October 12, 2004

MEMORANDUM TO: H. Lawrence McKague, Element Manager
Geology and Geophysics
Center for Nuclear Waste Regulatory Analyses
6220 Culebra Road
San Antonio, TX 78228-5166

FROM: Philip S. Justus, Program Element Manager **/RA/**
Division of High-Level Waste Repository Safety
Office of Nuclear Material Safety
and Safeguards

SUBJECT: ACCEPTANCE OF DELIVERABLE "FACIES ARCHITECTURE, HYDROSTRATIGRAPHY, AND AQUIFER CHARACTERIZATION OF QUATERNARY ALLUVIUM ADJACENT TO YUCCA MOUNTAIN, NEVADA" (INTERMEDIATE MILESTONE 06002.01.061.460)

This memo documents the basis for acceptance of the deliverable, "Facies Architecture, Hydrostratigraphy, and Aquifer Characterization of Quaternary Alluvium Adjacent to Yucca Mountain, Nevada," by T.R. Ressler, J.M. Sharp, Jr., K.D. Ridgway, J.A. Stamatakos, and J. Winterle. The deliverable is in the form of a journal article. The manuscript describes the alluvial sediments in Fortymile Wash, adjacent to the proposed Yucca Mountain repository. The importance of the study results lies in the realization that the Fortymile Wash sediments are natural analogs of the saturated zone alluvial aquifer being drilled in the subsurface of Fortymile Wash downstream from Yucca Mountain, in or near the projected saturated zone flowpath identified and modeled by both DOE and NRC.

The results suggest that the facies architecture, in particular, the horizontal layering of aquifers and aquitards and 'longitudinal' old stream channels, can influence hydraulic parameters and impart preferential flowpaths. Therefore, these possible influences warrant consideration when developing models of, and interpreting groundwater flow in, the saturated zone in alluvium.

This deliverable is accepted as the final report for the intermediate milestone 06002.01.061.460. We recommend pursuit of publication in a peer-reviewed journal. The authors should consider the suggestions in the attachment for improving clarity, consistency and precise use of terminology. Such improvements would enhance the published results. However, this report is useful to the staff, DOE, and other interested parties, as written. It is timely, in that Nye County and DOE continue to drill and sample alluvium in the Fortymile Wash environment and information or inferences from these drill holes will be used in the License Application that DOE indicated it will submit a few months from now. This report is acceptable for placement in the Public Document Room.

Attachment: General Comments

cc: D. Brooks (HLWRS)
A. Fetter (HLWRS)
J. Bradbury (HLWRS)
C. Grossman (HLWRS)
J. Stamatakos (CNWRA)

GENERAL COMMENTS

(1) Overall, the reviewers consider the report to be a “good job” and provides a useful basis for staff and Center reviews of the Nye County drilling results and the DOE saturated zone model and interpretations.

(2) We encourage the Center to pursue publication of the revised manuscript in a peer-reviewed journal. The staff believes that addressing the specific comments, below, would enhance the clarity, consistency and precision of the publication.

SPECIFIC COMMENTS (page numbers refer to the deliverable manuscript)

(1) INTRODUCTION, p.2, para. 1. The Introduction mentions groundwater transitioning from volcanics to alluvium about 15 km downstream from Yucca Mountain. It is unclear (from Figure 1) where the point of release from the repository footprint is located. Also, there is no reference to the evidence that the volcanic-alluvium boundary is 15 km from the ‘starting point.’ Consider clarifying by citing reference and identifying location on the map.

(2) PHYSIOGRAPHY...PREVIOUS WORK, p. 6, line 1. The term “effective porosity” is introduced. This is an important attribute for understanding groundwater flow velocity. Later the term “porosity” is used exclusively. It is important to define these different terms and used them within the context of their definitions. Ensure that the terms are used consistently and precisely.

(3) Hydraulic Properties...et seq., pp. 18-29. Hydraulic conductivity (K~cm/s) and permeability (k~cm^2) have two different units, however they are used somewhat interchangeably within the text, e.g., p. 28...”permeability varies over at least three orders of magnitude (10-3 to 10-6 cm/sec)” Ensure that the units are used precisely. [This may just be a typo.]

(4) The methods used to determine porosity are explained in detail while the hydraulic conductivity procedure is not. Consider the need to elucidate the method(s) used to determine hydraulic conductivity.

(5) Grain-Size Analysis, p. 21. All data used in your calculations appear to be enumerated in the manuscript except for grain-sizes. Consider including grain-size data in the paper, or make them available by reference.

(6) Summary of Hydraulic Properties, p. 25. Consider citing the reference to Kruger and Slichter, for consistency.

(7) Implications for Groundwater Flow, p. 25. We compared two statements of the outcome of this study, and prefer the one in the abstract: (Abstract, p. 1) “These data provide a framework to understand the spatial heterogeneity and distribution of aquifer properties” and (Implications, p. 25) “Our...data, provide a first approximation of the spatial heterogeneity and distribution of aquifer properties...” We are more comfortable with the claim of providing a framework to understand (sounds qualitative), than we are claiming to provide a first approximation (sounds quantitative). Consider aligning the statements, for consistency.

Attachment

(8) Implications for Groundwater Flow, p. 26. Clarify or expand a bit on the relationship of pedogenic calcrete layers and the paleosol facies (F6, F7), the potential for petrocalcic horizons to be found in the saturated zone, and their implications for groundwater flow.

(9) Implications for Groundwater Flow, p. 26. Given the importance attached to the open framework conglomerate in the highest- permeability facies in the alluvial aquifer (F1), consider adding for clarity an illustration (photo or sketch) and a more quantitative description than is found in the description of F1, p. 7, or the Implications section, p. 26.

(10) Implications and Conclusions. The two main conceptual models that you suggest for the buried alluvium, based on the exposed Fortymile Wash alluvium are: (1) conglomerate-dominated channel facies with relatively low porosities and higher permeabilities than the interlayered sandstone-dominated paleosol facies may result in vertical compartmentalization of groundwater flow; and (2) the continuity of open-framework conglomerates within channel facies, their orientation longitudinal to Fortymile Wash, and the transmissiveness of the channel facies, would produce a bulk horizontal anisotropy in hydraulic properties of the alluvial aquifer. Clarify whether you consider these concepts to be opposing or mutually exclusive models, or compatible, potentially co-existing models, or have some other relationship.

(11) Figure 1B. (1) This figure shows the location of the 'Potential Repository,' but it is not identified as a trace and projection onto the surface. Suggest adding a brief explanation in the caption; (2) this is the figure that could clearly show the location of the starting "point" of the groundwater flow path that would address specific comment (1).

(12) Figure 4. It is difficult to distinguish Facies 3 from Facies 7. Consider changing the color symbol of one of them.

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ML042860218 * See previous concurrence

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