WILLIAMS & ASSOCIATES, INC.

P.O. Box 48, Viola, Idaho 83872 (208) 883-0153 (208) 875-0147

Hydrogeology • Mineral Resources Waste Management • Geological Engineering • Mine Hydrology

May 6, 1988
Contract No. NRC-02-85-008
Fin No. D-1020
Communication No. 181

Mr. Jeff Pohle
Division of Waste Management
Mail Stop 4-H-3
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Jeff:

We have been evaluating the basic assumptions inherent in the description of the groundwater flow system presented in the Consultation Draft SCP (CDSCP). Some of the assumptions that we have considered are not stated explicitly in the CDSCP; nevertheless, we believe the assumptions noted below are inherent in the description of the groundwater flow system and in the testing plans presented in the CDSCP. Please view this letter as a first draft that outlines some major assumptions that we believe are inherent in the CDSCP. We foresee expanding this analysis to incorporate additional assumptions as we continue to develop our thoughts on the description of groundwater flow presented in the CDSCP. We have broken down our discussion of the assumptions into two general categories. The first category lists assumptions that are relevant to the mechanics of flow and the hydraulic properties which govern that flow. The second category lists those assumptions that are implicit in the discussion in the CDSCP that describes proposed testing to characterize the hydrogeology of the site.

Category 1: Assumptions About Mechanics of Flow and Related Hydraulic Properties

One of the primary assumptions inherent in the entire discussion of flow at the Yucca Mountain site is that Darcian flow is applicable ubiquitously. We have little doubt that Darcian flow is applicable at the regional scale. Questions may arise about the applicability of Darcian flow on smaller scales such as the scale of tens of feet in the vicinity of a pumping well during a pumping test. It is possible that non-Darcian flow may dominate in such a small-scale regime under stress conditions imposed by pumping. The validity of Darcian flow should be verified for tests conducted at this scale at the site.

The CDSCP assumes that no recharge occurs to the groundwater system through Yucca Mountain. The CDSCP assumes further that recharge is so low that lateral flow predominates in the saturated zone just below the water table beneath the site. These two assumptions are important to the consideration of transport of radionuclides from the site to the accessible environment. The implication that there is no recharge to the groundwater system implies that lateral flow will dominate within the upper few tens to hundreds of meters of the saturated zone. This assumption may not be valid if recharge is greater. Recharge will create a downward component of flow in recharge areas from the water table to deeper, possibly more transmissive hydrostratigraphic units. It is possible that a downward component of flow could intercept a highly transmissive unit which would provide a means of rapidly transporting potential radionuclides away from the site.

The question of whether or not a significant amount of recharge to the saturated zone occurs should be investigated further. Several different approaches could be used to answer this question regarding the amount of recharge. Continuous water level measurements should be made on a routine basis with wells open just below the water table, along with isolated, discrete intervals below the water table. The vertical distribution of head in the saturated zone will determine whether or not a significant downward component of flow occurs in the saturated zone in the area. Variable fluid density effects may be significant; this consideration is discussed below. Monitoring of the unsaturated zone above the water table also may indicate whether or not there is a significant amount of recharge to the groundwater system. However, the vertical gradient in the saturated zone is more definitive and easier to measure.

It is assumed in the CDSCP that flux through the unsaturated zone is essentially steady state at the depths below land surface encountered at Yucca Mountain. This assumption requires the predominance of matrix properties over fracture properties for the movement of water toward the water table. Periodic measurements of the elevation of the water table near the interface with the unsaturated zone should indicate whether or not pulses of recharge occur to the saturated zone. Such monitoring may provide more reliable and immediate evidence of recharge pulses than the evidence that can be detected using unsaturated zone monitoring techniques at the depths encountered in the vicinity of Yucca Mountain.

The CDSCP assumes that any potential upward flux from the regional ground water flow system to the shallow groundwater system is minor in the vicinity of Yucca Mountain. At this time detailed measurements of water levels at discrete depths over a significant areal extent have not been made. Such data are needed to verify whether or not this assumption is valid. Quantification of the hydrogeologic properties of the saturated tuffs will enable investigators to determine whether upward flux is significant. Two components, which are required for this estimation, are the distribution of head along a vertical line and the distribution of vertical hydraulic conductivity along that vertical line. Variable fluid density effects also

may prove to be significant in this estimation. Variable fluid density effects are discussed subsequently herein.

The CDSCP assumes that composite heads can provide a reasonable portrayal of the configuration of the water table. This assumption may be valid but it is important that composite water levels not be used to evaluate it. In addition, wells that are open to multiple zones should be redesigned so that only isolated intervals are open within the wells or piezometers. Such isolation will prevent the alteration of the natural hydraulic gradients in a lateral and vertical sense in the vicinity of those wells. Wells should be completed at specific isolated intervals along a vertical line in order to determine the vertical distribution of potential. These wells can be used in conjunction with additional data to portray the water table configuration in the vicinity of the site. Only then can the direction of groundwater flow be determined with any degree of certainty. Variable fluid density effects may have to be considered in evaluating data from such wells.

The CDSCP assumes continuity of flow paths along predicted flow directions that are based on what is believed to be the configuration of the water table. It is not clear that boundary conditions have been incorporated into the prediction of such flow paths. It may become evident that boundary conditions are more important to the distribution of groundwater flow than is believed to exist currently. The paucity of data points (wells) allows considerable latitude in the process of contouring water levels. It is probable that boundary conditions may alter the configuration of the water table significantly. The alteration of the configuration would then change the directions of groundwater flow in the vicinity of the site. The detection of hydrogeologic barriers is important to developing an accurate water table configuration map. In addition, additional data points are required to describe the water table configuration accurately. As discussed above, additional data are required to describe the distribution of potential along a vertical line. The potential existence of upwelling or downwelling is essential to identifying the fastest flow path.

The CDSCP assumes the variable fluid density effects will not have a significant effect on groundwater levels measured in monitoring wells. This assumption should be investigated further to insure that the effects indeed are insignificant. The variable fluid density effects could be created either by differences in total dissolved solids or temperature or both. Fluid densities are important for defining the distribution of potential along a vertical line. It is important that the water levels that have been measured at specific depth intervals be representative of those depth intervals. They should not be a composite of water levels in several zones. Also, variable fluid density effects may be significant with respect to interpreting groundwater potentials along a horizontal plane.

The CDSCP assumes that the current definition and sequence of "hydrogeologic units" is adequate for portraying groundwater flow in the region and in the vicinity of Yucca Mountain. This assumption was mandatory for the analyses

contained in the CDSCP. We are confident that DOE is aware that further testing may necessitate additional subdivisions of the current hydrogeologic units. An obvious implication of this assumption is that a high hydraulic conductivity unit may exist at the site that has not been defined at this time. Such a high hydraulic conductivity unit could act as a primary flow path to the accessible environment. Such a unit would exhibit shorter travel times than may be encompassed by the current methods of prediction. Resolution of this assumption requires that further testing be conducted at the site. The spatial correlation of values for hydraulic conductivity and related properties must be determined. This requires that adequate testing be conducted along the most probable pathway to the accessible environment.

Category 2: Assumptions Pertinent to Proposed Hydrogeologic Testing to Characterize Site Hydrogeology

The CDSCP assumes implicitly that conventional hydrogeologic testing techniques will be applicable at the Nevada Test Site. The testing conducted to date in the saturated zone does not indicate whether or not conventional testing techniques will be appropriate. The testing techniques could prove adequate but the analytical techniques for analyzing the data may prove inadequate for evaluating data derived from this testing; nonunique analyses may result. Conventional testing techniques must be applied with discretion and cognizance of the fact that the testing techniques may be inappropriate. Testing techniques must be evaluated before, during and after their use at a test site.

The CDSCP assumes implicity that one or possibly two test sites in the saturated zone will be adequate for characterizing the groundwater flow properties along the most probable fastest pathway to the accessible environment. This assumption is not warranted. Additional test sites will be required unless the two test sites happen to characterize the groundwater flow properties along two separate groundwater flow paths. In addition, these sites must be capable of characterizing the hydrogeologic properties between the repository block and the accessible environment which is 5 kilometers wide. It is highly unlikely that this assumption is valid. Additional testing of the site will be required to define the hydrogeologic properties adequately within the saturated zone. In addition, an adequate distribution of values for individual hydrogeologic units will not be possible with two test sites. Additional test sites will be required to provide reasonable assurance that the appropriate range of values has been quantified for the hydrogeologic properties.

Conclusions

We believe that assumptions are inherent in the CDSCP that are not stated or explained explicitly. We have outlined the major assumptions in this

category that are apparent at this time. We will continue our review of the assumptions that are implicit in the CDSCP. We believe that these assumptions should be reviewed and evaluated in order to determine whether or not the appropriate action has been outlined in the CDSCP to verify the validity of these assumptions. We will continue to update this analysis as our thoughts develop on this subject.

Please call us if you have any questions regarding this letter.

Sincerely,

Roy Williams/sl

Roy E. Williams

REW:sl

cc: D.L. Chery, Jr.