Mineral extraction by evaporation of brine occurs near Knolls, about 16 km northwest of the site. Limestone is quarried in the Cedar Mountains about 8 km east of the site. Presently no oil or gas production takes place in the area. There is no coal production in the area or geologic formations with coal resources. No mineral leases are located on the site.

3.4 Water Resources

Viable water resources are generally non-existent at the Clive site. There are no surface-water bodies on the Clive site. Additionally, groundwater is unpotable.

3.4.1 Surface Water

The area containing the Clive site lies within the Great Basin drainage, a closed basin having no outlet. The Clive site drains into the normally dry Ripple Valley depression on the eastern fringe of the Great Salt Lake Desert.

No surface-water bodies are present on the Clive site. The nearest stream channel ends about 2 miles east of the site and is typical of all the drainages along the transportation corridors within about 30 km of the Clive site. Stream flows from higher elevations usually evaporate and infiltrate into the ground before reaching lower, flatter land. The stream channels are well defined in their upper reaches, but as they approach the flatlands, the size of the channel reduces until there is no evidence of a stream.

None of the ephemeral surface water bodies in the vicinity of the Clive site are used for drinking purposes and most have no beneficial use. The nearest body of water with respect to the Clive site that is utilized is 28 miles to the east.

The Clive site lies to the west of the Cedar Mountains in a relatively flat basin. The streams within the watershed do not reach the site. There is no outlet for the watershed and any water that flows by the site would pond in a playa several miles to the west. The watershed above the site covers approximately 48.9 square miles. No data on historical floods are available for the Clive site.

Appendix F of Energy*Solutions*, (2005b) contains the calculations for runoff peak flow values attributable to the Probable Maximum Flood (PMF), resulting from the Probable Maximum Precipitation (PMP) of 9.7 inches of rain over a 6-hour period on the Clive watershed. The calculated peak flow is 2,779 yd^3/s.

The PMF would most likely flow predominantly to the south of the Clive site with the fringes of the flow encroaching upon the site. The maximum depth of flow at the Clive site was calculated to be less than 2 ft. Runoff from such a hypothetical event as the PMF will be diverted from encroaching into the disposal cell by the run-on berm surrounding the disposal area.

Surface water quality data are generally unavailable for Tooele County, which is a reflection of the lack of water and population centers. The Big Spring near Timpie feeds a waterfowl management area and has no other uses. The water is very hard and very high in dissolved solids, primarily sodium chloride. Moderate concentrations of arsenic, nickel, copper, and silver are also present.

3.4.2 Groundwater

The 11e.(2) Disposal Embankment is located in the eastern part of the semi-arid Great Salt Lake Desert. The site region is a sediment-filled basin, characteristic of the Basin and Range physiography. The basin fill in the site area is estimated to consist of approximately 82 yards of largely unconsolidated lacustrine and alluvial deposits underlain by semi-consolidated alluvial and fluvial gravel, sand, and clay.

The aquifer system that may be impacted by the Proposed Action occurs in the top 33 yards of the basin fill, where two aquifers have been identified and designated as a shallow unconfined aquifer and a deep confined aquifer. These aquifers are separated by confining clay and silt beds with the main confining bed located at a depth of about 12 m. The unconfined aquifer has poor quality, highly-saline water, with up to 75,000 mg/L total dissolved solids (TDS). Water in the confined aquifer has a TDS content typically above 20,000 mg/L.

The local groundwater recharge from meteoric sources in the site area and the Great Salt Lake Desert is generally limited. The recorded annual pan evaporation is more than 1.6 yards, which is significantly higher than the recorded annual precipitation of less than 8.6 inches. Due to a relatively higher precipitation and a more favorable lithology near the mountains, it is likely that the recharge occurs largely in the areas adjoining the mountain ranges and moves as subsurface flow toward the center of the basin. This is supported by the high salinity and the isotopic composition of the area groundwater, which are indicative of long flow paths and/or long residence time.

There is evidence that the site is located in a regional groundwater discharge setting, with largely upward flow and flow gradients. This is because (1) water level and density measurements in several wells completed to different depths in the site area indicate a consistent increase of the potentiometric head with depth; (2) the salinity and isotopic composition of the subsurface water are indicative of long flow paths, long residence time, or both; and, (3) the site is located in a regionally low physiographic and topographic setting, which is characteristic of regional groundwater flow discharge zones.

The hydrogeologic units in the disposal site area were delineated based on data obtained from borehole and monitoring-well drilling conducted at the site by Energy*Solutions*.

Four lithostratigraphic units have been identified in the basin fill to approximately 98-foot depth beneath the site. These include from the top, a silty clay layer, a silty sand layer with occasional silty to sandy clay lenses, a lower layer of clay, and a lower layer of silty sand interbedded with silt and clay layers. The layers dip gently westward and generally range from a few meters to 9 m in thickness, except for the lower silty sand layer, which has a thickness of up to 23 m or more. There is no available data to delineate the lithostratigraphy below a 30-m depth.

Both of the silty sand layers in the lithostratigraphic profile constitute water-bearing units in the site area. Groundwater occurs under unconfined conditions in the upper sand layer, and under confined conditions in the lower sand layer. These aquifers have been designated in this Environmental Report as shallow and deep aquifers, respectively.

The top clay layer is unsaturated and the lower clay layer constitutes the confining bed separating the shallow and deep aquifers. Although the lower clay layer appears to be the most prominent confining bed between the sand layers, there may be other less prominent clay and/or silt beds within the sand layers that may also be contributing to the confinement of the deep aquifer.

The hydraulic properties of the various hydrogeologic units were determined from field and laboratory tests. The field testing by Energy*Solutions* involved conducting slug-injection tests in approximately 100 wells to determine the hydraulic conductivity for the saturated lithostratigraphic units, (i.e., the upper and lower sand layers and the lower clay layer). The laboratory tests were conducted on selected samples obtained from the upper clay and upper sand layers to determine the field bulk density, water content, porosity, water retention characteristics, and the unsaturated hydraulic conductivity. Laboratory tests were also performed on soil cores to evaluate the vertical hydraulic conductivity of silty/clayey units in the lower sand layer. The samples were obtained from 13 to 18 m below ground surface, which is near the top of the lower sand layer.

The saturated hydraulic conductivities obtained from the slug-injection tests indicate a site-wide lower clay unit hydraulic conductivity of 2.98×10^{-4} cm/sec; with minimum and maximum values of 2.23×10^{-6} cm/sec and 4.30×10^{-3} cm/sec, respectively. The upper silty sandy material exhibited a saturated hydraulic conductivity of 3.19×10^{-4} cm/sec. Vertical conductivities from laboratory testing of silty/clayey units from the lower sand layer ranged from 2.2×10^{-8} to 1.6×10^{-6} cm/sec, with an arithmetic mean of 2.9×10^{-7} cm/sec.

Moisture-content measurements were conducted by Energy*Solutions* on a total of 50 lithologic samples obtained at different intervals from the ground surface to a maximum depth of 11 m. The total porosity was computed for 25 samples from the moisture-content data. The computed total porosity ranged between 0.36 and 0.58 for the top clay layer (10 samples); between 0.36 and 0.57 for the upper sand layer (7 samples); and between 0.38 and 0.59 for the lower clay representing the main confining bed (8 samples). The effective porosity values were estimated at 0.20 (lateral) and 0.10 (vertical). Division-approved site-specific distribution coefficients have been developed for cesium, cobalt, C-14, I-129, Np-237, Tc-99, uranium, and zinc.

Water Levels. Measured water levels in the unconfined aquifer indicate that the water table ranges from 6 to more than 9.8 yards below ground in the disposal site vicinity, and that the highest water table below the disposal cell is 6 yards.

The measured water levels and the freshwater-equivalent heads in the confined aquifer are higher than the corresponding levels in the unconfined aquifer. This is indicative of a local upward hydraulic gradient and flow from the confined aquifer to the unconfined aquifer. The upward hydraulic gradient was determined to range from 0.10 to 0.48, from measured water levels in well clusters with wells completed to different depths at five locations in the disposal site area. See Section 2.7.2.1 of the 11e.(2) license renewal application for discussion of short-term groundwater mounding that has temporarily reversed the predominant upward hydraulic gradient at one location (GW-19A/GW-19B).

Lateral Groundwater Flow. The total potentiometric heads were evaluated in freshwater-equivalent heads from measured water levels and measured specific gravity data. Except in the vicinity of localized mounding, horizontal groundwater gradients were determined to range from 0.0001 to 0.002.

The computed freshwater-equivalent heads were used to prepare potentiometric-head contour maps. The computed freshwater-equivalent heads for the unconfined aquifer indicated that the lateral subsurface flow in the area of the disposal site is generally toward the north, and locally toward the northeast and northwest. It is noted, however, that the land slopes toward the southwest, and therefore, the computed

flow gradients are in opposite direction to the prevailing land slope. This is not typical of unconfined flow conditions, where recharge is principally from local precipitation or local surface water sources.

The apparent nonconformity between the computed potentiometric heads and the land slope in the disposal site area could be attributed to a significant recharge component that the unconfined aquifer may be receiving in upward flow from the underlying confined aquifer, compared to an essentially insignificant local recharge from meteoric sources. Under these conditions, the potentiometric head gradients would be largely controlled by the magnitude and distribution of the upward flow over the site area, and less by the land topography.

Lateral subsurface flow velocity was determined to be about 6 m per year or about 4 miles over the design life of the disposal cell of 1,000 years.

Vertical Groundwater Flow. The available potentiometric head data indicate that wells screened in the confined aquifer at more than a 14-m depth, exhibit higher measured and freshwater-equivalent heads than wells screened in the unconfined aquifer, indicating an upward vertical flow component in the site area from the confined aquifer to the unconfined aquifer. The measured head differences range from 7 to 45 cm. The upward vertical flow velocity across the confining beds was determined to be about 2 m/yr, using a vertical hydraulic conductivity ranging from $5x10^{-5}$ to $1.7x10^{-4}$ cm/s, a vertical hydraulic gradient of 0.04, and an effective porosity of 0.29, based on the available database for the site area.

Groundwater Quality, Use, and Geochemistry

Groundwater quality data are available for the disposal site area from previous investigations, including data collected by DOE for the Vitro disposal cell, and by the Aptus Corporation. In addition, Energy*Solutions* has collected and analyzed water samples from on-site wells on a quarterly,semi-annual, and annual basis for several decades to meet the requirements of the existing permits. A total of fifteen on-site wells have been used in this monitoring of the 11e.(2) Disposal Embankment. Water samples from these wells are analyzed for inorganic constituents, radioactive constituents, and selected organic constituents.

Although the available groundwater quality database depicts some inconsistencies, the data conclusively indicate that the groundwater in the disposal site area is of a poor quality and unsuitable for most known uses. The unconfined uppermost aquifer has a TDS content of 20,000 to 75,000 mg/L; the TDS content in the confined aquifer is typically above 20,000 mg/L but significantly less than that of the unconfined aquifer. The groundwater aquifer classification system established in the State of Utah Groundwater Quality Protection Regulations designates both the shallow and deeper aquifers as Class IV aquifers, based on TDS above 10,000 mg/l; a classification equivalent to the EPA's Class III. Furthermore, the concentration of some of the inorganic constituents in the uppermost aquifer (sulfate, chloride, iron, and manganese) is significantly higher than the EPA's secondary groundwater standards. Radionuclide analysis by Energy*Solutions* includes Gross Beta, Ra-226, Ra-228, Th-230, Th-232, and total uranium on samples obtained from 11e.(2) compliance wells.

Sodium is the most predominant cation and chloride is the most predominant anion. The high levels of TDS and sodium and chloride concentrations in the water are characteristic of long flow paths, long residence time, or both. The sodium and chloride concentrations decrease with increasing depth, which provides additional evidence that there is minimal or no downward vertical movement from the unconfined to the confined aquifer.

Historically, stable isotope ratios were determined for selected isotopes by Energy*Solutions*, in order to characterize ground-water recharge sources, geochemistry, and flow. The following isotopes were analyzed: hydrogen (H-2/H-1), oxygen (0-18/0-16); carbon (C-13/C-12); and sulphur (S-34/S-32). Tritium (H-3) and carbon-14 (C-14) were also determined for selected wells to evaluate the age of the water. The results show there are low tritium concentrations (1.8-4.9 Tritium Units) in the groundwater, which suggests a pre-1953 recharge and subsequently long sub-surface flow paths, long residence time, or both. Radiocarbon dating of the water was inconclusive.

The historical groundwater quality assessment by Energy*Solutions* also involved determining the saturation index for selected minerals, which is a measure of the water's tendency to precipitate (positive saturation index) or dissolve (negative saturation index) a mineral. Energy*Solutions* concluded that groundwater in the site area has a tendency to precipitate such minerals as aragonite, calcite, dolomite, fluorite, and magnesite, and a tendency to dissolve such minerals as halite, gypsum, anhydrite, and mirabilite.

3.5 Ecological Resources

Impact to several ecological resources from the Proposed Action are also considered in the Environmental Assessment.

3.5.1 Vegetation

The vegetation of the Clive site is a homogeneous, semi-desert low shrubland, primarily composed of shadscale (Atriplex confertifolia). The shrubland is part of the Northern Desert Shrub Biome of the Cold Desert Formation and has been described as a Saltbush (Shadscale)-Greasewood Shrub complex. Plant communities identified on the site are Shadscale-Gray Molly (Kochia americana var. vestita), a transitional community type of Shadscale-Gray Molly-Black Greasewood (Sarcobatus vermiculatus), and Black Greasewood-Gardner Saltbush (Atriplex nuttallii).

Representative of the desert shrub/saltbush community are low widely spaced shrubs, totaling approximately 10% ground cover. Dominant shrubs on the Clive site include shadscale, Nuttall's saltbush, and winterfat. Vegetation patterns of the Clive site are correlated with soil salinity and corresponding shifts in presence or abundance of species. All three communities are low in species diversity. Seep-weed or inkweed (Suaeda torreyana) and scattered perfoliate pepperweed (Lepidium perfoliatum) are the only prominent understory species of the Shadscale-Gray Molly community. This community occurs over most of the Clive site, although black greasewood becomes prominent enough on the eastern quarter to form a Shadscale-Black Greasewood-Gray Molly community. Except for black greasewood and occasional stands of halogeton (Halogeton glomeratus), the composition is similar to the more prominent Shadscale-Gray Molly community.

The Black Greasewood-Gardner Saltbush community type is floristically the most diverse but only occurs in the extreme northeast corner and eastern edge of the Clive site. In addition to Gardner saltbush, the flora is composed of all species found in the other communities, except halogeton.

The Clive site occurs in the Desert Alkali range site, which is rated by BLM as being poor for grazing or forage production. However, the vegetation forms an important ground cover and deterrent to soil erosion and provides habitat for wildlife species. Annual production of the three community types ranged from 152 to 517 lbs/acre, air dry. Annual production for the range site is given as 50 to 200 lbs/acre and

500 to 1,499 lbs/acre during unfavorable and favorable years, respectively. Livestock-carrying capacity with such production would range from 3 to 80 acres per animal-unit month.

3.5.2 Terrestrial 'Wildlife

Two habitat types (shadscale flats and greasewood) occur on the Clive site. Animal species typical of the site include black-tailed jackrabbit (Lepus californicus), deer mouse (Peromyscus maniculatus), horned lark (Eremophila alpestris), and desert horned lizard (Phrynosoma platyrhinos); species diversity is low. All of these animal species could use the site for breeding or nesting. Ground squirrel, kangaroo rat, badger, jackrabbits, deer mice, and grasshopper mice (Onychomys leucogaster) were the only mammals collected during field surveys for this Environmental Report (SWCA, 2011).

The Clive site is located within the yearlong range of the pronghorn antelope. The West Desert Herd Unit 2A occurs south of Interstate 80 and includes the Clive site. Pronghorn are rare in the project area south of Interstate 80. The area is considered poor pronghorn habitat. Interstate 80 acts as a barrier to most pronghorn movement south from the Puddle Valley Herd Unit. No critical pronghorn habitat occurs on the West Desert Herd Unit near the Clive site.

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

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

3.5.3 Aquatic Biota

Aquatic ecosystems do not occur on or near the Clive site.

3.5.4 Endangered, Threatened or Other Special Status Species

No important plant or animal species, as defined by NRC, are known to occur on the Clive site and no known important habitats have been identified in the area. No threatened or endangered plant species are known to occur in the vicinity of the Clive site. Similarly, no threatened or endangered animal species are known to occur on the Clive site. However, the Utah Division of Wildlife Resources reports that the area is used for foraging by bald eagles (Haliaeetus leucocephalus) during the winter.

The bald eagle and American peregrine falcon are federally-listed endangered species that could occur within the project area. The bald eagle is a winter resident from late November to mid-March in the project vicinity. The majority of wintering eagles are found in Rush Valley with others occurring in Skull and Cedar Valleys. No bald eagle roosts are located within the project area; however, the black-tailed jackrabbit is the primary food source of bald eagles in Tooele County, and eagles may potentially hunt within this area.

One historical aerie of the American peregrine falcon was located near Timpie Springs Wildlife Management Area in the northern end of the Stansbury Mountains. The nest site became inactive following the construction of 1-80 in the late 1960s. In an attempt to re-establish a breeding pair of

peregrines, the Utah Division of Wildlife Resources, in cooperation with the U.S. Fish and Wildlife Service, erected a hack site at the Timpie Springs WMA, approximately 42 km from the Clive site. The hack site became active in 1983 and 1984, and a peregrine pair was observed using the site in Spring 1987. The hack site was occupied in 1989 by a nesting pair of peregrines. Peregrines are known to arrive in the area in March and, if nesting, may remain until September. Due to the distance between the Clive site and the aerie, it is unlikely that any peregrines utilize the project area. The U.S. Fish and Wildlife Service also concurs with the conclusion that the Proposed Action would not affect either the bald eagle or the peregrine falcon.

The Cedar Mountains contain a wild horse herd protected under the Wild and Free Roaming Horse and Burro Act of 1971. The Cedar Mountain herd presently contains an estimated 360 horses and extends from 4 miles north of Eight Mile Spring to the southern portion of the Cedar Mountain range. Wild horses are seldom encountered on the Clive site. The state sensitive kit fox may occur throughout the West Desert Hazardous Industry Area.

3.6 Meteorology, Climatology, and Air Quality

Energy*Solutions* has operated a weather station at Clive since July 1992. The station monitors wind speed and direction, 2-m and 10-m temperatures, precipitation, pan evaporation and solar radiation. A 19-year Summary Report from January 1, 1993 through December 31, 2011 was provided to the Division on February 23, 2012 (McCandless, 2012). Since the 11e.(2) Embankment is located entirely within Section 32, this information adequately characterizes the site. Furthermore, the 11e.(2) Embankment has no significant effects upon the meteorological conditions or air quality of the region.

3.6.1 Weather Patterns

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

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

3.6.2 Temperature

Temperatures at Clive range from an hourly minimum to hourly maximum of -25.5 to 41.3 degrees C. Monthly mean temperatures have been found to range from -2.5 degrees C in December to 26.4 degrees C in July. According to the data generated over the last 19 years, the coldest month of the year at the Clive site is December, while the warmest month of the year is July.

3.6.3 Precipitation

The Clive site receives an average of 8.62 inches of precipitation per year. Measurements taken at the Clive site showed that the lowest monthly precipitation recorded was 0 inches in May 2001. The highest recorded monthly precipitation was 4.28 inches, in May 2011.

3.6.4 Winds

In the 19-year period of time (July 1992 through December 2011) the most frequent (and predominant) winds were from the south-southwest direction, with the second most frequent direction being the east-northeast, followed by the south. Wind Rose data summarized in Figure 2-5 has been obtained from the on-site weather station and checked for accuracy by a certified meteorologist (MSI, 2012).

3.6.5 Evaporation

Pan evaporation measurements are taken from April through October when ambient temperatures remain above freezing. Maximum hourly evaporation values usually occur in July. The 17-year average annual evaporation at the Clive site is 52.73 inches (excluding 2 years of reported instrument malfunction).

3.6.6 Average Inversion Height

The average annual inversion height for Clive has been estimated at 1980 m above sea level, or about 460 to 610 m above the valley floor.

3.6.7 Air Quality

The National Ambient Air Quality Standards (NAAQS) are used to classify the counties as being below the NAAQS (attainment) or above the NAAQS (nonattainment). Portions of Tooele County, including the Clive site, are in attainment status for all NAAQS. Review of Clive air quality records since 2000 reveals that the highest single point emission (including background) for PM_{10} was approximately 142 $\mu g/m^3$ in 2005, and the annual average (including background) was approximately 43 $\mu g/m^3$, for that same year. Furthermore, the calculated annual potential to emit for fugitive PM_{10} is 69.0 tons per year and for non-fugitive is only 0.67 tons per year.

3.7 Noise

No measurements of ambient sound levels were made at the Clive site. Sound levels were characterized at the site on the basis of proximity to highways and industrial areas, and the like, according to typical values of ambient sound levels that have been measured in similar situations. The area south of Clive is rural, undeveloped, and populated by few people. On the basis of population density, the day-night sound levels near the stabilization area would be less than 35 dB.

3.8 Historic and Cultural Resources

No events of historical significance are known to have occurred on the site. The Donner Trail passed north of the site. An intensive cultural resource inventory was performed for the Vitro project.

An intensive cultural resource inventory of an area inclusive of the Clive site was conducted by the Archaeological-Environmental Research Corporation, (Envirocare, 1992). Prior to the field survey a record search was conducted. The record search consisted of a review of the cultural resource information and maps at the State Historic Preservation Office, Antiquities Section, Salt Lake City. No cultural resource sites were identified during the inventory, but one isolated artifact was found. This artifact consisted of four pieces of broken purple glass from some unknown glass object. It does not appear that such a find indicates the existence on the site of significant archaeological artifacts. Ground visibility during the cultural resource survey was 98%. There were no other adverse factors, (e.g., weather), affecting the accuracy of the survey party.

The historical sites closest to the Clive site are the Ground to Air Pilotless Aircraft Launch Site and Block house—listed in the National Register of Historic Places—located approximately 16 km west of Clive at Knolls; and the site of the Iosepa Settlement Cemetery, approximately 10 miles by air southwest of Clive.

3.9 Visual/Scenic Resources

The Clive site is located in the Basin and Range physiographic province which is characterized by broad, flat basins occasionally interrupted by small mountain ranges. The area within a 10-mile distance of the Clive site is typical of this province. Vistas of 48 km are common because of the flatness of the terrain.

The BLM Visual Resource Inventory and Evaluation system was used to rate the scenic quality of the Clive site relative to the physiographic province. This rating system employs a scale of 0 to 33, with higher ratings (19 or above) indicating that special management attention is required. The rating of 12 for the Clive Site is a low-to-medium rating for scenic quality, indicating that no special management attention is necessary.

The Interstate is about 2 miles to the north of the disposal area. The Clive site is about 4,265 ft above sea level, but elevations of 4,495 to 5,479 ft can be found nearby to the south, southwest, and southeast of the site. This local topographical relief provides a visual backdrop for the site when viewed from the Interstate. The existing Vitro site—which is mostly an above-grade mound—is not easily noticeable from the Interstate. Although the Energy*Solutions'* 11e.(2) Embankment is about 3 m higher, it would have the same general visual impact as the Vitro site.

3.10 Socioeconomic

An estimated 58,218 people resided within 80 km of the Clive site at the time of the 2010 census, but most of the area is uninhabited. The closest residents lived 15 to 20 miles to the northeast of the site. The largest number lived 30 to 50 miles to the east and southeast of the site in the Tooele-Grantsville area. Tooele City is the largest community in the county and Grantsville is the second largest city. Table 3.11 presents the 2010 population within 7.5 miles of the Clive site by compass direction and radial distance.

Tooele County is a rural area with a 2010 population density of approximately 8.6 persons/square mile. The majority of the population is concentrated in or near the communities of Tooele city, Grantsville, Wendover, and Dugway. It is expected that the largest percentages of growth will occur in Tooele City, Grantsville, and Wendover. Population projections for the county indicate that the number of people living in Tooele County by the year 2020 will exceed 101,386.

Economic data reveal that the Tooele County economy is stable due to federal military employment but, like most rural areas in Utah, has a relatively high unemployment rate and an underdeveloped secondary economy. The average annual unemployment rate in Tooele County in 2011 was 8.1%, which was higher than the state unemployment rate of 5.8% for the same period. The basic-to-non-basic employment multiplier for Tooele County (assuming that all federal and mining employment, 75% of all employment in the manufacturing sector, and 10% of all state and local government employment can be classified as basic) is estimated to be 1.5 jobs for every job created in the basic sectors. Mining makes up the second largest and most important employment sector of Tooele County providing 7.3% of the wage and salary jobs.

Table 3.11

12-Kilometer Population Wheel

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

3.11 Waste Management

The 11e.(2) material encompasses a broad spectrum of byproduct wastes including uranium mill tailings, thorium tailings, and other process residues. The concentrations in the original ores and the extraction processes normally limit the concentrations to less than 12,000 pCi/g for any radionuclide, with the average concentration at any large site ranging from a few hundred pCi/g to approximately 1,000 pCi/g. In order to arrive at a reasonable estimate of the characteristics of 11e.(2) waste, Energy*Solutions* has considered available data from operating and non-operating uranium mill sites and three sites where uranium and thorium processing has occurred.

The EPA compiled data on uranium mills for which statistical descriptions of 11e.(2) wastes can be derived (EPA, 1989). Table 3.12 provides volume and Ra-226 estimates for the 18 UMTRA inactive mill tailings sites where the volume-weighted mean Ra-226 concentration is 421 pCi/g. The type of waste being received at the Energy*Solutions* site is consistent with the site mean concentration and standard deviation for the UMTRA sites, which is 421 ± 508 pCi/g, with a range of 45 to 2,315 pCi/g. The highest concentration was reported for the Canonsburg site, which was a radium processing site rather than a mill site. If the Canonsburg site is excluded, the tailings range from 45 to 745 pCi/g.

Characterization data for the UMTRA sites generally show that in acid extraction processes, Th-230 follows the liquid effluent to a greater degree than Ra-226. Therefore, concentrations of Th-230 of up to 10,000 pCi/g are not uncommon in tailings slimes, raffinate pits, and evaporation ponds. However the site-wide average concentration of Th-230, Ra-226, and decay products should be approximately equal. The U-238 concentration averages approximately eight (8) percent of the Ra-226 concentration in uranium mill tailings.

The EPA also compiled data for the 11 mills that were operating in 1989. Table 3.13 provides the average Ra-226 concentration for the mill tailings where the site Ra-226 concentrations averaged 319 pCi/g with a standard deviation of 230 pCi/g. The Ra-226 concentration range was 87 to 981 pCi/g. No information was provided on tailings volume.

The UMTRA Disposal Site at Clive, Utah was created from relocating the uranium mill tailings from the Vitro Chemical Company Site in Salt Lake City. There are various reported average Ra-226 concentration values for this material, ranging from 460 pCi/g to 900 pCi/g, with individual sample analyses ranging from 100 to 2,000 pCi/g (DOE, 1983). The DOE used an average of 670 pCi/g as the basis for their Environmental Impact Assessment.

Another large cleanup of 11e.(2) wastes included properties in Maywood, New Jersey, estimated to create 395,000 cubic yards of contaminated soil and building debris (DOE, 1992). However, individual sample results indicate that thorium concentrations range up to 6,000 pCi/g or more, which is similar to those at other thorium processing plants (e.g. West Chicago Rare Earths Facility). Radionuclides from the U-238 decay chain are present in lesser concentrations. While the maximum concentrations are high, a large portion of the wastes appear to be from the dispersal of process waste and, therefore, may be highly diluted.

The waste sites described above all have similar characteristics. Process waste concentrates such as the sludges, slimes, and raffinates usually are segregated and constitute significantly large volumes (1,000 m3 or more) of higher activity wastes with average Ra-226 concentrations up to 2,000 pCi/g and average Th-232 concentrations up to 6,000 pCi/g. Building debris, contaminated soils, and mill tailings will make up approximately 80 percent of the waste. The average activity of this material will be below 1,000 pCi/g for any site with most probable averages closer to 400 pCi/g.

Table 3.12

Characteristics of UMTRA Mill Tailings

Mill Site	Volume (cu m)	Ra-226 (pCi/g)	Vol x Ra (cu m – pCi/g)/Volume
Tuba City	52,661	550	8.52
Durango	129,323	670	25.48
Grand Junction	249,410	665	48.77
Gunnison	119,863	315	11.1
Maybell	365,781	200	21.51
Naturita	58,167	45	0.77
New/Old Rifle	304,949	745	66.81
Slick Rock	7,513	115	0.25
Lowman	5,694	160	0.27
Ambrosia Lake	549,525	570	92.11
Shiprock	311,346	420	38.45
Bowman/Belfield	21,250	50	0.31
Lakeview	83,480	110	2.7
Canonsburg	38,958	2315	26.52
Falls City	901,125	190	50.35
Green River	13,774	75	0.3
Mexican Hat	9,045	670	1.78
Salt Lake	178,730	480	25.23
total volume	**3,400,594**		
mean		**464**	
std deviation		**509**	
vol st'd ave concentration			**421.25**

Table 3.13

Characteristics of Raffinate Pits at Weldon Spring Site

Average Radionuclide Concentration (pCi/g)					Volume Weighted Concentration
Radionuclide	Pit 1	Pit 2	Pit 3	Pit 4	
U-238	710	470	520	620	556
U-234	810	560	570	610	598
Th-232	100	120	120	120	118
Th-230	24,000	24,000	14,000	1,600	12,448
Ra-228	850	200	100	60	157
Ra-226	430	440	460	11	343
Waste Volume (m^3)	13,224	13,224	98,490	42,256	167,194

Summarizing the data presented above, the following radiological waste characteristics are observed for the Energy*Solutions* 11e.(2) Embankment. Considering the relative proportions of lower and higher activity waste that could be sent to the Clive Facility, Energy*Solutions* estimates that the overall average concentration for any radionuclide will be approximately 500 pCi/g. However, individual sites may vary widely around that average, as described above. Because of this, individual shipments of wastes may contain higher average concentrations of Ra-226 and Th-232. In the context of waste deliveries to the disposal site a shipment is taken to mean a single waste-hauling truck or rail car from a single generator. Weighted average concentrations in a shipment must not exceed 4,000 pCi/g for natural uranium or any radionuclide in the Ra-226 series; 60,000 pCi/g of thorium-230; or 6,000 pCi/g for any radionuclide within the thorium series, although they may be present at those concentrations together.

Estimate that the volume of material to be handled and disposed of at the site would be 500,000 tons/year. Assuming an average Ra-226 and Th-232 concentration of 500 pCi/g, the estimated annual average total activity disposed of would be 227 Curies for each of the radionuclides. Since the daughter products may be assumed to be in secular equilibrium, there would be approximately 227 Curies of each of the other important radionuclides, such as Ra-228 and Ra-224. The amount of uranium would be expected to be less than 25 percent that of Ra-226. The average Th-230 concentration is expected to be similar to that of Ra-226 and will depend upon the disequilibrium of the radionuclides in that decay series. The actual amount of radioactivity disposed of in a given year will vary around the estimated 227 curies per radionuclide as actual concentrations and disposal amounts vary.

In addition to the radiological constituents, these wastes would be expected to include those constituents found in mill tailings in general, regardless of the source. The EPA has reported the upper ranges of elements in mill tailings from several sources that are presented in Table 3.14. In some cases these are not significantly different from "normal" soils, but due to the limited number of sources, concentrations of any of these constituents could be several times higher than reported. At these concentrations it is expected that arsenic, barium and lead would fail TCLP and that those wastes would be classified as exempt wastes.

For most of those elements listed as hazardous constituents, the very high concentrations were found at only one mill site; therefore, the average concentrations are expected to be much lower. Rough averages, based on the observed range of concentrations of the hazardous constituents, were less than half of the maximum observed concentrations.

Energy*Solutions*' hydrogeologic report (Appendix E of Energy*Solutions*, 2005b) concluded that it would take 400 to 600 years for leachate to travel through the unsaturated zone and then another 800 years to reach the nearest off-site well. No non-radiological constituent would reach the ground water in less than 700 years.

4 ENVIRONMENTAL IMPACTS

Any area utilized for 11 e.(2) byproduct material receiving, unloading, hauling/handling, and placement in the embankment are considered a Restricted (or Controlled) area. Controlled areas are fenced and conspicuously posted with signs reading "Caution—Radioactive Materials." Entrances are through the administration building restricted-access portal or through vehicle or rail gates.

Table 3.14

Concentrations of stable elements in Uranium Mill Tailings compared to the average Earth's crustal abundance.

Element	Concentration (PPM)	Average Crustal Concentration (PPM)
Aluminum	72,000	81,000
Aresenic	600 [1,2]	5
Barium	4,000 [1,2]	250
Bromine	6	2
Calcium	87,000	36,000
Chlorine	68,000 [1]	310
Chromium	7,300 [1,2]	200
Cobalt	140 [1]	23
Copper	1,200 [1]	70
Iron	320,000 [1]	50,000
Lead	3,100 [1,2]	16
Magnesium	17,000	21,000
Manganese	2,100 [1]	1,000
Mercury	34 [1,2]	0.5
Molybdenum	550 [1]	15
Nickel	1,100 [1]	80
Potassium	25,000	26,000
Rubidium	560	310
Selenium	230 [1,2]	0.1
Silver	10 [1,2]	0.1
Sodium	47,000	28,000
Strontium	4,100 [1]	300
Terbium	5	0.9
Thallium	10 [1]	0.6
Tin	6,200 [1]	40
Titanium	5,700	4,400
Tungsten	570 [1]	69
Vanadium	4,400 [1]	150
Zinc	2,200 [1]	132

1. Maximum observed concentrations substantially greater than average
2. Hazardous constituents from 10 CFR 40, App A, Criterion 5C.

With the Proposed Action, site preparation and construction activities have already been completed. With the existing 11e.(2), Class A LLRW, and Low-Activity Radioactive Waste (LARW) facilities at the Clive site, the site preparation and construction activities have already been completed, such as the following items:

- roads to the facility,
- roads at the facility,
- vehicle wash-down area,
- rail spur(s) to the facility,
- railcar rollover facility,
- railcar wash-down facility,
- asphalt storage pad,
- maintenance building, and
- storage building.

4.1 Land Use

The Proposed Action does not conflict with land-use plans for the Clive site during operation. The site location is on private land owned by Energy*Solutions*. Most of the land within a 10-miLE radius of the Clive site is public domain administered by BLM and is used for, sheep grazing, transportation, hunting, and recreational-vehicles driving. There is no pubic use of the site.

The Clive site has a minimal effect on land use in the area, due to the small amount of land that is actually developed, the industrial-type activity which is already occurring in the area, and the abundant supply of federal land which would still be available for grazing purposes and recreation. No grazing allotments need be removed, because there are no grazing allotments currently available on the Energy*Solutions* property. The Clive site is within the Hazardous Industries District of Tooele County.

4.2 Geology

The extraction of clay material for the clay liner is obtained during project construction. Since there are no unique geological features or paleontological resources on the areas identified for development, no destruction or disturbance results from construction.

Impacts to soils resulting from construction activities include accelerated soil erosion and decreased productivity from vegetation removal, compaction, and horizon mixing. Soil loss from wind erosion could occur in areas of fine surface textures and dunal areas. Horizon mixing could create revegetation problems by bringing the more saline and alkaline material from the subsoils and substratum to the seedbed surface. The application of mechanical erosion control and revegetation techniques reduces overall wind erosion.

4.3 Air Quality

Continued operation on the Clive site will have minimal effect on air quality in the area. Operation activities during cell excavation and clay liner placement generate some fugitive dust. Based on an emission factor for construction activities of 1.2 tons/acre-month from EPA, (1995), a 279-acre disturbed area at any given time, and a 6-month operation schedule, fugitive dust emissions might total 180 tons per year. A dust emissions control program has been implemented during all operations. This program includes the application of water sprays and surfactants to disturbed areas.

In addition to operation activity, fugitive dust is generated by wind erosion of disturbed areas. EPA, (1998) provides an emission factor for wind erosion of 0.14 tons/acre-yr for exposed areas. This would result in fugitive dust emissions of approximately 39.1 tons/yr for wind erosion.

4.4 Hydrology

There are no perennial surface-water systems associated with the Clive site, and activities under the Proposed Action have no effect. Dewatering is not necessary because the bottom of the excavation is about 10 feet above the water table. Drainage ditches have the capacity to carry the runoff from the 100-year, 1-hour storm event. This event is estimated to result in a 2-feet flow depth in the 3-feet deep drainage ditches, leaving 1 feet of freeboard. Because of the lack of surface water and low-intensity precipitation events, surface water effects are minimal.

All precipitation that comes in contact with the waste materials and water necessary for decontamination is controlled and either collected in evaporation ponds or used for engineering purposes during embankment construction and operation.

During operation of the facility, groundwater is obtained from Energy*Solutions*' well, located to the northwest of the site, for dust suppression and engineering purposes. Energy*Solutions* estimates that during the course of excavation and clay liner placement, approximately 15,000 gallons of water per day was used. Similarly, it is estimated that 1.8×10^6 gallons of water will be required annually, over the course of the 11e.(2) Embankment operations. From the time of the 11e.(2) Embankment's initial construction to date, approximately 28.8 million gallons of water have been used for dust suppression and engineering purposes. At this rate, it is projected that another 54 million gallons will be required over the next 30 years of operation.

The groundwater has a high total dissolved solids content, ranging from 0.17 to 0.63 lb/gal in the unconfined, uppermost aquifer and about 0.17 lb/gal in the confined aquifer. The groundwater aquifer classification system established in the State of Utah Groundwater Quality Protection Regulations designates both the shallow and deeper aquifers as Class IV aquifers, based on TDS above 10,000 mg/l; a classification equivalent to the EPA's Class III. Furthermore, the concentration of some of the inorganic constituents in the uppermost aquifer (sulfate, chloride, iron, and manganese) is significantly higher than the EPA's secondary groundwater standards. Therefore, the groundwater in the disposal site area is of a poor quality and is not suitable for most known uses without significant treatment.

The continued operation of the 11e.(2) Embankment mainly involves excavation of soils and other natural materials to pre-specified design depths, construction of the clay liner, placement and compacting of the waste, and placement of the embankment cover. In accordance with the Ground Water Quality Discharge Permit, surface water and groundwater are protected during facility construction and operation. Control measures include quality control/quality assurance requirements during construction to ensure that the waste is properly compacted, preventive measures to control entry of the precipitation and runoff water into the Embankment, and preventive and corrective measures to prevent contamination of ground water in the event of a spill or inadvertent entry of excess water into the Embankment.

The disposal Embankment is designed, constructed, and operated in conformance with all of the applicable regulations for groundwater protection provided in Appendix A to 10 CFR Part 40, which are enforced through the conditions of the License targeted for renewal. Specifically, the regulatory requirements for groundwater protection in Appendix A to 10 CFR Part 40 require identifying site-

specific hazardous constituents, establishing their concentration limits (standards), and locating a point of compliance (POC) where the established limits will have to be met. A period of compliance is established, based on information and data provided by Energy*Solutions*. These requirements are enforced through license condition 11.1, which requires ongoing compliance with the facility's Ground Water Quality Discharge Permit.

The regulations also require Energy*Solutions* implement a corrective action program to meet the established standards in the event that any hazardous constituent concentrations are exceeded during the facility operation. Finally, the regulations require Energy*Solutions* to establish and operate groundwater monitoring programs to ensure that groundwater quality is protected during facility operation. These include: (1) a preoperational monitoring program to establish the background ground-water quality and a POC for the disposal facility; (2) a detection monitoring program to detect and identify site-specific hazardous constituents, and establish their concentration limits; (3) a compliance monitoring program to ensure that the hazardous constituent concentrations do not exceed the established standards at the POC; and (4) a compliance monitoring program to ensure that the concentrations will be restored to the standards in the event that the standards are exceeded and a corrective action is implemented, as required by the regulations.

In addition, the embankment design includes a bottom liner that minimizes seepage of contaminants from the disposal cell to the water table. The bottom liner consists of 2 feet of compacted clay with a maximum permeability of 1×10^{-6} cm/sec. Energy*Solutions* has conducted tests to ensure that the design permeability of this clay is attainable.

On the basis of the above, it is concluded that there are little or no foreseen impacts on the groundwater availability or quality during the continued construction/operation of the disposal facility, as long as the applicable regulations in Appendix A to 10 CFR Part 40 are met. In addition, the regulations in Appendix A to 10 CFR Part 40 provide mechanisms for detection of any contamination and for restoration of groundwater quality through corrective actions in the event that the established standards are exceeded at any time during the facility construction/operation.

4.5 Ecology

Construction procedures for the project include vegetation removal for site clearance. Construction of the facility affects only the desert shrub/ saltbush vegetation community.

Construction of the facility resulted in the displacement or death of smaller, less mobile wildlife species on site. Small mammals and reptiles are more subject to mortality from construction than other groups, but impacts are minor on a regional basis. Many of the affected species, especially small mammals, have high reproductive potential, are common in surrounding habitats, and therefore, are minimally impacted. Larger mammals, birds, and some reptiles are able to avoid the construction areas; therefore, impacts to these animals are minimal. Larger mammals such as pronghorn, bobcat, kit fox, and coyote, which may forage or travel through the habitats affected by the facility or crossed by the right-of-ways, avoid the disturbance during construction. These mammals are excluded from the facility during operations by on-site fencing and should return to these areas following restoration. Loss of pronghorn habitat and traffic effects on pronghorn individuals is no significant due to the minimal amount of area affected.

Acreage disturbed for the life of the project is unavailable for wildlife utilization. However, this is not a significant impact following facility restoration; wildlife species should re-invade the area of the facility following restoration and the natural vegetation process.

No federally listed threatened or endangered wildlife species, species proposed for listing, or designated or proposed critical habitats are known to occur in any areas that would be disturbed (Envirocare, 1992). The state-sensitive-listed kit fox could be temporarily displaced due to construction activities, but a significant amount of their habitat would not be lost.

4.6 Socioeconomic Impacts

Direct employment generated from the acceptance of additional wastes for the Proposed Action would be approximately the same as the current site operations. Currently, most Energy*Solutions* staff are from Tooele County. The remainder of the workers reside in Salt Lake County or Davis County. The operation of the Clive site also affects employment in supplying firms due to purchase of construction material, supplies, and machinery (such as heavy equipment, trucks, and rail cars). This effect is also small.

Since the Clive site is over 35 miles from the nearest community and since the Proposed Action does not create a significant population increase to the area, there are minimal effects on schools, hospitals, water supplies, sewage facilities and other local facilities. Any waste disposal at the Clive site results in wage payments to residents of both Salt Lake County and Tooele County, increasing personal income in both counties. This effect, while beneficial, would be very small given the present magnitude of personal income in the combined counties.

4.7 Radiation

The radiological effects during the construction phase for the lle.(2) byproduct material disposal Embankment are only the natural background plus any increment added from the existing operations. Refer to section 7.3 of the Renewal Application for detailed discussion.

4.8 Cultural Resources

The effects of the Proposed Action on scenic, historical, and cultural resources are not expected to be significant. There are no historical or cultural resources of significance at the Clive site or along the transportation corridors. Hence, the Proposed Action does not affect historical or cultural resources.

4.9 Other

Construction and operation of the Clive site has minimal effect on recreational activity in the area. The site is located on private land owned by Energy*Solutions*. No public land is used for the Proposed Action. There is no effect on the Cedar Mountains Wilderness area designated in 2006, the Knolls Special Recreation Management Area, the Horseshoe Springs Area of Critical Environmental Concern (ACEC), or the Bonneville Salt Flats ACEC from the construction at the Clive site.

Minimal visual effects at the Clive site result from construction activities. During the construction phase there is increased activity in the area, but the visual impact is insignificant to travelers on Interstate-80 or others in the area, based on the following:

(1) Most of the facilities are located about 2 miles from the nearest common vantage point on Interstate-80 and

(2) The Vitro embankment and corresponding features are already present.

As described previously, a scenic-quality rating of 12 was assigned to the Clive site, indicating that no special management attention regarding visual resources is required.

4.10 Resources Committed

For the Proposed Action, approximately 110 acres of the present terrain is occupied by a flat-topped mound, approximately 46 feet high, with side slopes of 1 vertical to 5 horizontal. Other than the Embankment itself, the Proposed Action does not create a major effect upon the local topography.

The excavation of the Embankment and the placement of the clay liner requires the use of electricity, fuel, water, labor, and construction materials. The use of water, labor, and soils is not a commitment of nonrenewable resources, but the uses of electricity and engine fuel are. Engine fuel and electricity are available at the Clive site. Additionally, the Proposed Action is situated upon private land owned by Energy*Solutions*, since no state or Federal resources are committed.

Soils removed during the excavation are reused in the construction of the reclamation cover. In addition, about 345,000 yd^3 of gravel or quarried bedrock are needed for the erosion barrier, access roads, and drainage ditches at the Clive disposal area. This material is available from quarries 5 to 10 miles northwest of the Clive site or in the Grayback Hills.

5 MITIGATION MEASURES

5.1 Air Quality

In an effort to control air quality Energy*Solutions* has the following controls designed to minimize fugitive dust emissions:

1. Limit vehicle speeds on site to no more than 25 mph,
2. Roads are treated with water and/or chemical dust suppressants as needed,
3. Limit disturbed areas (where project activities are being conducted) to as small an area as possible,
4. Limit dusting from stockpiled soil or overburden by applying a chemical dust suppressant where natural crusting does not occur,
5. Utilize watering or chemical suppressant on all material being disposed until it is covered during the closure phase, and
6. Monitor dust emissions and maintain a timely review of the results of such monitoring.

5.2 Radiological Environment

Mitigation measures for radiological considerations are essentially the same as those for air quality, except for special emphasis in the areas where disposal material is being placed. To confirm that air quality mitigation measures are effective for the disposal areas, air monitors are operated continuously during disposal operations to detect off-site transport of radionuclides. If unexpectedly high values are observed, Energy*Solutions* is required to determine the cause and provide mitigation.

5.3 Surface Water

There are no naturally occurring surface water bodies within the affected vicinity. Temporary surface waters resulting from natural precipitation will be collected and stored for use in dust control operations.

No release from the site is contemplated for normal periods of precipitation. Long term water control is provided by engineered erosion control drainage ditches which will carry runoff from the closed disposal embankment away from the site.

5.4 Groundwater

The disposal cell design is engineered to minimize water infiltration into the cell. The cell is underlain by a compacted clay liner to minimize water seepage into the underlying strata. The material being disposed will have a low moisture content and only water needed for dust control or to meet compaction specifications will be introduced.

5.5 Biota

There is no aquatic biota on the site. No effective short-term mitigation measures are available for terrestrial biota. Long-term impacts on terrestrial biota will be minimized by revegetation of disturbed areas and natural re-population.

6 ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAM

The following is a summary of the operational environmental monitoring and surveillance plan that has been implemented by Energy*Solutions*. The intent of the Plan is to characterize the general radiological and environmental profile of the Clive site during site operations. Monitoring results are used to document compliance with the Division's radiological and safety standards and to adjust operational and monitoring programs as necessary to maintain compliance. The monitoring program is designed to be capable of evaluating ambient conditions as well as documenting any effects of site operations on the radiological environment. The radiological monitoring program is described in Condition 26 of EnergySolutions, 2005b.

Energy*Solutions* has operated a similar environmental monitoring and surveillance program since 1988 for the Clive site designed to detect and quantify radionuclides in concentrations greater than those occurring naturally. This program was modified in 1995 to include detection and quantification of the presence of any radionuclides which might be disposed of in the lle.(2) byproduct material Embankment.

6.1 Radiological Monitoring

6.1.1 Airborne Particulate Monitoring

Airborne particulate samples are collected by means of low-volume, constant-flow air samplers operated at 60 L/min under conditions of standard temperature and pressure (76 cm mercury pressure, 21.1°C). Samples are collected on 5-cm diameter glass fiber filters. Samples are changed weekly, or more often, and are analyzed for gross alpha and gross beta concentrations.

Additionally, quarterly composite samples, consisting of all weekly samples taken from each specific station during the quarter, are analyzed by gamma spectrometry for specific identification of gamma-emitting radionuclides, for total uranium, Ra-226, Th-230, Th-232 and Pb-210. Analytical techniques chosen provide minimum detectable concentrations of 25% or less of the applicable airborne concentrations in Table II of 10 CFR Part 20, Appendix B. Of those radionuclides which might be accepted for disposal, the most restrictive limits in 10 CFR Part 20, Appendix B, Table II are, for alpha emitters, Th-230 at 0.08 pCi/m^3, and for beta emitters, Pb-210 at 4 pCi/m^3.

Samples with observed gross alpha concentrations of greater than 0.08 pCi/m^3 or gross beta concentrations of greater than 4 pCi/m^3 are individually analyzed by gamma spectrometry to identify the nuclides present. If it is believed that non-gamma-emitting radionuclides might be present in samples above the described action levels, the samples are analyzed for those nuclides as well.

6.1.2 Radon in Outdoor Air

Radon in outdoor air is measured on a continuous basis using Landauer RadTrak Dosimeters or equivalent. Radon detectors are placed at the air sampling stations listed in Table 1 of the Environmental Monitoring Plan controlled by condition 26 of Radioactive Material License #UT 2300249.

Past experience at uranium mill sites indicates that radon from uncovered mill tailings is usually not significantly above background beyond about 1.6 km. Two off-site stations are used to monitor off-site radon levels during site operations.

Detectors are collected quarterly, processed, and reported as the 3-month average concentration in pCi/L. Annual average radon concentrations since for 1988 have been reported in Energy*Solutions*' Environmental Reports. Minimum detectable concentrations for Rn-222 in air are about 0.4 pCi/m^3, or about 0.01% of the limit in 10 CFR Part 20, Appendix B, Table 2.

6.1.3 Gamma Radiation Exposure

Gamma ray exposures are measured using an optically stimulated luminescent dosimeter (OSL) or functionally equivalent device. These units are placed at the sampling stations listed in Table 1 of the Environmental Monitoring Plan controlled by condition 26 of Radioactive Material License #UT 2300249. The two off-site stations are used to establish off-site background exposure during site operations. The detectors are exchanged at quarterly intervals with the results averaged and reported in mrem/week + 2 standard deviations.

6.2 Soil Sampling

Soil samples are collected from a 15 x 15 x 2.5-cm deep area. After marking off the area with the sampling knife, a trench is dug along one side of the area to permit using the collection knife to remove a 2.5-cm (1-in.) deep block of soil. Samples are dried and pulverized before being submitted for laboratory analysis.

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6.3 Groundwater Monitoring

Energy*Solutions*' groundwater monitoring program is conducted in compliance with the requirements in 10 CFR Part 40, Appendix A. Details of the monitoring program are found in Ground Water Quality Discharge Permit (GWQDP) No. UGW450005.

The analysis parameters for Energy*Solutions'* groundwater monitoring program are described in Table 1C and 1D of the GWQDP. Water samples are collected by means of dedicated bladder pumps permanently located in each well. The Water Monitoring Quality Assurance Plan, which includes details of sampling methods, is included as Appendix B to the GWQDP.

6.4 Meteorological Monitoring

Energy*Solutions* initiated a meteorological monitoring program in July 1992, with the installation of a full weather station. The weather station monitors and records wind speed, wind direction, temperature, Delta T, precipitation, and evaporation. In accordance with Part I.H.10 of the GWQDP, annual summary reports of meteorological data are provided to the Division.

6.5 Ecological Monitoring

Since no commercial vegetation crops are grown near the site, vegetation samples are not obtained at the Clive facility. The vegetation sampling requirement does not pertain to the Clive facility because the vegetation surrounding the site does not present a credible exposure pathway. The land use survey included in the *Final Environmental Impact Statement to Construct and Operate a Facility to Receive, Store and Dispose of 11e.(2) Byproduct Material Near Clive, Utah* (NUREG-1476) states:

> "*There are no residents, game animals, or vegetable gardens within 5 miles of the site*."

NUREG-1476 goes on to state that the BLM issues grazing allotments on the land surrounding Clive, but sheep and cattle grazing is mostly limited to the winter and wet periods where there are puddles of water for drinking.

It should also be noted that the leaves available for vegetation sampling generally appear in Spring, but are sparse at best during the summer and winter months. As such, by the middle of June, there isn't enough viable material to collect for an adequate sample.

As the amount of collectable material is too sparse for collecting, then it is also too sparse for grazing. As such, Energy*Solutions* does not perform wildlife sampling; rather, Energy*Solutions* evaluates soil samples for the potential deposition of radioactive particulates to the surrounding environment.

7 COST BENEFIT ANALYSIS

There are large quantities of uranium and thorium mill tailings (11e.(2) byproduct material) that exist throughout the United States. These mill tailings are located at sites that are neither licensed by NRC or Agreement States nor are one of the 24 abandoned mill tailings sites being remediated by DOE under Title I of UMTRCA. The State of Utah has granted the applicant licenses to dispose of both Naturally-Occurring Radioactive Material (NORM) and Low-Level Waste (LLW) at the Clive site. The benefits to the general public of continuing to have a safe, remotely-located disposal site for 11e.(2) byproduct material appear to be significant. However, because these costs and benefits are not localized, it is appropriate to review the specific site-related benefits and costs for the Energy*Solutions* facility.

7.1 Quantifiable Socioeconomic Impacts

The socioeconomic impacts of continued operation of the lle.(2) byproduct material disposal site will be minimal, because the facility is currently in operation and similar to Energy*Solutions'* existing LLW and NORM facilities. Since Energy*Solutions* uses existing personnel, the impact on the labor force, housing, schools, and local economy will be minimal as well. Tax revenue from the disposal operations, however, may provide some additional public funds.

7.2 The Benefit-Cost Summary

The disposal project is beneficial, because it fills a public need in that it provides a location for the safe disposal of lle.(2) byproduct material and consolidates numerous sources of waste at one location, where other types of wastes [i.e., low-level radioactive, NORM, and Resource Conservation and Recovery Act (RCRA) wastes] are currently being consolidated. In addition, the waste is consolidated in an area specifically zoned for handling of hazardous waste. This area is remote from populated areas.

The cost of the project is limited to a slight increase, during operations, in radiation exposure to the nearby public and along transportation corridors, over and above that which currently exists due to the LLW, NORM, and RCRA operations. However, the monitoring and mitigating measures maintain potential exposure well below permissible guidelines for the protection of the health and safety of the public. After project completion and license termination, the site will be turned over for long-term care to DOE, to another Federal Agency designated by the President, or to the State of Utah at its option.

8 SUMMARY OF ENVIRONMENTAL CONSEQUENCES

The effects of disposal operations for the Proposed Action have been examined and no significant adverse impacts have been found related to the environment (Envirocare, 1992).

8.1.1 Land Use

The operational effects on land use are the same as discussed in Section 4.1 above.

8.1.2 Geology

The only additional effect on geology and soils, in addition to those described during construction (see Section 4.2), are from soils affected by a spill of contaminated material. In the event of a spill, only a

small amount of soil is contaminated (estimated at less than 10 yd^3). If soil was contaminated during a spill, the soil is removed and disposed of in the Embankment. The area would be reclaimed in accordance with Energy*Solutions'* reclamation plan for other areas disturbed during construction.

8.1.3 Air Quality

Minimal effects on air quality occur due to the operation of the site. The operation employs dust suppression procedures to reduce windblown particulates. Exhaust emissions are associated with the construction equipment and railroad switch engine used to operate the site. Energy*Solutions* operates under a permit from the Utah Division of Air Quality that requires there be minimal impact on air quality.

Release of radionuclides under normal conditions during operation of the site is usually limited to the following mechanisms:

- exhalation of radon gas from embankment area(s) that have not been covered with the compacted clay radon barrier, and
- windblown materials from the embankment and un-loading area.

These release mechanisms have been modeled to estimate the maximum exposure dose at the property boundary, and to the surrounding population. Results of this modeling are described in Streamline, (2005), Appendices A-1 and A-2 of Energy*Solutions*, (2005b), and Section 8.2.8 of this Environmental Assessment.

8.1.4 Hydrology

There are no perennial surface-water systems associated with the Clive site; therefore, there would be no effect on surface waters. There are two possible ways for temporary surface waters to be contaminated: (1) rainwater that comes in contact with the waste material, and (2) water that accumulates during decontamination of vehicles and equipment. Energy*Solutions* has obtained a Ground Water Quality Discharge Permit from the Utah Division of Water Quality. This permit requires significant controls to limit the contamination of any surface waters. All precipitation that comes in contact with the waste materials must be controlled and either placed in evaporative ponds or used for engineering purposes during embankment construction.

The water necessary for decontamination is obtained from a well located northwest of the site and owned by Energy*Solutions*. This water is collected at the decontamination facilities in systems designed and operated to meet Best Available Technology under the GWQDP. The water is then placed in evaporation ponds or used for engineering purposes on the embankment. Energy*Solutions* estimates that during the next 30 years of 11e.(2) Embankment operation that $54x10^6$ gallons of water will be used for dust control and decontamination purposes.

Dewatering of the waste material brought to the site is not necessary, because the moisture content of the incoming waste is monitored to restrict wet materials or free liquids. With the Proposed Action, degradation of water quality in either the unconfined or confined aquifer systems in the vicinity of the Clive site is highly unlikely. The groundwater at the site is already characterized as brackish or briny, with levels of many constituents (major ions, metals, total dissolved soils, uranium) exceeding EPA primary or secondary drinking water standards, often by large amounts.

During operation of the facility, groundwater is obtained from Energy*Solutions*' well, located to the northwest of the site, for dust suppression and engineering purposes. Energy*Solutions* estimates that

during the course of excavation and clay liner placement, approximately 15,000 gallons of water per day was used. Similarly, it is estimated that $1.8x10^6$ gallons of water will be required annually, over the course of the 11e.(2) Embankment operations. From the time of the 11e.(2) Embankment's initial construction to date, approximately 28.8 million gallons of water have been used for dust suppression and engineering purposes. At this rate, it is projected that another 54 million gallons will be required over the next 30 years of operation.

The disposal facility is operated as the facility is constructed. The waste is placed in the 11e.(2) Embankment and compacted, and such operations will be continued until the Embankment is filled to the design capacity, prior to the construction of the embankment cover. Accordingly, the impacts on groundwater due to facility operation are the same as those resulting from the facility construction and discussed in Section 4.4.

8.1.5 Ecology

No additional effects on vegetation or wildlife habitat are expected to result from operation of the facility beyond those described for the construction phase (see Section 4.5).

8.1.6 Socioeconomic Impacts

Socioeconomic impacts as a consequence of operation would be expected to be the same as for construction for the Proposed Action (see Section 4.6).

8.1.7 Cultural Resources

There are no historical or cultural resources of significance at the Clive site, or along the transportation corridors. Hence, the Proposed Action does not affect historical or cultural resources during the operation and closure of the facility.

8.1.8 Radiological Health Impacts

This section presents a generic assessment of the potential radiological impacts on humans and the surrounding environment resulting from continued operation of the 11e.(2) byproduct material Disposal Embankment. The major issues addressed in this review and assessment include: potential sources of exposure to workers and individual members of the public, potential releases of radiological contaminants, pathways leading to environmental contamination, approaches and methodologies employed in conducting the radiological impact assessment, and conclusions and results of the assessment. It is assumed that environmental systems will be adequately protected against any adverse radiological impacts if workers and members of the public are adequately protected against the same impacts. The major sources of exposures resulting from radionuclide releases under normal operating conditions are:

(1) radon gas from the decay of radium compounds,
(2) windblown material and resuspension of radioactive materials,
(3) direct gamma radiation, and
(4) water infiltration of radionuclides and subsequent transport and exposure.

The principal pathways by which an individual can be exposed to these sources are: (1) inhalation of radon and radon daughters, (2) inhalation or ingestion of windblown radioactive particulates, (3) exposure to direct gamma radiation from the lle.(2) byproduct material during the disposal operation, (4) ingestion of groundwater contaminated by water infiltrated through the waste, and (5) ingestion of contaminated

food produced in areas contaminated with lle.(2) byproduct material (either from direct soil or crop contamination or contamination associated with crop irrigation).

8.1.9 Hypothetical Accidents

The radiological and physical safety risks associated with the transportation and disposal of lle.(2) byproduct material have been evaluated. Based on the evaluations, the environmental risks associated with accidents are not large. This is primarily due to the nature of lle.(2) byproduct material and the type of facility under operation.

The maximum credible radiologic accident during the life of the facility is the accidental dumping of a load in some location other than those licensed. Energy*Solutions* has implemented at its present facility several programs to minimize the possibility of any such accidents. If a spill were to occur, Energy*Solutions* is equipped to quickly clean up any spilled material. The spill material would then be properly disposed in the licensed embankment. During the cleanup, it is expected that several yards of previously clean material would be excavated and would also be disposed.

Since there is no present or anticipated off-site population in the vicinity of the site, the actual off-site dose would be zero.

8.1.10 Radionuclide Release

Because there is only limited movement of low-activity radioactive materials through piping or other plumbing at the proposed facility, there would be no significant releases of radioactivity from piping breaks. The GWQDP requires prompt identification and remediation if such a release would occur. Flammable or explosive fuels are not stored in close proximity to the wastes and the principal flammable material is stored in the fuel tanks of the individual work vehicles. A vehicle fire, even on a loaded haul truck, would not be expected to release any significant quantity of the load as airborne dust. The possible release scenarios, all of low probability but ranged in order of increasing improbability, are:

1. on-site truck turnover or collision;
2. train derailment;
3. flooding; and,
4. tornado.

The above scenarios all result in the exposure of wastes to the natural elements and forces of nature. The Department of Energy evaluated the impacts of accidental releases of material associated with the disposal of mill tailings at Clive (DOE, 1984). They concluded that the worst accident would result in the spillage of the equivalent of a train car of bulk waste material in transit to the site. A second case was evaluated where a similar size spill occurred but the spillage occurred into the Great Salt Lake. Impacts of these events were found to be negligible compared to the impacts from normal operations. The average bulk 11e.(2) waste brought to the Energy*Solutions* site will be similar in physical and chemical form to the Vitro mill tailings and, therefore, no additional assessments of accidental releases off site will be made. The following accidental on-site releases have been evaluated 1) On-site truck turnover or collision, 2) Train derailment, 3) Flooding, 4) Tornado, and 5) Severe Winds.

Truck Turnover or Collision

From NUREG-0706 the probability of a truck accident is in the range of 1.0 to 1.6×10^{-6}/km (NRC, 1980). There are two kinds of truck movements to be considered at the Clive site. These are arriving waste shipments and haul trucks moving material from the rollover or storage to the disposal cell. Assuming that

there are 3 incoming trucks per day and 50 loaded trucks per day from the rollover or storage to the trench and assuming that the on-site distance traveled by any loaded truck is one kilometer, the probability of an accident in any one year is:

1.3 x 10-6/km x 53 loads/day x 260 days/year x 1 km/load
= 1.8 x 10-2 or about 1.8%.

Most of the material from the truck would be deposited on the ground in the immediate vicinity of the truck. Based on NUREG-0706, for a wind speed of 10 mph, about 0.1% of the material would become airborne immediately (for dry material) (NRC, 1980). Obviously if the material is moist, the release fraction would be less. For a 20-ton (40,000 pound) truck, about 40 pounds or less might become airborne. This compares with about 24 pounds of dust that becomes airborne daily per hectare of a mill tailings pile surface. If the spill is not cleaned up or dust controlled rapidly, the release fraction over a 24-hour period might increase to as much as 0.9 percent or 360 pounds. This is highly unlikely because of the presence on-site of crews and equipment that are there for the express purpose of managing bulk wastes. Because of moisture differences and differences in waste composition from the model mill assumptions, we would expect to have lower release fractions in an actual accident situation.

For a theoretical truck accident involving a yellowcake shipment, a 24-hour release period, all particles in the reparable range, and a population density of 7.5 persons per square mile, the NRC estimated 50-year dose commitments to the lungs of the general public in the range of 0.7 to 9 person-rem. The yellowcake specific activity is about 6.77×10^5 pCi/g while the average uranium or thorium concentrations expected at Energy*Solutions* would be 500 pCi/g, or a factor of 1,300 lower. Individual shipments to Energy*Solutions* might have Ra-226 concentrations as high as 4,000 pCi/g, or similar to those found in uranium mill tailings. Concentrations of 232Th in a small fraction of shipments could be as high as 6,000 pCi/g. The dose per unit intake via inhalation is higher for Th-232 wastes than for yellowcake by up to a factor of 1,000, depending upon the chemical form and radionuclide mix. Therefore, the postulated off-site public doses could be approximately an order of magnitude higher than for a yellowcake spill under the same circumstances. However, the population distribution around the Clive site is insignificant compared to that in the calculation and, therefore, the off-site population dose would be inconsequential.

For on-site workers, there would be a very short exposure time since there would be no reason to stand downwind for 24 hours (or even one hour). Assuming an accident involving the spill of a load of waste with a concentration of 15,000 pCi/g; a period of three hours for cleanup with no use of respiratory protection; an airborne concentration of 1 mg/m^3; and a respiratory rate of 1.2 m^3/hr a total of 54 pCi of each nuclide would be inhaled. Comparing these to the Allowable Limit of Intake (ALIs) from Appendix B of 10 CFR 20.1.001 - 4201, the sum of fractions is 0.022. The external gamma dose, using the relationship of 3.1 mrem/h/pCi/g for Ra-226 from condition 26 of Energy*Solutions*, (2012b) and doubling for the contribution from Ra-228, would be less than 140 mrem. Such a dose added to the projected maximum TEDE of 1,032 mrem/yr would still be well within the permissible annual exposures for radiation workers. In actual fact, no workers would be present under such conditions without respiratory protection and would not be standing on the spilled waste for more than a few minutes.

Radiation doses to non-radiation workers would be limited by promptly evacuating such persons from the vicinity of such an accident. Non-radiation workers who might respond as part of an emergency team would be monitored and would spend a limited amount of time in proximity to the waste. It is believed that no person who is not a radiation worker would remain in the vicinity for more than 30 minutes. Therefore,

comparing inhalation exposures and external doses to those for radiation workers, it is obvious that no non-radiation worker would receive in excess of 100 mrem.

Train Derailment

The probability of a train derailment occurring on the Clive site is not readily calculable. However, because of the short length of track involved and the low train speeds compared to truck speeds, the impact of derailment should be much less than the impact of a truck accident.

The dose to the workers and to the population should be much less than that for an off-site derailment and spillage event since trained workers and equipment would be available to immediately use dust control measures to control releases and clean-up the spill. The DOE, as discussed above, concluded that the dose to cleanup workers and nearby residents from such an off-site spill was insignificant. As a worst case, the same assumptions could be applied as for the truck accident scenario above, with the same low total dose to emergency response teams.

Flooding

Flood control features for both the Vitro and Clive sites have been designed and constructed to prevent erosion or off-site transport of wastes from the sites by overland flooding. Details of the flood control features are provided in Section 3.4.4 of Energy*Solutions*, (2005a). No off-site transport of radioactive waste by flooding is anticipated.

Tornado

From NUREG-0706, the probability of tornado occurrence in Utah is probably in the range of 1 to $5x10^{-4}$ (NRC, 1980). NUREG-0706 also estimates the consequences of a tornado striking a model uranium mill. In this case about 12.6 tons of yellowcake is entrained in the vortex, the vortex dissipates at the site boundary, all of the yellowcake is reparable in size, and the cloud is dispersed as a volume source by the prevailing winds. Settling velocity is negligible. The model predicts a maximum exposure at 2.5 miles from the mill, where the 50-year dose commitment is estimated to be 0.83 micro-rem. At the fence line (1600 feet) the dose is estimated to be 0.22 micro-rem. Our wastes would have average activities considerably less than this but as discussed above, the TEDE per unit intake is higher, resulting in comparable doses at receptor locations. Since there are no nearby population groups, this very small potential dose is even more insignificant.

Non Radiological Risks

Industrial Health Incorporated (IHI) performed an analysis of projected fatalities associated with the excavation, transportation, and disposal of lle.(2) byproduct material. This analysis is included as Appendix I-1 of the Environmental Report (Envirocare, 1992). IHI determined that for Standard Industrial Classification Code 16, which includes construction activities, there were 0.000293 fatalities per worker year. This means that for an estimated 20 construction workers of the Proposed Action there would be 0.00586 expected fatalities per year. For rail transportation, based on 200,000 yd^3 and a 2,300-mile haul, it was determined that there would be an estimated 0.26 fatalities per year.

8.1.11 Other Impacts

Annual receipts are not expected to increase with renewal of the 11e.(2) Radioactive Material License. Therefore, there are no transportation impacts beyond those associated with current shipments.

The generation point of the waste is varied. However, most rail and truck shipments that now arrive at the Clive facility have minimal travel time through populated areas. During both the Vitro project and the operation of the Class A LLRW facility, there have been no negative socioeconomic effects from the shipment of waste through populated areas (EUI 1992b). All waste that is shipped to Clive must be properly packaged in accordance with the DOT standards for the respective waste. This has proven to minimize the concern of citizens along the transportation routes.

Minimal visual effects at the Clive site result from operation activities. During operations, there is increased activity in the area, but the visual impact is insignificant to travelers on Interstate-80 or others in the area, based on the following:

- Most of the facilities are located about 2 miles from the nearest common vantage point on Interstate-80.
- The facility is most often be seen by viewers from a distance.
- The Vitro embankment and corresponding features are already present.

A scenic-quality rating of 12 was assigned to the Clive site, indicating that no special management attention regarding visual resources is required.

Operation of the Clive site has minimal effect on recreation activity in the area. The site is located on private land owned by Energy*Solutions*. The use of any public land is not anticipated for the Proposed Action. There would be no effect to the Cedar Mountains Wilderness area, the Knolls Special Recreation Management Area (SRMA), the Horseshoe Springs ACEC, or the Bonneville Salt Flats ACEC from operations at the Clive site.

8.1.12 Resources Committed

For the Proposed Action, approximately 110 acres of the present terrain would be occupied by a flat-topped mound, approximately 40 feet high, with side slopes of 1 vertical to 5 horizontal. The Proposed Action does not create a major effect on the local topography.

The excavation of the cell and the placement of the clay liner requires the use of electricity, fuel, water, labor, and construction materials. The use of water, labor, and soils is not a commitment of non-renewable resources, but the use of electricity and engine fuel is. Engine fuel and electricity are available at the Clive site.

8.2 Closure

Site closure and stabilization will include decontamination and decommissioning of the entire site. This would include the removal of all facilities, including roads, rail spurs, railcar rollover, storage pads, wash pads, and administrative buildings. Any material that did not meet the standards for unrestricted release would be placed into the embankment. Closure would also entail decontaminating the site, with contaminated materials being included in the embankment. Remediation would then be performed on the decontaminated and decommissioned areas.

Closure of an lle.(2) byproduct material disposal embankment will begin once the embankment is filled and the radon and erosion barriers are completed. For the Proposed Action, the Clive site closure consists generally of the following activities:

- The disturbed areas will be restored and revegetated, except for the embankment area. Site requirements in terms of soil characteristics, fertilizer, and mulch will be assessed, and the area seeded with native grasses.
- A fence will be installed around the embankment. Fences will be 1.8-m (6-ft) chain-link with posts cemented in concrete and topped with 3 strands of barbed wire. The fence will be posted at regular intervals with warning signs as described in UAC R313-15-902.
- Custody and ownership of the Embankment will be transferred to DOE, or to another Federal Agency as designated by the President, or to the State at its option for long-term surveillance and monitoring. The custodial Agency will also become a licensee of the NRC for these activities as required pursuant to the Uranium Mill Tailings Radiation Control Act (UMTRCA) and regulated under 10 CFR Part 40.28.

8.2.1 Land Use

The closure of the lle.(2) byproduct material disposal facility will continue to keep approximately 45 ha (110 acres) of land from other uses.

8.2.2 Geology/Seismicity

The effects of facility and site closure on the local geology and soils will be similar to those described for construction and operation. Stockpiled and temporarily stored piles of materials will be removed.

8.2.3 Air Quality

Minimal effects on air quality occur due to the operation of the site. The operation employs dust suppression procedures to reduce windblown particulates. Exhaust emissions are associated with the construction equipment and railroad switch engine used to operate the site. Energy*Solutions* operates under a permit from the Utah Division of Air Quality that requires there be minimal impact on air quality.

Release of radionuclides under normal conditions during operation of the site is usually limited to the following mechanisms:

- exhalation of radon gas from embankment area(s) that have not been covered with the compacted clay radon barrier, and
- windblown materials from the embankment and un-loading area.

These release mechanisms have been modeled to estimate the maximum exposure dose at the property boundary, and to the surrounding population. Results of this modeling are described in Streamline (2005), and Appendices A-1 and A-2 of EnergySolutions, (2005b).

An effect of closure of the 11e.(2) Embankment will be a cessation of the effects due to lle.(2) byproduct material disposal facility operations. The radon barrier on the 11e.(2) Embankment will control the exhalation of radon that occurred during normal operations.

8.2.4 Hydrology

There will be no effects on surface water for the l le.(2) byproduct material disposal, because of the total lack of surface water. The effects of precipitation and water used for decontamination are described for construction and operation.

There are no effects on the groundwater expected from the closure of the 1le.(2) byproduct material disposal facility at Clive. The NRC requirements under 10 CFR Part 40, Appendix A require the design

of the disposal embankment or cell to minimize any leaching through the liner and to contain the waste for up to 1,000 years, but in any case, for at least 200 years.

The embankment design includes two key features that will contribute to water resources protection at the disposal site after the facility closure. These include an embankment cover and a bottom liner that are designed to contain the waste and minimize the mobility of contaminants. The bottom liner has already been discussed in Section 5.1.4. The embankment cover consists of a 3.5 to 4 foot thick radon cover, a 12 inch filter zone, and a 12 to 18 inch thick, graded-rock cover for protection against erosion. The radon barrier is designed to minimize the infiltration of precipitation and runoff water into the cell. The filter zone is intended to trap dew and condensation, thereby reducing the potential for drying of the clay in the radon cover. The rock cover is intended to protect the integrity of the radon cover and the disposal cell by providing protection against water and wind erosion.

There are no foreseen impacts on the groundwater flow or the groundwater quality in the disposal site area after facility closure. As noted above, the groundwater at the site contains up to 75,000 ppm of dissolved solids and, as a result, is not potable.

8.2.5 Ecology

Upon closure of the facilities and sites, reclamation will be completed. Revegetation will be completed, and wildlife species are expected to migrate back into the area (with the exception of the fenced embankments), utilizing the habitat as before.

8.2.6 Socioeconomic Impacts

These effects are grouped with those under construction of the waste facility (see Section 5.1.6).

8.2.7 Radiation

At the termination of disposal activities, the entire facility and all equipment used in the embankment construction will be decontaminated and brought to radiation and removable-contamination levels in accordance with NRC requirements; or disposed of as radioactive waste. Details of facility decontamination and decommissioning are provided in Appendix C of the 11e.(2) License Renewal Application.

Following the final cleanup of the site, documentation of the cleanup will be prepared and provided to the Division.

All data collected during the Clive site closure activities will become a part of the permanent decommissioning record and would be retained by Energy*Solutions* or provided to the custodial agency. These records would be available for review by the Division.

All completed disposal embankments will be fenced using permanent chain-link wire mesh fence, meeting the materials and construction specifications as discussed in Appendix O of the Environmental Report (Envirocare, 1992), "Construction Technical Specifications."

8.2.8 Cultural Resources

Closure will have no further effects on these resources other than those described for construction and operation.

8.2.9 Other Environmental Impacts

Minimal visual effects at the Clive site will result from closure activities. It is unlikely that the visual impact will be significant to travelers on Interstate-80 or others in the area, based on the following:

- Most of the facilities will be located about 3 km (2 mi) from the nearest common vantage point on Interstate-80.
- The facility will most often be seen by viewers from a distance.
- The Vitro embankment and corresponding features are already present.

A scenic-quality rating of 12 was assigned to the Clive site, indicating that no special management attention regarding visual resources would be required.

For the Proposed Action at the Clive site, the only effect would be a rock-covered mound covering about 45 ha (110 acres), similar to the existing mound from DOE's disposal of the Vitro material.

Closure would have no additional effect on recreation at the Clive site, because the facility will be on private land owned by Energy*Solutions* and not available to the public for recreational use. After closure the land will be owned by DOE, under license from the Division, and access will be restricted.

8.2.10 Resources Committed

No additional resources would need to be committed other than those required for operation.

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