U.S NUCLEAR REGULATORY COMMISSION
DIVISION OF WASTE MANAGEMENT

BWIP CONCEPTUAL MODEL UPDATE

Basalt Waste Isolation Project
Subtask 3.4

Prepared by

Terra Therma, Inc.

for

Nuclear Waste Consultants

TECHNICAL ASSISTANCE IN HYDROGEOLOGY
PROJECT B - ANALYSIS
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TERRA THERMA, INC.
WATER CONSULTANTS AND ENGINEERS
8341 S. Sangre de Cristo Rd., Suite 14, Littleton, CO 80127 (303) 973-7492

May 1, 1987

Nuclear Waste Consultants
8341 S. Sangre de Cristo Road
Littleton, Colorado 80127

Att: Mark Logsdon, Project Manager

Re: Subtask 2.4 Update

Dear Mr. Logsdon:

Please find attached the Subtask 2.4 Update (Conceptual Model) as required by the Technical Assistance contract. Terra Therma has used the results of Subtask 2.5 analyses to support or modify previous observations concerning the BWIP conceptual model.

The attached document concentrates on the areas of potential vertical leakage, hydraulic continuity across the RRL, hydraulic gradients, and boundary conditions. These issues are discussed within the framework of the five categories first proposed in the initial conceptual model report.

If we can provide any additional information or clarification, please do not hesitate to call us.

Sincerely,
TERRA THERMA, INC.

Michael Galloway

Michael Galloway
Project Manager

ATT

1.0 INTRODUCTION

As in the previous semi-annual Conceptual Model Update report (October, 1986), the five categories first proposed in the initial Conceptual Model report will be used as an outline to describe ongoing anaylses of various model issues. Although developed over one year ago, the concepts, as defined by the five categories, remain relevant and extremely useful in defining a BWIP conceptual model. The five categories are listed below:

1. Framework - Includes the rigid structure within which the processes occur.

2. Parametric Data - Includes the hydraulic characteristics of the framework.

3. Boundary Conditions - Includes the nature and geometry of the model's boundaries.

4. Stimuli - Include any number of processes, such as aquifer testing, drilling, and repository placement which create a hydraulic stress in the conceptual model.

5. Responses - Include various reactions to the stimuli described above, such as observed hydraulic heads and some aspects of hydrochemistry.

In this update, the results of ongoing Subtask 2.5 analyses which modify or support previous concepts of the BWIP model will be discussed. However, the bulk of the conceptual model as reported in the initial Subtask 2.4 Conceptual Model document remains unmodified at this time, pending the generation of additional site characterization data at the BWIP site.

2.0 FRAMEWORK

In general, the nature of the framework at the BWIP site remains unmodified, since relatively little information has been generated. However, reevaluation of existing parametric data and the recent acquisition of the RRL-2C completion report, suggests that the nature of vertical features within the framework can be further evaluated. At the time of the initial conceptual model report, BWIP testing had not specifically addressed vertical leakage, and it was considered an unresolved issue. Although formal testing to address this issue has not been performed at BWIP, evaluation of head responses as a result of drilling indicates that vertical communication between interflow zones may locally be quite high. The parametric aspects of this question will be discussed in the next section.

Based on visual observation of basalt outcrops, the occurrence of vertical heterogeneous features within the flow interiors has been documented for some time. However, the nature and occurrence of these features at depth within the RRL vicinity has remained an unresolved issue. The conclusions drawn from the initial evaluation of the effects of drilling and testing, as reported in Terra Therma (TTI), 1986a, 1986b, and 1987a, indicate that vertical leakage between adjacent interflow zones may locally be significant, suggesting the existence of local, relatively high permeability features within the flow interiors.

Additional evidence supporting the concept of local areas of high vertical communication are analyses of the piezometer responses during drilling, testing, and well development (Golder and Associates, 1987) and conclusions regarding the hydrochemistry of the BWIP site (Davis and others, 1987).

The exact nature of these features, from a framework perspective, is unknown. They could represent basalt formation irregularities which control the density of fracturing (fanning entabulature, spiracles, breccia, and flow interior thickness irregularities), contemporaneous structural zones of weakness (collapse features), or more recent tectonics (faulting and fracturing). It should be kept in mind, however, that the issue of vertical communication (due to incomplete seals) is not yet fully resolved, since intra-borehole communication has not been completely ruled out.

3.0 PARAMETRIC DATA

Little new information has been made available from which to assess previously reported conclusions regarding the parametric data. Reevaluation of existing information, however, has led to several qualitative conclusions regarding horizontal and vertical hydraulic conductivity. The preliminary conclusions of Terra Therma (1987a) are listed below:

1. The Priest Rapids appears to exhibit lateral hydraulic continuity across the RRL and vicinity.

2. Hydraulic responses were observed in the Grande Ronde over large distances, but the data is insufficient to assess the overall lateral continuity.

3. The Cohassett interflow in the vicinity of RRL-14 and RRL-17 may have relatively high transmissivity.

4. Vertical hydraulic communication in the Grande Ronde near DC-20C is significant (either from formation leakage or poor borehole sealing).

Recent acquisition of the drilling and completion report for RRL-2C (Jackson, 1986) could lead to further analyses of hydraulic responses observed in flow interior piezometers during development of adjacent interflow piezometers. This could provide more quantitative conclusions regarding vertical hydraulic conductivity of flow interiors. After our initial reading of the document, it appears that vertical communication between adjacent interflows, within the borehole or within the formation, is significant.

4.0 BOUNDARY CONDITIONS

With respect to specific hydrologic boundaries, little can be added to what has been stated in previous documents. However, Terra Therma (1987d) has attempted to clarify to what extent boundary conditions are significant to the BWIP site. The preliminary conclusions are that the distance to any given boundary from the RRL is directly proportional to the hydraulic head variation required to produce a significant effect on the gradients within the RRL. In other words, at a distance of 10 km from the RRL, a head variation of 10 meters or greater would be required to produce a significant effect (+/- 1 m head difference) at the RRL. This suggests that gradients in the RRL are not very sensitive to boundary conditions which are more than a few kilometers away, within the range of known uncertainties in head measurements.

5.0 STIMULI

Stimuli which have been discussed in the initial Conceptual Model report, such as documented short-term stimuli (drilling, well development, and small-scale testing), have been used to test various aspects of the conceptual model, as described above. Other possible stimuli, such as thermal effects of repository placement, have been the subject of several Subtask 2.5 analyses in an attempt to understand the significance of this type of mechanism.

Terra Therma (1987c) concludes that repository heat will have a significant affect on the groundwater flux through the repository, increasing the flux by an order of magnitude over the pre-emplacement value. Also, the residual heat will persist for a relatively long time-period, making the flux calculation significant with respect to the 10,000 year criterion. However, further analyses are needed to determine the significance of predicted flux rates with respect to the 10,000 year criterion. Initial indications are that the post-emplacement flow rate through the repository is on the order of gallons per minute or less.

6.0 RESPONSES

Hydraulic responses to the short-term stimuli have been noted and/or discussed in the sections above. Longer-term responses, such as hydraulic heads and horizontal and vertical gradients were discussed in the initial conceptual model report and have been the topic of subsequent Subtask 2.5 analyses (Terra Therma, 1986c and 1987b). These reports address the issue of stabilization of the heads and gradients with respect to "baseline" conditions. The major conclusions of these analyses indicate that the present head and gradients are representative of "baseline" conditions and further stabilization will not result in a significant reduction in the uncertainty concerning this data.

7.0 CONCLUSIONS

The primary conclusions resulting from the various Subtask 2.5 analyses that influence the BWIP conceptual model are listed below.

1. If it is assumed that the various observed hydraulic responses are not due to poor sealing within the boreholes, then it is likely that significant vertical leakage exists in the areas of DC-20C and RRL-2C. This suggests that the heterogeneous features existing within basalt flow interiors may be hydraulically significant.

2. Hydraulic responses due to drilling and testing suggest that lateral hydraulic continuity within the interflow zones is maintained across the RRL. This is verified for 3 interflows where sufficient data exists.

3. Initial analyses suggest that repository heat will be a significant factor in determining the total groundwater flux through the repository. It is not known at this time whether the resulting flow rate through the repository is significant with respect to the 10,000 year performance criterion.

4. Observations concerning vertical and horizontal hydraulic gradients which were included in the initial Conceptual Model report appear to be valid with respect to pre-emplacement baseline conditions.

REFERENCES CITED

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