UTAH DIVISION OF RADIATION CONTROL: ENERGY*SOLUTIONS'* CLIVE LLRW DISPOSAL FACILITY;

LICENSE AMENDMENT REQUEST; CLASS A WEST EMBANKMENT

ROUND 2C INTERROGATORIES

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(Highlighted items addressed in these Round 2C)

ABBREVIATIONS AND ACRONYMS

CAW LAR	Class A West Embankment License Amendment Request
cm	centimeter
ft	foot
HELP	Hydrologic Evaluation of Landfill Performance Model
kg	kilogram
L	liter
LLW	low-level waste
UAC	Utah Code Annotated
US	United States

INTERROGATORY CAW R313-25-6(3)-01/2A: DESCRIPTION OF FACILITY

Refer to Interrogatory Round 2A

INTERROGATORY CAWR313-25-7(1)-02/1: SPECIFIC TECHNICAL INFORMATION – GROUNDWATER ELEVATION VALUE(S) USED IN ANALYSES

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-7(2)-03/2A: SPECIFIC TECHNICAL INFORMATION – BUFFER ZONE

Refer to Interrogatory Round 2A

INTERROGATORY CAW R313-25-7(3)-04/2A: SPECIFIC TECHNICAL INFORMATION – DESIGN CRITERION FOR DISTORTION OF LINER AND CLAY COVER COMPONENTS

Refer to Interrogatory Round 2A

INTERROGATORY CAW R313-25-7(7)-05/2B: SPECIFIC TECHNICAL INFORMATION -- CLOSURE PLAN

Refer to Interrogatory Round 2B

INTERROGATORY CAW R313-25-7(9)-06/1: SPECIFIC TECHNICAL INFORMATION – QUANTITIES OF RADIOACTIVE MATERIALS

Round 1 Interrogatory revised response (based on revised CAW cover design) is satisfactory.

INTERROGATORY CAW R313-25-7(10)-07/1: SPECIFIC TECHNICAL INFORMATION – CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL MANUAL

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-8(1)-08/1: TECHNICAL ANALYSES; RELEASES OF RADIOACTIVITY

Round 1 Interrogatory revised response (based on revised CAW cover design) is satisfactory.

INTERROGATORY CAW R313-25-8(2)-09/2B: TECHNICAL ANALYSES; PROTECTION OF INADVERTENT INTRUDERS

A performance assessment to be completed in 2012 will address dose limits for disposal.

INTERROGATORY CAW R313-25-8(4)-10/1: TECHNICAL ANALYSIS – DESIGN SAFETY FACTORS

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-8(4)-11/2B: TECHNICAL ANALYSIS - ROCK COVER DESIGN AND ROCK COVER DESIGN CALCULATIONS/ ANALYSES

Refer to Interrogatory Round 2B

INTERROGATORY CAW R313-25-8(4)-12/1: TECHNICAL ANALYSIS - FILTER STABILITY/ FILTER PERMEABILITY CRITERIA

Round 1 Interrogatory response is satisfactory.

INTERROGATORY CAW R313-25-8(4)-13/1: TECHNICAL ANALYSES-PERIMETER DRAINAGE DITCH CALCULATIONS

Round 1 Interrogatory revised response (based on revised CAW cover design) is satisfactory.

INTERROGATORY CAW R313-25-8(4)-14/2B: TECHNICAL ANALYSES – INFILTRATION AND TRANSPORT MODELING: CLIMATE CONDITIONS, ENGINEERED BARRIER CONDITIONS, AND VERTICAL TRANSPORT DISTANCE

Refer to Interrogatory Round 2B

INTERROGATORY CAW R313-25-8(4)-15/1: TECHNICAL ANALYSES – GROUNDWATER DEPTH IN GEOTECHNICAL STABILITY ANALYSIS

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-8(4)-16/2B: SEISMIC HAZARD EVALUATION / SEISMIC STABILITY ANALYSIS UPDATE

PRELIMINARY FINDING:

Refer to Interrogatory Round 2B.

INTERROGATORY CAW R313-25-8(4)-16/2C: POTENTIAL EFFECTS OF LIQUEFACTION IN NATIVE SOILS AT THE CLIVE SITE

PRELIMINARY FINDING:

Refer to R313-25-8(5). Analyses of the long-term stability of the disposal site shall be based upon analyses of active natural processes including erosion, mass wasting, slope failure, settlement of wastes and backfill, infiltration through covers over disposal areas and adjacent soils, and surface drainage of the disposal site. The analyses shall provide reasonable assurance that there will not be a need for ongoing active maintenance of the disposal site following closure.

INTERROGATORY STATEMENT

Please demonstrate that the potential effects of soil liquefaction and/or cyclic softening phenomena in native soils at the Clive Facility have been adequately accounted for in the geotechnical analyses supporting the design of the proposed CAW Embankment. In doing so, clearly justify the selection of soil parameters and any design assumptions by comparison of such with correlations, field test results, and/or laboratory test results (including cyclic shear

testing) consistent with the guidance given by developers of current, published analytical methods.

BASIS FOR INTERROGATORY

In recent years, the geotechnical engineering profession's understanding of, and analysis methods for, liquefaction-related phenomena have evolved. In the past, liquefaction was treated as a phenomenon largely associated with the seismic loading of loose, clean sands which could result in significant loss of strength and large deformations. However, the 1999 earthquakes in Kocaeli, Turkey and Chi-Chi, Taiwan both highlighted the potential for significant strength loss and deformation of finer-grained soils – soils previously considered "non-liquefiable." Subsequent research (e.g., Andrews and Martin, 2000; Seed et al., 2003; Boulanger and Idriss, 2004, 2005, and 2006; Bray and Sancio, 2006; and Youd et al., 2009) has generally led to a distinction between "sand-like" soils which undergo liquefaction and "clay-like" soils which undergo cyclic-softening. Both phenomena are generally associated with generation of high pore pressures and strains during shear; however, the distinction between liquefaction and cyclic softening is important in that the methods of analysis and assessment are different for the different types of soil. Also important is that the resulting behaviors can vary.

In previous reports as well as "Geotechnical Update Report" dated February 15, 2011 (Attachment 5 to EnergySolutions, 2011), the Licensee addressed liquefaction susceptibility using site specific data and analyses (see Section 4.5.2, page 19, of referenced document). However, rather than presenting quantitative factors of safety and/or cyclic resistance and cyclic stress ratios, the Licensee qualitatively summarized the results of the analyses thusly:

> *"The 2005 study determined that for the design event, the majority of the soils in the upper 30 to 60 feet of the soil profile consist of cohesive deposits, which have a low probability of liquefaction due to their high clay content. It was also found that the interbedded cohesionless silt and silty sand deposits would also be unlikely to liquefy under the design seismic event."*

A close reading of this statement reveals that the susceptibility of non-silty or "clean" sands (those which, if loose, are most prone to liquefaction) which may be at the site has not been addressed. Also, from the information provided, it is not clear how the finer-grained soils were treated in the analyses. Similarly, with respect to slope stability and other deformation-related assessments, it is unclear how the shear strengths of finer-grained soils subject to seismic loading conditions were assessed and quantified. Reported fines content, moisture content, and Atterberg limit data suggest that some of the loose/soft soils at the site are "marginal" soils which may or may not experience liquefaction and/or cyclic softening. Published guidance and criteria (e.g., Youd et al., 2001; Boulanger and Idriss, 2008, Bray and Sancio, 2008, Boulanger and Idriss, 2011) currently referenced in the geotechnical engineering profession typically recommend that such soils be examined in greater detail and potentially be subjected to cyclic shear testing.

Stability and deformation calculations for existing embankments may be affected by the particular issues described in this interrogatory. Stability and deformations associated with the

proposed CAW Embankment, particularly given the increase in embankment height and longer slopes of this embankment relative to other embankments at the Clive Facility, need to be assessed with consideration given to these issues.

Also, it should be noted that other current/recent interrogatories submitted for the proposed CAW Embankment License Amendment Request focus on further verifying the level of ground acceleration expected at the site. The effect of any revision to that parameter on previous liquefaction and embankment stability assessments needs to evaluated and documented.

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INTERROGATORY CAW R313-25-24(1 THROUGH 3)-17/1: DISPOSAL SITE DESIGN FOR NEAR-SURFACE DISPOSAL - LINER DESIGN AND CONSTRUCTION

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-24(5)-18/1: DISPOSAL SITE DESIGN FOR NEAR-SURFACE DISPOSAL - DRAINAGE JUNCTURE AND DRAINAGE OUTLET DESIGN FOR PERIMETER DRAINAGE DITCH SYSTEM

Round 1 Interrogatory revised response (based on revised CAW cover design) is satisfactory.

INTERROGATORY CAW R313-25-25(6)-19/2A: RADIATION DOSE RATE AT THE SURFACE OF THE COVER

Refer to Interrogatory Round 2A

INTERROGATORY CAW R313-25-26(1)-20/2A: ENVIRONMENTAL MONITORING

Refer to Interrogatory Round 2A

INTERROGATORY CAW R313-25-26 (2 AND 3)-21/2B: TECHNICAL ANALYSES - HORIZONTAL TRANSPORT AND WELL SPACING ANALYSIS INPUT PARAMETERS

Refer to Interrogatory Round 2B

INTERROGATORY CAW R313-25-33(1)-22/1: RECORDS

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R317-6-6.4-23/2A: ISSUANCE OF DISCHARGE PERMIT: BEST AVAILABLE TECHNOLOGIES - MONITORING WELLS REQUIRING ABANDONMENT AND DECOMMISSIONING AND LYSIMETERS PROPOSED FOR ABANDONMENT

Refer to Interrogatory Round 2A