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O. L. Olson, Project Manager
BWIP Project Office
U.S. Department of Energy
Box 550
Richland, Washington 99352

Dear Mr. Olson:

During the June 12-13, 1984, workshop on BWIP hydrology, the BWIP group commented that: "The hydrologic characterization program described by the BWIP meets the intent of NRC STP 1.1." Somewhat in contrast, the NRC staff commented that: "Based on presentations during the workshop, we consider that the current testing strategy is consistent with the objectives of STP 1.1., with the following significant exceptions:

1. Lack of an adequate test program for RRL-2B (i.e., testing only two intervals in a limited time period concurrently with shaft construction may be inadequate).

2. Lack of facilities for characterization of hydraulic responses near the pumping well RRL-2B (i.e., lack of monitoring and observation opportunities in RRL-2).

3. Existing bridge packer installations in RRL-6 and RRL-14 fail to take advantage of multi-level monitoring opportunities within the RRL.

4. No description has been provided of how BWIP will take advantage of existing monitoring opportunities outside of the RRL (i.e., other holes with bridge packers and other holes not mentioned).

5. A strategy for hydrologic boundary evaluation, including wells and intervals to be tested, has not been delineated.

6. A strategy for field measurement of vertical permeability, including wells and intervals to be tested, has not been delineated.

7. A strategy for definition of possible transport pathways (i.e., hydraulic continuity), including wells and intervals to be tested, has not been delineated."

Since the workshop, we have examined (with the aid of contractors) the significant exceptions noted above. In particular, attention was given to the possible impact of the exceptions on the satisfaction of future licensing needs. Enclosed you will find a discussion of this matter, "Follow-up Comments

(*See previous concurence)

OFC	:WMRP:ec	:WMRP WR	:WMGT NC	:WMGT MG	:WMGT	:WMGT RJS for	:WMRP
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on June 1984 DOE/NRC Hydrogeology Workshop." The two principal conclusions are found beginning on page 1. In summary they are:

(1) The modified testing and monitoring program does not fully meet the intent of STP 1.1 in that sufficient and accurate measurements of hydrogeologic parameters may not be obtained, and hydrogeologic discontinuities may not be identified on a representative scale.

(2) Our concerns about BWIP's failure to delineate strategies for testing of certain parameters and conditions might be dispensed with upon receipt of more detailed information regarding test plans.

On a related matter, in open item #1 of the Summary Meeting Notes to the June, 1984 workshop, NRC offered to provide written comments on SD-BWI-TC-016, "Drilling, Piezometer Design, and Testing Specifications for the DC-19, DC-20, and DC-22 Borehole Clusters and RRL-2B." We consider this older document (Dec. 83) to be superseded by BWIP's presentations during the workshop, and that our attached comments address issues relevant to the piezometer installation and testing.

If you have any questions, please contact the authors of the attachment--Neil Coleman (FTS 427-4131) and Matthew Gordon (FTS 427-4438).

Sincerely,

ORIGINAL SIGNED BY

Robert J. Wright, Senior
Technical Advisor
Repository Projects Branch
Division of Waste Management

Enclosure:
Follow-up Comments on DOE/NRC
Hydrogeology Workshop

Record Note: This has been coordinated with Knapp, Coleman, & Gordon. R. Wright discussed this with Mr. Browning

(*See previous concurence)

OFC	:WMRP:ec	:WMRP	:WMGT	:WMGT	:WMGT	:WMGT	:WMRP
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FOLLOW-UP COMMENTS ON JUNE 1984 DOE/NRC HYDROGEOLOGY WORKSHOP

1.0 Background

In July 1983, a general agreement was reached between NRC and BWIP regarding a testing approach appropriate for partial hydrogeologic characterization of the BWIP site. The summary of general understandings reached during the July 1983 workshop is attached (Attachment 1). On the basis of discussions during the July 1983 Workshop, the NRC developed a Draft Site Technical Position (STP 1.1) on a hydrogeologic testing strategy for the BWIP site. The intent of STP 1.1 (1983) is to guide BWIP on a general approach to testing that is appropriate to develop and acquire information needed for licensing.

During the June 1984 NRC/BWIP Hydrogeology Workshop, BWIP presented an updated description of the status of and plans for hydrogeologic monitoring and testing at the BWIP site. The presentations indicated that substantial progress had been made toward implementation of the testing strategy discussed during the July 1983 meeting. In particular, the nested piezometers in boreholes DC-19C, DC-20C and DC-22C had been installed with reasonable success, and the hydrologic baseline monitoring had begun. In addition, the feasibility of the planned large-scale hydraulic stress (LHS) tests was clearly demonstrated by observations of drawdowns in DC-16B, DB-14, and DC-1 during air-mist drilling of the cluster "C" holes. Throughout this document please refer to Figure 1 which illustrates, relative to the boundaries of the Reference Repository Location (RRL), the locations of most of the boreholes discussed in this letter.

BWIP also pointed out during the June 1984 workshop those areas where the updated program diverged from the July 1983 program. BWIP indicated in its summary comments (Attachment 2) that they considered the modified program to meet the intent of STP 1.1.

2.0 Conclusions

NRC noted in its summary comments on the workshop (Attachment 3) seven significant exceptions in the modified strategy to the understandings reached during July 1983, as well as several additional areas of concern. NRC has evaluated the potential impact of these exceptions on the satisfaction of future licensing information needs with regard to BWIP site hydrogeologic characterization. From this evaluation we have reached the following conclusions:

1) We consider that the modified testing and monitoring program does not fully meet the intent of STP 1.1. In particular, we consider that the scheduling of LHS tests concurrent with Exploratory Shaft (ES) drilling, as well as the lack

of deep monitoring opportunities in DC-23 (presently undrilled), RRL-2, RRL-6, RRL-14, and elsewhere both on and off the Hanford Site, may significantly diminish BWIP's ability to obtain sufficient and accurate measurements of hydrogeologic parameters, and to identify large- and small-scale hydrogeologic discontinuities which may control groundwater flow and radionuclide transport from the repository. Also, we question whether three monitoring sites are sufficient to establish a hydraulic head baseline for the RRL, let alone the Hanford Site. The suggested monitoring network described in STP 1.1 would have included more than 20 monitoring sites (DC-1,2,3,4,5,6,7,8,12,16(A & C),18,19,20,22; 57-83 (now DC-23); RRL-4,6,14; McGee cluster; and DC-X (no well number assigned) -- STP 1.1, p. A-4)(Exception #4).

2) Several of NRC's concerns, specifically those which relate to BWIP's failure to delineate strategies for testing of certain parameters (e.g., vertical hydraulic conductivity) and conditions (e.g., presence of structural or stratigraphic hydrogeologic boundaries), might be dispensed with upon receipt of more detailed information from BWIP regarding their test plans. However, until these important strategies are delineated in detail (i.e., at a minimum, indicating holes and zones to be pumped, pumping rates, and holes and zones to be monitored), NRC is unable to evaluate whether or not BWIP's updated program fully meets the intent of STP 1.1 in those particular respects.

The bases for these conclusions is provided below. Our technical comments further address our preliminary review as provided in the Summary Meeting Notes, NRC comments (Attachment 3). In particular, discussions pertaining to the seven significant exceptions outlined in Attachment 3 under Evaluation of Testing Strategy are identified as follows: Exception # 1, Exception #2, etc.

3.0 Technical Comments

3.1. Concurrent LHS Testing and ES Drilling.

As currently planned by BWIP, initial large-scale hydraulic stress (LHS) testing will occur while the Exploratory Shaft (ES) is being drilled (BWIP presentation in Hydrogeology Workshop, June, 1984)(Exception #1). As discussed during the July, 1983 Workshop, a careful evaluation should be made of the potential perturbing effects that shaft sinking may have on concurrent LHS testing results. As stated by BWIP in the Summary Meeting Notes (June 1984) (Attachment 2), BWIP comment #8, "The potential for interference between Exploratory Shaft (ES) drilling and LHS test interpretation will be evaluated." However, neither the evaluation nor the methodology for performing this evaluation has yet been provided by BWIP. The NRC staff considers that, at

this stage in the BWIP program, this issue should be quickly and clearly resolved.

NRC's principal concerns about concurrent shaft construction and LHS testing are summarized below:

a. Reliable baseline measurements of hydraulic heads near the proposed shaft location are not available. Such data could be used to identify head changes caused by shaft construction.
b. Hydraulic heads can be perturbed by the infiltration of drilling fluid into the adjacent formations during the period of shaft boring. Infiltration would likely occur if an effective filter cake (i.e., a seal formed by mud and lost circulation materials) fails to form along the sides of the borehole.
c. Hydraulic head perturbations may also occur as a result of vertical interconnection of aquifers along a leaky shaft seal. This could possibly occur during later phases of ES construction and could affect concurrent LHS tests, especially those involving pumping from RRL-2B.

The NRC staff believes that BWIP should seriously consider the advantages of completing LHS tests prior to emplacement of the ES. This would preclude any potential impacts of shaft drilling on the LHS data. The early test results are especially important in planning subsequent tests for evaluation of hydrogeologic boundaries.

3.2. BWIP's Proposed LHS Monitoring Program Changes.

The NRC staff is concerned that important hydrologic monitoring opportunities have been overlooked in the proposed monitoring program. This is especially true of RRL-2 which is near the ES and RRL-2B (Exception #2). The latter well is proposed as the principal pumping well for the initial LHS testing, and drilling is scheduled by BWIP to begin in November of 1984. Aquifer parameters determined from drawdown data in RRL-2 would provide useful information characteristic of the heart of the RRL and in close proximity to the ES. This could provide important additional information regarding conditions related to potential water influx to the In-Situ Test Facility within the candidate horizon. There exists the possibility of anomalous hydraulic characteristics in the Umtanum Basalt in the vicinity of RRL-2, where a significant thickening of the flow top was discovered. On page 6 of SD-BWI-TC-001, BWIP investigators predicted prior to the completion of RRL-2 that, on the basis of regional trends, the Umtanum Flow Top thickness would approximate 18 meters. Subsequent to drilling, the actual thickness was reported to be about 45 meters (p. 14 of SD-BWI-TI-113 and p. 122 of SD-BWI-DP-035). This unexpected departure from predicted trends is notable and implies the existence of anomalous local stratigraphic conditions which could significantly influence hydraulic

properties. This possibility can be examined through multi-level monitoring of deep hydrostratigraphic units in RRL-2, including the Umtanum Flow Top. Anomalous conditions in units other than the Umtanum might also be identified in this way.

It would prove especially important to have extensive monitoring capability in RRL-2 in the event that BWIP decides to concurrently perform LHS testing with ES emplacement. We maintain that if shaft drilling is found to induce significant and irregular perturbing effects on RRL-2 heads, then results of concurrent LHS tests would become questionable.

3.3. BWIP's Proposed Piezometric Baseline Monitoring Program.

Baseline data are needed to define general flow directions and the degree of transience of the layered basalt hydrologic system. In addition, the baseline is necessary for successful analyses of the LHS tests.

We are pleased to note new emphasis in the BWIP program regarding proposed instrumental error analyses of the piezometer network, as evidenced by BWIP's presentation of this subject at the workshop. However, we believe that a concerted effort of the BWIP technical staff will be necessary to implement these analyses so that previously stated NRC concerns about the reliability of this data base may be resolved. Our foremost concerns are those relating to transducer accuracy and repeatibility at working depths in the Grande Ronde, and the significant effects, on heads, of fluid density variations within wellbores as a function of fluid temperature, TDS, gases, etc.

The program modifications proposed during the June, 1984 workshop may have a considerable negative impact with regard to knowledge of areal head distributions and trends within the piezometer network. Specifically, the delayed construction of DC-23 and the deferred installation of multi-level monitoring assemblies in RRL-2 and RRL-14 will significantly reduce the total number of head monitoring points in the RRL vicinity (Exception #3). This condition will significantly reduce confidence in the representativeness of the baseline data and will reduce the number of observation points used to monitor the initial RRL-2B LHS tests. This is unfortunate, given that results of the early tests will be important in evaluating subsequent data needs and in planning future LHS testing.

During the July 1983 workshop BWIP recommended that a minimum of three new, dedicated piezometer sites be installed at strategic locations across the RRL. This recommendation was presented under the title "Minimum Number of Sites Required at This Time". The criteria presented at that time by BWIP are quoted below:

"CONSIDERATIONS:

1. A minimum of three sites are (sic) required to determine hydraulic gradients if potentiometric surface is planar.

2. More than three sites are probably unwarranted at this time based on:

   - o Uncertainties
   - o The potential for using testing data from other boreholes to supplement piezometer data and (to) refine potentiometric surfaces."

With regard to BWIP consideration #1, available head data from boreholes RRL-2, DC-16A and DB-11, when compared with data from the dedicated borehole clusters (DC-19C,20C,22C), demonstrate that the potentiometric surface characteristic of the Mabton Interbed in the RRL proximity is significantly non-planar. For example, in comparison to the small intra-unit head differences between the cluster sites (DC-19,20,22), a head difference of approximately 80 meters is reported to exist between borehole DB-11 and the RRL and is attributed to the existence of the so-called Cold Creek structural barrier (SCR 1982). The Priest Rapids member of the Wanapum Basalt also was reportedly affected, raising the possibility that many hydrostratigraphic units are involved. These head differences significantly depart from the relative trends observed in units beneath the RRL.

The NRC staff considers that more than three monitoring points per hydrostratigraphic unit may be needed to adequately characterize groundwater gradients within the Cold Creek Syncline.

BWIP consideration #2 states that more than 3 sites are probably unwarranted based on the "potential for utilizing data from other boreholes". The deferral of construction of DC-18 and DC-23 and delays in installation of multi-level monitoring equipment in RRL-2 and RRL-14 are inconsistent with these BWIP-specified criteria for minimum siting (Consideration #2), especially in view of known anomalous conditions within and near the RRL (Cold Creek barrier, and Umtanum flow top thickening in RRL-2).

With regard to the planned duration of monitoring, it appears that programmatic scheduling was a factor in designating a 1-year period for baseline head measurements. As acknowledged by BWIP during the workshop, it is possible that one year of monitoring may not be sufficient for evaluations of seasonal or longer-term head variations. We wish to reiterate the importance of accurately determining temporal trends in providing a reliable baseline for the interpretation of LHS tests. Undetermined temporal trends, irregular transient

hydraulic changes, and problems introduced by difficulties in accurately evaluating the potentially significant variations in wellbore fluid density present the most serious obstacles to error characterization of the hydrogeologic baseline.

3.4. Bridge Plug Integrity.

Additionally, the NRC staff is concerned about the long-term integrity of bridge plugs and other sealing devices and materials which have been installed in boreholes within the RRL. Failure of one or more bridge plugs or cement seals prior to or concurrent with LHS testing could result in vertical communication via the borehole between hydrostratigraphic units. This could potentially result in observations of heads which do not reflect unique aquifer conditions. The effects of bridge plug failure would be most strongly manifested if failure occurred in a piezometer near the pumping well during LHS testing. Failure of a bridge plug in RRL-2 would create such a scenario. Of considerable concern is the fact that failure of a deeply placed bridge plug would probably go undetected, or at least unconfirmed, until the eventual removal of the entire series of bridge plugs from the affected well.

The NRC staff considers it advantageous to proceed with BWIP's earlier proposed plan (July, 1983) of installing multi-level monitoring arrays in RRL-2 and RRL-14. It would also prove advantageous to consider placing similar monitoring equipment in RRL-6 (Exception # 3). Besides reducing the total number of installed bridge plugs (and corresponding uncertainties about aquifer interconnection via boreholes within the RRL), this would increase the number of available monitoring points. Equipment failures, if any, would more likely be detectable because of active, multi-level monitoring.

3.5. Vertical hydraulic conductivity of aquitards (Exception #6).

A strategy for field measurement of vertical permeability, including wells and intervals to be tested, has not been delineated. An understanding of the magnitudes and of the spatial variation of the vertical hydraulic conductivities of Pasco Basin basalts is necessary for proper evaluation of the Hanford Site hydrogeology. This information will be necessary for demonstrations of compliance with the 1000-year pre-emplacement groundwater travel time requirement of 10 CFR Part 60 and the overall radionuclide release criterion of 40 CFR Part 191. Those demonstrations cannot reliably be approached until representative values of aquitard leakance (vertical permeability) are obtained. Specific plans for determining reliable and representative values of this important parameter were not presented during the workshop and thus cannot be fully evaluated by the NRC staff. Leakage from

both overlying and underlying aquitards should be determined before boundary effects on aquifer responses can be uniquely analyzed (i. e., "upper" and "lower" aquifer boundary conditions should be understood before proceeding to analyze the effects of "lateral" boundaries).

3.6. Hydrologic evaluation of geologic boundary conditions (influenced by structural and stratigraphic discontinuities)(Exception # 5).

Along with the determination of large-scale aquifer parameters, an important goal of the proposed LHS testing program is the evaluation of the properties of hydrogeologic boundaries. A major concern of the NRC staff relates to the lack of a well-defined strategy for evaluating the hydrologic effects of geologic structures within the Pasco Basin. The existing characterization plan, as presented during the 1984 workshop, appears to be primarily designed to investigate boundary conditions on the scale of the Cold Creek Syncline. Based on current understandings of site hydrogeology, significant structural features on this scale include the Umtanum Ridge and Yakima Ridge anticlines, the so-called Cold Creek structural barrier, and the northwesterly extension of the Rattlesnake Mountain anticline. The true nature of the Cold Creek barrier is presently unknown, but its close proximity to the RRL raises the question of whether other analogous, especially undiscovered, features may be present. Attempts to evaluate hydrologic boundary conditions within the Umtanum Ridge/Gable Butte/Gable Mtn. structure will be diminished by the decision to delay drilling of both DC-18 and DC-23. These proposed wells, which would be advantageously situated for monitoring aquifer responses north of the RRL, will not be available during the early LHS testing, nor will long-term baseline data be available for this well. BWIP's decision to delete DC-X (no well # assigned), originally planned for an unspecified location south of the RRL, will significantly reduce the program's ability to evaluate boundary conditions along Rattlesnake Mountain and its apparent subsurface structural continuation to the northwest. The NRC staff considers that it is important to evaluate this potentially significant structural boundary, especially in the area located southwest of the RRL where the Yakima Anticline intersects Rattlesnake Mountain. To evaluate this boundary a possible alternative to constructing a new well could be the placement of multi-level monitoring equipment in the already existing well RRL-6.

BWIP should consider the advantages of utilizing additional monitoring points in existing wells located outside of or on the margins of the Cold Creek Syncline (Exception #4). The monitoring network originally suggested in NRC's STP 1.1 (1984) would help to demonstrate the presence or absence of hydraulic continuity across the perceived margins of the syncline. Such wells could

provide valuable information about the degree of areal isolation of local hydrologic systems.

Proper evaluation of laterally bounded aquifers is partly related to determinations of aquitard permeability. During discharge (pumping) tests the effects of aquitard leakage into the pumped aquifer become more pronounced at late times and over large radial distances from the discharging well(s). Accordingly, it is generally assumed that more reliable estimates of leakage are obtained from observation wells at larger radial distances using later-time data. The placement of the new cluster sites (DC-19,20,22) around the proposed location of RRL-2B is apparently intended to meet this relative distance criterion. However, we are concerned about the potential interfering effects of relatively low-permeability structures which may inhibit lateral aquifer flow. It is possible that the Cold Creek barrier represents such a feature. Such features are likely to influence later time data obtained during pumping tests within the Cold Creek Syncline. The effects of barrier boundaries at lateral distances within the aquifers would promote increased drawdowns in observation wells on the stressed side of the boundaries, opposite in sense from the reduced drawdown effects of leakage. In other words, at large times barriers may reduce or mask the effects of leakage. The effects of undiscovered barriers could thereby lead field hydrogeologists to underestimate the vertical hydraulic conductivities of the aquitards, which would directly lead to underestimates of vertical ground water velocities. Even if the locations of boundaries are well established, lack of knowledge about flow conditions across the boundaries introduces many uncertainties and ambiguities to analyses of aquifer test data. The potential for such a scenario should be evaluated by the BWIP. This discussion points out one example of the kinds of effects which can contribute to the inherent nonuniqueness of pumping test interpretation. The NRC staff recognizes that the practice of interpreting aquifer tests inherently involves a certain degree of ambiguity. However, the degree of nonuniqueness might be reduced by taking advantage of existing piezometers in locations which favor the detection and evaluation of subsurface structures which could influence lateral and vertical groundwater flow.

4.0 Additional Comments.

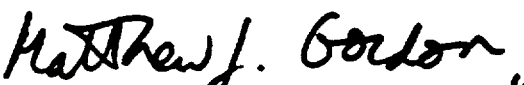
4.1. The test plans proposed by BWIP at the 1984 workshop have all been based on the assumption of classical porous media flow. BWIP should consider tests at various scales and locations to evaluate the validity of the "porous media" assumption for the fractured basalts at Hanford. Methods such as the cross-hole test method described in Hsieh et. al (1983) could be used for this purpose. The potential for groundwater flow and radionuclide transport along preferred paths such as interconnected fractures should be thoroughly investigated by BWIP prior to licensing (Exception # 7).

4.2. Strategies for measuring representative values of effective porosity and dispersivity were not presented during the workshop. BWIP was apparently unprepared to discuss the relevant agenda item referring to the discussion of topics contained in five recent NRC-to-DOE letters. One of these letters (NRC Staff, 1984) was a review of RHO-BW-CR-131 P (Gelhar, 1982), which described an analysis of a two-well tracer test at DC-7/8 and calculated values of effective porosity and dispersivity. Concerns of the NRC staff were presented in that review and should be promptly addressed by BWIP. Failure to obtain representative ranges of values for these parameters would preclude the accurate calculation of solute transport times within the Pasco Basin.

4.3 The construction of the multiple cluster wells at DC-19,20,22 and proposed large-scale hydrologic stress testing potentially represent major steps forward in the hydrologic characterization of the Hanford basalts. However, deficiencies remain in the form of a poorly-defined strategy for boundary evaluation, hydrologic baseline evaluation, and apparent difficulty in obtaining representative values of key hydrologic parameters. These deficiencies were identified during the June 1984 Workshop and have been further addressed above. The programmatic changes in number of monitoring and observation points and the scheduling constraints imposed by the construction of the Exploratory Shaft may make it difficult to resolve these deficiencies in time for licensing review. The NRC staff believes it is essential for our concerns to be addressed by BWIP prior to the initiation of LHS testing or ES construction in order to assure an adequate approach to site characterization prior to licensing review.

OCT. 10, 1984

Neil M. Coleman
Hydrology Section
Geotechnical Branch



10/10/84

Matthew J. Gordon
Hydrology Section
Geotechnical Branch

REFERENCES

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BWIP Staff, 1983. Principal Borehole Report, Borehole RRL-2. RHO BWIP, SD-BWI-TI-113, 95 p.

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DOE/BWIP, 1984. Meeting notes of "Basalt Waste Isolation Project Presentation to NRC on Basalt Waste Isolation Project Hydrologic Characterization Plans/Status", June 12-13, 1984, 157 p.

Gelhar, L., 1982. Analysis of Two-Well Tracer Tests with a Pulse Input. RHO BWIP, RHO-BW-CR-131 P, 15 p.

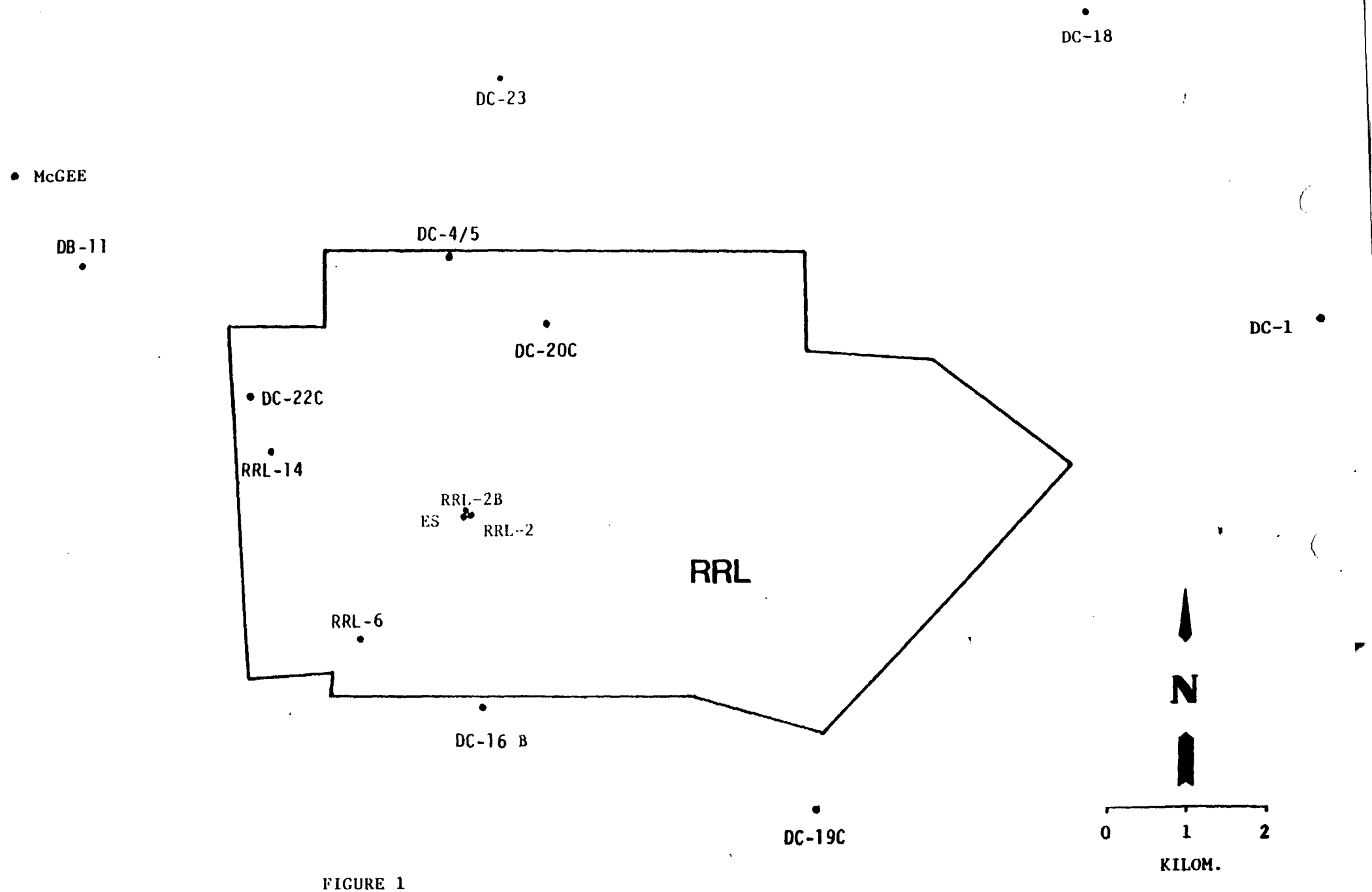
Hsieh, P. A., S. P. Neuman, and E. S. Simpson, 1983. Pressure Testing of Fractured Rocks--A Methodology Employing Three-Dimensional Cross-Hole Tests. NRC NUREG/CR-3213, 176 p.

Moak, D. J. and T. M. Wintczak, 1982. Test Procedure for the Principal Borehole RRL-2. RHO BWIP, SD-BWI-TC-001, 56 p.

NRC Staff, 1983. BWIP Site Technical Position No. 1.1: Hydrogeologic Testing Strategy for the BWIP Site, 12 p. Transmitted to BWIP via NRC letter from Wright to Olson (January 11, 1984), Division of Waste Management, NMSS, USNRC, 4 p.

NRC Staff, 1984. Review of "Analysis of Two-Well Tracer Tests with a Pulse Input", NRC letter from Wright to Olson (April 6, 1984), Division of Waste Management, NMSS, USNRC, 12 p.

FIGURE 1 AND
ATTACHMENTS 1 - 3


DC-18
DC-23
McGEE
DB-11
DC-4/5
DC-1
DC-20C
DC-22C
RRL-14
RRL-2B
ES
RRL-2
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RRL-6
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DC-19C
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FIGURE 1

ATTA MENT #1 TO NRC LTR

BWIP-NRC General Understanding on Testing Strategy July 14, 1983

1.0 GENERAL

1.1 Additional data are required for hydrologic characterization of the Reference Repository Location (RRL).

(a) Continuous head measurements are required.

(b) Large-scale hydraulic testing is necessary.

(c) Small-scale testing should be continued at the designated wells.

(d) Short-duration, low stress interference tests should be continued.

(e) The completion of a pumping well near RRL-2 will provide important information.

1.2 Periodic consultation between DOE and NRC should be continued prior to decision points in the program. These discussions will be held sufficiently early so that any changes that NRC comments may entail can be duly considered by DOE in a manner not to delay DOE activities.

1.3 Hydrochemistry is principally used to confirm groundwater flow systems as determined from hydraulic data.

2.0 INSTALLATIONS

2.1 The proposed large-scale aquifer test facilities are appropriate in number and location.

2.2 The selection of the 9 designated units to be monitored appears appropriate.

2.3 Installation of a pumping well (RRL-2B) near RRL-2 will provide useful information.

2.4 Multiport equipment for specific applications in cored holes should be qualified.

2.5 Cement off only those zones in the Grande Ronde that are necessary for well construction, allowing for maximum potential for future testing.

3.0 HEAD MEASUREMENT

3.1 Plans (as presented) for installing piezometers are appropriate and should be implemented as soon as possible. Specifically, the number, location and air mist drilling methods for the piezometers including use of drilling mud through the Mabton, are appropriate.

3.2 The use of multiple-completion standpipe piezometers for long-term head measurements is appropriate.

3.3 The viewgraph entitled "Validity of Head Data" outlines three approches to correlation of new head data and existing head data. Two of these use data from RRL-2 and DC-16A and involve correlations with interpolated and extrapolated new head data. It is unlikely that these two approaches will be highly convincing in validating the existing head data. Continuing thought should be given to other possible means for qualifying the existing head data.

4.0 LARGE SCALE TESTS

4.1 The initial large-scale test should be performed after initial piezometric data are obtained such that pre-emplacement conditions can be reasonably well-defined.

4.2 The Grande Ronde formation is the primary target for large-scale hydraulic property testing, but the major aquifers in the Wanapum should also be tested.

4.3 The burden of proving the hydraulic continuity of rock units across the RRL cannot be put on hydraulic testing if hydraulic parameters do not allow long distance response (say, 1-3 km). If large scale tests do not work, local-scale tests may be necessary to characterize hydrologic conditions.

4.4 The large scale pump tests may provide opportunities to quality existing horizontal conductivity values. Values from interference tests should be compared with values from earlier single-hole tests.

4.5 The approach to testing presented for the BC-16 borehole cluster test specification seems appropriate.

4.6 The tests proposed under "Large Scale Multiple Well Aquifer Testing" in viewgraph "Major Activities Required for Hydrologic Characterization" may not provide adequate information about the groundwater system near the repository. An understanding of this part of the system is needed to predict pre-emplacement groundwater travel time, as required by 10 CFR 60. The proposed pump test at RRL-2B, and related tests in the RRL, will address this matter.

5.0 MUD EFFECTS

5.1 In investigating possible effects of drilling mud on hydraulic properties, attention should be given not only to high and low permeability units but also to intermediate permeability units - say, 10^{-6} to 10^{-8} m/s.

5.2 The DB-2 test specification should be modified to better simulate drilling conditions.

5.3 Mud loss in boreholes will be reported as cumulative gallons with depth.

6.0 TRACER TESTS

6.1 The two hole tracer tests should be conducted in wells near the RRL. They should include, at a minimum, determination of effective porosity and longitudinal dispersivity.

ATTACHMENT #2 TO NRC LTR

Attachment 4

BWIP COMMENTS

General

1. The hydrologic characterization program described by the BWIP meets the intent of NRC STP 1.1. The BWIP will take under advisement the seven exceptions noted by NRC in their comment #1.

2. BWIP/DOE will provide by early July a schedule and plan to address the comments, questions, and issues identified in NRC letters:

   11/4/83 (Applicability of the Van der Kamp method in slug test analysis)
   3/2/84 (Numerical modeling of parametric uncertainties)
   3/9/84 (Comments on the exploratory shaft test plan)
   4/6/84 (Analysis of two-well tracer tests with a pulse input)
   5/25/84 (Comments on hydrogeologic test data)

Ground-Water Level Baseline

3. Ground-water level data will be collected throughout the BWIP hydrologic characterization program to provide a basis for model calibrations.

4. The BWIP intends to develop criteria for establishing a ground-water level baseline prior to Large-Scale Hydraulic Stress (LHS) Testing utilizing data from as-built facilities (DC-19, DC-20, and DC-22) using the following evaluation tools:

   - parametric sensitivity evaluations
   - corroborative data (e.g., head data, RRL-6, DC-16, RRL-14, etc.)
   - statistics
   - correlations with stress data
   - rate and characteristics of observed change
   - error characterization

5. The piezometer monthly data reports discussed in the BWIP presentation will provide a technical basis for performing the baseline evaluation required for the start of LHS testing.

Large Scale Hydraulic Stress Testing (LHS)

6. Both analytical and numerical parameter identification techniques are appropriate to interpret LHS test results.

7. The new data to be collected will provide a basis for evaluating the quality of existing drill and test data (conductivity and heads).

8. The potential for interference between Exploratory Shaft (ES) drilling and LHS test interpretation will be evaluated.

9. Details regarding the design of LHS tests will be provided to NRC as they are developed.

ATTACHMENT #3 TO NRC LTR

Attachment 5

NRC COMMENTS

1. Current and Proposed Testing Strategy

Objective: (NRC Point of View)

The purpose of the field hydrogeology program is to allow evaluation of the hydrology aspects of repository performance in order to provide reasonable assurance of meeting (or failing to meet) the requirements of 10 CFR 60.

Needs:

To achieve the objective above, the following will need to be evaluated:

- travel times
- fluxes
- radionuclide transport

Modeling Data Needs:

"Predictive modeling of groundwater flow will require:

- defensible conceptual models of the flow system
- defensible boundary conditions
- defensible hydraulic parameters"

(Ref. STP 1.1, p. 3)

General Statement:

"Hydrogeologic characterization of the Hanford Site should rely to the maximum extent possible on direct testing of the hydraulic response of the site to an induced hydraulic stress."

(Ref. STP 1.1, p.4)

Development of Assurance:

"The approach recognizes that direct testing of the groundwater flow system's hydraulic performance subsequently extrapolated to spatial and temporal scales appropriate to licensing assessments is more convincing than is performance modeling without direct testing of the site's hydraulic response."

(Ref. STP 1.1, p.4)

Evaluation of Testing Strategy:

Based on presentations during the workshop, we consider that the current testing strategy is consistent with the objectives of STP 1.1, with the following significant exceptions:

1. Lack of an adequate test program for RRL-2B (i.e., testing only two intervals in a limited time period concurrently with shaft construction may be inadequate.)

2. Lack of facilities for characterization of hydraulic responses near the pumping well RRL-2B (i.e., lack of monitoring and observation opportunities in RRL-2).

3. Existing bridge packer installations in RRL-6 and RRL-14 fail to take advantage of multi-level monitoring opportunities within the RRL.

4. No description has been provided of how BWIP will take advantage of existing monitoring opportunities outside of the RRL (i.e., other holes with bridge packers and other holes not mentioned).

5. A strategy for hydrologic boundary evaluation, including wells and intervals to be tested, has not been delineated.

6. A strategy for field measurement of vertical permeability, including wells and intervals to be tested, has not been delineated.

7. A strategy for definition of possible transport pathways (i.e., hydraulic continuity), including wells and intervals to be tested, has not been delineated.

Evaluation of DC-19, -20 and -22 installations:

Based on presentations during the workshop, we consider that the cluster wells DC-19, -20 and -22 have been installed in a manner consistent with the agreement reached during the July 11-15, 1983 workshop. However, we note that these cluster wells may not provide the data suitable for calculations of vertical hydraulic conductivity.

2. Reasonable Assurance.

BWIP viewgraph "Development of Reasonable Assurance" appears to represent a constructive approach in linking site characterization activities to the level of confidence in system performance. This is needed to identify the level of confidence that is needed to support licensing decisions which are based on "reasonable assurance," as discussed in 10 CFR 60.

3. Measurement of Fluid Potential.

A defensible, consistent method of determining representative formation fluid potential is required. If water levels are used to measure fluid potential, then it should be demonstrated that fluid density effects in the well column are either unimportant or can be evaluated when water level measurements and pressure measurements are correlated and used interchangeably.

4. Monthly Data Package.

We consider the proposed delivery of a monthly hydrologic data package to be a positive development in terms of providing current data for the NRC staff's site characterization review activities.

5. Drawdown Data from DB-14 and DC-16B.

The presentation of hydrologic data from DB-14 and DC-16B during drilling of DC-19C serves as a non-quantitative evaluation that suggests that the hydraulic testing approach of STP 1.1 may be feasible for the hydrogeologic conditions at the BWIP.

6. Concensus on Establishment of Hydraulic Head Baseline.

NRC agrees, in principle, with the four-stage approach suggested by BWIP for development of a concensus on establishment of a static hydraulic head baseline. However, we consider that BWIP has not sufficiently addressed in this workshop's presentations the major task in developing a concensus on baseline head establishment: identifying the magnitude of the "errors in baseline" (see viewgraph "Parametric Sensitivity"), such as those due to limited time data. The estimation of the range of possible error in observed average head or long-term head trend is probably the most difficult task with regard to this issue.

7. Limitations of STP 1.1 in Providing Guidance on All Hydrologic Information Necessary for Licensing.

We consider that the head baseline establishment and the large scale pump tests, as proposed, will not yield the complete set of hydrologic data needed for a licensing review. In particular, certain factors relevant to radionuclide transport (e.g., effective porosity, fracture flow parameters) will need to be addressed through a program supplementary to that described during this workshop. Our position on this matter today is consistent with that stated in Section 2.4 of STP 1.1.

8. Data Quality.

NRC considers that in the development of hydrologic test plans, target data quality needs (i.e., accuracy, precision and frequency of specific data collection) should be established for all testing irrespective of the type of instrument being used. These needs should be related to the objective of the various tests to obtain data in support of identified analytical needs relative to requirements of 10 CFR 60. This is a matter for further discussion during future interactions on quality assurance.

9. Regional Flow System.

Because the BWIP Site Characterization Plan (SCP) is due for release in early 1985, it is necessary for NRC to complete preparation for its analysis

of the SCP by that time. An important part of this preparation is the updating of NRC's groundwater modeling capability for the Pasco Basin. This makes it necessary for NRC to have in hand, no later than January 1, 1985, the regional flow system model (and data) under development by the "interagency hydrology working group." This regional information is essential to the Pasco Basin model, because it is used to set the boundary conditions. To permit its independent evaluation and interpretation of the basic data, it is necessary for NRC to have access to the complete data set used for modeling.