State of Utah

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Department of
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Executive Director

DIVISION OF WASTE MANAGEMENT
AND RADIATION CONTROL

Douglas J. Hansen
Director

January 19, 2023

Vern C. Rogers, Director of Regulatory Affairs
Energy*Solutions*, LLC
299 South Main Street, Suite 1700
Salt Lake City, UT 84111

RE: Federal Cell Facility Application Request for Information

Dear Mr. Rogers:

The Division of Waste Management and Radiation Control hereby provides Requests for Information (RFI) regarding the Federal Cell Facility Application dated August 4, 2022. Each individual paragraph in the attached document is numbered and represents an issue discovered in a review of the application. When responding to an RFI, please use the assigned number representing the question. The Division will track all responses and provide regular updated information to the public and reviewers.

The current review does not represent a comprehensive evaluation of the Application's merit and additional RFI's will follow where appropriate.

If you have any questions regarding this letter, please call Otis Willoughby at (801) 536-0220.

Sincerely,

Douglas J. Hansen, Director
Division of Waste Management and Radiation Control

DJH//JK/wa

Enclosure: Federal Cell Application, Request for Information (DRC-2023-000537)

c: Jeff Coombs, EHS, Health Officer, Tooele County Health Department
Bryan Slade, Environmental Health Director, Tooele County Health Department
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DRC-2023-000525

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Federal Cell Application Review

Request for Information or Updates to the Application (RFI)

General

- Each of the RFI's has been assigned an identifier with a numbering convention as follows-
  - Application/Appendix Section
    - Section/Appendix Subsection
      - Section/Appendix Subsubsection (when applicable)
        - Sequential numbering

Example: A question in Section 1, subsection 1, subsubsection 1 -The first RFI # would be 1.1.1-1, the next question in that section/subsection would be numbered 1.1.1-2

Please refer to the assigned RFI number when submitting a response.

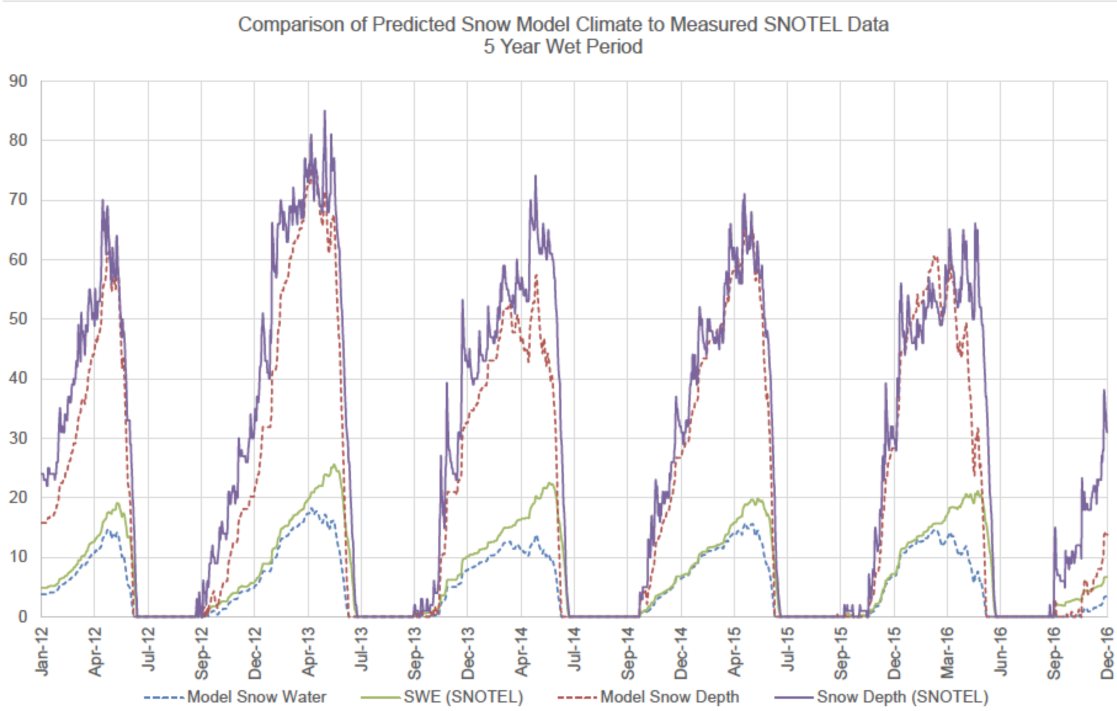
Appendix O: Unsaturated Zone Modeling

- **O-9**

Unsaturated Zone Scaling- Well documented procedures consistent with current practice are necessary to define input parameters that are representative of spatially averaged conditions, and the uncertainty in these spatial averages. No basis consistent with existing practice has been provided for the scaling approach used in the Clive DU PA v2.0, where central tendencies for hydraulic properties are represented by arithmetic or geometric means and uncertainty is described by the standard error from historical databases. The standard error of the mean has been proffered to account for uncertainty, but the appropriateness of the standard error has not been demonstrated as an accepted method in hydrologic practice. Please provide a quantitative assessment consistent with accepted hydrologic practice that demonstrates the validity of the scaling approach used in Clive DU PA v2.0.

- **O-10**

Snowmelt- The current version of the cover hydrology model uses the "HYDRUS snowmelt module." The efficacy of this model for predicting snow accumulation, snow melt, and infiltration has not been demonstrated for snow melt in the Clive locale. The parameters used in the model have not been presented or justified. For the DU PA v2.0, comparisons have been made to snowmelt over short windows of time and compared to the average record. However, the accepted practice is to develop a locale-specific calibration of the snowmelt function that provides predictions of snow accumulation and snowmelt consistent with observations. An example of such a comparison is provided in the figure below, which was developed for a similar assessment of an earthen cover at a different site.



Please develop a locale-specific calibration of the snowmelt function by comparing predicted and measured snowpack over a multi-year period. Use that snowmelt algorithm in the unsaturated zone model to predict percolation from the cover.

- **O-11**

Flow Mechanisms and Model Validation- The HYDRUS model used for the evaluation of final cover over the Federal Cell considers only hydraulically driven flow. However, thermally driven flows often are predominant relative to hydraulically driven flows in semi-arid and arid regions like Clive, Utah, particularly for depths greater than 0.3 m (Scanlon 1994; Scanlon and Milly 1994). For example, at the White Mesa site in Blanding, Utah, thermally driven mechanisms have been found to be the predominant mechanism responsible for percolation, yielding percolation rates on the order of 0.6 to 0.8 mm/yr. Evaluate the significance of thermally driven flows in the final cover over the Federal Cell, and compare the magnitude of thermally driven flows to the hydraulically driven flows predicted with the HYDRUS model.

  - Scanlon, B., 1994, Water and Heat Fluxes in Desert Soils, 1. Field Studies: *Water Resources Research*, 30(3), pp 709-719
  - Scanlon, B. and Milly, P., 1994, Water and Heat Fluxes in Desert Soils, 2. Numerical Simulations: *Water Resources Research*, 30(3), pp 721-733.

- **O-12**

  Hydraulic Properties Measurement and Reporting- The unsaturated zone analysis relies heavily on the hydraulic properties cited in Bingham (1991) for water retention and hydraulic conductivity. These engineering properties are used extensively in the unsaturated zone analysis, but only scant documentation has been provided regarding how these properties were measured and whether the measurement techniques used in the late 1980s or very early 1990s provided engineering properties consistent with the current standard of care for engineering design. Provide the report issued by the Colorado State University Porous Media Laboratory that is cited in the report by Bingham Environmental (1991), including documentation on the procedures that were followed by the laboratory. Describe how the methods that were used by the Colorado State University Porous Media Laboratory are consistent with accepted industry standards for measuring the unsaturated hydraulic properties of earthen materials for use in engineering design, such as ASTM D6836 (*Standard Test Methods for Determination of the Soil Water Characteristic Curve for Desorption Using Hanging Column, Pressure Extractor, Chilled Mirror Hygrometer, or Centrifuge1*) and ASTM D7664 (*Standard Test Methods for Measurement of Hydraulic Conductivity of Unsaturated Soils*). Describe the representativeness of these properties to field conditions associated with the Federal Cell, including scaling phenomena.

  - Bingham Environmental, 1991, Hydrogeologic Report, Envirocare Waste Disposal Facility South Clive, Utah: Prepared for Envirocare of Utah, Salt Lake City, UT, October 9, 1991.

- **O-13**

  Hydraulic Properties Parameterization- The unsaturated zone analysis relies heavily on hydraulic property functions that apparently were parameterized, in part, using water retention and hydraulic conductivity data reported in Bingham Environmental (1991). Documentation on how these parameters were determined has not been provided and in some cases the parameters that have been employed are inconsistent with the current standard of care in engineering practice for hydrologic design. For example, the residual water content, representing the lowest water content that can be realized, is assigned values commensurate with a water saturation on the order of 30%. Similarly, the pore interaction term is assigned a single value of 0.5 based on information nearly five decades old (i.e., Mualem 1976), whereas more recent information suggests that the pore interaction term should be assigned different values depending on soil texture (Schapp and Leij 2000, Benson and Bareither 2012).

  - Bingham Environmental, 1991, Hydrogeologic Report, Envirocare Waste Disposal Facility South Clive, Utah: Prepared for Envirocare of Utah, Salt Lake City, UT, October 9, 1991.
  - Benson, C. and Bareither, C., 2012, Designing Water Balance Covers for Sustainable Waste Containment: Transitioning State-of-the-Art to State-of-the-

Practice: in K. Rollins and D. Zekkos, eds, *State of the Art and Practice in Geotechnical Engineering, Keynote Lectures from GeoCongress 2012, GSP No. 226*, ASCE, Reston VA, 1-32.

- Mualem, Y., 1976, A new model predicting the hydraulic conductivity of unsaturated porous media. *Water Resources Research,* 12, pp 513–522.
- Schaap, M., and Leij, F., 2000, Improved Prediction of Unsaturated Hydraulic Conductivity with the Mualem-Van Genuchten Model: *Soil Science Society of America Journal*, 64(3), pp 843-851.

- **O-14**

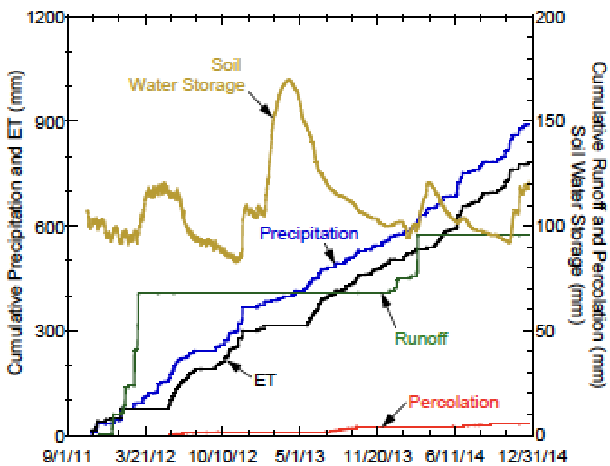
Hydraulic Properties of Frost Protection Layer- The unsaturated zone analysis of the final cover relies heavily on the capillary break assumed to form between the evaporative zone layer and the frost protection layer. No information is provided to indicate how the hydraulic properties of this layer were determined, and whether they are consistent with the materials available for construction. Provide documentation on how the hydraulic properties of the frost protection layer, which also serves as a capillary barrier, were measured, how variability in the hydraulic properties of the frost protection material was characterized, and how the hydraulic property functions were parameterized.

- **O-15**

Soil Cover Fraction- The earthen cover for the Federal Cell relies on evapotranspiration (ET) to remove water that infiltrates and is stored within the cover profile. The dynamics and timing of infiltration, water re-distribution, and ET influence deep penetration of water and percolation from the base of the cover. Appendix O indicates that a unique soil cover fraction (SCF) was assigned to partition evapotranspiration (ET) into evapotranspiration (E) and transpiration (T) for each of the 1000 realizations. Describe how the SCF was varied temporally during the growing season and over longer periods of time in response to variations in meteorological conditions. If the SCF was time invariant, provide justification for using a single SCF to describe the time varying process and describe how this affects predictions of percolation and water content within the cover profile. Additionally, provide documentation that the SCF methodology is applicable and has been validated for partitioning ET in vegetative communities in arid regions. This information will provide the information needed to evaluate assumptions made when formulating and parameterizing the model, and the impact of the assumptions on the predictions.

- **O-16**

Water Balance Graphs and Water Content Records- The reliability of predictions from a variably saturated flow model used to predict the hydrology of an earthen cover depends on whether the model accurately captures soil water dynamics and redistribution within the cover in response to a broad range of hydrological conditions. Provide water balance graphs, corresponding to ten 3-year periods during the 1000-yr simulation that correspond to ten different hydrologic conditions over 3-year periods that (i) are much wetter than normal, (ii) are much drier than normal, (iii) contain one or more extreme events with high liquid precipitation, (iv) contain one or more extreme events with high frozen precipitation, and (v) are representative of typical conditions. These graphs will be used to evaluate the reliability of the predictions. A water balance graph is a line graph showing cumulative water balance quantities (precipitation, runoff, lateral flow, evapotranspiration, and percolation) along with soil water storage as a function of time. An example of such a water balance graph from Benson (2017) is provided below. In these graphs, include two different lines for soil water storage: soil water storage in the materials above the radon barrier and soil water storage in the radon barrier. Provide a water content graph to complement each water balance graph that is a line graph showing the water content at mid-depth in each layer as a function of time.



- Benson, C., 2017, Using Principles of Unsaturated Soil Behavior to Design Water Balance Covers for Waste Containment: Case Study: in Hoyos, J. McCartney, S. Houston, and W. Likos, eds, *Proc. PanAm Unsaturated Soils 2017, Plenary Papers, GSP No. 300*, L.., ASCE, Reston VA, pp 306-324.

- **O-17**

Efficacy of Capillary Break- The efficacy of the earthen cover is highly dependent on the hydrologic control provided by the capillary break between the evaporative zone and the frost protection layer. Evaluating the sensitivity of the predictions to the assumed conditions is critical to understanding the reliability of the predictions. Provide sensitivity analyses describing how predictions from the variably saturated flow model for the earthen cover varies depending on the sharpness of the capillary break between the evaporative zone and the frost protection layer. For these analyses, systematically vary the unsaturated properties of the frost protection layer over the range anticipated based on the geotechnical and hydraulic properties characterization of the frost protection material. Conduct the analyses over the 1000-yr record and provide the outcomes in terms of water balance graphs and water content graphs like those in RFI question 8.

- **O-18**

  Impacts of Bioturbation from Burrowing Mammals- SWCA (2012) indicates that the Federal Cell is within a habitat associated with badgers, burrowing owls, and ants. SWCA (2012) indicates that a biointrusion barrier will be needed for earthen covers at the Clive site to address badgers and owls. Williams et al. (2022) illustrate how ant colonization can alter the hydraulic properties of protection layers and radon barriers. Describe how biointrusion, bioturbation and other disturbance of the cover associated with burrowing mammals, birds, and insects will affect the hydraulic properties of the cover soils, the efficacy of the capillary break, and percolation. Document the scientific basis underpinning the impacts from biointrusion and bioturbation that are described.

SWCA, 2012, Vegetated Cover System for the Energy Solutions Clive Site: Literature Review, Evaluation of Existing Data, and Field Studies Summary Report; Prepared for EnergySolutions by SWCA Environmental Consultants, Salt Lake City UT, August 2012.

Williams, M., Fuhrmann, M., Stefani, N., Michaud, A., Likos, W., Benson, C., and Waugh, W., 2022, Evaluation of In-Service Radon Barriers over Uranium Mill Tailings Disposal Facilities: NUREG/CR-7288, Office of Research, US Nuclear Reg. Comm., Washington, DC.