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Ms. Hedges:

THE U.S. DEPARTMENT OF ENERGY, OFFICE OF RIVER PROTECTIONS RESPONSE TO THE WASHINGTON STATE DEPARTMENT OF ECOLOGY LETTER 14-NWP-240

Reference: Ecology letter from C. Whalen to J.A. Dowell, ORP, "United Stated Department of Energy's (USDOE) 'WMA C PA Model Development – A Briefing to Washington State Department of Ecology for WMA C Performance Assessment,' CHPRC-02348-VA, Revision 0, Presented on October 29, 2014," 14-NWP-240, dated December 8, 2014.

The Washington State Department of Ecology's (Ecology) letter (Reference) relates a concern of vadose zone modeling for the Waste Management Area – C (WMA-C). The U.S. Department of Energy, Office of River Protection (ORP) staff have worked with Ecology on the development of the WMA-C performance assessment (PA), maintaining an effective working relationship and collaboratively creating a final PA tool that is used for closure decisions.

Based on the feedback from the stakeholders and Ecology, in the WMA-C PA working sessions, ORP has modified the heterogeneity assumptions in the vadose zone model proposed for the WMA-C PA. This change is a departure from the assumptions used in the Tank Closure and Waste Management Environmental Impact Statement. ORP is analyzing and performing sensitivity cases to include heterogeneous features. This letter and its attachment delineate the efforts to incorporate small-scale heterogeneities in a systematic way into a detailed and fully parameterized three-dimensional numerical model for use in the PA effort. The approach that ORP has taken to examine heterogeneity is to include a number of modeling sensitivity cases. ORP is continuing to evaluate approaches using the moisture content information to develop other alternative conceptual model(s) and will keep Ecology abreast of those developments.

If Ecology can provide ORP with another modeling approach or alternative conceptual model that incorporates these small-scale heterogeneities along with the appropriate parameterization of the heterogeneities, ORP would be open to discussing potential inclusion as a sensitivity case for WMA-C PA.

If you have any questions, please contact Ryan E. Beach at (509) 376-9291.

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ATTACHMENT

15-TF-0039

ACTIONS TAKEN TO ADDRESS SOIL HETEROGENEITY

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The performance assessment (PA) effort is currently supporting the development of a geostatistically facies-based heterogeneous representation of the hydrogeologic framework at Waste Management Area – C (WMA-C). The approach being used in heterogeneous models at WMA-C is similar to what was done on a similar effort at BC Cribs by Pacific Northwest National Laboratory (PNNL). A few of these geostatistical realizations of heterogeneity at WMA-C will be developed into numerical models based on Subsurface Transport Over Multiple Phases (STOMP) for use in the PA effort. Under separate funding, the Advanced Scientific Capability for Environmental Management (ASCEM) program is conducting a demonstration project that will use the geostatistically-based models to evaluate the effects of heterogeneities with modeling codes developed by the ASCEM project.

The PA team has been using cross-sectional models of WMA-C in which idealized low-permeability lenses of varying lateral continuity have been introduced into the model domain to examine the effect of heterogeneities on groundwater impacts from a release of contaminants an idealized unit source. Simulations examined a range of cases including a base case without heterogeneities and several other cases with idealized discrete fine-grained low-permeability lenses added over a range of frequencies (2 percent, 5 percent, and 10 percent) and a range of lateral continuity.

One set of heterogeneous cases assumed the finer-grained lenses were impermeable and did not interact with the main hydrogeologic units in the domain. Another set of heterogeneous cases assumed that the finer-grained lenses were assigned finite hydraulic properties that would allow them to interact with the main hydrogologic units in the model domain. Each set of cases were evaluated using both relatively low recharge conditions (i.e., infiltration of 0.5 mm/yr) representing post-closure conditions and relatively high recharge conditions (i.e., infiltration = 63 mm/yr) representing wetter conditions the period of operation to gain some insight of the effect of heterogeneities under different recharge conditions.

Results that showed the greatest consistency with observations seen in moisture logs in selected boreholes at WMA-C were the cases where we assumed the finer-grained lenses were assigned finite hydraulic properties that would allow the fine-grained lenses to interact with the main hydrogologic units in the model domain. The key observations of simulated breakthrough curves in groundwater for these model runs were as follows:

- Concentrations in groundwater arrived earlier and at higher concentration levels at higher recharge conditions.
- Breakthrough curves of contaminant concentrations in groundwater arrived first from releases in the base case and later for all the other cases that considered any type of heterogeneities.
- Concentrations in groundwater among the different cases for each recharge condition were in close agreement with each other.

Additional simulation work is planned using this technical approach to support the scoping analysis of past leaks. The PA effort is providing support to PNNL for the specific development and implementation of a technical approach that uses available and relevant characterization data, with specific emphasis on field-measured water contents, to more accurately characterize

the effects of heterogeneities on subsurface flow and transport behavior in detailed hydrogeologic conceptual models. This effort will make use of data and information collected at WMA-C to demonstrate the technical approach and associated methodologies that would be applicable to other PA efforts ongoing at Washington River Protection Solutions LLC (WRPS). Our hope is that alternative model(s) developed in this effort can be used in the scoping analysis of past leaks at WMA-C.

The U.S. Department of Energy, Office of River Protection's (ORP) responses to the specific concerns expressed in the Washington State Department of Ecology (Ecology) letter 14-NWP-240, dated December 14, 2014, that the WMA-C PA does not incorporate both geologic and hydrogeologic heterogeneities, are provided below.

- Item 1
  In the referenced letter, Ecology implies that ORP appears to be deviating from an agreed on approach made during scoping sessions to evaluate geologic and hydrogeological heterogeneities as a part of the PA effort. Ecology cites the discussion of model development presented in October 29, 2014, as the basis for the argument and fails to mention the range of other meetings and recent discussions related to modeling of heterogeneities at WMA-C that have been ongoing. The concept of geologic heterogeneities and the associated uncertainties associated with them have been topics of discussion with Ecology and other stakeholders going back to the natural system scoping session held in May 2010. At that time, two agreements were reached that ORP has remained committed to. The agreements were as follow:

  - The WMA-C PA team has collaborated with the Nez Perce which developed an alternative conceptual model to incorporate the effect of dipping stratigraphic beds on potential lateral water flow and transport within the vadose zone.
  - The PA effort would include the development of a sensitivity case that would evaluate a highly heterogeneous representation of the hydrogeologic system. A geostatistical approach similar to what had been done at BC Cribs by PNNL was suggested by the Oregon's Department of Energy as an approach that could be used to develop this conceptual model at WMA-C.

- Item 2
  In 2014, as a follow-up on the first agreement, WRPS staff worked closely with the Nez Perce to solicit their input in development of alternative geologic conceptual models and this effort lead to the development of two alternative conceptual models that include the following major stratigraphic units described in detail in RPP-RPT-56356 (2014).

  - One conceptual model representing the major hydrostratigraphic units (backfill, Hanford H1 gravelly-sand dominated unit, Hanford H2 sand-dominated unit, and an undifferentiated Hanford H3/Cold Creek/Ringold gravelly-sand dominated unit).
  - A second conceptual model representing the same units with some refinement of the Hanford H2 sand unit to include two additional subunits: a gravelly-sand dominated subunit, and a fine silt sand subunit, as suggested by the Nez Perce. The Nez Perce provided the stratigraphic tops of these subunits.

Also in fiscal year 2014, as a follow-up on the second agreement, WRPS enlisted the services of PNNL to develop a detailed facies-based geologic conceptual model of the WMA-C similar to the PNNL work at BC Cribs. Currently, existing conceptual models of the geologic framework being used for the WMA-C PA are represented by the large-scale hydrogeologic units identified at the site. The intent of this effort is to develop an alternative conceptual model that considers the detailed heterogeneity of sediments within the major hydrogeologic units found beneath the WMA-C. This development work will be based on a geostatistical analysis of available geophysical and borehole log data and information at WMA-C. This analysis relies on cluster analysis of Potassium-Uranium-Thorium (KUT) spectral data as a basis for definition of the major facies. The initial set of multiple realizations of the subsurface conditions developed from this effort is providing the basis for a demonstration of quantitative modeling analysis being performed at PNNL under separate funding using the ASCEM toolset. The intent of this effort is to also provide the PA effort with some geostatistical realizations using field data collected during the request for information process that could be used as sensitivity cases for evaluation of tank residual and past tank leak impacts. This analysis shows that while there are variations in facies within WMA-C, these variations are not to the extent as shown in other areas of the site, such as BC Cribs.

- Item 3
  While this work was being developed, WRPS and subcontractor staff were also engaged in a dialogue with staff of the State of Oregon and Ecology during the summer of fiscal year 2014 and shared borehole information, primarily neutron log information, with staff from the State of Oregon and the Nez Perce Tribe. After some initial evaluation of this data and information, we've had follow-on discussions with staff from the State of Oregon, Ecology, and the Nez Perce Tribe about the potential development of another alternative heterogeneous conceptual model that considers the representation of thin silty sand layers with high moisture content that are inferred from neutron logging data and information that could have some effect on lateral flow and transport at WMA-C.

- Item 4
  An initial meeting was held on September 3, 2014, where some general observations and interpretations by the State of Oregon were shared. Discussion was initially focused on gaining a good understanding of observations and interpretations offered by the State of Oregon. Much of the information that was provided was in the form of spread sheets and hand interpretations of the neutron moisture log data and information showing inferred correlations of thin zones with higher-moisture contents between boreholes. While ORP acknowledges that a considerable amount of effort was undertaken by the State of Oregon in coming up with their interpretation, it represented just an initial step of what would be required in the development of a detailed conceptual model and numerical model that could be used in the PA effort. Much of discussion that followed involved identifying specific approaches and the level of effort that would be required to take the information provided by the State of Oregon to develop a detailed three dimensional conceptual model for WMA-C and parameterize for use in the PA.

- Item 5
  A second meeting was held on November 6, 2014, on this subject where three topics were presented:

- A status of development of the geostatistically-based heterogeneous model by PNNL based on KUT data from selected direct push boreholes. The feedback from the State of Oregon, Ecology, and the Nez Perce on this effort was that the model being developed by PNNL would not capture the fine-scale heterogeneity and thin high moisture zones that they would like to see evaluated in the PA effort.
- Another set of observations and interpretations of the soil moisture data was presented by the Nez Perce Tribe. Much of the information that was provided by the Nez Perce was in the form of hand-interpreted correlations of moisture zones drawn onto geologic cross-sections developed by the Nez Perce and in use by the PA effort. ORP also acknowledges that a considerable amount of effort was undertaken by the Nez Perce in coming up with their sets of interpretations. However, like the interpretation provided by the State of Oregon, it represented just an initial step of what would be required in the systematic development of detail conceptual model and numerical model that could be used in the PA effort. ORP has concluded that a considerable amount of additional effort would be required to develop a workable, detailed three dimensional conceptual model that could be parameterized for use in the PA.
- A generalized approach for evaluating the effects of idealized system heterogeneities using proposed by the INTERA staff. Several schemes were proposed that including the introduction of randomly generated low-permeability zones of various frequency and configuration.

- Item 6
  In the coming months, WRPS and its subcontractor will be performing a scoping analysis of past leaks where we will make use of the numerical models of WMA-C, based on the STOMP code, to examine the uncertainties on key model parameters that could influence the observed groundwater impacts of past tank leaks in the vicinity of WMA-C. The key factors that will need to be evaluated include uncertainties in the estimated timing of leaks, leak volumes, and estimated inventories; effective recharge during the period of operations; uncertainties in hydraulic properties of vadose zone sediments; and the possible role of preferential pathways in the downward migration of past leaks and losses to groundwater. As a part of this effort, the analysis will attempt to evaluate the potential impacts of system heterogeneities on flow and transport in the vadose zone and groundwater using the generalized approach proposed by INTERA.