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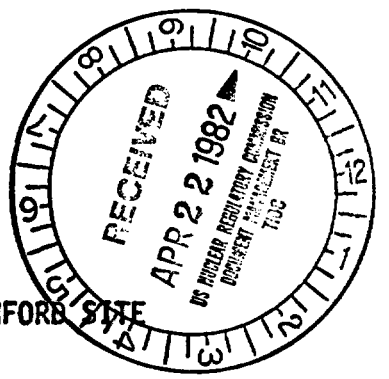

SUBJECT: STRATEGY FOR SENSITIVITY ANALYSIS ON THE HANFORD SITE

Attached is the Strategy for Sensitivity Analysis on the Hanford Site. This fulfills Operating Plan Milestone 311446.

ORIGINAL SIGNED BY

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STRATEGY FOR SENSITIVITY ANALYSIS ON THE HANFORD SITE

One of the proposed tasks for the performance assessment staff during the next six months is a sensitivity analysis on hydrologic parameters at BWIP. The purpose of the work is two-fold: to fulfill our obligations for review of the performance assessment section of the SCR, and to aid the BWIP team in evaluating the validity of the proposed flow field. Also, the use of sensitivity analysis will provide further understanding of the potential for flow from deep basalt units to discharge to the Columbia River.

In order to explain the need for the work and the choice of parameters, a brief explanation of the work done to date and its relation to the BWIP team is necessary. Work done by the performance assessment staff has concentrated on an analysis of groundwater flow patterns at the basalt site. This has included developing a three-dimensional finite difference grid for the Pasco Basin and then comparing the boundary conditions of Rockwell Hanford (RHO) and Pacific Northwest Laboratories (PNL). For a description of these analyses, the reader is referred to the report: Comparison of Model Studies - The Hanford Reservation, Lehman and Quinn, April 1982. The results of the studies have shown several areas where additional work is necessary to define the system. The work has also provided input to the development of the site issues discussed in the BWIP trip reports. The modeling studies will continue to be used in the analysis of the BWIP site suitability issues outlined for site characterization review.

The work will provide a study of the model's sensitivity to changes in the vertical to horizontal conductivity ratio and to the boundary conditions. This portion of the work will be done on the current three-dimensional gridding system. The effect of varying radionuclide transport parameters will be determined using a simplified pipe flow model.

The plans for this work are similar to recommendations of Rockwell given in their most recent modeling study - Pasco Basin modeling and Far Field Radionuclide Migration Potential - RHO-BWI-LD-44. In this document they recommend that a sensitivity and parametric analysis be conducted at a Pasco Basin scale. This analysis would include a sensitivity analysis of hydraulic conductivity (including anisotropic ratios), effective porosity and boundary conditions.

By conducting these analyses, we should be paralleling the Rockwell effort while maintaining an independent capacity to conduct the investigations.

Ratio of Vertical to Horizontal Conductivity

An important parameter to consider in the sensitivity anlaysis is the ratio of horizontal to vertical permeability. Currently, there are ranges of horizontal conductivity values for various portions of the stratigraphic section. Although the ranges are large (greater than 4 orders of magnitude), they do provide some bound for expected values of the interbeds, interflows and dense basalts in the three formations.

In contrast, there are no measurements of vertical conductivity for any of the beds. Some estimates have been used, but no reliance can be placed on these values without some field verification. The columnar fracturing of the dense basalts could produce significant amounts of vertical flow but the amount has not been quantified. There is also disagreement between the PNL modeling assumptions and the RHO modeling work on their choice of ratio. RHO uses an overall ratio of 10^{-4} although they note that 10^{-3} might be more consistent with field information. PNL varies the ratio spatially depending on the structures, suspected degree of fracturing and information from transmissivity maps.

The analysis of the K_v/K_h ratio will have several aspects. First, the ratios in the three formations will be varied by formations to see the effect on the flow field. This work will be done using both PNL and RHO boundary conditions, although the effort will be concentrated on RHO values. One useful measure of comparison will be to show what ratio would be necessary to redirect flow to the river. Some preliminary analysis (Comparison of Models, Lehman and Quinn) do show flow going toward the river in the K_v/K_h ratio is increased.

The second phase will be varying the ratios by hydrostatigraphic unit. The current NRC layering system divides the formations into the various hydrostratigraphic units interflows, interbeds, and dense basalts. The dense basalt units appear to contain most of the vertical flow. By varying the ratio in the different layer types individually, we will gain some understanding about the reasonableness of the composite K_v/K_h. We will not get a unique solution in the system: if K_v for the Umtanum unit is a certain value then flow must go to the river. However, we will gain

some range of values which, under the qualifying assumptions, would give such a flow path.

Finally, the ratio will be varied spatially to reflect the structures and suspected degree of fracturing. This has already been included in analysis of PNL's work since a spatially variable ratio was an initial assumption on their model. However, these changes were not included in the RHO analysis. One portion of this work will include changing the ratio in the river node blocks. This will allow simulation of the proposed fault or structural weakness along the river (Geochemical Interpretations of Groundwater Flow Systems in the Central Columbia Plateau, Lehman & Quinn, February, 1982).

The results of this task will be particularly useful in the issue analysis at the BWIP site. The need to determine the vertical conductivity of the dense basalt units has been stated by many groups including: NRC, PNL and the RHO Hydrology Overview Committee. This value is important because it affects not only the travel time but the direction of flow. However, no studies have determined the effect of changing the conductivity values on Rockwell's flow path. By determining the changes in flow direction, we can quantify the importance of the parameters and determine the value range which would be acceptable.

Analysis of Boundary Conditions

The choice of boundary conditions is a principal area of disagreement between the RHO and PNL modeling studies. Major differences in the choice of pressure head occur in the northern and northwest section of the Pasco Basin. Differences in downhole pressure distribution occur

along the eastern and southeastern boundaries. The largest difference occurs along the northwest boundary where RHO has assigned 1099 feet of pressure head while PNL assumes a no flow boundary. At present we feel these high pressures combined with the constant gradient in the southeastern section of the flowpath control the particle streamlines.

Although we would not expect identical boundary conditions for the two models, the ranges seen in the two simulations are unreasonably large. One method of testing these values would be to develop a regional model to predict the head measurements at the boundary of the Pasco Basin. However, given the time and information constraints we do not feel an in house development of this work is justified.

To refine our understanding of the system we will vary the pressures at the boundaries. All the changes will be intermediate between the two proposed flow systems. This analysis will help determine which portions of the model have large uncertainties and appear to be controlling flow. The analysis will also show how much change in the boundaries is required to significantly divert the flow path.

Both the changes in conductivities and the changes in ratios will be performed as a steady-state three-dimensional analysis. This is to allow evaluation of changes in flow path. Use of a two-dimensional model for this work would not allow as thorough an analysis of flow path changes.

The proposed analyses do not contain the random selection of input variables associated with sensitivity studies. For example, the Latin Hypercube sampling program will not be used. This reflects the site specific nature of the current study. Random selection of parameters or

endless repetitive runs are not necessary when our problem areas are already well defined.

Two-Dimensional Analysis

Some sensitivity analysis will be performed using NWFT/DVM to obtain a preliminary understanding of the effect of various transport factors including Kd, solubility limit, dispersivity, porosity and leach time. This work serves a dual function since it is also being performed to evaluate the relationship of the EPA standard to the requirements of 10 CFR Part 60. The flow path for this analysis will not be varied; it is assumed that the nuclides will travel vertically to an aquifer and then travel horizontally to the discharge point. The horizontal pathlength to the discharge point is 1 mile. The composite layering used will be consistent with that provided in the Sandia draft report - "Technical Assistance for Regulatory Development: A Simplified Repository Analysis in a Reference Basalt Site," Pepping, Chu and Siegel, 1982.

The variables will be input as distributions. The values for the runs will be chosen randomly through use of the Latin hypercube sampling technique. These vectors will then be run in NWFT/DVM to simulate flow through the basalts to the discharge location. Output will be given in terms of discharge rate and EPA release fraction. This work will not be an evaluation of the site against the EPA standard. It is intended to show the relative importance of various transport parameters.

Products of the Sensitivity Analysis

I. Summary of the results of the K_v/K_h analysis.

II. Summary of the results of the boundary condition analysis.

III. Summary of the results of the two-dimensional analysis.

All work is expected to be completed before receipt of the Site Characterization Report for BWIP. The exact completion dates will depend on the staff commitments required to fulfill the other analyses outlined in the performance assessment plans for site characterization analyses (March 2, 1982 memo) and requested by the WMHT branch.