WM Record File 101

WM Project 70
Docket No.
PDR ✓
LPDR ✓

101
~~3101.5/MG/85/07/02/0~~

Distribution:
JUL 03 1985

(Return to WM, 623-SS)

DISTRIBUTION w/o encl.
~~WM 3101.5~~ (w/encl.)
WMGT rf
NMSS rf
RBrowning
MBell
JBunting
MKnapp
MGordon & rf
MFliegel
JGreeves
MNataraja
PDR

MEMORANDUM FOR: John Buckley
Rock Mechanics Section
Engineering Branch
Division of Waste Management

FROM: Matthew Gordon
Hydrology Section
Geotechnical Branch
Division of Waste Management

SUBJECT: DRAFT FINAL REPORT - BASALT WASTE ISOLATION PROJECT: HANFORD SITE DISQUALIFYING CONDITION - PRELIMINARY POSITION FOR REPOSITORY WATER INFLOW UNDER HIGH PRESSURE SEPTEMBER 1984

As you requested, I have reviewed the hydrologic aspects of the subject report by R.D. Allen of PNL. My comments are summarized below:

1. The document presents three "back-of-the-envelope" calculations (which the author calls a "numerical analysis") of instantaneous water inflows into a tunnel beneath the Hanford site. These calculations are based on questionable assumptions and, in one case, an incorrect mathematical model. The calculations will likely lead to underestimates in initial water inflow. However, they may overestimate the longer-term inflow rate, as noted by Allen on page 5.7.

2. The document presents a summary of parameter values for hydraulic head, hydraulic conductivity, and storativity of the various aquifers and confining units, which are based on optimistic interpretations of unreliable data. As noted in NUREG-0960, and in Coleman and Gordon (1984, attached), the heads and hydraulic property data collected during the BWIP drill and test program reflect, at best, the conditions in the immediate vicinity (i.e., tens of meters) of the borehole. Higher conductivity zones, channels, etc., are not likely to have been detected in these tests. The measurements are further confounded by the effects of fluid temperature, wellbore skin, wellbore storage and irregular testing procedures as noted in Coleman and Gordon (1984). There are also several cases of incorrect analytical interpretations of hydraulic tests, particularly in the Strait and Spane reports listed in the document's reference section. For example, the report on hydraulic testing of the Cohassett colonnade/entablature at RRL-2 has been reviewed by NRC (Gordon, 1984, attached) and was found to probably underestimate the horizontal hydraulic conductivity of that unit by at least an order of magnitude.

OFC	:WMGT	:WMGT	:	:	:	:	:
NAME	:MGordon/tl	:MFliegel	:	:	:	:	:
DATE	:85/07/02	:85/07/	:	:	:	:	:

1474

Other tests were also analyzed incorrectly, e.g., the over- pressure pulse test of the Cohassett flow top. For this test, an incorrect application of the analytical method apparently resulted in an under-estimate of the hydraulic conductivity by a factor of twenty. These reports have never been corrected by BWIP. Due to the uncorrected analytical errors and the uninvestigated uncertainties, the test results should not have been used in the subject report. It would have been more appropriate to use a bounding value of horizontal hydraulic conductivity slightly higher than the highest measured values to date.

3. A two-order-of-magnitude uncertainty in the hydraulic conductivity is claimed to have been assumed in the "numerical analysis"; This uncertainty does not seem to be reflected in the three "cases" analyzed. In any case, the uncertainty range described should be substantially larger than two orders of magnitude for the reasons noted in item 2 above. In fact, the actual systematic error in analysis, by itself, probably approached two orders of magnitude without even considering the uncertainties in scale, spatial variability, etc.

4. On page 4.11, estimates from uncited "earlier studies" of vertical hydraulic conductivity are presented. There have been, to my knowledge, <u>no</u> acceptable direct tests nor indirect interpretations of vertical conductivity to date. Thus, there is currently no basis for evaluating potential inflow into the roof or floor of the tunnel in the presence of a vertical gradient, unless DOE can develop a supportable bounding estimate of vertical conductivity.

5. The ambient horizontal hydraulic gradient is estimated to be in a range of 10^{-4} to 10^{-3}. However, the method used to calculate hydraulic gradients is faulty and non-conservative, as we noted in our comments on the draft BWIP EA (comment no. 6-15). Also, gradients higher than 10^{-3} can be inferred, even based on the faulty method (see comment no. 6-15 from NRC's Draft EA review.)

6. On page 3.4 the units given for hydraulic conductivity (m/day) should apparently be (m/sec). The factor of 3.1 in each of the estimates suggests that the values were obtained by converting order-of-magnitude estimates in terms of feet/sec to meters/sec. Assuming standard rounding procedures were used (5 or above rounded up, below rounded down), this could cause an additional error of up to a factor of five in the estimates of hydraulic conductivity.

7. It is indicated in the document that any aquifer would be incapable of supplying the calculated potential flow rates (page 5.6). The potential

OFC	:WMGT	:WMGT	:	:	:	:	:
NAME	:MGordon/tl	:MFliegel	:	:	:	:	:
DATE	:85/07/02	:85/07/	:	:	:	:	:

for local connections between aquifers has not been considered in reaching this conclusion. Recent data collected at the Hanford site appears to indicate strong vertical connection between the Rocky Coulee and Cohassett flow tops at RRL-2C. While this observation may be an anomaly, it is possible that such vertical connections exist at other locations. Also, there may be other high-conductivity zones present, such as the fracture zone encountered in the Umtanum interior at RRL-2C. These vertical connections and high conductivity zones might provide an increased water supply to allow sustained high water inflows into a tunnel.

8. In cases I, II, and III on pages 5.5 and 5.6, it is not clear how the numbers used for fracture and aquifer properties were derived. The numbers used for fracture properties appear to be fairly conservative compared to data in Long and WCC (1984). The 800 ft. head difference between the aquifer and the open tunnel does not appear unreasonable. However, the condition of a 40 meter distance between the aquifer and the tunnel would not likely be present for the host rock units being considered.

9. For case 3, where the tunnel is assumed to intersect the Cohassett flow top, a one meter distance over which the head drop occurs and Darcian flow is calculated is assumed, apparently to avoid the infinite head gradient that occurs mathematically at the discontinuity in head. This is an inappropriate mathematical model for this scenario. A more appropriate model would be one of the type described by McWhorter (1981); a discussion by Walton (1982) of this type of analytical model is attached.

10. The concept of transient decay of inflow presented on page 5.7 appears to be reasonable; however, the calculated rate of decay and quantity of inflow is impossible to evaluate without more information about the boundary conditions and hydraulic properties assumed. (The McWhorter (1981) analytical solutions attached are appropriate for transient analysis.)

I hope that these comments are useful for your intended purpose. Please call me (427-4438) if you have any comments or questions.

/s/

Matthew Gordon
Hydrology Section
Geotechnical Branch
Division of Waste Management

Enclosures: as stated (already in PDR)

FC	:WMGT	:WMGT	:	:	:	:
AME	:MGordon/tl	:MFliegel	:	:	:	:
ATE	:85/07/02	:85/07/	:	:	:	: