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MEMORANDUM FOR: Joseph Holonich, Acting Director
Repository Licensing and Quality Assurance
Project Directorate
Division of High-Level Waste Management

FROM: Margaret Federline, Branch Chief
Hydrology and Systems Performance Branch
Division of High-Level Waste Management

SUBJECT: PHASE I REVIEW OF STUDY PLAN 8.3.1.2.2.6, FOR CHARACTERIZATION OF THE YUCCA MOUNTAIN UNSATURATED-ZONE PERCOLATION: SURFACE-BASED STUDIES [PPSAS 411421/L60200]

As requested, we have completed the Phase I review of the Study Plan 8.3.1.2.2.6, for Characterization of the Yucca Mountain Unsaturated-Zone Percolation: Surface-Based Studies (see enclosure). This review was conducted using the Review Plan for NRC Staff Review of DOE Study Plans Revision 1 (December 6, 1990).

This study plan describes an investigative program to characterize fluid flow in the unsaturated zone from the surface to the water table. The focus of this plan is physical property measurement and characterization of liquid and vapor movement in the unsaturated zone. The study describes an extensive sampling and laboratory testing program to measure the hydrologic properties of core samples taken from surface boreholes and the exploratory studies facility. The plan also describes a hydrologic study at one specific location along the Solitario Canyon fault. Another study will attempt to measure in situ hydrologic conditions from the land surface to the water table both inside and outside the Conceptual Drift Boundary, while the Vertical Seismic Profiling activity will provide subsurface geophysical data to reach interpretations of the structure and stratigraphy across the central section of Yucca Mountain.

Work outlined in this study plan is entirely dependent upon gaining direct physical access to the geologic units beneath Yucca Mountain. The activities in this study plan require the drilling of one 300 meter horizontal borehole and 19 vertical boreholes from the surface to the water table. Of the 19 vertical boreholes, 8 will be located within the Conceptual Drift Boundary. Presently only invasive methods can measure in situ pneumatic, thermal, and moisture potentials. Therefore, drilling boreholes are required to accomplish the objectives of this study.

The borehole siting strategy described in the study plan was guided by consideration of multiple, working hypotheses of water flow in unsaturated-

Finally, the NRC staff is concerned because, although the study plan describes general relationships between this and other studies, there is no explicit discussion of an overall program of iterative performance assessment, or discussion of the timing of this study relative to such a program. This kind of systematic, iterative approach to identifying the information and analyses needed to support a license application has previously been recommended in other NRC documents (e.g., Comment 1 in NRC's Site Characterization Analysis of DOE's SCP).

The review was conducted by William Ford of the Hydrologic Transport Section, who can be reached on ext. 20506.

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Enclosures:
As stated

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fractured rock at Yucca Mountain and recognition of the need to support performance assessment evaluations. Vertical borehole drill sites were chosen to satisfy requirements to: (1) investigate specific geohydrologic features; (2) cover Yucca Mountain areally; (3) minimize disturbance to the main body of the proposed repository within the Conceptual Perimeter Drift Boundary; (4) locate in areas suitable for construction of relatively large drilling pads with a minimum of disturbance to the natural terrain; and (5) locate in areas sufficiently distant from boreholes previously drilled with water or foam-based drilling fluid.

Borehole construction would be the most likely cause of negative impacts on repository performance. Boreholes might allow more water to flow from the surface to the repository or become faster paths for radionuclide transport from the repository to the water table. The main method of mitigating this impact is to seal the boreholes. At the time of repository closure it is planned that each unsaturated-zone borehole located within the Conceptual Perimeter Drift Boundary, and possibly every borehole in the site will be plugged and sealed. Present plans for the Yucca Mountain sealing program call for: (1) preliminary testing and laboratory work during site characterization; (2) development of a preliminary sealing concept for the repository license application; (3) confirmation testing during repository construction and operation; and (4) development of a final sealing concept for the license amendment to close the repository. The study plan states that current sealing plans comply with regulatory requirements, but explicit sealing requirements are not currently available to guide borehole construction and completion during site characterization.

It does not appear to the staff that the conduct of the activities described in this study plan will have significant adverse impacts on repository performance. This decision was influenced by the following considerations: (1) the information from this study plan is important to site characterization; (2) there does not appear to be a noninvasive method of collecting the data; (3) DOE has committed to sealing each unsaturated-zone borehole within the Conceptual Perimeter Drift Boundary; and (4) the study plan has outlined a process to develop acceptable borehole sealing requirements and approaches. In regards to the fourth point, the NRC staff expects that proper sealing of boreholes will eventually be performed consistent with 10 CFR 60.134, which states "Seals for shafts and boreholes shall be designed so that following permanent closure they do not become pathways that compromise the geologic repository's ability to meet the performance objectives for the period of permanent closure." It should also be noted that in the future, additional boreholes may be proposed by the DOE as data from boreholes and the exploratory studies facility are developed and compared. However, conclusions concerning this study plan, should not be construed to mean that the NRC has reached these same conclusions with respect to additional or other boreholes not identified in this study plan (i.e., Revision 0).

The magnitude of test interference effects described in the study plan are deemed acceptable to the NRC staff. The study plan describes the expected magnitude of interference effects and precautions taken to lessen them. Test interferences will occur because many kinds of testing activities are planned for each individual borehole and drilling disturbs the in situ hydrologic conditions of core samples. Many of the interference effects are unavoidable, but some of the effects may be eliminated by drilling more boreholes and conducting fewer kinds of tests in each hole. However, it is probably not justified to take these approaches, because: (1) the predicted magnitude of interference effects attributable to study plan activities looks acceptable; (2) the study plan methods to mitigate and evaluate interference effects appear well thought out; (3) there is a value to collecting many different kinds of data from the same location; and (4) there may be potential adverse impacts on repository performance from more boreholes.

In reviewing this study plan the NRC concludes that some test interferences will occur and that there may be some impacts on repository performance. However, the NRC staff did not identify an "objection" level concern. The staff did not identify any concerns with activities, tests, and analyses which, if started, could cause significant and irreparable adverse effects on the site, the site characterization program, or the eventual usability of the data for licensing (programmatic fatal flaws).

This study plan is a candidate for a detailed technical review based on criteria 1, 2, 3, 4, and 5 from step 6 of part 4.2 of the Review Plan. This review has shown that the study plan is: (1) related to one or more key site related issues; (2) pertains to some NRC open items; (3) references many prototype tests; (4) is important to the evaluation of site performance, and (5) does not relate this study plan to an overall program of iterative performance assessment.

It is important to note that this study plan references many prototype tests. Testing procedures have been chosen that investigators expect will work as planned. However, the investigators recognize that there is a degree of risk associated with many of the tests which have not been previously tried. Therefore, tests to evaluate the feasibility of proposed testing methods are planned. Critical prototype testing identified in this study plan will be completed successfully before site-characterization testing is started. Characterization of the site will not be conducted by methods described in this study plan if prototype testing demonstrates that the methods and/or equipment cannot be applied successfully to Yucca Mountain.

Having identified the need for a detailed technical review, we note that much prototype testing still needs to be conducted, that the study plan will not use the methods described if the prototype tests are not successful, and of 119 technical procedures 69 or 58% remain to be developed. Therefore it is recommended that a detailed technical review not be performed at this time.